NOISE EXPOSURE, DIABETES MELLITUS AND HYPERTENSION AS PREDICTORS OF HEARING LOSS AMONG ELDERLY PATIENTS IN SELECTED TEACHING HOSPITALS IN SOUTH - WEST, NIGERIA

BY

Olawale OGUNDIRAN

MATRIC NO: 99478

B.Ed., M.Ed. (Ibadan)

A THESIS IN THE DEPARTMENT OF SPECIAL EDUCATION SUBMITTED TO THE FACULTY OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) UNIVERSITY OF IBADAN

AUGUST, 2012

ABSRACT

Hearing loss due to advancement in age is a phenomenon which is universally accepted as one of the challenges of old age. In spite of this fact, there is a paucity of studies on predictors and patterns of hearing loss which should serve as essential basis for developing preventive measures and strategies to reduce or eliminate the causes of hearing loss among the elderly. This study, therefore, investigated noise exposure, diabetes mellitus and hypertension as predictors of hearing loss among the elderly patients in six teaching hospitals in South-West, Nigeria.

The study utilized a descriptive survey design of the *expost-facto* type. Purposive sampling technique was used in selecting the health institutions and 469 elderly patients with hearing loss aged 65years and above were used as participants of the study. Data were collected through audiometers, audiograms, sound pressure level meter and case notes. Three research questions were answered and four hypotheses tested at the 0.05 level of significance. Data collected were analysed using descriptive statistics and multiple regression analysis.

The patients possessed bilateral (92.5%), sensorineural (right ear: 65.7%; left ear: 64%), moderately-severe (right ear: 25.4%; left ear: 25.4%) and sloping (right ear: 57.1%; left ear: 54.6%) pattern of hearing loss. Noise exposure, diabetes mellitus and hypertension correlated positively with right ear hearing loss ($R = 0.56$; $F_{(3, 465)} = 72.05$) and explained 32% of the variance in the dependent variable. The three factors also correlated positvely with left ear hearing loss ($R = 0.50$; $F_{(3, 465)} = 51.71$) explaining 25% of the variance in the dependent variable. The contributions of the independent variables to right ear hearing loss are in the following order: noise exposure (β=0.41), diabetes mellitus (β= 0.23) and hypertension (β=0.11). For left ear hearing loss, the order is: noise exposure (β=0.36), diabetes mellitus (β= 0.27) and hypertension (β=0.02). Furthermore, noise exposure (B=18.11; t=10.33; $p<0.05$), diabetes mellitus (B=11.40; t=5.52; $p<0.05$) and hypertension (B=4.71; t=2.65; $p<0.05$) could predict right ear hearing loss. On the other hand, only two of the factors: noise exposure (B=15.28; t=8.56; $p<0.05$) and diabetes mellitus (B=13.07; t=6.21; $p<0.05$) could predict left ear hearing loss.

History of noise exposure, diabetes mellitus and hypertension predispose elderly people to loss of hearing. Therefore, noise should be abated at the source through sound barriers, sound diffusers and sound enclosures. Personal ear protectors such as earmuffs and earplugs should be worn by people in noisy environments. In addition, lifestyle modification and routine medical checkup are advocated for the elderly patients with diabetes mellitus and hypertension.

Key words: Hearing loss, Elderly patients, Noise exposure, Diabetes mellitus, Hypertension
Word count: 415

CERTIFICATION

I certify that the research embodied in this dissertation was carried out by Olawale OGUNDIRAN of the Audiology and Speech Pathology unit in the Department of Special Education, University of Ibadan.

....

Date

Supervisor

Dr. Kola Abiodun

B.Ed, M.Ed, Ph.D (Ibadan)

Department of Special Education

University of Ibadan, Ibadan

DEDICATION

This piece of work is dedicated to the Almighty God, All-Knowing God, the God of the beginning, the God of the middle and the God of the end of the road, He is the one that has helped me to score this major success.

ACKNOWLEDGMENTS

All glory and honour is given back to God for this great thing He has done. Indeed, God rules in the affairs of men, Hallelujah!

I would like to express my sincere appreciation to all those who helped me in different ways to make this work possible. First, I would like to specially acknowledge my wonderful supervisor – Dr. Kola Abiodun, for his love, patience and dedication to this work. Although, he had passed to the great beyond but his name is forever engraved in this noble profession of ours- Speech Language Pathology and Audiology. The Lord be with the family he left behind, amen.

My profound gratitude to the current Ag. Head of Department, Dr. J. O. Oyundoyin for being instrumental to my successes in life. May God reward him and his family abundantly.

I must specially say a big thank you to Dr. Oyewumi and Dr. Fakolade. Thank you ma and sir. Also, my profound gratitude to Dr. Osisanya, God bless you abundantly.

To the current and past Sub-Dean Postgraduate - Dr. O. A. Adegbesan and Dr. M. K. Akinsola respectively, I say a big thank you.

Special thanks to Prof. C. A. Bakare, Prof. Moji Oyebola, Prof. Nwazuoke, Prof. Ademokoya, Prof. Ijaduola, Dr. Ojo (of blessed memory), Dr. Eni-olorunda, Dr. Oduolowu, Dr. Abass, Dr. Ogunleye, Dr. Ajiboye, Dr. Popoola, Dr. Olumide Olajide, Dr. Lazarus, Dr. Isaiah Ojo, Dr. Tobih, Dr. Olaosun, Dr. Sogebi, Dr. Adeosun and Dr. Adedeji. I am very grateful.

I wish to extend my gratitude to all the students in the department, especially the postgraduate students for their helpful support at different stages of this study. I cannot forget the contributions of Otoayele Aliyu, my prayer is that God sees him through in his academic pursuit.

Also, I acknowledge the debt I owe to the managements of the selected teaching hospitals, the participants and the various authors whose work I consulted in the course of this study. Special gratitude to my research assistants - Mrs Bola Ojurongbe and Bro. Rufus Adejumo. They have all made valuable contributions to this work.

My profound gratitude to my parents in the Lord - Rev. Olusola Kolade, Rev. Bridget Kolade, Daddy Areogun and Mummy Areogun. I am very grateful for your prayers. Indeed many ‘‘seas of different colours’’ were parted in the course of the programme. Glory to God in the highest.

Special thanks to the best parents in the world: Pa D. O. Ogundiran (of blessed memory) and Deaconess C. O. Ogundiran for your encouragement to start this programme. Dad, although you have passed on to eternity but the Lord has made it possible for your wife to witness this, Hallelujah.

Thanks always to my siblings and their family members: Bro. Tunde, Bro. Tunji, Sis. Lanre, Bro. Niyi, Sis. Yemi, Sis. Funke, Bro. Demola, Sis. Dammy. Special thanks to Olola Joseph and his cousins – Ewaoluwa, Isegunnitemi, Adeola and Adebolanle that served as temporary audiences during my rehearsals. May you be hundred times better than your peers as you have started listening to postgraduate seminar presentations at tender ages.

How can I forget my angel? It is impossible! I cannot thank you enough. My success is yours, I say congratulations to you.

A million thanks to my brilliant and lovely editor- Mr. Jide Aremu. My wish is that every writer could have such a magnificent editing experience.

And to this essential ones: Mr. Nicholas, Yvonne, Dapo Adediran, Shittu Sulaiman, Yinka Ajetumobi, Dr. Omorege, Mr. Edmund, Ogu David, Prince Sigo, Moshood, Jawara, Dada, Sister Grace, Esther, Femi, Chivoptera, Sister Yemi Ojo, Segun Adebayo. For those whose names are not mentioned, I am not ungrateful.

May the good Lord bless you all, amen.

Olawale OGUNDIRAN

TABLE OF CONTENTS

	Pages
Title Page	i
Abstract	ii
Certification	iii
Dedication	iv
Acknowledgments	v
Table of Contents	vii
List of Tables	xi
List of Figures	xiii
CHAPTER ONE: INTRODUCTION	1
Background to the Study	1
Statement of the Problem	7
Purpose of the Study	8
Significance of the Study	9
Research Questions	10
Hypotheses	10
Scope of the Study	10
Operational Definition of Terms	12

CHAPTER TWO: Literature Review.. 13

Theoretical Review.. 14

Theories of Ageing.. 14

Importance of Normal Hearing... 16

Hearing Loss among the Elderly... 18

Lifestyle, Hearing Loss and the Elderly…………………………………………… 20

Biological and Psychological Issues with Ageing………………………………… 21

Diabetes Mellitus, Hearing Loss and the Elderly…………………………………. 23

Hypertension, Hearing Loss and the Elderly……………………………………… 27

Noise, Hearing Loss and the Elderly……………………………………………… 34

Conceptual Review………………………………………………………………… 41

Anatomy and Physiology of the Ear………………………………………………. 41

Types of Hearing Loss……………………………………………………………… 44

Aetiology of Hearing Loss………………………………………………………….. 47

Presbyacusis………………………………………………………………………… 48

Patterns of Hearing loss…………………………………………………………….. 54

Empirical Review…………………………………………………………………… 64

Degrees and Types of Hearing Loss among the Elderly……………………………….. 64

Patterns of Hearing Loss among the Elderly………………………………………. 65

Diabetes Mellitus and Hearing Loss among Elderly Patients………………………….. 66

Noise Exposure, Hypertension and Hearing Loss among Elderly Patients……………….. 68

Appraisal of Reviewed Literature………………………………………………………..78

Conceptual Model for the Study………………………………………………………80

CHAPTER THREE: Research Methodology…………………………………………..81

Research Design…………………………………………………………………………81

Variables in the Study... 81

Population.. 81

Sample.. 81

Sampling Procedure.. 83

Research Instruments.. 84

Validity and Reliability of the Equipment.. 85

Procedure for Data Collection... 87

Data Analysis.. 87

CHAPTER FOUR: Presentation of Results.. 88

Presentation of Results and Hypotheses Testing.. 88

Summary of Findings... 99

CHAPTER FIVE: Discussion, Implication and Recommendation.................................. 100

Discussion of Results... 100

Implication of the Findings... 106

Limitations of the Study... 107

Conclusion..108

Suggestions for Further Studies.. 108

Contribution to Knowledge.. 109

Recommendations.. 109

REFERENCES.. 112

APPENDICES... 134

LIST OF TABLES

Tables	Description	Pages
1.	Classification of Blood Pressure for Adults Aged 18 Years or Older	29
2.	Permissible Noise Exposure Time for Continuous Time Weighted Average	39
3.	Common Sounds and their Intensities	40
4.	Sound Pressure Levels Measured in the Study	40
5.	Hearing Loss and Difficulty in Hearing Speech	43
6.	Aetiology of Hearing Loss	47
7.	Health Institutions Selected for the Study	82
8.	Patients' Age in Years	82
9.	Sex Distribution of the Patients	82
10.	Descriptors of Hearing Loss	83
11.	Patterns of Hearing Loss among the Elderly in the Right Ear	88
12.	Patterns of Hearing Loss among the Elderly in the Left Ear	90
13.	Degrees of Hearing Loss among the Elderly in the Right Ear	91
14.	Degrees of Hearing Loss among the Elderly in the Left Ear	92
15.	Types of Hearing Loss among the Elderly in the Right Ear	93
16.	Types of Hearing Loss among the Elderly in the Left Ear	94
17.	Multiple Regression Analysis Table Showing Noise exposure, Diabetes Mellitus and Hypertension as Joint Predictors of Hearing Loss in the Right Ears	95

18. Multiple Regression Analysis Table Showing Noise Exposure, Diabetes Mellitus and Hypertension as Independent Predictors of Hearing Loss in the Right Ears 96

19. Multiple Regression Analysis Table showing Noise Exposure, Diabetes Mellitus and Hypertension as Joint Predictors of Hearing Loss in the Left Ears 97

20. Multiple Regression Analysisis Table showing Noise Exposure, Diabetes Mellitus and Hypertension as Independent Predictors of Hearing Loss in the Left Ears 98

LIST OF FIGURES

Figures	Description	Pages
1.	Anatomy of the Human Ear	41
2.	Audiogram Depicting Conductive Hearing Loss	44
3.	Audiogram Depicting Sensorineural Hearing Loss	45
4.	Audiogram Depicting Mixed Hearing Loss	46
5.	Pathophysiology of Presbyacusis	48
6.	Normal Pattern of Audiogram	54
7.	Flat Pattern of Audiogram	55
8.	Sloping Pattern of Audiogram	56
9.	Rising Pattern of Audiogram	57
10.	Trough Pattern of Audiogram	58
11.	Peaked Pattern of Audiogram	59
12.	Notched Pattern of Audiogram	60
13.	Precipitous Pattern of Audiogram	61
14.	Low Frequency Pattern of Audiogram	62
15.	High Frequency Pattern of Audiogram	63
16.	Conceptual Model for the Study	80
17.	Patterns of Hearing Loss among the Elderly in the Right Ear	89

18. Patterns of Hearing Loss among the Elderly in the Left Ear 90

19. Degrees of Hearing Loss among the Elderly in the Right Ear 91

20. Degrees of Hearing Loss among the Elderly in the Left Ear 92

21. Types of Hearing Loss among the Elderly in the Right Ear 93

22. Types of Hearing Loss among the Elderly in the Left Ear 94

23. Diagnostic Audiometer 134

24. Audiogram 135

25. Sound Pressure Level Meter 136

26. A Pair of Earplug 137

27. Earmuff 137

28. Behind the Ear Hearing Aid 138

29. In the Ear Hearing Aid 138

30. In the Canal Hearing Aid 138

31. Completely in the Canal Hearing Aid 138

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Hearing loss due to age is a phenomenon which is universally accepted as one of the challenges of old age. Although, ageing is not a uniform process in all people, it is unique in each individual, the ageing process and the last stage of life is satisfying for some while it is disappointing for others. Old age is generally the chronological age, a universal phenomenon and a challenge to everyone, who reaches it irrespective of occupation, skill or learning (Tungdim & Kappoor, 2002). The World Health Organization, WHO (2005) defines ageing as a process of progressive change in the biological, psychological and social structure of individuals. Hearing loss is one of the most prevalent conditions in the aged and it poses a challenge to medical treatment, affects day to day functioning, communication and socializing. It can also have a number of psychological effects such as cognitive decline, depression, social withdrawal, loss of self-esteem and strained interpersonal relationships.

Hearing impairment affects one in five adults worldwide (Koester, Eggemann & Zorowka, 2002). The prevalence of severe hearing loss in general population rapidly increases with age from 25% - 60% over 65 years of age to approximately 80% in those over 85 years (Gussekloo, de Bont & von Faber, 2003). According to National Population Commission- NPC (2006), the population of the elderly people in Nigeria between 65 years and above is 4,536,761 (male 2,534,541, female 2,002,220) with a prevalence of 6.1% hearing loss among them (Lasisi, Abiona & Guruje, 2010). Victoria, Velkoff and Kowal (2007) estimated that 4.7% of the elderly population is found in sub-saharan Africa while in developed countries, people of this age group constitute 11 % - 18 % of the population.

Hearing loss due to age is called presbyacusis . It is a progressive, bilateral, sensorineural hearing loss that occurs in older people as they age, a multifactorial process driven by environmental factors and exacerbated by concurrent disease (Lui & Yan, 2007). It is this clinical picture of a gradually progressive, bilaterally symmetrical hearing loss associated with age that has been termed presbyacusis (Greek: Presbys meaning-old man and Akousis meaning-hearing, that is, old man’s hearing). The characteristic presbyacusic hearing loss is sensorineural and sloping pattern on the audiogram, ranging from mild to moderately severe intensity

(Dhingra, 2004).

Pure tone audiometry (PTA) is one of the methods used in measuring hearing sensitivity across a range of frequencies. For each frequency, a pure tone signal is presented to the ear and the intensity of the signal is varied until the level at which the patient is just able to perceive the tone is identified. That level is the pure tone threshold for that particular frequency. A higher threshold indicates that a more intense signal is needed to perceive the tone and signifies greater hearing impairment. Audiometric evaluation assesses both degree and type of hearing loss for each ear individually. PTA is done using an electronic device called audiometer which produces pure tones. The intensity of these tones or frequencies can be adjusted according to the threshold of sound perception of the patient. In age related hearing loss, the threshold for the higher frequencies is usually increased. The amount of intensity (measured in decibels) that has to be raised above the normal level is a measure of the degree of hearing impairment at that frequency. Pure tone test results are recorded on a graph commonly referred to as audiogram. The audiogram is simply a graph of frequency versus intensity. The frequency scale along the abscissa is measured in hertz (Hz) while the intensity scale which is on the ordinate of the graph is measured in decibels (dB). The frequencies used in clinical measurement inlude only those from 250 Hz to 8000 Hz even though young normal adults can hear frequencies as low as 20 Hz to as high as 20,000 Hz (Miller, Groher, Yorkston & Rees, 1993).

Age related hearing loss is a highly multifactorial process involving a multitude of intrinsic and extrinsic factors. A relationship between cardiovascular disease (CVD) and poor hearing in old age was proposed almost 40 years ago (Rosen & Olin, 1965). It is well known that noise can seriously damage the hearing system but it is only recently that research has been done on its possible contribution to hypertension (Van Kempen, Kruize, Boshuizen, Ameling, Staatsen & De Hollande, 2002) and cardiovascular disease (Tomei, Tomao, Papaleo, Baccolo & Alfi 1991; Kawada & Suzuki, 1999). Noise is a psychosocial stressor that may cause hypertension by activating the hypothalamic-pituitary-adrenal and sympathetic nervous systems and thus causing elevated levels of adrenaline, noradrenaline and cortisol (Spreng, 2000; Babisch, 2002; Ising & Kruppa, 2004). These three hormones contribute to blood pressure regulation.

In occupational settings with noise levels above 85 A-weighted decibels (dBA), the association between noise exposure and hypertension is inconsistent. Some studies have suggested that occupational noise exposure is associated with a sustained elevation of blood pressure (Lee, Kang, Yaang, Choy & Lee 2009; Tomei, Fioravanti, Cerratti, Sancini, Tomao, Rosati, Vacca, Palitti, Di Famiani, Giubilati, De Sio &Tomei, 2010), but other studies have not revealed any significant interaction (Wu, Shen, Ko, Guu, Gau, Lai, Chen & Chang, 1996; Inoue, Laskar & Harada, 2005). Similarly, Babisch (1998) said the role of noise exposure in the aetiology of hypertension is unclear. There is a risk for hypertension in men (but not women) associated with high noise annoyance (Belojevic & Saric-Tanascovic, 2002). Since high noise levels might cause noise induced hearing loss (NIHL), there might be an interaction between exposure to noise, stress, noise induced hearing loss and hypertension.

A study on hearing loss suggested that hypertension is an accelerating factor of degeneration of the hearing apparatus due to ageing. Hypertension or high blood pressure is a condition in which the blood pressure in the arteries is chronically elevated. With every heart beat, the heart pumps blood through the arteries to the rest of the body. Blood pressure is the force of blood that is pushing up against the walls of the blood vessels. If the pressure is too high, the heart has to work harder to pump, and this could lead to organ damage and several illnesses such as heart attack, stroke, heart failure, aneurysm, or renal failure. Hypertension may be classified as essential or secondary. Essential hypertension is the term for high blood pressure with unknown cause. It accounts for about 95% of cases. Risk factors for essential hypertension include smoking, sedentary lifestyle, high level of salt intake, high level of alcohol consumption, stress and history of hypertension. Secondary hypertension is the term for high blood pressure with a known direct cause, such as ageing, kidney disease, diabetes and tumors (Crosta, 2009).

The clinical effects of the above changes are further compounded by the general biological ageing of the brain. Various other pathologies accompanying ageing may affect the auditory pathways, such as arteriosclerosis, hypoxic, metabolic disorders, hepatic and renal dysfunction. Changes in the central auditory system contribute to age related hearing loss, it is thought that they have less of an impact on hearing in the elderly than the changes in the cochlea. The ageing process itself is associated with degeneration of the auditory system, other insults to the cochlea from noise or ototoxic drugs can accumulate over a lifetime and add to the decline in hearing experienced by older people. However, the histopathology of cochlea damage as a consequence of noise, ototoxic drugs or from ageing is indistinguishable.

The relationship between diabetes mellitus and hearing loss has been debated for many years when a case report of a diabetic patient with hearing loss was published (Jordao, 1857).

Edgar (1915) was the first to report a high-frequency sensorineural hearing loss in a diabetic patient. Diabetes mellitus is characterized by abnormally high levels of sugar (glucose), both in the blood and the urine. Diabetes occurs when the body does not produce adequate quantities (or the appropriate quality) of the hormone insulin. Insulin is normally produced and secreted by the pancreas. When diabetes occurs, the cells of the body are unable to absorb glucose, leaving excessive glucose in the bloodstream to wreak havoc with serum chemistry. The excessive glucose is then passed out of the body in the urine (Zelenka & Kozak, 1965).

According to Max (2003), there are two basic classifications of diabetes mellitus: Type I, or insulin-dependent diabetes, is generally recognized as juvenile diabetes, with this type of diabetes, the pancreas makes no insulin. Type I diabetes can be life-threatening if left untreated. Without medical attention, ketoacidosis will develop, which can cause a number of health problems, including hearing loss, blindness, weight loss, neuropathy, compromised immunology, amputation or death. Ages of those diagnosed with Type I diabetes generally range from 8 to 40 years. Type I is generally managed with daily insulin, diet, and control of body energy. The relationship between hearing loss and Type I diabetes has been determined to be conclusive in numerous studies, showing that many sufferers, depending upon length of time and efficacy of treatment, exhibit a somewhat less efficient auditory function, as compared to their non-diabetic counterparts. Type II diabetes primarily affects adults, especially those over 40 years of age. Slightly, more women than men experience Type II diabetes, and it tends to run in families (mitochondrial inheritance). In this case, the pancreas produces insulin, but not the type and quality needed by the body.

Harner (1981) said that some authors concluded that there is no relationship between hyperglycemia and hearing loss, even the bulk of literature supports a poorly defined association. The link between diabetes and sensorineural hearing loss makes intuitive sense, given the documented neuropathic and microvascular complications of diabetes and the complex blood supply of the inner ear. Most audiometric studies of hearing in patients with diabetes show a mild to moderate high-frequency sensorineural hearing loss, although Celik, Yalcin & Celebi (1996) noted higher thresholds in diabetic patients at all frequencies tested. Also, diabetes mellitus and arterial hypertension are two common diseases that often co-exist. Patients with diabetes have much higher rate of hypertension than that in general population. The co-existence of these disorders appears to accelerate microvascular and macrovascular complications and greatly increases the cardiovascular risk, risk of stroke and end stage renal disease. Arterial hypertension is clearly related to nephropathy in people with type 1 diabetes. In patients with type 2 diabetes, insulin resistance seems to play a pivotal role in the pathogenesis of hypertension (Sampanis & Zamboulis, 2008). It has been suggested that diabetic end-organ damage of the cochlea is augmented in the setting of hypertension (Sigsbee, Jiri, Scott & Harold, 1997).

The elderly are more susceptible to ototoxicity, this is because of polypharmacy, use of potentially ototoxic drugs and impaired renal function. Ototoxicity as a cause of hearing loss in elderly is often unrecognized. A number of commonly used drugs are ototoxic, namely aminoglycosides, quinine, betablockers, diuretics, non-steroidal anti-inflammatory drugs and tricyclic antidepressants. The underlying mechanism of ototoxicity and the clinical picture depends on the offending drug. The clinical picture seen with cochleotoxic aminoglycosides is of a progressive high frequency sensorineural hearing loss associated with tinnitus occurring after a few days of treatment, although some aminoglycosides are predominantly vestibulotoxic. Other drugs such as loop diuretics or beta-blockers may produce a reversible hearing loss (Gupta & Gupta, 2008).

Lifestyles, genetic and environmental factors also play a role in the development of age-related hearing loss. Cigarette smoking may affect hearing through its effects on antioxidative mechanisms or on the vasculature supplying the auditory system (Shapiro, 1964). An association between cigarette smoking and hearing loss among adults has been found in some clinical studies. Men who smoked more than 1 pack per day had worse hearing thresholds at 250 to 1000 Hz than nonsmokers or "light" smokers (Weiss, 1970). Numerous studies have shown that tobacco smoking is associated with a significant risk of hearing loss (Agrawal, Platz & Niparko, 2009; Gopinath, Flood & McMahon, 2010). Cruickshanks, Klein and Klein (1998), reported that current smokers were 1.69 times more likely to have a hearing loss relative to non-smokers. Chronic and heavy alcohol consumption is neurotoxic and may lead to Wernicke-Korsakoff syndrome, which is characterized by severe memory impairment. Data also revealed that exercise can improve cognitive function by raising cardiovascular function which enhances brain processing speed, memory, mental flexibility, and cognitive function (Angevaren, Vanhees, Wendel-Vos, Verhaar, Aufdemkampe, Aleman & Verschuren, 2007). Exercise can also increase cerebral supply capacity and improve cell proliferation (Netz & Jacob, 1994). It is also possible that increased physical activity can increase the activities of frontal and prefrontal areas in the brain, which are responsible for planning, co-ordination, control memory, communications, and further improve the cognitive function (Colcombe, Kramer, Erickson, Scalf, McAuley, Cohen, Webb, Jerome, Marquez & Elavsky, 2004).

Hearing impairment could cause psychological and social difficulties because it interferes with a person's ability to communicate effectively. Communication plays an essential role in maintaining relationships and the quality of life, and hearing loss deprives not only the individual, but also family and friends of easy communication. Repeated instances of unheard or incorrectly heard communication are frustrating for an elderly individual and everyone he converses with and may also cause people to avoid him in their conversation. When these frustrating situations occur over prolonged periods, family relationships can be severely strained, religious and social functions could be affected because elderly people with hearing loss cannot hear well enough to enjoy these activities (Elwell, 1984; Hull, 1977).

Ageing can bring many kinds of losses: loss of income and decreased sense of usefulness associated with retirement; loss of relationships due to the death of spouse, siblings, and friends or due to a physical move from a familiar home or community; and diminished health, energy, and mobility. While most elderly people cope well with these losses, hearing impairment can hinder the coping process by interfering with the person's ability to become involved in new activities, form new relationships, and arrange for needed services (Becker, Flower, Glass & Newcomer, 1984). However, gerontologists are trying to understand the causes of the effects of ageing on elderly people, and their explanations centred on such things as a declining immune system, the slowing of cellular replication, and other processes. Some recent researches have focused on centenarians to try to find out what enables them to live so long. There are about 85,000 centenarians in the United States, and this number is expected to reach 580,000 by 2040 (Mozes, 2008). They tend to be as healthy as people in their early 80s, and their medical expenses are lower. Some eat red meat and some are vegetarians, and some exercise a lot while others exercise little. Scientists think they may have "supergenes" that protect them from cancer or Alzheimer's disease and are trying to find these genes. The relative health of the centenarians led one researcher to observe, and said "Now that we know that a substantial number of people can remain robust and healthy through their 90s, at least, that should change our attitude about old age. It is no longer a curse, but an opportunity" (Hilts, 1999). The effects of biological and psychological ageing are not necessarily inevitable, but "successful ageing" is possible (Evans, 2009). Regular exercise, good nutrition, and stress reduction stand at the top of most gerontologists' recommendations for continued vitality in later life. In fact, Americans live about 10 years less than an average set of genes should let them live because they do not exercise enough and because they eat inadequate diets (Perls & Silver, 1999).

1.2 Statement of the Problem

In Nigeria, there has not been adequate published epidemiological studies on hearing loss among the elderly. Although, a cohort study by Lasisi, Abiona and Guruje (2010) revealed a prevalence of 6.1% hearing loss among the elderly aged 65 years and above in Nigeria. It has been reported that 580 million people in the world are 60 years old or older, with 355 million in developing countries (WHO, 1999). Also, in several developing countries, the population of people aged 60 years or over is increasing at a faster rate than the population as a whole. Between 1980 and 2020, the population of the developing world is expected to increase by 95%, whereas the elderly population will probably rise by almost 240% (WHO, 1989). It is estimated that the worldwide population of the elderly will exceed 1 billion, and 700 million of the elderly would be in the developing countries by the year 2020 (WHO, 1998). Now that we live in an ageing world with the population of older people rising steadily and the human life span is steadily lengthening, a common corollary of these processes is a gradual diminution in auditory function. The industrial revolution that brought several conveniences had also brought in its wake louder machines, thus, the stage was set for a significant increase in the number of individuals exposed to noise levels that by far exceed the oto-destructive level and many people are exposed to these noise levels that exceed accepted standards without proper ear protection which predispose them to noise induced hearing loss.

Similarly, some diminutions in hearing thresholds among the elderly could be associated with diabetes mellitus and hypertention which could be secondary to unhealthy lifestyles such as sedentary lifestyle, cigarette smoking, consumption of unhealthy diets, bad eating habits and chronic and heavy alcohol consumption especially in a noisy environment. There has been an increase in the prevalence of diabetes mellitus over the past 40 years worldwide. The worldwide prevalence of diabetes mellitus in 2000 was approximately 2.8% and is estimated to grow to 4.4% by 2030 (Govindarajan, Sowers & Stump, 2006). This translates to a projected rise of diabetes mellitus from 171 million in 2000 to over 350 million in 2030. In the past, diabetes was a rare condition in Africa. According to Abubakari and Bhopal (2008), statistics has shown that the prevalence of diabetes seemed rare at 0.2% in Ghana in 1963 and 1.65% in Nigeria in 1985, but the prevalence of diabetes in Nigerian adults rose to 6.8% in 2000 while in Ghana, the prevalence of diabetes in adults rose to 6.3% in 1998. The epidemic of diabetes will continue to rise as there is growing prevalence of obesity in children.

In Africa, extensive epidemiological studies showed that hypertension is one of the commonest cardiovascular ailments and that blood pressure assumes much more importance with advancement in age, whereas in the past there were rare cases of hypertensive patients and this could be linked with non-industrial and tribal African group. Hypertension is now a global epidemic affecting 1.5 billion people worldwide. In Nigeria, 30 million people suffer from this condition which is the main risk factor for stroke and renal failure (Abubakar, Mabruok, Gerie, Dikko, Aliyu, Yusuf, Magaji, Kabir & Adama, 2009). The prevalence of hypertension is probably on the increase in Nigeria due to adoption of western lifestyles and the stress of urbanization. In a study of cardiovascular diseases in multiple centres in Nigeria, hypertension ranked first and its complications constituted 25% of emergency medical admissions in urban hospitals in the country (Ekere, Yellowe & Umune, 2005). A 1977 report by the International Collaborative Study of Hypertensive in Blacks put the age adjusted prevalence of hypertension in Nigeria at 14.5% (Cooper, Rotimi, Ataman, Mc Gee & Osotimilehin, 1997). However, using the current definition of hypertension from the Seventh Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure of 2003, 20-25% of Nigerians would be classified as hypertensives (Ogah, 2006). There is considerable evidence for an increased prevalence of hypertension in diabetic persons and researches have shown that diabetic end-organ damage of the cochlea is intensified by concomitant hypertension. This study therefore, investigated noise exposure, diabetes mellitus and hypertension as predictors of hearing loss among elderly patients in South-West, Nigeria.

Purpose of the Study

There is a growing need for greater understanding about hearing loss and other geriatric phenomena among the elderly patients. Understanding is essential if we are to deal effectively with the complex problems of the elderly with the accompanying structural and behavioural changes related to hearing loss among them. Even though the majority of elderly people in the world reside in developing countries and the proportion of the elderly population in these developing countries is projected to rise even further, there has been little published studies on the major causes of disability among them. Our knowledge will be scanty and defective if we do not fully understand the degree, type and pattern of hearing loss among the elderly and if these happen, management will be a rat race or trial and error. Specifically, there is a paucity of published studies addressing the predictors and patterns of hearing loss among the elderly in Nigeria with a consequent gap in our knowledge about effective strategies to prevent the problem.The purpose of this study was to investigate the types of hearing loss, degrees of hearing loss and patterns of hearing loss that could be found among the elderly with noise exposure, diabetes mellitus and hypertension. The study also investigated risk factors of hearing loss such as noise exposure, diabetes mellitus and hypertension and their contributions to hearing loss.

1.4 Significance of the Study

There are paucity of published studies in Nigeria and in many developing countries on predictors and patterns of hearing loss among the elderly. The information collected in this study would be used to generate data and support specific policies and public services for this age group. This study would serve as an essential basis for developing preventive measures and strategies to reduce or eliminate the causes of hearing loss among the elderly which would improve family and social integration with the cumulative effect of improving the quality of life of the elderly people. For example, existing researches have confirmed the risk of a permanent, irreversible hearing loss when exposed to noise level greater than 85dB, the effect of such on people whose knowledge of adverse effect on general health is assumed to be grossly inadequate requires such investigation. Some people will lose their hearing to a greater or lesser extent as they become older while some will maintain a normal hearing. It is therefore pivotal to study hearing loss among the elderly patients in developing countries so as to be able to plan a hearing conservation programme for those with normal hearing and effective management programme for those with hearing loss in order to enjoy better quality of life. This study is expected to contribute to the field of knowledge by revealing the strongest predictor variable to hearing loss among noise exposure, diabetes mellitus and hypertension. This study is also expected to reveal the patterns of hearing loss among the elderly. It would also provide preventive measures and management options as regard hearing loss, noise exposure, diabetes mellitus and hypertension among the elderly.

Findings from this study are also expected to serve as an effective tool in the hands of policy makers, Audiologists, Speech Therapists, Otorhinolaryngologists, elderly people and caregivers in managing hearing loss and its risk factors.

1.5 Research Questions

1. What are the patterns of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?
2. What are the degrees of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?
3. What are the types of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?

1.6 Hypotheses

The following hypotheses were tested in this study at the 0.05 level of significance.

1. There is no significant joint prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.
2. There is no significant independent prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.
3. There is no significant joint prediction of hearing loss in the left ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.
4. There is no significant independent prediction of hearing loss in the left ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

1.7 Scope of the Study

This study focused on noise exposure, diabetes mellitus and hypertension as predictors of hearing loss among elderly patients. The research was carried out among elderly patients aged 65 years and above with hearing loss and history of noise exposure, diabetes mellitus or hypertension in the Departments of Otorhinolaryngology–Head and Neck Surgery of the following Teaching Hospitals in South-West, Nigeria:

Oyo State

1. University College Hospital, Ibadan – Oyo State.

   Osun State

2. Obafemi Awolowo Teaching Hospital, Ile-Ife, Osun State.
3. Ladoke Akintola University of Technology Teaching Hospital, Osogbo – Osun State.

Lagos State

4. Lagos University Teaching Hospital, Lagos State.
5. Lagos State University Teaching Hospital, Lagos State.

Ogun State

6. Olabisi Onabanjo University Teaching Hospital, Sagamu – Ogun State.

1.8 Operational Definition of Terms

Baseline audiogram: This connotes the audiogram obtained from an audiometric examination administered before employment or within the first 30 days of employment that is preceded by a period of at least 12 hours of quiet living. The baseline audiogram is the audiogram against which subsequent audiograms will be compared for the calculation of significant threshold shift.

Degree of Hearing Loss: It refers to the severity of hearing loss which might be described as mild, moderate, severe or profound loss of hearing depending on the results of the hearing test.

Elderly Patients: These are people aged 65 years old or older who have hearing loss with history of noise exposure, diabetes mellitus or hypertension.

Elderly: This refers to a chronological age of 65 years old or above.

Hearing Threshold: This is the faintest sound a person hears at each frequency at least 50% of time.

Noise: This refers to as audible acoustic energy that adversely affects or may affect the physiological and psychological well being of people.

Pattern of hearing loss: This refers to the audiometric configuration or shape of hearing sensitivity on the audiogram which indicates the likely cause of hearing loss.

Pure Tone Average: It refers to the average of the speech frequencies (500Hz, 1000Hz and 2000Hz).

Types of Hearing Loss: They refer to as sites of lesion, which are conductive hearing loss, sensorineural hearing loss and mixed hearing loss.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, literature relevant to this research work was reviewed under the following headings:

Theoretical Review

2.1 Theories of Ageing

2.2 Importance of Normal Hearing

2.3 Hearing Loss among the Elderly

2.4 Lifestyle, Hearing Loss and the Elderly

2.5 Biological and Psychosocial Issues with Ageing

2.6 Diabetes Mellitus, Hearing Loss and the Elderly

2.7 Hypertension, Hearing Loss and the Elderly

2.8 Noise, Hearing Loss and the Elderly

Conceptual Review

2.9 Anatomy and Physiology of the Ear

2.10 Types of Hearing Loss

2.11 Aetiology of Hearing Loss

2.12 Presbyacusis

2.13 Patterns of Hearing loss

Empirical Review

2.14 Degrees and Types of Hearing Loss among the Elderly

2.15 Patterns of Hearing Loss among the Elderly

2.16 Diabetes Mellitus and Hearing Loss among the Elderly

2.17 Noise Exposure Hypertension and Hearing Loss among the Elderly

2.18 Appraisal of Reviewed Literature

2.19 Conceptual Model of Elderly Patients with Noise Exposure, Diabetes Mellitus and Hypertension in South-West, Nigeria

Theoretical Review

2.1 Theories of Ageing

There is a growing interest in scientific explanations of ageing and in the search for a general theory that can explain what ageing is and why and how it happens. There is also a need for a general theoretical framework that would allow researchers to handle an enormous amount of diverse observations related to ageing phenomena (Leonid & Natalia, 2006). Finch (1990), defined ageing as a decline in performance and fitness with advancing age. Theories of ageing can be divided into two categories: Those that answer the question "Why do we age?" And those that address the question "How do we age?". A critical issue in ageing research is whether ageing is affected by one, several, or a multitude of underlying processes. If there are hundreds of different biological pathways that affect ageing, then odds are slim that science will find a way to slow down how we age or even understand why ageing happens (American Foundation for Ageing Research - AFAR, 2006).

The Evolutionary Theory of Ageing

The most widely accepted overall theory of ageing is currently the evolutionary theory of ageing. This theory suggests that ageing was an adaptive response to the threat of over-crowding which might be associated with accelerated evolutionary changes and essentially good for the species. It also indicates that life expectancies are very short compared with survival in a protected environment and that natural selection which is the key evolutionary process cannot lead to the acquisition of ageing genes as none lives long enough in natural conditions (Bennett & Ebrahim, 1995). Evolutionary theory cannot operate at specie level, but only at the level of individual who survive with a greater chance of preserving their germ line. Therefore, to make this theory workable, the individual needs to survive and be preserved before the manifestation of changes in the human body systems.

Genetic Theory

Genetic theory of ageing is developmentally controlled as the whole human process from conception through differentiation and growth to senescence, which is strictly under a regulatory gene complex. Here, emphasis is on the fact that different species have different survival prospects, and that longevity has some bearing with genetic materials. Therefore, it is possible to say that longevity genes are linked with characteristics that make us more ingenuous , and that ageing is simply an unfortunate by-product of advantages reaped earlier in life. This theory is always linked with longevity, and that longevity genes are linked with characteristics that make human beings to be resistant to diseases. With this, the progress and ageing of the human beings are developmentally controlled. The whole process from conception through differentiation and growth to senescence is under a regulatory gene complex. It has been reported that different species have different survival prospects, and that their genetic materials must have some bearing with longevity. However, big species always live longer than small ones. This is why some simple organisms like hydra do not appear to age at all but can regenerate themselves from tiny fragments (Bennett & Ebrahim, 1995).

Disposable Soma Theory

Disposable Soma theory indicates that there should be a balance between the energy an individual puts into reproduction and the energy he puts into maintenance. For example, if investment in terms of maintenance is very high, the specie will effectively appear immortal. Whereas, if the investment in maintenance is very low, the specie will age rapidlly and be exposed to a short life span (Bennett & Ebrahim, 1995). This theory is a natural way of protecting the language of life (DNA) by preserving it within a body (Soma). Here, the postulation is that human energy is expended to preserve the carrier until sexual maturity and passage of DNA into an new individual is recorded (Kyriazis, 1994; Barker, 1998). This theory suggests that at any level of environmental hazard, the optimal level of maintenance is always less than the minimum required level for imortality. This indicates that wear and tear are an inevitable part of being alive. Hence, there should be optimum balance between maintenance and reproduction, and long life. A low investment on maintenance will automatically bring a short life span and a low reproductive rate. In other words, a high investment on the maintenance of human beings shall spring-forth long life span and a relatively high reproductive rate.

Waste Product Accumulation Theory

This theory proposes that ageing is a consequence of accumulated waste products of metabolism inside cell vacuoles, which gradually fill up the available space, and limits movement of substances through the cell, thereby affecting its normal functioning. The products have been identified in specific areas as neurons, accumulated lipofuscin and B – amyloid but they have not been found hamful (Barker, 1998).

Wear and Tear Theory

Wear and tear theory was proposed by Dr. August Weismann in 1982. It is one of the cellular theories, which suggests that human body wears out and dies as a result of use. Barker (1988) attributed ageing to an accumulation of the products of metabolism as we use our body structures on a daily basis. This theory tries to enunciate that as the human beings grow, there is high tendency for the cells and muscles to wear out. This automatically contributed greatly to the ageing of mankind and reduction in human efficiency. Wear and tear theory postulated that the daily grind of life, in particular abuse or overuse, literally wears the body out, leading to disease states. The degeneration of cartilage and eventual grinding of bone on bone is an example of the ageing process on body joints, as wear and tear exceed the body's ability to repair (AFAR, 2006).

This study anchors on wear and tear theory because the theory is based on the idea that ageing is a 'secondary effect' of physiological work of cells by which the daily grind of life, in particular abuse or overuse wears the body out and leads to disease states. The effect of wear and tear on the hearing ability among elderly is seen in the death and degeneration of hair cells in the cochlea and other auditory pathways commonly referred to as presbyacusis.

2.2 Importance of Normal Hearing

Hearing is perhaps man's most important sense, for without it, his power to communicate is greatly diminished. It is, after all, this superior ability to communicate that sets man above other animals. Unfortunately, it is frequently affected by pathology in which a person develops a hearing impairment which results in a hearing disability. William (2000) described sense of hearing as one of the most important of the human senses, needed for communication, protection from danger and enjoyment of surroundings. Sound constantly surrounds us and informs us about many objects in our environment. Its localization is one of the most important biological traits in man. Sound localization enables an animal to locate food, avoid predators, find a mate and to communicate. Sounds from various sources are combined into one complex sound field and travels to the outer ear. The pinnae help in funneling them toward the external auditory canal from where it reaches the tympanic membrane, it is then transmitted through the middle ear to the inner ear. The intricate motions and interactions of the various parts of the cochlea lead to the generation of electric potentials. The hearing mechanism is our only sense which never shuts off and which receives input from all directions, giving us a continual connection with and warning of our surroundings. Unlike vision, which can be shut off by simply closing our eyes, hearing can only be partially protected from continual high intensity noise by complex central nervous system mechanisms. Although hearing impairment is not life-threatening and does not directly restrict physical activity, it can cause severe disability. Hearing loss limits a person's ability to interact socially with family and friends and to receive and interpret information (Becker, Flower, Glass & Newcomer, 1984).

The elderly with hearing loss would have no problem, if there were no need to communicate everyday. Helen Keller is credited with noting that blindness cuts us off from things, but deafness cuts us off from people (Dewane, 2010). The significant impact of hearing loss on communication and interaction with others sometimes goes unrecognized by healthcare practitioners. Coping with hearing loss is different from other disabilities in that it is an invisible handicap. The reactions or behaviours associated with hearing loss may not be apparent, and even the sight of a hearing aid may not guarantee recognition of a disability. Individuals with normal hearing often assume that simply saying something louder or turning up the volume will enable an elderly with hearing loss to hear. Volume is not necessarily the issue; difficulties with sound and word discrimination may be involved. The need to repeat what is being said adds to negative perceptions of the elderly with hearing loss as being slow. Internalizing these stereotypes and the resultant negative self-perception certainly contributes to emotional sequelae of hearing loss (Dewane, 2010).

Many warning devices such as fire alarms rely on sound signals. Furthermore, hearing is an important method of identifying dangers in the environment, such as approaching vehicles. Thus, hearing impairment can affect personal safety. It can also interfere with important activities of daily living, including shopping, using public transportation, communicating with health care professionals, tradespeople, and community service providers. When hearing impairment limits a person's ability to function independently, it can result in a need for formal and informal long-term care services (U.S Congress, 1986).

2.3 Hearing Loss among the Elderly

Clinically significant hearing loss is the third most common condition among older adults, that is, after hypertension and arthritis (Gates, Cooper & Kannel, 1983). According to Dalton, Cruickshanks and Klein (2003), it can range from bothersome to severely disabling in its effects on the sufferer, and in moderate to severe cases, it can cause the older person to become isolated, depressed and may significantly worsen age-related disabilities and dementia.

Degenerative changes due to ageing can affect almost any stage of the process of conversion of sound stimuli to brain perception of sound. The human auditory system channels and transduces the sound waves into electrophysiological signals which are then localized and interpreted by the brain.The site of degeneration in this pathway determines the type and severity of hearing loss (Chisolm, Willott & Lister, 2003). The cochlea is the site of conversion of mechanical energy to electrophysiological signal. The major age related changes occur within the cochlea, leading to significant hearing loss. The hair cells within the cochlea are generated within the first trimester of development and are then required to survive for the lifetime of the person. Regeneration does not occur after loss of hair cells. As there is little redundancy within the cochlea, with each region in the cochlea transducing a particular frequency of sound, it had been discovered that the loss of any of this small population of cells will have a noticeable effect on hearing (Howarth & Shone, 2006).

The number of functional neurons in the cochlea nuclei and auditory brain centres however, decrease with age. This is due to the reduction in the neuronal size and certain neurochemical alterations. This loss of neural input from the impaired peripheral auditory system, that is, cochlea, contributes partly to the decline in the functioning of the central auditory system. A variety of cochlea lesions have been described as part of age related hearing loss. When considered individually, each of these lesions gives a different clinical and audiological picture. However, a combination of these lesions in the ageing ear results in bilateral sensorineural hearing loss (Schuknecht & Gacek 1993). Age related hearing loss maximally affects the higher frequencies. This is because the cochlea degeneration affects mainly the base of the cochlea. Pure tone sensitivity tends to further deteriorate with age and males exhibit poorer thresholds than female counterparts of comparable age (Gates, Cooper, Kannel & Miller, 1990).

Hearing impairment is very common among elderly people and can seriously affect their quality of life, personal safety, and ability to function independently. Many of the chronic conditions that affect elderly people, including the types of hearing impairment that are most common, cannot be cured with available medical and surgical treatments, as a result, some elderly people, their families, and others assume that these conditions cannot be managed. Yet assistive technologies can often help to maintain functioning even when the underlying disease or condition cannot be cured. In the case of hearing impairment, these technologies include hearing aids, infrared and FM assistive listening devices, telephone amplification devices and other telecommunication systems, signaling and alarm devices and aural rehabilitation techniques. Used singly or in combination, these technologies can facilitate communication and help to maintain an independent lifestyle for many hearing impaired people (U.S Congress, 1986). National Health Policy for Physically Challenged Persons in Brazil (2002), said presbacusis is age-related hearing loss, and is the main cause of hearing loss in adults. Its estimated prevalence is about 30% in the elderly population, which is defined as people aged 65 or above. Noise, particularly in the working environment, is implicated as the second cause of hearing loss in adults. Presbyacusis remains the leading cause of sensorineural deafness in the elderly (Loh and Elango, 2005).

Presbyacusis, the predominant diagnosis in older adults, is a diagnosis of exclusion. Ageing and noise exposure are the key factors implicated. Hearing loss with ageing can be thought of as the incremental sum of many otologic traumas acquired thoughout a lifetime, superimposed on the background of an intrinsic ageing process. Of these, noise exposure is not only the most common cause but the one most difficult to separate from the aging process itself (Manohar, 2007). More than 90 percent of all hearing aid wearers have sensorineural hearing loss and the most common causes of sensorineural hearing loss are age related changes, noise exposure, disturbance of inner ear circulation and increased inner fluid pressure or disturbances of nerve transmission (Wayner, 2002). Brazil has witnessed a significant growth of its elderly population. Currently, there are 16.8 million people aged 60 years or more in the country, in a total population of 183 million people. It is expected that this number will grow to 32 million by 2024. Brazil is thus included in the world scenario of increased human longevity (Veras, 2003). In Nigeria, the population of people aged 65 years and above is 4,536,761 which constitutes 3.2% of the total population of about 140 million people (NPC, 2006).

However, during the 20th century, the number of people in the U.S. under age 65 has tripled while the number of persons over 65 has increased eleven times. Those people 85 and over are the fastest growing group. According to U.S. Census (U.S. Census Data and Projection, 1994) 1 in 8 Americans was elderly. The Census Bureau's middle projections estimated that the elderly population will be more than double by the year 2050 and that 1 in 5 Americans will be elderly. In United Kingdom, the Royal National Institute for the Deaf - RIND (2003) reports that above 40years of age, more men than women become hard of hearing, probably because more men are exposed to industrial noise. However, over the age of 80, there is a greater number of hard of hearing women than men perhaps because the life expectancy of women is higher than that of men. Wallhagen, Strawbridge, Cohen and Kaplan (1997), found the same difference between men and women in U S data. It was reported that men are more frequently affected than women between 35 to 60 year age group.

Elderly patients are estimated to have 3.5 times more medical problems than those under age 65 (Gordon & Byron 2004). These patients are also likely to be on multiple medications and have an increased sensitivity to side effects of those medications. There are important socioeconomic factors that need to be considered in the care of the geriatric patients. Medical problems can often contribute to diminished independence and depression. The elderly can also have diminished social interaction that is worsened by head and neck problems. Some of the common otolaryngology related complaints are hearing loss, dysphagia, balance disorders, nasal complaints, vocal disturbance, head and neck cancers, and cosmetic problems. Generally, presbycusis results in a bilateral, symmetric hearing loss with the greatest loss in the high frequencies. This produces a “down-sloping” pattern on the audiogram (Gordon & Byron, 2004).

2.4 Lifestyle, Hearing Loss and the Elderly

Hearing loss is estimated to affect 30% to 35% of adults aged 65 to 75 years in the United States, yet little is known about the etiology of this disorder (Bethesda, 1996), hearing loss may be a consequence of ageing, representing the cumulative damage from products of normal cellular metabolic processes (Jarvis & van Heerdeen, 1967). This may suggest that genetic, environmental, and lifestyle factors play a role in the development of presbycusis. Cigarette smoking may affect hearing through its effects on antioxidative mechanisms or on the vasculature supplying the auditory system (Shapiro, 1964). An association between cigarette smoking and hearing loss among adults has been found in some clinical studies. Men who smoked more than 1 pack per day had worse hearing thresholds at 250 to 1000 Hz than nonsmokers or "light" smokers (Weiss, 1970).

Numerous studies have shown primary tobacco smoke to be associated with a significant risk of hearing loss (Agrawal, Platz & Niparko, 2009; Gopinath, Flood & McMahon 2010). For example, Cruickshanks, Klein and Klein (1998), using a population-based cross-sectional study design, reported that current smokers were 1.69 times more likely to have a hearing loss relative to non-smokers. Given the emerging evidence of a relationship between primary tobacco smoking and hearing loss, it is reasonable to postulate that a similar association exists between secondhand smoke (SHS) exposure and hearing loss. Also, chronic and heavy alcohol consumption is neurotoxic and may lead to the Wernicke-Korsakoff syndrome, which is characterized by severe memory impairment. There are a number of cross-sectional and longitudinal epidemiologic studies on smoking, drinking, and cognitive function in the elderly (Cervilla, Prince & Mann, 2000; Hill, 1989). In the majority of the most recent ones, smoking is associated with reduced cognitive function, whereas moderate alcohol consumption seemed to be related to better cognitive function (Sandra, Martin, Monique, Jelle & Lenore, 2002).

Former smokers tend to develop high frequency hearing loss, thus suggesting that the harmful effects of smoking upon hearing are cumulative and permanent (Nakanishi, Okamoto, Nakamura, Suzuki & Tatara, 2000). According to the literature, smoking is associated with lower blood oxygen levels, vascular obstruction, altered blood viscosity, and possibly ototoxicity. But it is not known how much of it impacts the auditory system. There is controversy as to whether cigarettes can really be deemed as a risk factor for the development of hearing loss. **(**Carolina & Marisa, 2009). A healthy lifestyle is related to a stable self-perceived health, a delay in functional dependence, and mortality. Inactivity and smoking, and to a lesser extent a low-quality diet, increased mortality risk. A healthy lifestyle at older ages is related to a delay in the deterioration of health status and a reduced mortality risk (Lisette, Marieke, Stefaan, Marianne & Wija, 2004).

2.5 Biological and Psychological Issues with Ageing

Biological changes certainly occur as people age. The first signs are probably in the appearance. The hair begins to turn gray, the (male) hairlines recede, and a few wrinkles set in.

Hooyman and Kiyak (2011) opined that the internal changes that often accompany ageing are more consequential, among them being that fat replaces lean body mass and many people gain weight, bone and muscle loss occur, lungs lose their ability to take in air and the respiratory efficiency declines, the functions of the cardiovascular and renal (kidney) systems decline, the number of brain cells declines, as does brain mass overall, and vision and hearing decline.

Sawchuk (2009) observed that cognitive and psychological changes also occur. Learning and memory begin declining after people reach their 70s, depression and other mental or emotional disorders can set in, and dementia, including Alzheimer's disease, can occur. Sometimes hearing loss exerts a direct impact on mental health (Dewane, 2010). Depression and adjustment disorder can occur as a natural response to hearing loss and its subsequent impact on the quality of life. On the other hand, some people have pre-morbid mental health issues and hearing loss simply compounds the problem (Dewane, 2010). Inability to hear and discern message and meaning can result in feelings of shame, humiliation, and inadequacy. It can be highly embarrassing to be unable to behave according to applicable social rules. The feeling of shame linked to hearing loss stems from the elderly inadvertently reacting in inappropriate and socially unacceptable ways, such as responding to a misunderstood question in an inaccurate fashion. Elderly people may think "How stupid I must look!" "How embarrassing!" or "What will others think?" Feeling inadequate, stupid, awkward, embarrassed, different, or abnormal are some of the negative emotions that plague the elderly with hearing loss when the condition manifests itself in an unpleasant way (Dewane, 2010).

The desire to hide hearing aids often arises from feelings of shame. Hearing aids render visible the fact that an elderly differs socially from others (Dewane, 2010). Society's value on physical perfection and beauty affects everyone, including the elderly. Many elderly people with hearing loss report subtle and sometimes overt prejudice toward those with hearing aids or cochlea implants. The elderly with hearing loss may feel shame related directly to difficulties in understanding what is being said. Inability to understand verbal communication results in feelings of isolation when elders are left out of group conversations and also to avoid shame, the elderly with hearing loss sometimes choose isolation (Dewane, 2010).

According to Dewane (2010), contemporary psychiatrist William Glasser, proposed that all individuals have five basic needs. How might hearing loss affect these needs?

• **Survival**: Is the sense of security threatened when an elderly is concerned about hearing a fire alarm or a car horn?

• **Love and belonging**: Where do the elderly with hearing loss belong in the larger society? How does hearing loss affect a relationship or the ability to have a relationship?

• **Power and recognition**: Does hearing loss affect job performance or others' perceptions of the abilities of the individual with hearing loss?

• **Freedom**: How is autonomy or self-sufficiency affected?

• **Fun**: Does the loss impair the abilities of elderly people to hear jokes, banter, or music or to have fun in any number of ways?

The stress of living with hearing loss can put people at risk for many reactions, including distrust, chronic sadness or depression, nervousness, anger or irritability, isolation, poor self-image, feelings of incompetence or inadequacy, or feeling marginalized (Dewane, 2010). A sense of guilt frequently accompanies hearing loss among the elderly. Many of the elderly with hearing loss assume responsibility for unsuccessful communication and blame themselves for misunderstandings caused by the hearing loss. Many feel apologetic about repeatedly asking for others' help to understand what is being said or when they are unable to participate in social events. Some elderly people with hearing loss feel isolated or lonely within their own families. They miss the side conversations during family outings or conversations. Hearing loss affects everyone in the family, not just those who are unable to hear. With this invisible disability, others tend to forget hearing difficulties and minimize the extent to which hearing impairment may result in misunderstandings (Dewane, 2010). The nature and extent of all of these changes vary widely among older people. Some individuals are frail at 65, while others remain vigorous well into their 70s and beyond. People can be "old" at 60 or even 50, while others can be "young" at 80. Many elderly pople are no longer able to work, but others remain in the labour force. Above all, most elderly people do not fit the doddering image myth and can still live a satisfying and productive life. (Sawchuk, 2009).

2.6 Diabetes Mellitus, Hearing Loss and the Elderly

Almost 2,000 years ago, physicians first wrote of diabetes describing it as a disease causing its sufferers to urinate frequently, in great quantity and to have a great thirst. These early physicians watched helplessly as their patients consumed enormous volumes of fluids that seemed to pour through them unstopped, became progressively more ill and emanciated, and finally died. The disease causing this wretched condition they named "diabetes", which means "to run like a siphon." It took 1,600 years before physicians realized that along with vast quantities of body fluids, their diabetic patients were losing sugar in their urine. Thomas Willis, a professor at Oxford University in the seventeenth century, wrote of his experience with diabetic patients that their urine was " wonderfully sweet, as if imbued with honey or sugar." He added to the name the Latin term *mellitus*, meaning "sweetened with honey" (Eades & Eades, 1996).

Diabetes mellitus is subdivided into two different pathological causes but essentially the same symptoms. Sixty or seventy years ago, physicians believed that all diabetes were the same and that there was just a difference in severity. Some people got it in childhood or early adulthood, suffered a progressively rapid course, were unreponsive to treatment and died within a few years. Others developed it much later, had much less severe cases and could be at least treated fairly successfully by diet. Both groups of patients produced large amounts of sweet urine and so were diagnosed as having diabetes mellitus. Physicians now recognize that although both disorders are called diabetes, the circumstances and pathology leading to their development are entirely different. Type 1 diabetes, the more rapidly serious of the two, usually develops in childhood or adolescence when a virus or other toxic substance destroys the insulin-producing cells in the pancreas and requires aggressive treatment with insulin in shot form. It is a disease of insulin lack. In contrast, type 2 diabetes develops later in life, can usually be treated with diet and or oral medicines and is a disease of insulin excess. It seems strange that the same disease can be caused by both excess and an insufficiency of insulin, but that is precisely the case (Eades & Eades, 1996).

Many factors affect a person's blood sugar level. A body's homeostatic mechanism, when operating normally, restores the blood sugar level to a narrow range of about 4.4 to 6.1 mmol/L, that is, millimoles per litre (82 to 110 mg/dL, that is, milligrams per decilitre). Normal value ranges may vary slightly among different laboratories. Despite widely variable intervals between meals or the occasional consumption of meals with a substantial carbohydrate load, human blood glucose levels tend to remain within the normal range. However, shortly after eating, the blood glucose level may rise, in non-diabetics, temporarily up to 7.8 mmol/L (140 mg/dL) or more.

The American Diabetes Association recommends a post-meal glucose level of less than 10 mmol/L (180 mg/dl) and a pre-meal plasma glucose of 5 to 7.2 mmol/L (90–130 mg/dL) as the normal blood glucose values (American Diabetes Association, 2006).

In the elderly patients presenting with deafness, 80% may show evidence of disease processes implicated in hearing loss and over 50% of patients presenting with hearing loss may have evidence of previously unrecognized medical disorders (Lim & Stephens, 1991). A number of systemic diseases have been suggested as potentially contributing to hearing loss with age. These comprise hypertension, atherosclerosis, hyperlipidemia, metabolic bone disease, diabetes mellitus, hypothyroidism and alzheimer’s disease (Jennings & Jones, 2001). The most frequent causes of vestibular and auditory abnormalities are attributed to dysfunctions in the metabolism of carbohydrates, thyroid affections, supra adrenal, and other different metabolic disorders. Among glucose metabolism disorders, diabetes mellitus is the affection most commonly related with auditory disorders (Albernaz, 1995). It has been postulated that the micro vascular complications affect the hearing of individuals with diabetes. Studies in diabetic animals have demonstrated thickening of the basement membrane of the capillaries of stria vascularis (Jorgensen & Buch, 1961). Histopathological studies have shown damage to the nerves and vessels of the inner ear of the individuals with diabetes. These vascular changes have been theorized to be an important causative factor for neuronal degeneration in the auditory system (Fukushima, Cureoglu, Schachern, Paparella, Harada & Oktay, 2006).

Moreso, NIH (2008) said hearing loss is about twice as common in adults with diabetes compared to those who do not have the disease. The link between diabetes and auditory decline has long been hypothesized. findings had also indicated that people with this illness show signs of hearing loss at younger ages than those without it (Nancy, 2004). Diabetes mellitus is a genetically determined metabolic disorder associated with absolute or relative impairment of insulin and in complete clinical manifestation is characterized by metabolic affections, vascular and neuropathic complications (Clicia & Carlos, 2005). Diabetes mellitus affects an estimated 9.6% of the U.S. adult population (Cowie, Rust, Byrd-Holt, Eberhardt, Flegal & Engelgau, 2006). In Brazil, the incidence of chronic complications of diabetes is quite high. It is estimated that there are five million people with diabetes and half of them are not aware of the diagnosis. A large number of people, especially children and adolescents, have diagnosis of diabetes made in face of complications, especially infections (Chacra, 2001).

One of the morphological aspects more constant in diabetes mellitus is diffuse thickness of basal membrane, which may also happen with vascular endothelium, and it is named diabetic microangiopathy. It is more evident in skin capillaries, skeletal muscles, retina, renal glomeruli, and renal medulla. Its pathogenesis is still obscure, but it is clearly associated with hyperglycemia. Other morphological affections refer to impairment of both motor and sensorial nerves of lower limbs, characterized as Schwann cell lesions, degeneration of myelin and axon damage. The cause of neuropathy is still very controversial, and it may be related with diffuse microangiopathy that would affect nourishment of peripheral nerves (Robbins, Cotran & Kumar, 1991). Neuropathy and angiopathy are common affections in diabetes mellitus. Angiopathy has been observed in small arteries and skin capillaries, muscle, kidney, retina and peripheral nerves. The factors that may cause neuropathy are metabolic disorders (glucose metabolism, lipid metabolism defects and vitamins). Some researchers referred to the fact that vascular affections in interfascicular or intrafascicular branches of vasonbervorum contribute to neuropathy(Clicia & Carlos, 2005). Atherosclerosis, however, is very common in diabetics, it can also contribute to neuropathy, owing to interference in rate of nutrient transfer (Makishima & Tanaka, 1971). Angiopathy may occur in direct way by interfering with blood supply to the cochlea by reducing its transport through the thickened walls of capillaries, and indirectly by the reduction of flow in vascular pathways or through the secondary degeneration of 8th cranial nerve (Taylor & Irwin, 1978).

Concerning diabetes mellitus and hearing loss, there are different opinions about the pathological affections caused in the auditory system. In the literature, there are many different types of hearing loss found in diabetic patients. One of them is progressive, gradual bilateral sensorineural loss, affecting especially high frequencies among the elderly. It would be similar to presbyacusis, but with more severe losses than those expected by ageing (Taylor & Irwin, 1978). Conversely, there are authors that report the possibility of having early sensorineural hearing loss (Friedman, Schulman & Weiss 1975) and others that reported hearing loss in low and medium frequencies (Tay, Ray, Ohri & Fronntko, 1995). Some studies described diabetes as the possible cause of unilateral sudden hearing loss (Makishima & Tanaka, 1971), but other authors did not find the same association (Dalton, Klein, Klein, Moss & Cruickshanks, 1998). Rajendran, Anandhalakshmi, Mythili & Viswanatha (2011) said that many researchers have tried to identify the cause of auditory dysfunction among patients with diabetes and based on their conclusions, the probable mechanisms are microangiopathy of the inner ear, neuropathy of the cochlea nerve, a combination of both, outer hair dysfunction and distruption of endolymphatic potential.

2.7 Hypertension, Hearing Loss and the Elderly

The Joint National Committee 7 (JNC 7) defines normal blood pressure as a systolic blood pressure less than 120 mmHg and diastolic blood pressure less than 80 mmHg. (Chobanian, Bakris, Black, Cushman, Green, Izzo, Jones, Materson, Oparil, Wright, Roccella, 2003). There is a continuous, consistent, and independent relationship between elevated blood pressure and risk of cardiovascular events. This was clearly demonstrated in a meta-analysis that evaluated mortality due to vascular events in a million participants that included 61 observational trials. Results from this study demonstrated that a blood pressure level of less than 115/75 mm Hg appears to better define as optimal blood pressure (Lewington, Clarke & Qizilbash, 2002).

All living cells in the human body depend on a proper supply of oxygen and nutrients in order to maintain their function, and such supply depend on the functional and structural integrity of the heart and blood vessels. Hypertension, the most common vascular disorder, may facilitate structural changes in the heart and blood vessels (Nagahar, Fisch & Yagi, 1983). High pressure in the vascular system may cause inner ear hemorrhage, which is supplied by the anterior inferior cerebelar artery, which supports the inner ear artery and is divided into cochlea artery and anterior vestibular artery (Bachor, Selig, Jahnke, Rettinger & Kaemody, 2001), which may cause progressive or sudden hearing loss (Nagahar et al.,1983). This circulatory system pathology may directly affect hearing in a number of ways. One of the vascular physiopathological mechanisms described is the increase in blood viscosity, which reduce capillary blood flow and ends up reducing oxygen transport, causing tissue hypoxia, thus causing hearing complaints and hearing loss in patients (Ohinata, Makimoto, Kawakami & Takahashi, 1994). Moreover, arterial hypertension may cause ionic changes in cell potentials, thus causing hearing loss (Rarey, Ma, Gerhardt, Fregly, Garg & Rybak, 1996).

Maarchiori, Rego, Eduardo and Matsuo (2006); Park, Johnson, Shear-Miller and DeChicchis (2007); Crosta (2009) reported an association between hypertension and hearing loss. There are two forms of hypertension; essential (or primary) hypertension and secondary hypertension. Essential hypertension is a far more common condition and accounts for 95% of hypertension. The cause of essential hypertension is multifactorial, that is, there are several factors whose combined effects produce hypertension and a single cause might be difficult to pinpoint. Risks factors for essential hypertension include smoking, sedentary lifestyle, high level of salt intake, high level of alcohol consumption and family history of hypertension. In secondary hypertension, which accounts for 5% of hypertension, the high blood pressure is secondary to (caused by) a specific abnormality in one of the organs or systems of the body such as kidney disease, diabetes and tumors. Essential hypertension affects approximately 72 million Americans, yet its basic causes or underlying defects are not always known. Nevertheless, certain associations have been recognized in people with essential hypertension. For example, essential hypertension develops only in groups or societies that have a high intake of salt, exceeding 5.8 grams daily. Salt intake may be a particularly important factor in relation to essential hypertension in several situations, and excess salt may be involved in the hypertension that is associated with advancing age, African American background and obesity (Crosta, 2009).

Hypertension affects approximately 1 billion individuals worldwide. As the population ages, the prevalence of hypertension will increase even further, unless broad and effective preventive measures are implemented. Recent data from the Framingham Heart Study by Vasan, Beiser, Seshadri, Larson, Kannel, D'Agostino & Levy (2002) suggested that individuals who are normotensive at 55 years of age have a 90% lifetime risk for developing hypertension. The relationship between blood pressure and risk of cardiovascular disease (CVD) events is continuous, consistent, and independent of other risk factors. The higher the blood pressure, the greater the chance of myocardial infarction, heart failure (HF), stroke, and kidney disease. For individuals aged 40 to 70 years, each increment of 20 mmHg in systolic blood pressure or 10 mmHg in diastolic blood pressure doubles the risk of cardiovascular disease across the entire blood pressure range from 115/75 to 185/115 mmHg (Lewington, Clarke, Qizilbash, Peto & Collins 2002).

Table 1: Classification of Blood Pressure for Adults 18 Years or Older

BP Classification	Systolic BP, mmHg	Diastolic BP,mmHg	Lifestyle Modification
Normal	< 120	< 80	Encourage
Prehypertension	120 - 139	80 – 89	Yes
Stage 1 Hypertension	140 – 159	90 – 99	Yes
Stage 2 Hypertension	≥ 160	≥ 100	Yes

The above table 1 provides a classification of blood pressure for adults aged 18 years or older. The classification is based on the mean of two or more properly measured blood pressure readings on each of two or more clinic visits. In contrast with the classification provided in the JNC VI report, a new category designated prehypertension has been added, and stages two and three hypertension have been combined. Patients with prehypertension are at increased risk for progression to hypertension; those in the 130/80 to 139/89 mmHg blood pressure range are at twice the risk to develop hypertension as those with lower values (Chobanian etal., 2003).

Systolic Measurement

More attention is now paid to systolic blood pressure than the diastolic as was in the past. The argument now is that systolic blood pressure is critically important and has been under appreciated for many years. Risk of cardiovascular events correlates better with systolic than diastolic blood pressure. Therefore managing patient requires putting more emphasis on systolic blood pressure (Nwachukwu, 2011).

Pulse Pressure

Nwachukwu (2011) said that pulse pressure is a new concept that explains why isolated systolic hypertension is so risky. Pulse pressure is the difference between peak systolic pressure and peak diastolic pressure. A patient with a BP reading of 120/80 mmHg has a pulse pressure of 120 – 80 = 40. If pulse pressure is 60 or higher, it signals that the patient has an increased risk. For instance, a patient with a BP of 170/70 mmHg (pulse pressure of 100) is in a much worse situation than another patient who had 170/100 mmHg (pulse pressure of 70).

Risk Factors for Hypertension

Risk factors are behaviour or conditions that have been shown to significantly incerease the likelihood of developing hypertension. Risk factors for hypertension may be non-modifiable or modifiable.

A. Non-modifiable Factors

(i) Family history of hypertension or heart disease (heredity)

(ii) Increasing age

(iii) Gender

(iv) Black race

(V) Post menopausal state (female)

B. Modifiable Factors

(i) Smoking

(ii) Excess salt intake

(iii) Overweight or Obesity

(iv) Physical exercise inactivity or sedentry lifestyle

(v) Excessive alcohol consumption

(vi) High cholesterol

(vii) Stress

(xiii) Depression

(ix) Political situation

The presence of multiple risk factors in an individual is synergistic in their combined effect generating hypertension. According to Nwachukwu, (2011), hot temper makes one more vulnerable to developing hypertension.

Symptoms of Hypertension

Hypertension usually has no symptoms. It is truly a "silent killer". Most people with hypertension feel fine and can only be discovered during routine check when the blood pressure is mesured. Some people report vague symptoms such as headache, dizziness, fatigue, chest pain, epistaxis (nose bleeding) and palpitation. However, these are not related to hypertension, which usually does not cause such symtoms. Very severe hypertension may cause pulsating headache, visual disturbances, nausea and vomiting (Nwachukwu, 2011).

Types of Hypertension in the Elderly

There are at least two types of hypertension seen in this group. The first is classic essential hypertension when both systolic and diastolic blood pressure readings are above the normal range. The second is isolated systolic hypertension when the systolic is high, that is, greater than 140 mmHg and the diastolic is normal, that is, 80 mmHg. In general, hypertension in the elderly increases the risk of stroke, heart attack, heart failure, kidney failure, and death. However, isolated systolic hypertension is more common, more progressive and associated with increased risk of these complications in the elderly more than regular classic hypertension. Unfortunately, many elderly people continue to live with uncontrolled or inadequately controlled hypertension

Advancement in age is associated with changes in the structure of the walls of the blood vessels tha makes them more inelastic. These changes produce loss of vascular compliance and it affects size and volume of the lining of the arteries and ultimately results in hypertension. These biological changes in the arterial caliber (diameter of blood vessels) translate into overall cardiac dysfunction and to heart failure (Nwachukwu, 2011).

Treatment of Hypertension in the Elderly

Nwachukwu (2011) opined that hypertension in the elderly should be treated to reduce the risk associated with it, since proper treatment reduces death and disability. Close blood pressure monitoring is important in the elderly for early diagnosis and prompt initiation of therapy. Medical treatment should always be accompanied by lifestyle modification in the elderly. Focussed and guided lifestyle modification is safe for the elderly. Choice of medications should be based on both anti-hypertensive effect and their ability to reduce overall risk for heart failure, heart attack, kidney failure and stroke.

Management Strategy

The overall management may be in two parts:

A. Lifestyle Modification or Non-pharmacological Measures

Nwachukwu (2011) said that lifestyles modification helps a lot and it should be instituted wherever appropriate in all patients including those who require drug treatment. They are used for a number of complimentary reasons as outlined in WHO Techincal Report-Hypertension Control: to lower the blood pressure in individual patient, to reduce the need of antihypertensive drugs and maximize their efficiency, to address other risks present and for primary prevention of hypertension and associated cardivascular disorders in the populations. Lifestyles measures include: no smoking, maintaining an ideal weight, restriction of salt intake, exercise on regular basis, minimizing alcohol consumption, stress reduction, positive thinking, checking blood presssure regularly and dietary changes.

A healthy eating plan can both reduce risk of developing hypertension and lower an already elevated blood pressure, for instance, DASH diet. “Dash” stands for “Dietary Approach to Stop Hypertension” a clinical study that tested the effects of nutrients on blood pressure. Study results indicated that blood pressure were reduced by an eating plan that emphaizes fruits, vegetables, low fats diary foods and food that is low on saturated fat, total fat and cholesterol. The DASH diet includes whole grains, poultry, fish, nuts and has reduced amount of fats, red meat, sweets and sugared beverages. So, by eating fewer processed or refined foods, more fruits and vegetables (which contain potassium) and low-fat diary foods (which contain calcium and magnesium), the elderly can increase the intake of helpful nutrients and decrease salt intake at the same time (Nwachukwu, 2011). Adoption of healthy lifestyles by all individuals is critical for the prevention of high blood pressure and an indispensable part of the management of those with hypertension. In clinical trials, antihypertensive therapy has been associated with 35% to 40% mean reductions in stroke incidence; 20% to 25% in myocardial infarction; and more than 50% in heart failure. (Neal, MacMahon & Chapman, 2000).

Major lifestyle modifications show to lower blood pressure which include weight reduction in those individuals who are overweight or obese (He, Whelton, Appel, Charleston, Klag, 2000); adoption of Dietary Approaches to Stop Hypertension (Sacks, Svetkey, Vollmer, Appel, Bray, Harsha, Obarzanek, Conlin, Miller, Simons-Morton, Karanja, Lin, Aickin, Marlene, Moore, Proschan and Cutler, 2001) which is rich in potassium and calcium (Vollmer, Sacks, Ard, Appel, Bray, Simons-Morton , Conlin, Svetkey, Erlinger, Moore & Karanja, 2001); dietary sodium reduction (Sacks et al., 2001); physical activity (Kelly & Kelly, 2000); and moderation of alcohol consumption (Xin, He, Frontini, Ogden, Motsamai, Whelton , 2001). Lifestyle modifications decrease blood pressure, enhance antihypertensive drug efficacy, and decrease cardiovascular risk. For example, a 1600-mg sodium Dietary Approaches to Stop Hypertension has effects similar to single drug therapy (Sacks et al., 2001). Combinations of two or more lifestyle modifications can achieve even better results.

B. **Drug Treatment (Pharmacological Therapy)** Medicines used to control hypertension are called antihypertensive. If lifestyles changes do not lead to the desired antihypertensive effect, medical treatment for hypertension may become necessary. (Nwachukwu, 2011). Most patients with Hypertension will require two or more antihypertensive medications to achieve their blood pressure goals. (Cushman, Ford, Cutler, Margolis, Davis, Grimm, Black, Hamilton, Holland, Nwachuku, Papademetriou, Probstfield, Wright, Alderman, Weiss, Piller, Linda, Bettencourt & Walsh, 2002). Addition of a second drug from a different class should be initiated when use of a single drug in adequate doses fails to achieve the blood pressure goal. When blood pressure is more than 20/10 mmHg above goal, consideration should be given to initiating therapy with 2 drugs, either as separate prescriptions or in fixed-dose combinations.

The initiation of drug therapy with more than one agent may increase the likelihood of achieving the blood pressure goal in a more timely fashion, but particular caution is advised in those at risk for orthostatic hypotension, such as patients with diabetes, autonomic dysfunction, and some older persons. Use of generic drugs or combination drugs should be considered to reduce prescription costs. The patient with hypertension and certain comorbidities requires special attention and follow-up by the clinician. Failure to titrate or combine medications, despite knowing the patient is not at blood pressure goal, represents clinical inertia and must be overcome (Philips, Branch, Cook, Doyle, El-Kebbi, Gallina, Miler, Ziemer & Barnes, 2001). Decision support systems (that is, electronic and paper), flow sheets, feedback reminders, and involvement of nurse, clinicians and pharmacists can be helpful.

The Institute of Medicine of the National Academies recommends healthy 19 to 50-year-old adults to consume only 3.8 grams of salt to replace the average amount lost daily through perspiration and to achieve a diet that provides sufficient amounts of other essential nutrients. Approximately 30% of cases of essential hypertension are attributable to genetic factors. For example, in the United States, the incidence of high blood pressure is greater among African Americans than among Caucasians or Asians. Also, in individuals who have one or two parents with hypertension, high blood pressure is twice as common compared to the general population (Crosta, 2009). One hypothesis is that there may be a population at increased risk for both hearing loss and high blood pressure. This is in accordance to animal studies in which genetically hypertensive rats have been found to be more susceptible to NIHL than normotensive rats (Borg, 1982). However, animals with induced hypertension showed no correlation between hearing loss and systolic blood pressure (Borg, 1987).This observation does not support the hypothesis that hypertension directly interacts with noise exposure. A review of the literature studying possible correlations between hearing function and cardiovascular disease (CVD) reveals a complex and somewhat contradictory picture.

2.8 Noise, Hearing Loss and the Elderly

Noise is often arbitrarily defined as an unpleasant or undesired sound (Churchill, 1989). According to Berglund and Lindvall (1995), sound is physically produced by mechanical disturbance propagated as a wave motion in air or other media and physical sound evokes physiological responses in the ear and auditory pathways. Psychologically, sound is a sensory perception originated as a mental event evoked by physiological processes in the auditory and other parts of the brain. Thus, it is merely through the perceptual analysis of sounds that the complex pattern of sound waves may be classified and labelled noise, music or speech. Noise is a sound especially a loud or unpleasant one. It is also a series or confusion of loud sounds, irregular fluctuations accompanying a transmitted signal. Noise is a number of tonal components disagreeable to man and more or less intolerable to him because of the discomfort, fatigue, disturbances and, in some cases, pain it causes (Hamza, 2008).

Noise pollution is one of the environmental hazards affecting human as well as climate. In most urban areas of the third or developing countries of the world, there are lots of noise pollutants which include noise from exhaust cars, industries as well as home generating plants. In the advanced countries however, scientific experimentations like launching and re-launching of rockets, bombs and satellites sounds constitutes a major climate pollutant. Human being, animals, plants and even inert objects like buildings and bridges have been victim of the increasing noise pollution caused in the world. Noise has become a very significant stress factor in the environment, to the level that the term noise pollution has been used to signify the hazard of sound which consequences in the modern day development is immeasurable.

Although not physically visible, noise has been a major catalyst to climate change and practical sources of human health catastrophes globally. Therefore, from the foregoing, it can rightly be summed up that noise is an unwanted pollutant introduced directly or indirectly into the environment usually at 80-85dB level and at which sound becomes so painful and of deleterious effects as harm to living resources, hazard to human health and sea amenities (Alawode, Stephen & Adeyemi, 2008). A major distinction between sound and noise is that sound is regarded as noise when it becomes a source of inconvenience to another (Mohammed, 2008). Therefore, from a physical point of view, there is no difference between the concepts of sound and noise, although it is an important distinction for the human listener. Thus, sound can have a range of different physical characteristics, but it only becomes noise when it has an undesirable physiological or psychological effect on people. Experts therefore, agreed that it is not possible to define noise exclusively on the basis of physical parameters of sound. Rather, noise is defined operationally as audible acoustic energy that adversely affects, or may affect the physiological and psychological wellbeing of people (Berglund & Lindvall, 1995).

While noise in high enough doses produces permanent damage to the auditory system, it can lead to significant hearing loss, it also produces stress and interferes with the ability to communicate (Michael & Byrne, 2000). In measuring noise, the temporal pattern and characteristics of sound are taken into consideration. The temporal patterns of environmental noise are typically described as continuous, flunctuating, intermittent or impulsive. Continuous noise remains relatively constant, flunctuating noise rises and falls in level over time and intermittent sounds are interrupted for varying time periods. Impulsive or impact noises are caused by explosive or metal-on-metal mechanical events and have rapidly changing pressure characteristics consisting of intense, short-lasting (milliseconds) wave forms, followed by much smaller reverberations and echoes that can last many seconds (Lonsbury-Martin & Martin, 1993). The two basic characteristics of sound, frequency and amplitude are related to how loud and annoying a sound is. Frequency describes the rate of vibration, that is how fast the object is moving back and forth. The more rapid the movement, the higer the frequency of the sound pressure waves created. The unit for measuring frequency is Hertz (Hz) which is equivalent to one wave or cycle per second (Lonsbury-Martin & Martin, 1993).

The instrument for measuring noise is called sound pressure level meter or a number of its derivatives, including noise dose meters (usually called dosimeters), integrating sound level meters, graphic level recorders, and community noise analyzers. Improvements in all of these instruments have taken place during the last decade. This is especially true of the computerized dosimeters and integrating meters, which can measure, compute, store, and display comprehensive data on the noise field (Earshen, 1986). Rosen, Bergman, Plester, El- Mofty and Satti (1962) conducted a study in the Sudan. They found that those members of the population over 70 years of age did not show any appreciable decrease in hearing acuity as did similar group in the United States of America. Since research studies have confirmed no racial differences in the ability of ears to withstand loud noises, they concluded that the elderly in Sudan had better hearing because the people lived in a relatively noise-free environment.

Hearing loss caused by exposure to recreational and occupational noise is a devastating disability and it is virtually 100 percent preventable (Humes, Joellenbeck & Durch, 2005). Hearing loss caused by exposure to nonoccupational noise is collectively called sociocusis. It includes recreational and environmental noise (e.g., loud music, guns, power tools, and household appliances) that affect the ear the same as occupational noise (National Institute for Occupational Safety and Health - NIOSH, 1998). Brookhouser (1994) said out of more than 28 million Americans with some degree of hearing impairment, as many as 10 million had their hearing loss caused in part by excessive noise exposure in the workplace or during recreational activities. According to NIOSH (1996), 30 million Americans are exposed to potentially harmful sound levels in their workplaces, even outside work, many people pursue recreational activities that can produce harmful noise. Over sixty million Americans own firearms, and many use them without adequate hearing protection (Dobie, 1995). Occupational noise induced hearing loss (ONIHL) is defined as bilateral sensorineural hearing loss that develops slowly over a period of several years as the result of exposure to continuous or intermittent loud noise in the workplace. Tinnitus and noise induced hearing loss have been commonly reported in military personnel who are routinely exposed to occupational noise (Humes et al., 2005). Estimates suggest that about 30 million Americans are exposed to hazardous noise levels in the workplace (American Academy of Audiology, 2008). Based on exposure levels, about one out of every four workers would develop permanent hearing loss (Prince, Stayner, Smith and Gilbert 1997).

Occupational noise-induced hearing loss can significantly influence worker communication and safety and can have a tremendous impact on the lives of workers (Hetu, Getty & Quoc, 1995). Typically, the first sign of hearing loss from noise exposure is a notching of the audiogram at 3,000 Hz, 4,000 Hz, or 6,000 Hz, with recovery at 8,000 Hz (McBride & Williams, 2001). In early stages of noise induced hearing loss, the average hearing thresholds at 500 Hz, 1,000 Hz, and 2,000 Hz are better than the average at 3,000 Hz, 4,000 Hz, and 6,000 Hz, and the hearing level at 8,000 Hz is usually better than the deepest part of the notch. This notch is in contrast to age-related hearing loss, which also produces high frequency hearing loss, but in a down-sloping pattern without recovery at 8,000 Hz. Noise induced hearing loss is the second most common form of sensorineural hearing deficit after presbyacusis. Shearing forces caused by any sound have an impact on the stereocilia of the hair cells of the basilar membrane of the cochlea. When excessive, these forces can cause cell death. Avoiding noise exposure stops further progression of the damage. Noise-induced hearing loss is a common occupational disease among workers exposed to noise in the workplace. According to the results of a regular health checkup in Japan in 2004, some 8.4% of the one million people who took the test had hearing loss of more than 20 dB on a hearing test at 4,000 Hz. The Japanese Ministry of Health, Labour and Welfare formulated “Guidelines for Noise Control” (No. 546, October 1, 2002) and has promoted hearing protection in workers exposed to noise at work. Wearing noise protection devices is an important measure that individuals can take to prevent noise induced hearing loss. Two major issues in the prevention of hearing loss with noise protection devices are to increase the wearing rate of those devices in the workplace and to make sure they are used in an effective way. (Tsukimi & Hisataka, 2008).

Occupational noise-induced hearing loss (ONIHL) is a more common cause of noise-induced hearing loss with much more problems than socioacusis for the following two reasons: first, the threat of loss of employment may convince people to remain in environments with noise levels higher than they would otherwise accept, and second, in the workplace, high levels of noise may be sustained on a regular basis for many hours each day over many years (Neeraj, 2009). Hearing loss caused by sociocusis includes recreational and environmental noise from loud music, hunting, power tools, and household appliances(NIOSH, 1998). The average, otherwise healthy person, will have essentially normal hearing at least up to the age of 60 if his or her unprotected ears are not exposed to high noise levels of 85dB and above (American College of Occupational and Environmental Medicine - ACOEM, 2003). In Japan, even after workers receive noise protection education, little effect is reported in terms of an increased usage rate of ear protectors (Yoshioka, Taniyama, Okazaki, Ito & Hyakukei, 2004). Recently, Ariyoshi (2007), reported that the rate of wearing earplugs was 57% among noise-exposed workers and similar findings were also reported in other countries (Williams, Purdy, Murray, Dillon, LePage, Challinor & Storey, 2005).

Interview surveys indicated that elderly men have a higher prevalence of hearing impairment than elderly women (U.S Department of Health and Human Services, 1981). Hull (1977) said men and women aged 50 to 80 experience hearing loss in the same frequency range, but hearing loss increases more rapidly in men than in women. After age 80, these differences in hearing impairment between men and women become indistinguishable. Some experts suggested that these different rates are the result of lifelong exposure to loud noise while hunting, serving in the military, or working in farm and factory occupations (Becker, Flower, Glass & Newcomer, 1984). Many studies have approached the theme gender and hearing loss in relation to age (Lee, Matthews, Dubno & Mills, 2005). Pearson, Morrell, Gordon-Salant, Brant, Metter, Klein and Fozard (1995) said that there is a two-fold increase in the speed at which men lose their hearing, when compared to women, showing that age and gender are indeed related to hearing loss even in groups without signs of noise-induced hearing loss. Cruickshanks, Wiley, Tweed, Klein, Klein, Mares-Perlman and Nondahl (1998) also said that average hearing thresholds in men are typically poorer than those of women in the high frequencies, men exhibited a sharply sloping hearing loss in the moderately severe range in the high frequencies, women exhibited a more gradual sloping hearing loss in the moderate range in the high frequencies.

However, results of recent studies indicated that age-related sensorineural hearing loss is still the most prevalent type and occupational noise induced hearing loss accounts for less than 10% of the burden of adult hearing loss in the United States (Dobie, 2008). It is universally accepted that ageing and noise are the most common causes of adult sensorinerural hearing loss. The American Academy of Otolaryngology-Head and Neck Surgery – AAOHNS (2007), reported that ageing and noise exposure are the common causes of sensorineural hearing loss with one in 10 Americans experiencing hearing loss that affects speech understanding ability.

Noise induced hearing loss can be prevented by avoiding excessive noise and using ear protectors such as earplugs and earmuffs (Rabinowitz, 2000). Earplugs are small inserts that fit into the outer ear canal. To be effective they must totally block the ear canal with an airtight seal. They are available in a variety of shapes and sizes to fit individual ear canals and can be custom made. For people who have trouble keeping them in their ear, they can be fitted to a headband. On the other hand, Earmuffs fit over the entire outer ear to form an air seal so the entire circumference of the ear canal is blocked, and they are held in place by an adjustable band.

Apart from the deliterious effects of noise on hearing, other effects of noise on man has been catalogued (Report on the Conference on Acoustics and Societal Problems, 1972). Among the extra-auditory effects of sounds are, the effect of noise on performance, general physiological effects and interference with sleep (Bakare, 1980). According to National Institute for

Occupational Safety and Health & Centre for Disease Control - NIOSH and CDC (2002), table 2 below shows the accepted standards for recommended permissible noise exposure time for continuous time weighted average. For every 3 decibels over 85 dB, the permissible exposure time before possible damage can occur is cut into half:

Table 2: Permissible Noise Exposure Time for Continuous Time Weighted Average

Continuous dB	Permissible Exposure Time
85 dB	8 hours
88 dB	4 hours
91 dB	2 hours
94 dB	1 hour
97 dB	30 minutes
100 dB	15 minutes
103 dB	7.5 minutes
106dB	3.75 min (< 4min)
109 dB	1.875 min (< 2min)

The below table according to American Hearing Research Foundation, AHRF (2008) are common sounds and their intensities:

Table 3: Common Sounds and their Intensities

Approximate Decibel Level	Examples
0 dB	Faintest sound heard by human ear
30 dB	Whisper, quiet library
60 dB	Normal conversation, sewing machine, typewriter
85 dB	A dangerous decibel; motocycle, bulldozer that is idling (not actively bulldozing and 8 hours per day is the maximum exposure time without protection)
90 dB	Lawnmower
100 dB	Automobile horn, listening to music on earphones at standard volume
120 dB	Sandblasting, loud rock concert, a clap of thunder, ambulance siren
140 dB	Gun shot (depending on the weapon), jet engine. Noise can cause pain and brief exposure injuries in unprotected ears. Maximum allowed noise even with ear protectors.

Table 4: Sound Pressure Levels Measured in the Study

82 dB	Toy
85 dB	Air Conditioner (window type), Mobile phone ring tone
86 dB	Small electricity generator
96 dB	Grinding machine
97 dB	Television set at the peak volume
100 dB	Buldozer working at a construction site
103 dB	Music at social gathering, radio station at its peak volume
105 dB	Tractor
106 dB	Airplane at parking
112 dB	Big electricity generator
128 dB	Train

CONCEPTUAL REVIEW

2.9 Anatomy and Physiology of the Human Ear

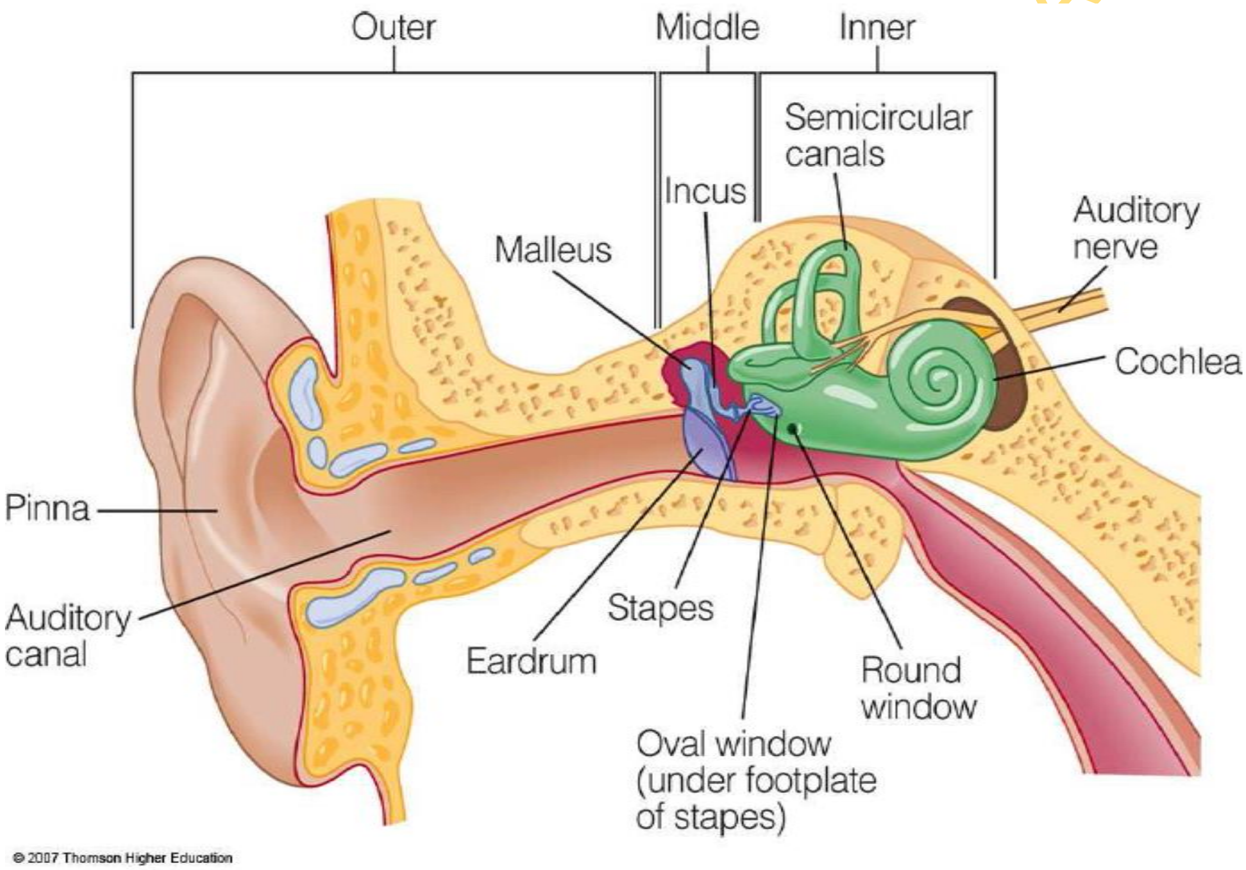


Figure 1: Anatomy of the Human Ear

According to Glynn (2009), the human ear is the anatomical structure responsible for hearing and balance. The ear consists of three parts: the outer, middle, and inner ears. The outer ear collects sounds from the environment and funnels them through the auditory system. The outer ear is composed of three parts, the pinna (or auricle), the external auditory canal (or external auditory meatus), and the tympanic membrane (or eardrum). The middle ear transmits sound from the outer ear to the inner ear. The middle ear consists of an oval, air-filled space approximately 2 cubic cm in volume. The middle ear can be thought of as a room, the outer wall of which contains the tympanic membrane. The back wall, separating the middle ear from the inner ear, has two windows, the oval window and the round window. There is a long hallway leading away from the side wall of the room, known as the eustachian tube. The brain lies above the room and the jugular vein lies below. The middle ear is lined entirely with mucous membrane (similar to the nose) and is surrounded by the bones of the skull. The inner ear is responsible for interpreting and transmitting sound (auditory) sensations and balance (vestibular) sensations to the brain. The inner ear is small (about the size of a pea) and complex in shape, where its series of winding interconnected chambers has been compared to and called labyrinth. The main components of the inner ear are the vestibule, semicircular canals, and the cochlea. The three parts of the ear and their unique functions are discussed below:

The Outer or External Ear

The external ear consist of two portions, the first being the pinna, the skin covered flabby cartilage of the ear visible on both sides of the head. The basic function of the outer ear or pinna is to protect the eardrum (tympanic membrane). The outer ear also functions to collect sound waves to the eardrum through the ear canal. The second component of the external ear is the auditory ear canal or meatus. There are modified sweat glands that secrete ear wax in the ear canal. If ear wax is excessive, the ear drum can be damaged or lead to blockage of the transmission of sound (ENTMAGS, 2009).

The Middle Ear

The middle ear refers to the hollowed air-filled bony space (tympanic cavity) in the temporal bone of the skull behind the eardrum. It is just separated from the outer ear by the ear drum. There are three tiny bones (auditory ossicles; malleus, incus and stapes) in the tympanic cavity that vibrates when exposed to sound waves. These bones form a chain around the middle ear and extend to the oval window of the inner ear and their main function is to amplify sound. The middle ear connects to the back of the throat and nose through the Eustachian tube. The Eustachian tube is the auditory pathways that open during yawning or swallowing (ENTMAGS, 2009).

The Inner Ear

The inner ear is the most complicated component of the auditory system located into a tiny space of the hardest temporal bone and inaccessible to direct examination or clinical manipulation. The inner ear comprise of three intimately related structures - the cochlea (spiral tube), three semicircular canals and the vestibule (labyrinth). The cochlea is directly responsible for hearing and contains nerves responsible for converting energy vibrations within the inner ear fluid into nerve impulses which can be transmitted to the brain. While the vestibule (labyrinth) and semicircular canals function to maintain balance or equilibrium (ENTMAGS, 2009).

Degree of Hearing Loss

Normal degree of hearing is between 0-25 dB. World Health Organisation in 1980 recommended the following classification on the basis of pure tone audiogram taking the average of the thresholds of hearing for frequencies of 500,1000 & 2000 Hz (Dhingra, 2004)

Mild	26-40dB
Moderate	41-55dB
Moderately severe	56-70dB
Severe	71-90dB
Profound	91dB above

Table 5: Hearing Loss and Difficulty in Hearing Speech

Hearing Threshold	Degree of Impairment	Ability to Understand Speech
0-25dB	not significant	no significant difficulty with faint speech
26-40dB	Mild	difficulty with faint speech
41-55dB	Moderate	frequent difficulty with normal speech
56-70dB	moderately severe	frequent difficulty even with loud speech
71-90dB	severe	can understand only shouted or amplified speech
above 91dB	Profound	usually cannot understand even amplified speech

2.10 Types of Hearing Loss

The main three types of hearing loss according to Walter (2010) are Conductive hearing loss, Sensorienural hearing loss and Mixed hearing loss.

Conductive Hearing Loss - Conductive hearing loss has normal bone-conduction thresholds, but air-conduction thresholds are poorer than normal by at least 10 dB. Conductive hearing loss is secondary to an outer ear or middle ear abnormality, which can include abnormalities of the tympanic membrane. The abnormality reduces the effective intensity of the air-conducted signal reaching the cochlea, but it does not affect the bone-conducted signal that does not pass through the outer or middle ear. Examples of abnormalities include occlusion of the external auditory canal by cerumen or a mass, middle ear infection and/or fluid, perforation of the tympanic membrane, or ossicular abnormalities. Pure-tone air-conduction threshold is more than 25 dB while bone-conduction threshold is within normal range, that is, less than 25 dB (Walter, 2010).

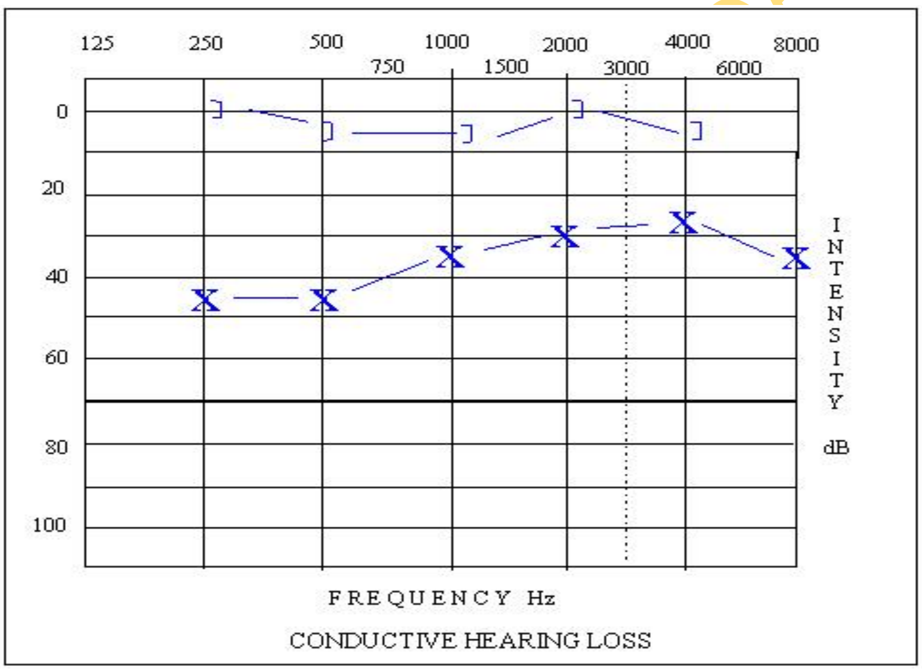


Figure 2: Audiogram Depicting Conductive Hearing Loss

Sensorineural Hearing Loss - It results from lesions of the cochlea (sensory type) or VIIIth nerve and its central connectons (neural type). Causes of sensorineural hearing loss include: meniere's disease, hearing loss of ageing (presbycusis), nerve injury from syphilis, noise exposure, nerve tumors and, drug toxicity (such as aspirin and aminoglycosides). Sensorineural hearing loss has bone- and air-conduction thresholds within 10 dB of each other, and thresholds are higher than 25 dB (Walter, 2010).

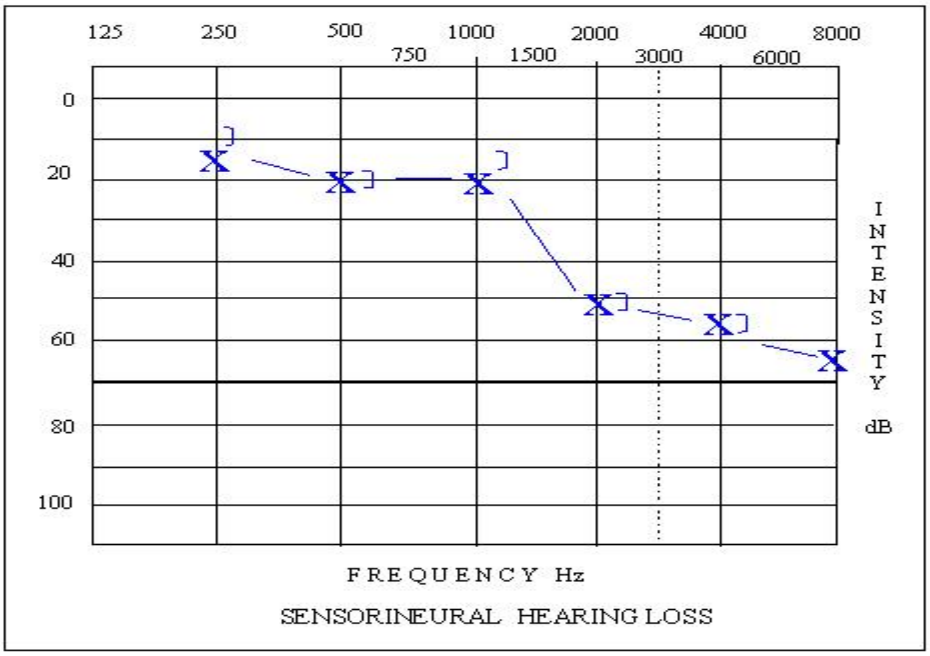


Figure 3: Audiogram Depicting Sensorineural Hearing Loss

Mixed Hearing Loss - In this type, elements of both conductive and sensorineural deafness are present in the same ear. There is air - bone gap indicating conductive element, and impairment of bone conduction indicating sensorineural loss. Pure-tone air-conduction threshold is poorer than bone-conduction threshold by more than 10 dB, and bone-conduction threshold is more than 25 dB (Walter, 2010).

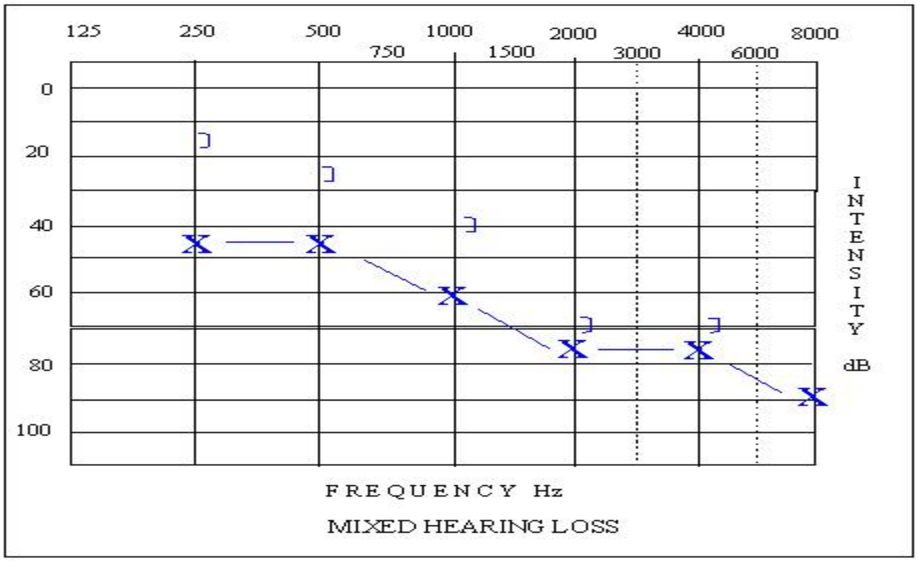


Figure 4: Audiogram Depicting Mixed Hearing Loss

Other types of hearing loss according to Olusesi (2004) are Central auditory dysfunctioning and functional hearing loss.

Central Auditory Dysfunction - Central hearing loss occurs in the presence of normal external and middle ear (conductive routes), and normal cochlea . It refers to loss of hearing sensitivity due to damage to the auditory nerve in the brainstem or in the hearing centers of the brain.

Functional Hearing Loss - Functional (Psychogenic) hearing loss is due to non-organic causes, that is, hysteria or malingering.

2.11 Aetiology of Hearing Loss

Ijaduola (2010) highlighted the following types and causes of hearing loss:

Table 6: Aetiology of Hearing Loss

Conductive deafness	**Sensorineural deafness**		**Psychogenic deafness**
	Sensori	**Neural**	
A. Congenital i)Congenital meatal stenosis ii)Fusion or agenesis of Ossicular chain iii)Otosclerosis B. Trauma i)Barotrauma ii)Foreign bodies iii)Rupture of tympanic membrane iv)Traumatic Ossicular Chain Disconnection C. Wax D. Infection i)Otitis externa ii)Acute otitis media iii)Secretory otitis media iv)Chroic otitis media E. Tumors i)Tumors of external ear ii)Tumors of middle ear iii)Nasopharyngeal tumor	A.Congenital i)Genetic ii)Intra-Uterine viral infection e.g maternal rubella iii)Hemolytic disease of the new born iv)Anoxia v)Birth injuries vi)Congenital syphilis B.Trauma i)Head injuries ii)Bomb blasts iii)Noise exposue C. Infection i)Measles ii)Mumps iii)Suppurative labyrinthitis D.Influenza Herpes Otitis E. Drugs i) Streptomycin ii) Viiomycin iii) Vancomycin F. Others i) Meniere's disease ii) Late Otosclerosis	A.Cochlear nerve injury B.Cochlear nerve tumor e.g Acoustic neuroma	A. Malingering B. Inattentiveness C. Hysterics

2.12 Presbyacusis

Presbyacusis is a progressive, usually bilateral, sensorineural hearing loss that occurs in older people as they age. It is a multifactorial process driven by environmental factors and exacerbated by concurrent disease (Lui & Yan, 2007). Dhingra (2004), says presbyacusis usually manifests at the age of 65 years but may do so early if there is hereditary predisposition, chronic noise exposure or generalised vascular disease.

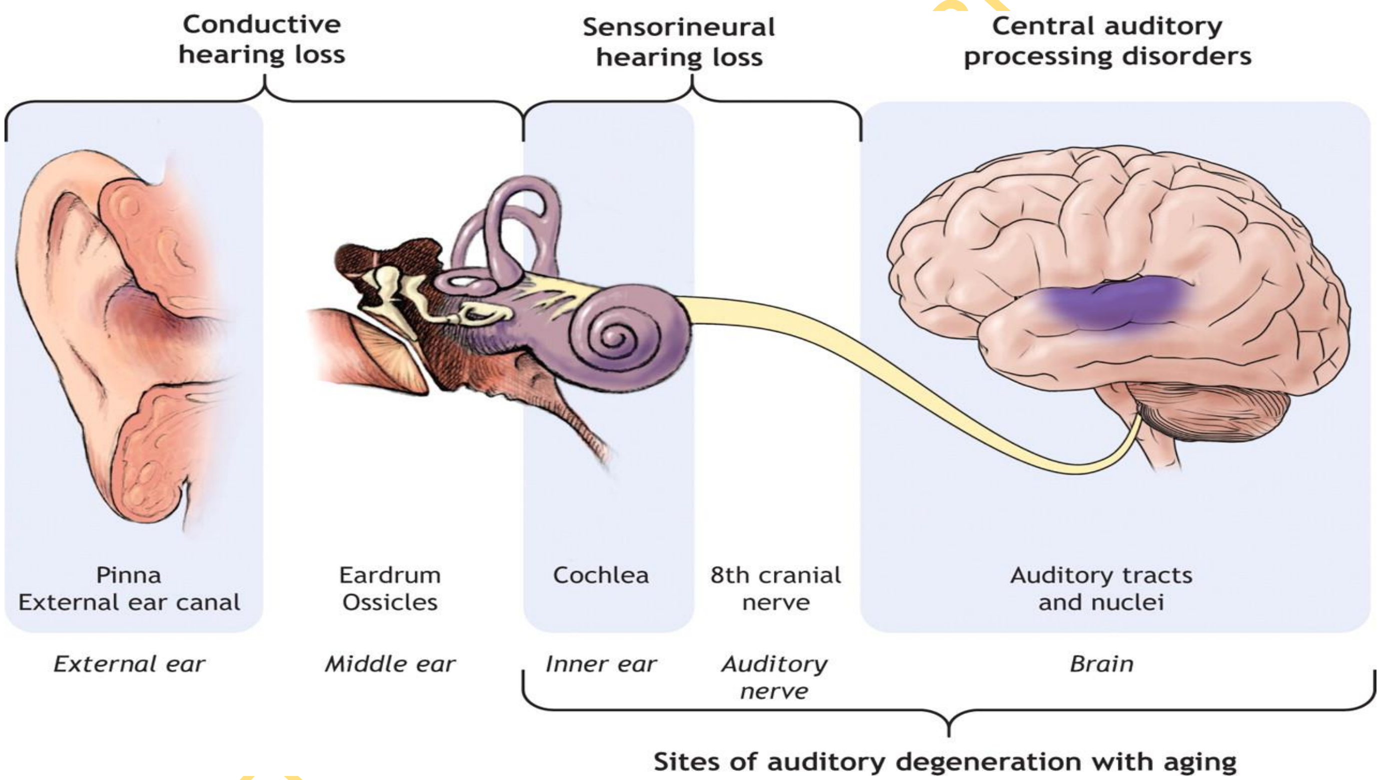


Figure 5: Pathophysiology of Presbyacusis

Loss of cochlea outer hair cells, ganglion cell loss in vestibulocochlear nerve fibres and atrophy of the highly vascular stria in the lateral cochlea wall all contribute to hearing loss among the elderly people. Stiffness of the cochlea basilar membrane (cochlea conductive deafness) was considered to contribute but is now thought to be of minor relevance. It is not ageing of itself that causes the problem, rather the effects accumulated environmental noise toxicity and metabolic/oxidative stress. Degenerative central nervous mechanisms (central presbyacusis) can cause poor speech discrimination in some individuals (10%) but is unusual in isolation and difficult to distinguish from peripheral causes. Central presbycusis may still be improved by treatment aimed at peripheral mechanisms (Lui & Yan, 2007)

Types of Presbyacusis

Presbyacusis can occur in 4 differing pathological types or in combination. These are sensory presbyacusis, neural presbyacusis, strial presbyacusis and cochlea conductive presbyacusis (Balasubramanian, 2006).

Sensory Presbyacusis: is caused by loss of hair cells at the basal end of the cochlea. This commonly occurs in an ageing cochlea. The area of involvement may extend to involve even the speech frequency area of the cochlea. These changes cause a rapid decrease in the threshold for high freqency sounds.

Neural Presbyacusis: is caused by a loss in the population of cochlea neurons, but the end organs are still functional causing severe loss in speech discrimintion. Pure tone thresholds are nearly normal.

Strial Presbyacusis: This is also known as Metabolic presbyacusis. Atrophy of stria vascularis is commonly seen in this condition. Hearing loss in these patients is insidious in onset occurring during the 3rd - 6th decades of life and it runs in families. The clinical feature that identifies this condition from the other types of presbyacusis is the presence of a flat or a slightly descending audiometric curve but speech discrimination is good. These patients respond well to the amplification produced by hearing aids. This type of presbyacusis carries the best prognosis because of this feature.

Cochlea Conductive (Mechanical) Presbyacusis: This type of presbyacusis is differentiated from others by a linear descending audiogram. This is postulated to be caused due to stiffening of the basilar membrane of the cochlea. The thickening has been found to be more severe in the basilar turn of the cochlea where the basilar membrane is thin.

Prevention of Presbyacusis

Some causes of hearing impairment in elderly people are not well enough understood to allow effective preventive measures. For example, dietary factors and circulatory changes have been implicated as accelerators of deterioration in the auditory system. Yet the specific relationship of these factors to hearing loss is not known, and further research is needed before preventive strategies can be developed (Becker, Flower, Glass & Newcomer, 1984). Other causes of hearing impairment are well understood and often preventable; these include untreated ear infections, exposure to loud noise, and some medications. Untreated or inadequately treated ear infections at any time in life can cause conductive hearing loss, though it may not be immediately disabling. In old age, however, as sensorineural loss further reduces hearing acuity, serious disability may develop. Thus better health care throughout life could prevent some hearing impairments in old age (Becker et al., 1984).

Exposure to loud noise at any age can cause irreversible sensorineural damage and significant hearing loss. Airplanes, motorcycles, heavy traffic, farm and industrial machinery, gunfire, and loud music are sources of noise that can permanently damage hearing (U.S. Congress 1986). However, hearing protective devices such as earplugs and earmuffs should provide adequate attenuation to reduce noise exposure at the eardrum to less than 85dB time-weighted average. In addition, technology is now available which can provide an individualized attenuation rating for these hearing protective devices and continous monitoring fo noise at the eardrum (Michael, Tougaw & Wilkinson, 2011; Hagar, 2011).

Noise control procedures have been implemented in some industries in the U.S. In addition, some local governments have enacted noise control legislation and violators are being prosecuted (Taylor, 1984). These efforts eventually may reduce the prevalence and severity of noise-induced hearing loss. Many incidents of exposure to loud noise, however, are not within government regulatory control. Increased public education is needed to alert people of all ages to the impact of loud noise on hearing and the long-term damage that can result. Some drugs also damage auditory mechanisms. Although not a major cause of hearing impairment, these “ototoxic” drugs must be considered in any discussion of prevention. The best known of these drugs are the aminoglycosides, a class of antibiotics that include gentamicin, neomycin and streptomycin. These drugs can be life-saving; unfortunately, they also sometimes damage hearing (Becker et al., 1984). Even commonly used, over the counter drugs such as aspirin can be ototoxic, although probably only in the high dosages sometimes used to treat arthritis. Fortunately, aspirin induced hearing loss is usually reversible if it is recognized early and aspirin dosage is reduced. Ototoxic drugs can create problems in people of any age. Nevertheless, diseases that require their use are more prevalent in later life. Too little research has been done to provide a full understanding of the mechanisms of ototoxicity and of the essential chemistry of the agents that may be ototoxic (Becker et al., 1984).

Hearing loss is a symptom with many possible causes and accurate diagnosis can sometimes help prevent permanent hearing impairment. Yet some elderly people do not receive thorough diagnostic evaluation. Symptoms such as sudden onset of hearing impairment and unilateral deafness suggest a diagnosis other than presbycusis, and medical evaluation of patients with these symptoms can sometimes lead to effective treatment (Mader, 1984).

Gates and Mills (2005) said sensory presbycusis is inevitable but avoiding noise exposure and using ear protection in noisy environments will prevent progressive damage. Youngsters should be informed of the danger of repeated and prolonged noise exposure in clubs or at music events. Good diet, general health and fitness can reduce cardiovascular contribution to hearing loss. Darrat, Ahmad and Seidman (2007) also said the role of anti-oxidants in the management and prevention of hearing loss is still being investigated but a recent review suggests promising results for the future.

Management of Presbyacusis

Regular otoscopy, tympanometry and audiometry should be part of general medical checkup. Also the need for continue medical education for the general practitioner for early referral of patients as early intervention will greatly enhance the otological wellbeing of the elderly people in Nigeria and so lighten the burdens of the difficult period of old age. (Afolabi & Ijaduola, 2008). However, the following management options should be considered:

Communication Courtesy and Environmental Noise Manipulation

Those communicating with older patients should take care to speak face-to-face in a clear and unhurried manner. Sufferers should be encouraged to voice difficulties with misheard phrases and ask for clarification. If possible, there should be a clear explanation of the problem to family and friends (Olivia, 2009).

Reassurance and Education

Patients often find it very reassuring to know that they will not go completely deaf. It has been shown that proactive communication education programmes have an important role to play in the management of these patients. This may be as an adjunct to or even replace more traditional interventions like hearing aid fitting (Hickson, Worrall & Scarinci, 2007)

Amplification

According to Olivia (2009), there is a variety of hearing aids using analogue or digital amplification with the digital aids superior to those of analogue. There are ongoing advances in directional microphones and noise-suppression circuitry which continue to improve performance. Hearing aids have their associated problems about which patients should be counselled; normal hearing is not restored, it takes time to learn to use and adapt to one optimally, they can be uncomfortable or cosmetically undesirable and they are expensive. However, they remain the mainstay of managing presbyacusis and are particularly helpful to those with severe hearing loss. Patients should be encouraged to persevere if background amplification is annoying as they will adapt to this problem. Intermittent use prevents central adaptation and should be advised against.

Assistive Listening Devices

In addition to hearing aids, the following types of assistive listening devices can be used to increase auditory effectiveness: hardwire devices, audio loop systems, radio frequency devices (AM and FM), and infrared amplification devices. These devices transmit sound directly from the speaker or other source to the listener, thus reducing interference caused by background noise. They have been used primarily in classrooms and public meeting rooms and are often referred to as "large room systems. " They are now being used by some people for one-to-one or small group listening as well as television and radio listening. Assistive listening devices can be used by elderly people who have hearing aids and have difficulty tuning out background noise. In addition, these devices can give some elderly persons with mild to moderate hearing loss enough amplification to allow them to hear effectively without a hearing aid in some situations (U.S. Congress, Office of Technology Assessment, 1986).

Speech Reading

According to Oyebola (1997), speech reading is the method of reading speech by watching the lips and face of the speaker. The use of facial visual cues and study of lip movements aids understanding of speech (Olivia, 2009).

Auditory Training

Auditory training refers to exercises to cultivate the power of percieving sounds. These sounds may include singing tones or spoken vowels on various notes produced by musical instruments, whistling or ringing of bells. Sometimes, auditory training includes work rhythm, utilizing piano or other musical instruments. These exercises are, in fact, auditory training, so long as they are designed to cultivate and develop the power of perceiving sounds and variations of sounds in time, pitch and intensity. However, auditory training means not only the cultivation of sound perception but also the training of the brain to associate language ideas with the arbitrary sequences of sound, known as words (Oyebola, 1997). Auditory training helps to recognise speech sounds and key words especially with amplification (Olivia, 2009).

Cochlea Implants

These are indicated for any patient, regardless of age, who has bilateral severe hearing loss not materially improved by hearing aids. (Gates & Mills, 2005). Older patients tend to do well due to good language skills and relatively short duration of deafness (Olivia, 2009). However, with these available management options, many elderly people denied they have a hearing problem despite substantial evidence to the contrary. Many authors have discussed the problems of denial and refusal to seek treatment (Maurer & Rupp, 1979), but little attention has been given to the underlying reasons for it. Elderly people who deny or avoid confronting a hearing loss are not doing so in a vacuum. Becker et al. (1984) opined that negative social attitudes about hearing impairment and growing old encourage denial. Hearing impairment is not visible, and invisibility facilitates denial. In addition, hearing impairment in elderly people often has a very gradual onset that can make it difficult to recognize. For elderly persons with one or more life-threatening illness, hearing impairment may seem insignificant in comparison.

The onset of depression, withdrawal, paranoia, and other mental health problems associated with hearing impairment is slow and insidious and may seem unrelated to the hearing loss. An elderly person's inability to receive aural cues can lead to accidents, though the causes may seem ambiguous. Likewise, difficulties in communication and social relationships may not be attributed to hearing loss, even when the loss is acknowledged. As a result, hearing impairment often is mistakenly seen as unimportant by elderly people, their families, and health care providers (Becker et al., 1984). This denial of hearing impairment and the failure to recognize its full impact on independent functioning are clear obstacles to effective management.

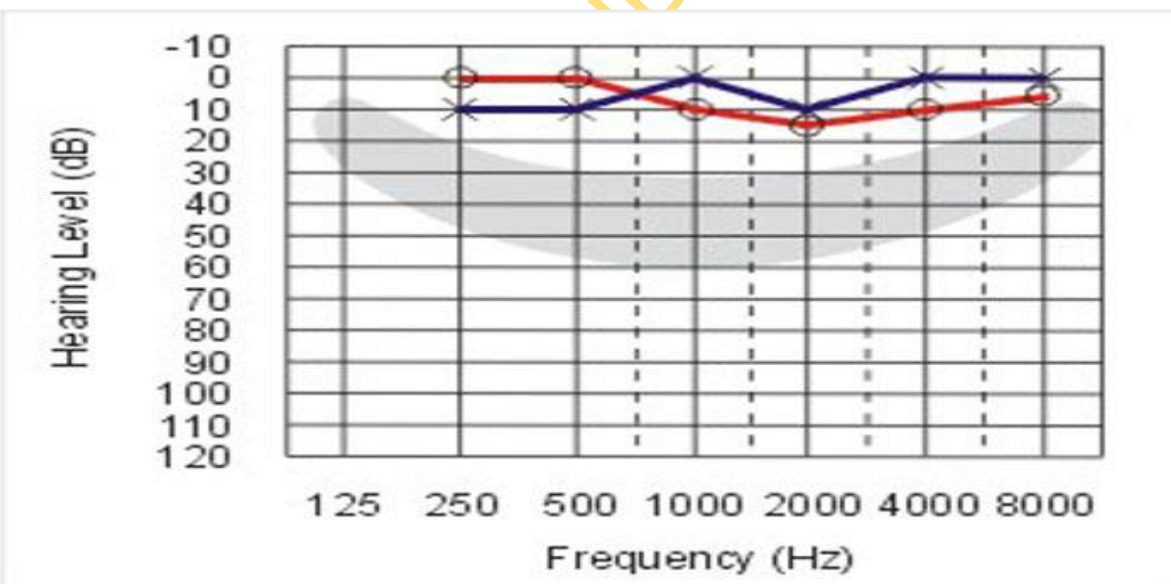
Untreated presbycusis leads to social isolation, depression and may cause or worsen cognitive impairment and dementia (Dalton, Cruickshanks & Klein, 2003; Lui & Yan, 2007). The stereotypical image of old age as an inevitable decline into severe deafness is not warranted. Early identification and management of presbycusis can significantly improve the lives of elderly people and help to change this picture.

2.13 Patterns of Hearing Loss

Robert & George (2008), said the method for classifying patterns of audiogram include the selection of configurations selected from the group consisting of a normal configuration, a flat configuration, a sloping configuration, a rising configuration, a trough configuration, a peaked configuration, and other configurations.

Normal Audiogram

A normal audiogram indicates that a person has normal hearing threshold. An audiogram with a normal configuration is an audiogram that displays thresholds lower than or equal to 25dB (Robert & George 2008).



Figrure 6: Normal Pattern of Audiogram

Flat Audiogram

A flat audiogram indicates that a patient needs the same amount of loudness to hear at low, middle, or high frequencies. An audiogram with a flat configuration displays thresholds higher than 25dB and it is always indicative of Meniere's disease (late), dead ear due to acoustic neuroma or surgery and sudden hearing loss (Margolis and Saly, 2008).

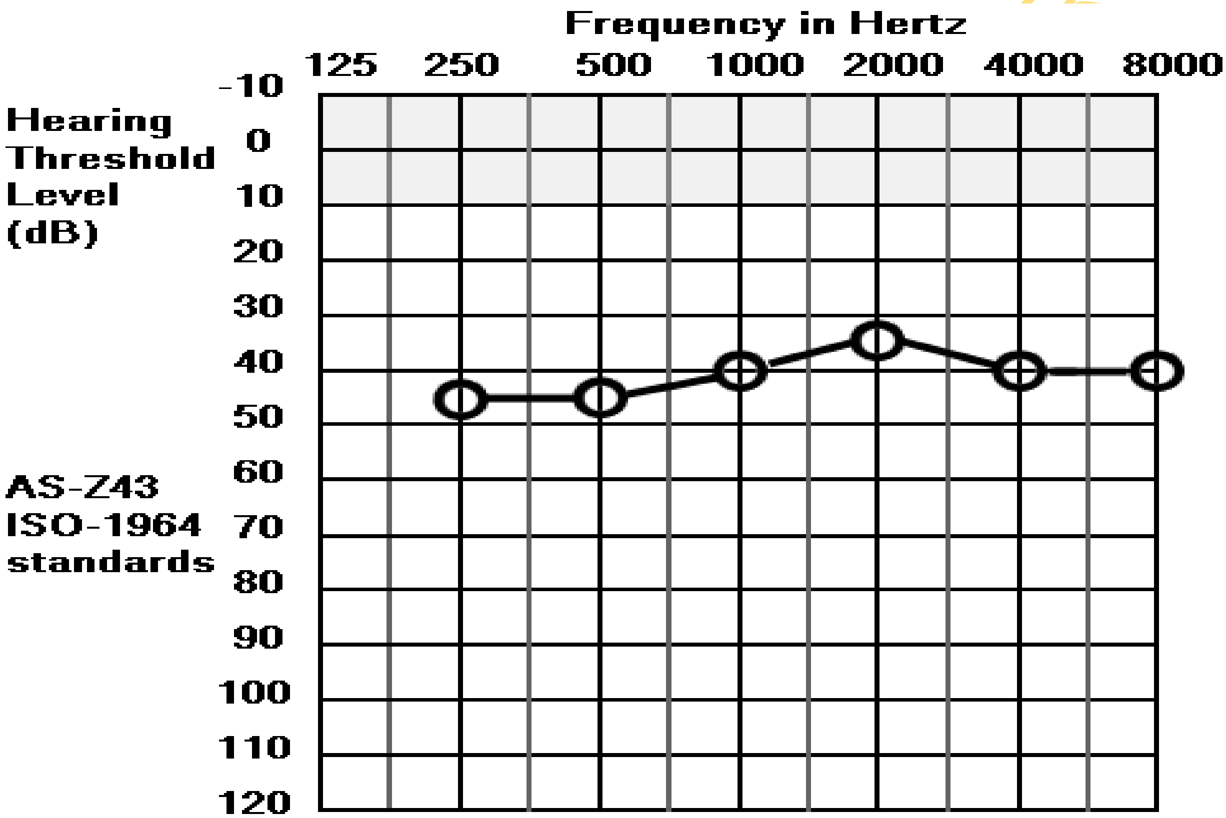


Figure 7: Flat Pattern of Audiogram

Sloping Audiogram

A sloping audiogram indicates that a patient has better hearing in the low frequencies. An audiogram with a sloping configuration displays a generally downward trend in thresholds. That is, thresholds are low in the low frequencies but become higher in the high frequencies. It indicates presbyacusis (Robert & George, 2008).

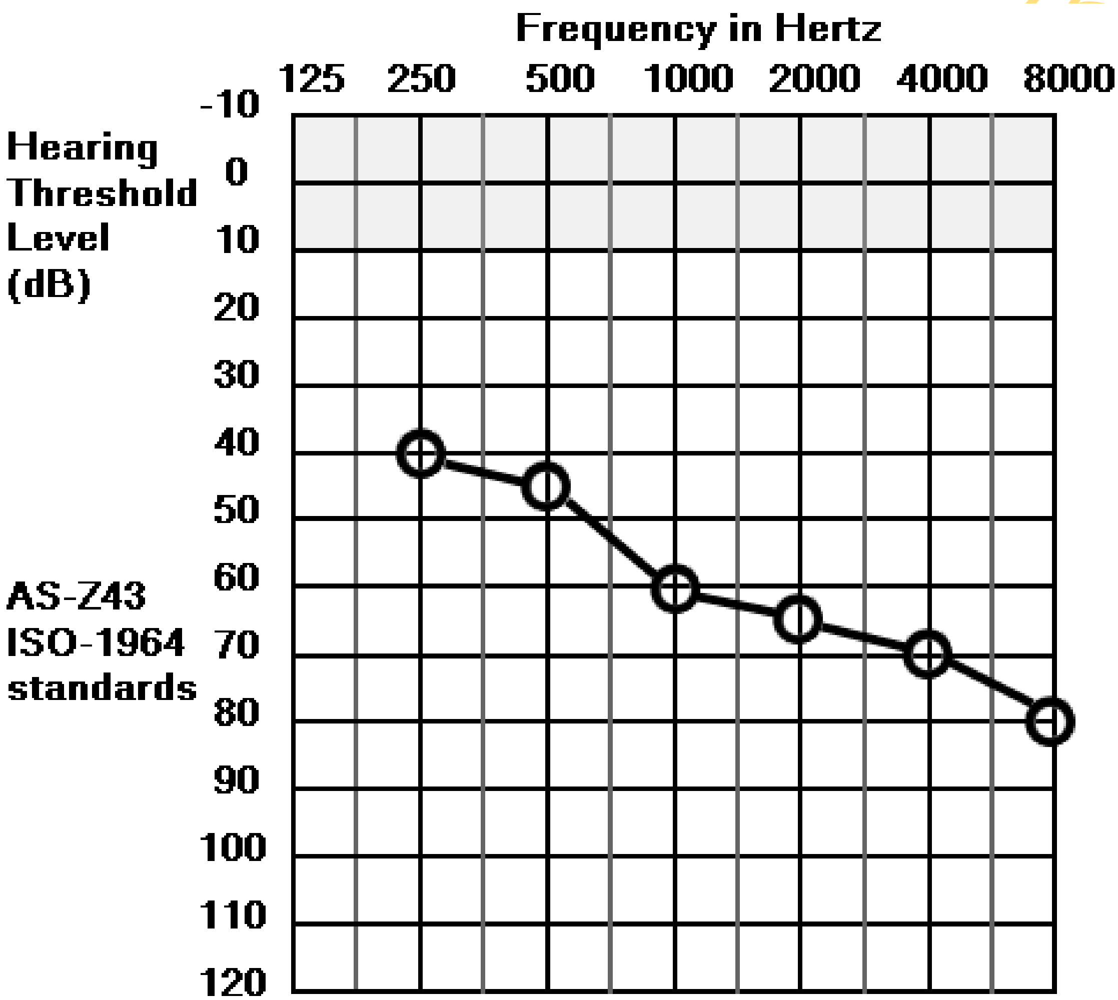


Figure 8: Sloping Pattern of Audiogram

Rising Audiogram

A rising audiogram indicates that a patient has better hearing in the high frequencies. An audiogram with a rising configuration displays a generally upward trend in thresholds. Rising is similar to sloping but in the reverse direction. Thresholds are higher in the low frequencies but become lower in the higher frequencies. Rising pattern indicates meniere's disease, middle ear disease such as otosclerosis or otitis media with effusion (Robert & George, 2008).

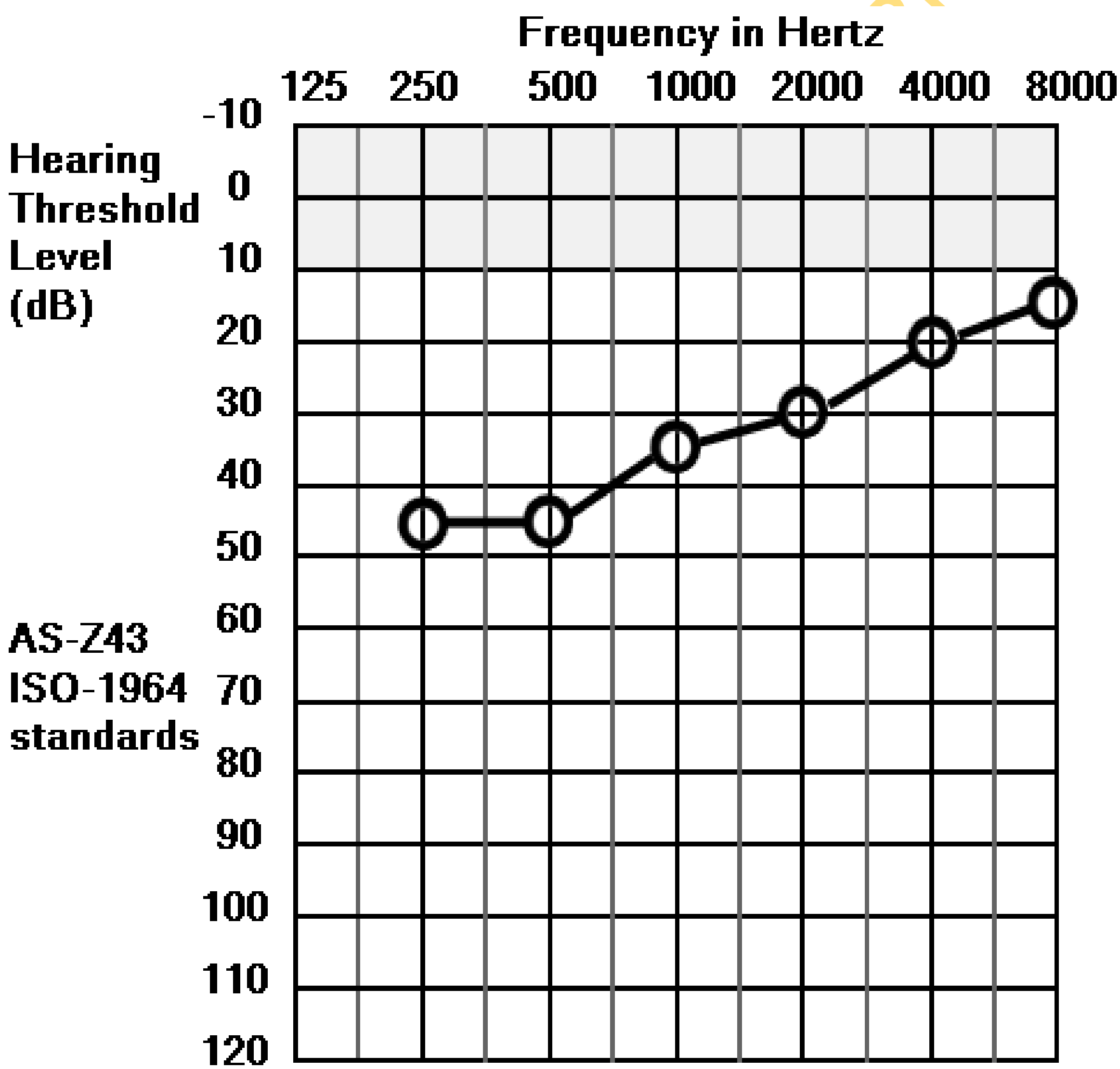


Figure 9: Rising Pattern of Audiogram

Trough Audiogram

A trough audiogram indicates that a patient has better hearing in the high frequencies and low frequencies than in the middle frequencies. An audiogram with a trough configuration displays a dip in thresholds in the middle frequencies usually caused by genetic or hereditary factor as seen in “cookie bite” (Robert & George, 2008).

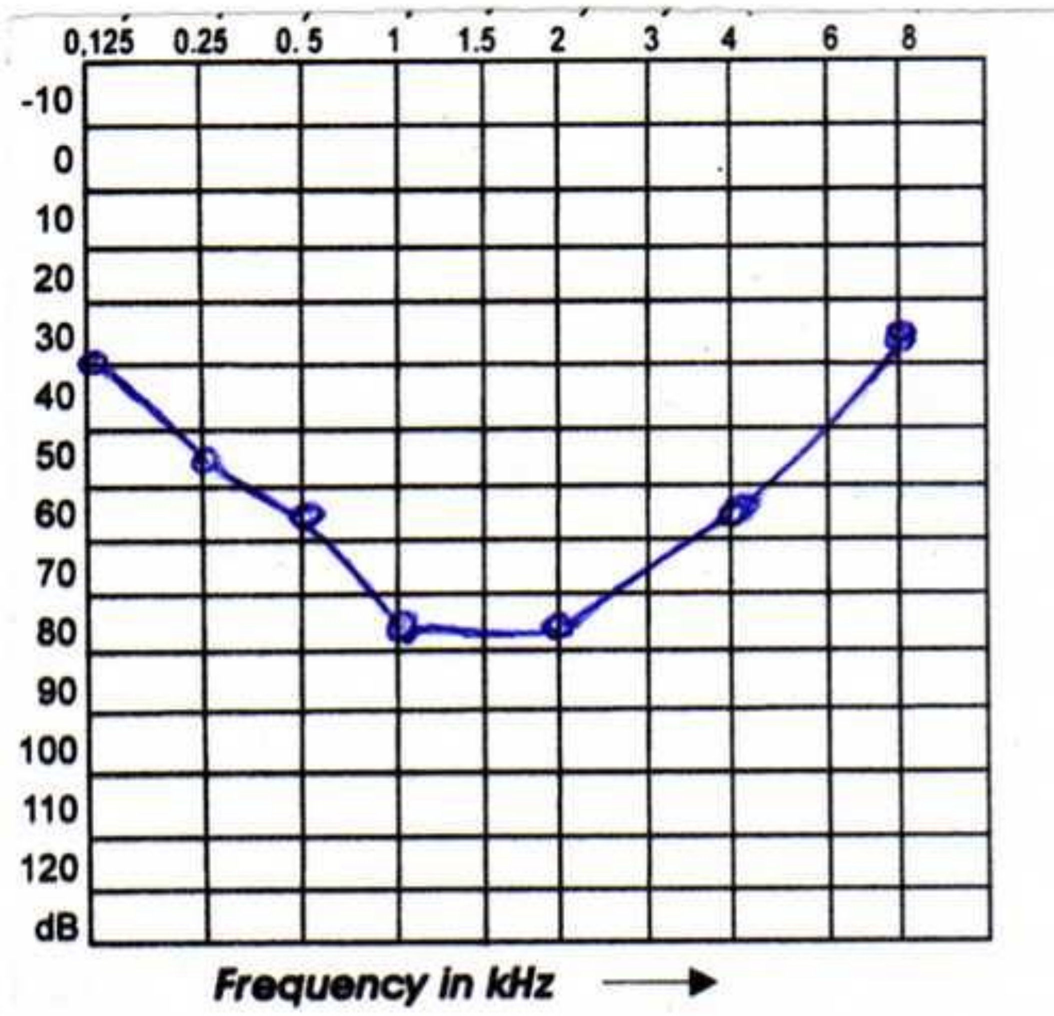


Figure 10: Trough Pattern of Audiogram

Peaked Audiogram

A peaked audiogram indicates that a patient has better hearing in the middle frequencies than the high frequencies and low frequencies. An audiogram with a peaked configuration displays a peak in thresholds in the middle frequencies. Peaked is similar to trough but with best hearing in the middle frequencies (Robert & George, 2008). Savastano, Guerrieri and Marioni (2006), said the most common audiometric pattern at the onset of the meniere's disease is the peak pattern, long-term transformation of the initial audiometric pattern into a flat curve has been confirmed. High-frequency involvement seemed to be related more to Meniere's disease duration than to the influence of ageing on hearing loss.

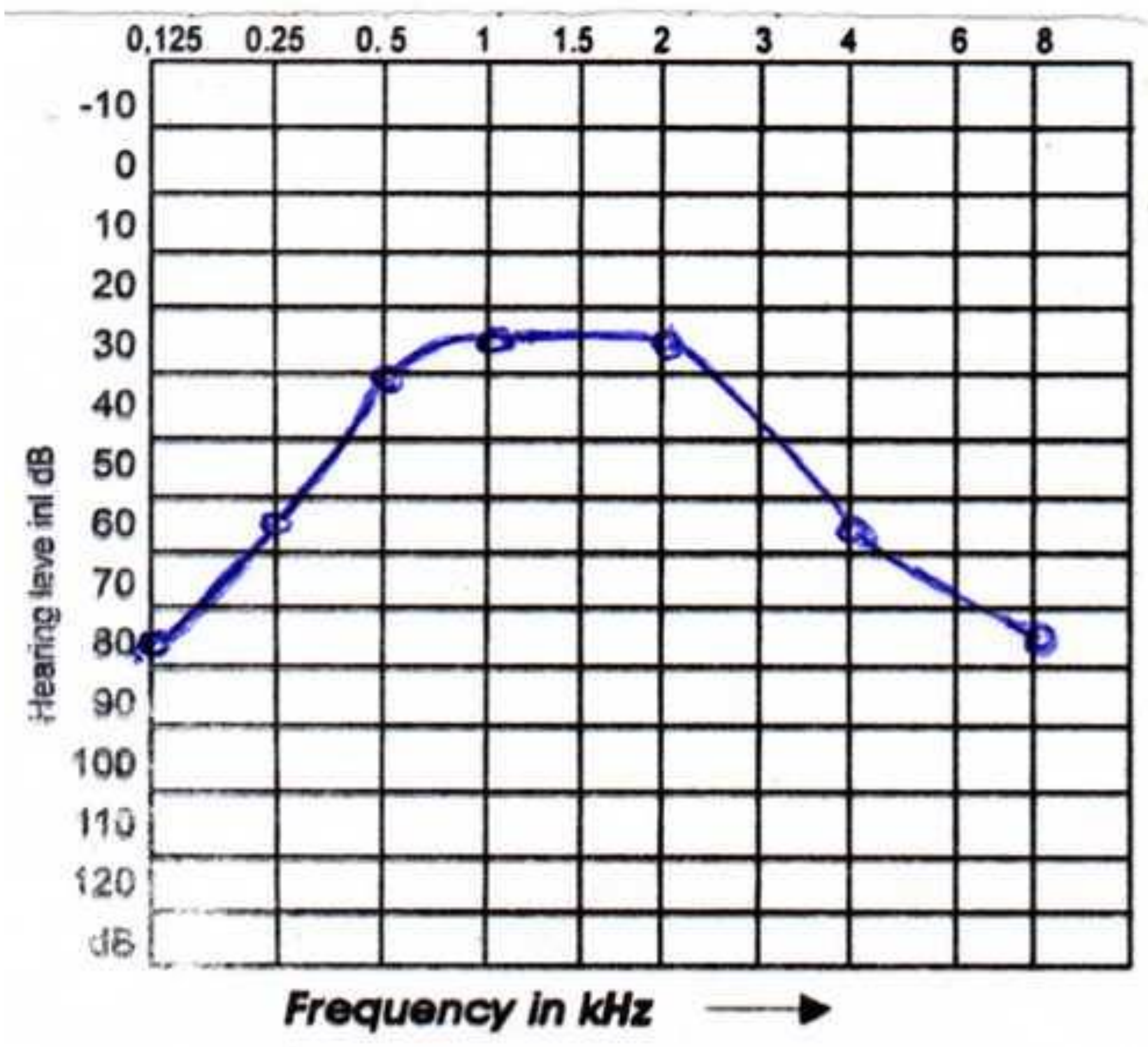


Figure 11: Peaked Pattern of Audiogram

Notched Audiogram

This is a pattern which is a typical of noise induced hearing loss. The person has been continuously exposed to noise which eventually damaged the tiny hair cells in the inner ear called cilia and this is known on the audiogram as 4000Hz notch (Robert & George, 2008).

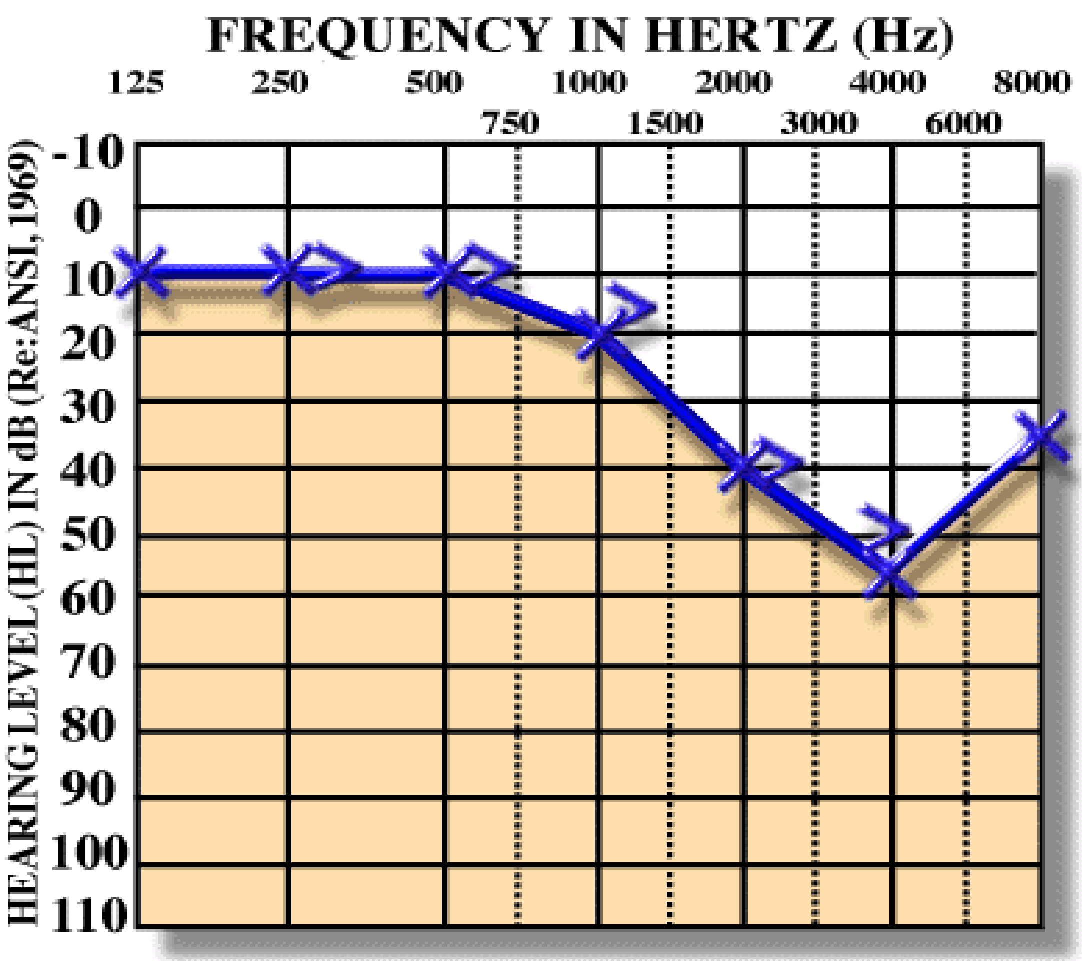


Figure 12: Notched Pattern of Audiogram

Precipitous Audiogram

This is a steepy slopy hearing loss. It is sky slope with hearing loss in both middle and high frequencies commonly caused by ototoxicity and noise exposure at the latter stage (Robert & George, 2008).

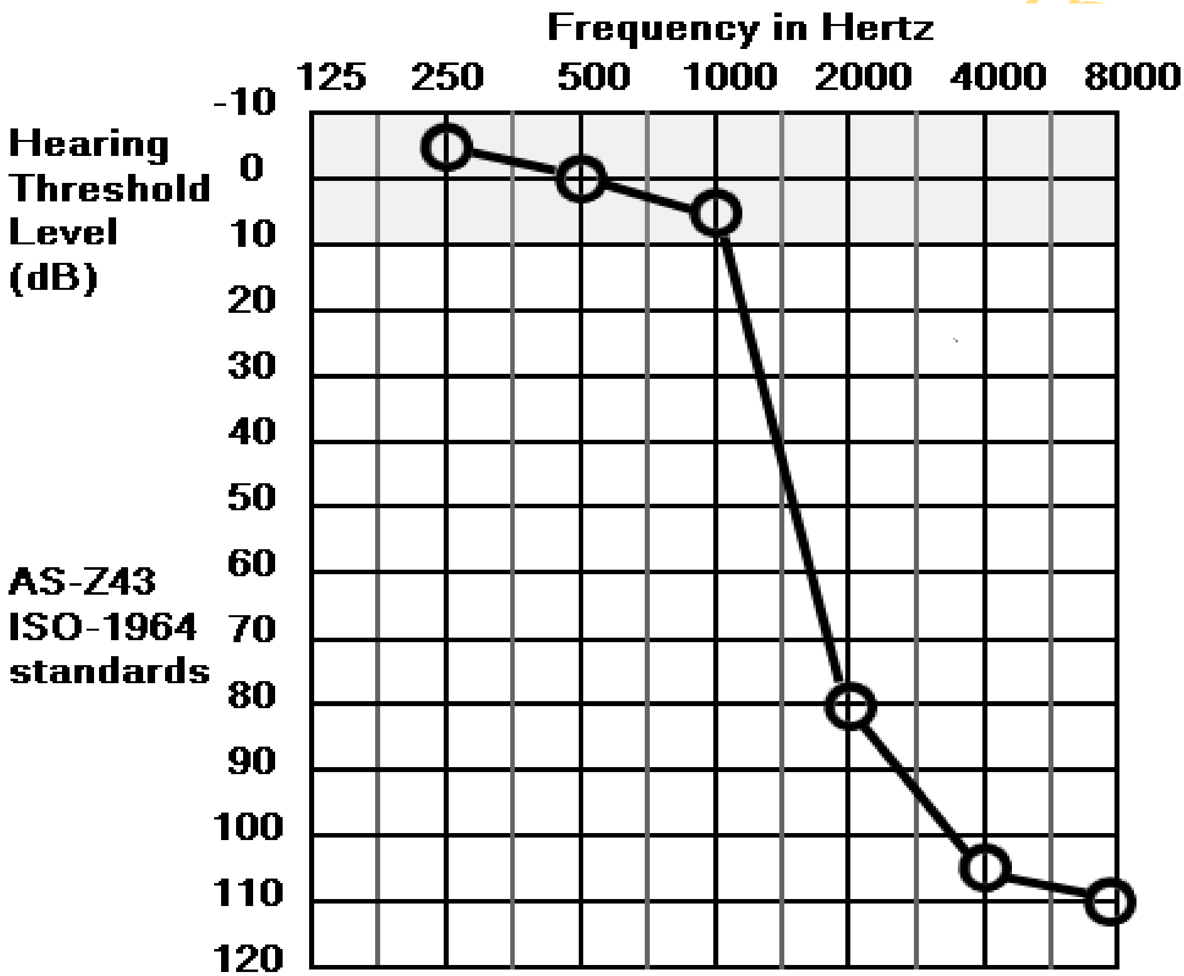


Figure 13: Precipitous Pattern of Audiogram

Low Frequency Audiogram

A low frequency audiogram indicates that a person has hearing loss only in the low frequency portion of the audiogram and it is commonly caused by congenital anomalies like Wolfram syndrome and Mondini dysplasia. Other causes include sudden hearing loss and Meniere’s disease (Robert & George, 2008).

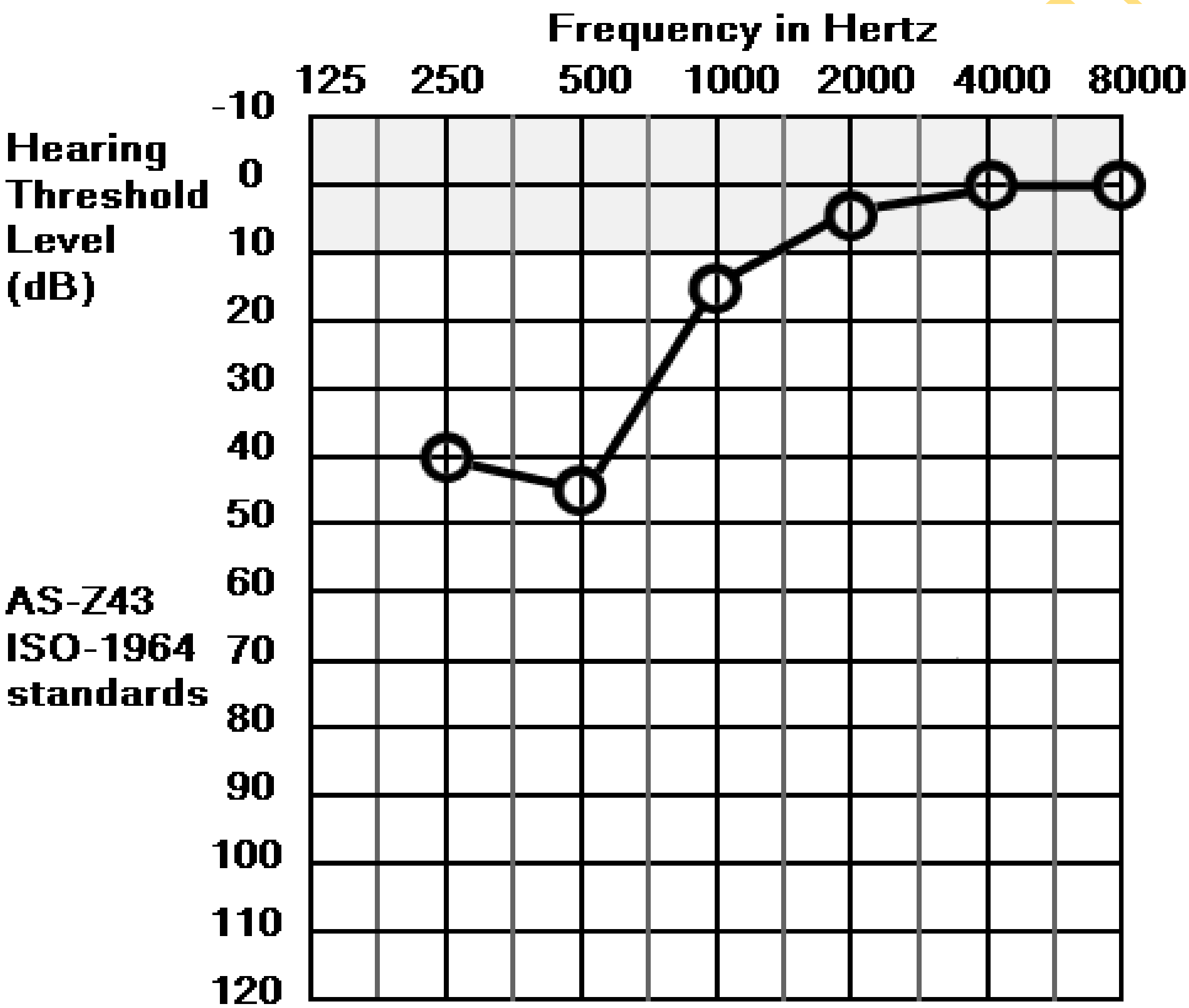


Figure 14: Low Frequency Pattern of Audiogram

High Frequency Audiogram

A high frequency audiogram indicates that a person has hearing loss only in the high frequency portion of the audiogram. This is usually caused by noise exposure (latter stage), ototoxic drugs and frebile illnes (Robert & George, 2008).

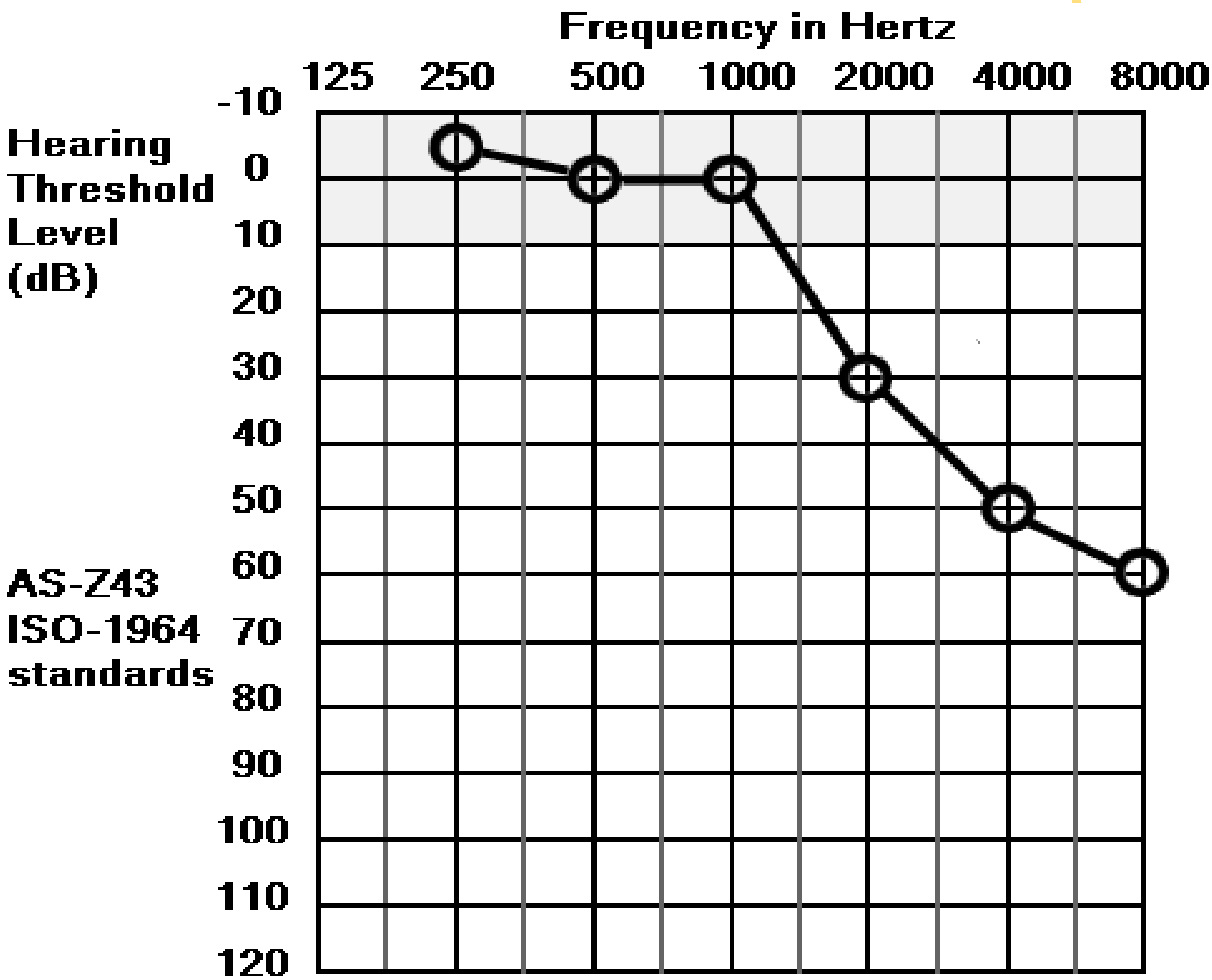


Figure 15: High Frequency Pattern of Audiogram

Empirical Review

2.14 Degrees and Types of Hearing Loss among Elderly Patients

In a study of 63 patients with a median age of 79 years by Wu, Chin and Tong (2004), a total of 25 male (39.7%) patients and 38 female (60.3%) completed the study. 83% (n=52) of the participants were tested positive audiometrically for hearing impairment. 54% (n=34) had moderately-severe hearing impairment and 29% (n=18) had mild hearing impairment. The remaining 17% (n=11) had normal hearing.

Ahmad, Abdulbari, Khalid, Lili and Loida (2007), studied 207 elderly patients. The proportion of hearing loss was higher in the studied patients especially in female patients (89.4% for R. E. and 86.2% for L. E. That is, R. E: right ear; L. E: left ear) than in males (81.4% for both the ears). Hearing loss was more severe in women (29.8% for R. E. and 28.7% for L. E.) than in men (18.6% for R. E. and 15.1% for L. E.) and sloping audiometric curves were found to be the most prevalent one in elderly patients (69.9% & 67.3% for males, 66.0% & 61.7% for females).

In a population-based longitudinal study of age-related hearing loss conducted in Beaver Dam, Wisconsin between March 1998 and July 2000. 2,800 people were eligible and participated in the study and out of the 2,800 study participants, analyzable audiometric data were available for 2,688. The mean age of participants was 69 (range 53–97) years and 42% were male. More than half (51%) of the participants were classified as having a hearing loss. Out of those participants, 27.5% had a mild loss and 23.8% had a moderate to severe loss. Severity of hearing loss was significantly associated with having a hearing handicap and with self-reported communication difficulties. Overall, 52% of the study participants reported having problems with communication. Participants with moderate to severe hearing loss were almost eight times as likely as those without hearing loss to have self-reported difficulties with communication, and participants with mild hearing loss nearly three times as likely as those without hearing loss to report difficulties with communication (Dalton, Cruickshanks, Klein, Klein, Wiley & Nondahl, 2003).

Another study was carried out by Pramanik, Taous, Lodh, Rahim & Alauddin (2009) with the aim to evaluate the prevalence of hearing loss, find out the pattern and extent of hearing loss among the elderly people. The study included 100 people aged over 50 years. Out of 100 cases, 59% were found with normal hearing and 41% had variable degree of hearing impairment. The highest prevalence of hearing impairment was found 100% in 9th decade with gradually decreasing tendency and lowest was 29.50% in 6th decade. Most of the cases were found to be bilateral (65.85%). Majority (65.85%) of the people with hearing impairment had sensorineural type of loss with a significant number (21.95%) of conductive loss. About 44.44% of the hearing impaired person of 6th decade, showed mild hearing loss. In the 7th decade maximum (50%) had moderate to severe hearing loss. About 31% of persons of 8th decade and 50% of 9th decade had severe degree of hearing loss.

Ramkissonon and Cole (2011) also conducted a study of 170 participants who received a hearing test including immittance, pure-tone and speech audiometry, only 16.5% of them had mild hearing loss. Sangster, Gerace & Seewald (1991), in a study, evaluated elderly patients aged 65 and above. The mean age of the patients was 74 (extremes 65 and 93) years. Most (64%) were women. Out of the patients evaluated at the clinic 60% were found to have severe hearing impairment. Moreover, Lin (2011), carried out a study on 639 elderly patients, out of which 125 had mild hearing loss (25 to 40 decibels), 53 had moderate hearing loss (41 to 70 decibels) and six had severe hearing loss (more than 70 decibels).

Omokhodion, Adeosun and Fajola (2007) conducted a study in which noise exposure and hearing impairment were assessed among 85 mill workers. Audiometry was done on mill workers and 45 controls with no known exposure to noise and no history of aural disease. Noise levels at work stations ranged from 88-90dB for small mills and 101-105 for larger mills. None of the workers used hearing protection. Analysis based on total number of ears showed that 56% of the workers had hearing impairment ranging from mild (49%) moderate (6.4%) to severe (0.6%) while 33% of the controls had hearing impairment which was mild (26%), moderate (7%) and no severe losses.

2.15 Patterns of Hearing Loss among Elderly Patients

The study by Ahmad, Abdulbari, Khalid, Lili, and Loida (2007) demonstrated that most of the elderly patients showed sloping (68.1% for RE & 64.7% for LE), followed by flat audiogram shape (12.1% for RE & 16.9% for LE). Overall, around 24% had severe hearing loss and nearly 27% had moderate hearing loss which is much lower than the rate reported in a study done by Sangster, Gerace and Seewald (1991) that 60% of the patients tested at the hearing clinic were found to have severe hearing loss.· In a study on the prevalence of specific audiometric configuration in a healthy, otologically screened population between 55 and 65 years old. The audiograms of 1147 subjects (549 males and 598 females between 55 and 65 years old) Flat audiograms were most dominantly represented (37%) followed by High frequency gently sloping audiograms (35%) and High frequency Steeply sloping audiograms (27%). Low frequency Ascending audiograms, Mid frequency U-shape audiograms and Mid frequency Reverse U-shape audiograms were very rare (together less than 1%). The flat configuration was significantly more common in females, whereas the High frequency Steeply sloping configuration was more common in males. In addition, females with a Flat audiogram had a significantly larger amount of overall hearing loss compared to males. Furthermore, data revealed a significant association between the prevalence of high frequency Steeply sloping audiograms and the degree of noise exposure. (Kelly, Astrid, Hendrickx, Ved, Erik, Guy & Paul, 2009). In a study by Maggi, Minicuci, Martini, Langlois, Siviero, Pavan and Enzi (1998) it was revealed that the shape of audiogram which is regarded as reflector of the pathology underlying presbyacusis are slope and ski-slope type curves.

In a study by Cruickshanks, Wiley, Tweed, Klein, Klein, Mares-Perlman and Nondahl (1998), pure tone thresholds of 3,753 adults from four age-groups (49-59 years, 60-69 years, 70-79 years, and 80-89 years) showed that the average hearing thresholds in men are typically poorer than those of women in the high frequencies and men exhibited a sharply sloping hearing loss in the moderately severe range in the high frequencies while women exhibited a more gradual sloping hearing loss in the moderate range in the high frequencies.

2.16 Diabetes Mellitus and Hearing Loss among Elderly Patients

It has been postulated that micro vascular complications affect the hearing of individuals with diabetes. Studies in diabetic animals have demonstrated thickening of the basement membrane of the capillaries of stria vascularis (Jorgensen & Buch, 1961). Duck, Prazma, Bennett & Pillsbury (1997), investigated interactions between diabetes and auditory function in both clinical and animal studies and found that insulin-dependent diabetes and hypertension were found to have a synergistic effect on high-frequency hearing loss. Histopathological studies have shown damage to the nerves and vessels of the inner ear of the individuals with diabetes. These vascular changes have been theorized to be an important causative factor for neuronal degeneration in the auditory system (Fukushima, Cureoglu, Schachern, Paparella, Harada & Oktay 2006). According to a study by Pemmaiah and Srinivas (2011), out of 110 patients with type 2 diabetes mellitus, 45 patients were females and 65 patients were males. Mean age was 46 years. 48 of 110 type 2 diabetic patients (43.6%) had bilateral sensorineural hearing loss in higher frequency (2000Hz, 4000Hz). This was seen as hearing threshold raised for both bone and air conduction. Among them, severe hearing loss (71 dB to 90dB) was seen in 7 patients (6.36%), moderately severe hearing loss (61dB to 70dB) in 16 patients (14.54%) and moderate hearing loss (30dB to 60 dB) in 25 patients (22.7%). 2 out of 8 (25%) patients between the age of 30- 40years; 9 out of 20 (45%) between age 40- 50years; 10 out of 18 (55.55%) between age 50-60years; and between the age of 60 -70years 25 out of 36 (69.44%) patients had some degree of hearing loss. 47 patients out of 110 patients had duration of diabetes more than 10 years. Among them 29 patients (61.7%) showed at least mild hearing loss. 63 out of 110 who had duration of Diabetes less than 10 years did not have any detectable hearing loss. Duration of diabetes mellitus and sensorineural hearing loss at 2000Hz, 4000Hz showed statistically significant correlation (Pearson coefficient r= 0.561 and r= 0.727 respectively) at 0.01 level. Coefficient of determination was r^2=0.31(31%) and r^2=0.52(52%) respectively between duration of diabetes mellitus and hearing loss at 2000Hz and 4000Hz. In lower frequencies, no significant correlation was found. Moreover, correlation between threshold of hearing and duration of diabetes mellitus indicates that as the duration of diabetes mellitus increases patients develop mild to moderate hearing loss.

Diaz de Leon-Morales, Jauregui-Renaud, Garay-Sevilla, Hernande-Prado and Malacara-Hernandes (2005) reported changes in central auditory processing associated with diabetes using Auditory brainstem responses (ABRs). The same result was found by Konrad-Martin et al., (2009). Group differences were found among patients under age 50. For these younger patients, ABRs adjusted for hearing at 3000Hz revealed abnormal central conduction among patients with insulin-dependent diabetes, but ABRs were normal in patients with diabetes who did not require insulin. Their conclusion is that diabetes appears to affect hearing and brainstem function but these effects appear somewhat independent.

National Institute of Health - NIH (2008) reported that hearing loss is about twice as common in adults with diabetes compared to those who do not have the disease. The study, which analyzed data from hearing tests administered to over 5,000 participants, showed that patients with diabetes are more than twice as likely to have hearing loss than non-diabetics.The researchers discovered the higher rate of hearing loss (68%) in those with diabetes after analyzing the results of hearing tests given to a nationally representative sample of adults in the United States. The test measured participants' ability to hear low, middle, and high frequency sounds in both ears. The link between diabetes and hearing loss was evident across all frequencies, with a stronger association in the high frequency range. Mild or greater hearing impairment of low- or mid-frequency sounds in the worse ear was about 21 percent in 399 adults with diabetes compared to about 9 percent in 4,741 adults without diabetes. For high frequency sounds, mild or greater hearing impairment in the worse ear was 54 percent in those with diabetes compared to 32 percent in those who did not have the disease. Adults with pre-diabetes, whose blood glucose is higher than normal but not high enough for a diabetes diagnosis, had a 30 percent higher rate of hearing loss compared to those with normal blood sugar tested after an overnight fast .

Also, Tay, Ray, Ohri and Fronntko (1995) prospectively performed a hearing survey in a sample of 102 diabetic patients. The hearing data were compared with the hearing thresholds of three control population groups. A significant difference was found in the average hearing thresholds between the diabetic patients and all of the three control populations. Diabetic patients have worse hearing threshold levels especially at low and mid frequencies. In another study by Venkata, Robert & Hinrich (2003),the prevalence of diabetes in the group of patients with sensorineural hearing loss was 23%, compared with 19% in the group without hearing loss. The prevalence of sensorineural hearing loss in the diabetic group was 13.1%, compared with 10.3% in the group without diabetes, which was statistically significant ($p < 0.05$). Audiometric data from patients with diabetes and sensorineural hearing loss were compiled. The average pure tone average in the right ear was 52dB while the left ear was 53 dB . A study by Friedman, Schulman & Weiss, (1975) showed a 55% incidence of hearing loss in diabetic patients. Kakarlapudi, Sawyer & Staecker (2003) found that hearing loss was more common in diabetic patients (13.1% prevalence) than the control non diabetic healthy patients. Weng, Chen, Hsu & Tseng (2005) noted that among the 67 diabetic patients examined, 44.8% of them had profound hearing loss.

2.17 Noise Exposure, Hypertension and Hearing Loss among Elderly Patients

Correlations between hearing loss - above all, noise induced hearing loss (NIHL) and exposure to noise and cardiovascular disease (CVD) have been investigated. Axelsson and Lindgren (1965) found an association between both high- and low-cholesterol levels and NIHL. Talbott , Helmkamp , Matthews , Kuller and Cottington (1985) reported that severe NIHL was an independent predictor of hypertension in retired metal assembly workers, 64 years or older. Milkovic-Kraus (1990) found that systolic and diastolic blood pressure was increased in noise-exposed workers, who also had hearing loss. Tarter and Robins (1990) studied industrial workers exposed to noise and reported that hearing loss at 4000Hz was significantly associated with hypertension among black workers but not among white workers. Hirai, Takata, Mikawa, Yasumoto, Iida and Sasayama (1991) did not find any significant relationship between NIHL and hypertension. It has been suggested that noise exposure increases the risk of hypertension. Road traffic is the dominant source of community noise exposure. A stratified random sample procedure was applied consisting of two strata with 500 residents in each. The noise-exposed group was drawn from those living within100m on each side of the high way and main roads. Since the study focussed on exposure to road traffic noise: thus, people who are residing close to the railway were not included. The strongest association between exposure to traffic noise and hypertension was found among those with the group of participants indicated by not having triple-glazed windows, living in an old house and having the bedroom window facing a street. Results of the study suggest an associaiton between exposure to residential road traffic noise and hypertension (Gosta, Niklas , Emma & Mats, 2007).

The HYENA (Hypertension and Exposure to Noise near Airports) study by Jarup, Babisch, Houthuijs, Pershagen, Katsouyanni, Cadum, Dudley, Savigny, Seiffert, Swart, Breugelmans, Bluhm, Selander, Haralabidis, Dimakopoulou, Sourtzi, Velonakis and Vigna-Taglianti (2008), aimed to assess the relationship between noise from aircraft or road traffic near airports and the risk of hypertension. In the epidemiologic analyses, the researchers said they combined the measurements with information on diagnoses of hypertensive disease and medication. The study definition of Hypertension included individuals who had either blood pressure levels above the WHO cutoff points or a diagnosis of Hypertension (by a physician) in conjunction with use of anti-hypertensive medication, as reported in the interview questionnaire. Hypertension was defined according to the World Health Organization (WHO 1999; WHO 2003) as a systolic BP $\geq$ 140 or a diastolic BP $\geq$ 90. They measured blood pressure and collected data on health, socioeconomic, and lifestyle factors, including diet and physical activity, via questionnaire at home visits for 4,861 persons 45–70 years of age, who had lived at least 5 years near any of six major European airports (London Heathrow (United Kingdom), Berlin Tegel (Germany), Amsterdam Schiphol (the Netherlands), Stockholm Arlanda (Sweden), Milan Malpensa (Italy), and Athens Elephterios Venizelos (Greece) Airports). In Stockholm, the population living near City airport (Bromma) was also included to increase the number of exposed subjects. Studies carried out around Schiphol (Amsterdam, the Netherlands) airport in the 1970s showed excess risks of hypertension and other cardiovascular diseases in subjects exposed to high levels of aircraft noise (Knipschild, 1977).

In a recent study around the same airport, only a slight increase [odds ratio (OR) = 1.2] of self-reported use of cardiovascular drugs was found (Franssen, van Wiechen, Nagelkerke, Lebret, 2004). A Swedish cross-sectional study indicated an exposure–response relation between residential aircraft noise exposure and self-reported (diagnosed by a physician) hypertension (Rosenlund, Berglind, Pershagen, Jarup & Bluhm, 2001). In a Japanese study near a military air base, there was an exposure–response relationship between aircraft noise and prevalence of hypertension (Matsui, Uehara, Miyakita, Hitamatsu, Osada & Yamamoto, 2004). The HYENA study found statistically significant effects on blood pressure of nighttime aircraft noise and average 24-hr road traffic noise exposure, the latter for men in particular (Jarup et al. 2008). Talbott, Findlay, Kuller, Lenkener, Matthews, Day, Ishii (1990), studied the relationships among occupational noise exposure, noise-induced hearing loss, and high blood pressure. The study population consisted of 245 retired metal assembly workers from Pittsburgh aged 56 to 68 with chronic noise exposure of 30 years or more at greater than or equal to 89 dB. Results of the audiometric testing indicated 52% of the younger workers (ages 56 to 63) have severe noise-induced hearing loss (greater than or equal to 65 dB loss at 3, 4, or 6 kHz) and 67% of older workers (ages 64 to 68).

Body mass index and alcohol intake were significantly related to systolic and diastolic blood pressure. Among older men, there was a marginally significant increased prevalence of high blood pressure greater than or equal to 90 mm diastolic blood pressure. Multiple regression analysis revealed severe noise-induced hearing loss as independent predictors of hypertension in the older, but not in the younger group of retired workers. Talbott, Helmkamp, Mathews, Kuller, Cottington and Redmond (1985), in cross-sectional study of occupational noise exposure and high blood pressure was conducted in March 1981–August 1982 in a group of blue-collar workers from a noisy (≥89 dBA) and a less noisy plant (<81 dBA) randomly sampled 197 men from the noisier plant and 169 from the comparison factory. Clinical examinations, audiograms and a psychologic inventory were conducted. There was a strong relationship between severe noise-induced hearing loss (≥65 dBA loss at 3, 4, or 6 k Hz) and high blood pressure (≥90 mmHg diastolic blood pressure). Multiple regression analysis revealed that in the noisier plant, body mass index, severe noise-induced hearing loss, and noisy hobbies explained a significant amount of the variation in diastolic pressure ($p<0.05$) $R^2 = 0.19$. This suggests an increased risk for hearing loss and high blood pressure. Also, Neghab, Maddahi and Rajaeefard (2009), carried out a study in a local petrochemical plant consisting of 31 units of which 12 were identified as being noisy (SPL>85 dBA). From these noisy units, 5 were selected by multistage random sampling. Likewise, 140 out of 500 employees of these units were selected by the same method. Similarly, one hundred and forty unexposed employees at the same age level, serving as the referent group, were also selected from the units with very low levels of ambient noise (≤55dBA). The sample size was calculated based on the prevalence of occupational noise induced hearing loss of at least 16% among noise exposed populations. The participants underwent physical examination and audiometry testing at the site (as part of their annual periodic examination) and their blood pressure was taken at normal resting position. Using WHO criteria, they defined hypertension as a systolic blood pressure (SBP) of 140 mmHg or greater and/or a diastolic blood pressure (DBP) of 90 mmHg or greater (WHO, 1999). Furthermore, the participants were interviewed and a questionnaire with 40 items was completed by them. This contained items concerning, age, sex, weight, height, eye color, qualitative estimation of dietary salt intake (low, normal, high), years of service, workplace noise levels, history of using ear protective devices as well as past and present complaint of tinnitus, vertigo, speech perception impairment, sleep disturbances and history of some diseases such as renal failure, thyroid, autoimmune and meniere's diseases, meningitis, encephalitis, syphilis, scarlet fever, diphtheria, and rubella.

Similarly, the history of diabetes mellitus, hypertension, hyperlipoproteinemia, ischemic heart disease and family history of hypertension as well as present and past history of using ototoxic drugs such as streptomycin, vancomycin, aspirin and quinine and its derivatives were included. Likewise, the questionnaire included items on the history of exposure to known ototoxic chemical agents such as carbon monoxide and solvents such as toluene, carbon disulfide, methanol, styrene, xylene, trichloroethylene, benzene and n-heptane. To eliminate or minimize the effects of confounding variables, the employees with a history of exposure to non-occupational high noise levels as well as individuals with a family or personal history of hypertension or current use of ototoxic drugs were excluded. To effectively minimize the effects of noise-induced temporary threshold shift (NITTS), noise exposure was avoided forty eight hours prior to the audiometric testing. The prevalence of hearing impairment among exposed and unexposed participants was found to be 38.5% and 7.8%, respectively and the difference was statistically significant (Chi-square=37.046, p<0.001). The number of hypertensive participants among the exposed individuals was significantly higher than its corresponding value in the unexposed group and the positive relationship between noise exposure and hypertension was still significant.

Rosen, Bergman, Plester, El- Mofty and Satti (1962), in a study carried out with hypertensive patients in the USA, said there was a correlation between high blood pressure and hearing loss in high frequencies. However, such correlation was not seen by the same author in a later study carried out with a Sudanese native population. Hansen and Denmark (1968), in a retrospective study carried out in Denmark with 342 patients assessed between 1945 and 1961 consecutively, do not relate arterial hypertension to hearing loss in this population. Markova (1990), in the Tcheck Republic, after analyzing the hearing symptoms of 50 hypertensive patients submitted that arterial hypertension is an important risk factor for hearing loss. Nazar, Otarola and Acevedo (1992), in a study carried out with controlled chronic hypertensive patients in specialized centres, without diabetes and without exposure to intense noise and ototoxic drugs for at least 3 years, observed that of the 217 controleld chronic hypertensive patients, most presented with hearing alterations; however, with varied audiogram profiles. After such study, the authors stated that individual predisposing factors (structural or metabolic) may, in isolate cases, cause hearing loss, which does not represent a habitual development in chronic hypertensive patients. Brohem, Caovilla and Gananca (1996), assessed audiometrically 50 hypertensive patients with ages above 45 years in Brazil, and 62% of those had sensorineural hearing loss.

In a controlled-case study carried out in Kenya with 50 elderly individuals using ABR, Chen and Ding (1991), observed a relationship between hearing loss and arterial hypertension in this elderly population. Marchiori, Freitas and Vieira (2002) aiming at observing the frequency range and the audiometric profile of hypertensive individuals, studied 552 audiologic examinations from patients referred for audiologic assessment. Out of the 552 examination studied, 137 were patients with arterial hypertension of both genders, 121 (88.32%) of these hypertensive patients had hearing loss, (43.06%) had moderate to sensorineural hearing loss while (38.32%) had hearing complaints such as tinnitus, fullness in the ear and vertigo. Contrary to the studies by Marchiori, Freitas and Vieira (2002); Rosen, Bergman, Plester, El- Mofty and Satti (1962); Markova (1990); Nazar, Otarola and Acevedo (1992); Brohem, Caovilla and Gananca (1996) and Chen and Ding (1991), Rey, Morello-Castro and Curto (2002) tested 59 patients hearing levels with mean age of 75 years and reported a significantly negative relationship with hypertension.

Jonsson and Hansson (1977) described their study of 44 male industrial workers in Sweden with noise-induced hearing loss. The criterion for entry to their study group was auditory impairment of 65 dB or greater at 3000, 4000 or 6000 Hz but less than 20 dB at other frequencies. The systolic and diastolic blood pressures of these men were compared with those of 74 others from the same plant who had "normal hearing". The investigators found significantly higher blood pressure in the study group and a higher proportion of individuals whom they classed as having hypertension. Contrary to the study by Jonsson and Hansson (1977), Takala, Vark and Vaheri (1977), measured blood pressure and hearing acuity in a group of individuals in Finland. They identified 32 men who had noise-induced hearing losses of 65 dB or greater at 4000 and 6000 Hz and a history of noise exposure at work. Their blood pressures were compared with those of 67 men in the same age group (40 to 59 years) who had normal hearing. These investigators found no significant differences in the blood pressures of the two groups.

In a study conducted by Chang, Liu, Huang, Chen, Lai and Bao (2011), participants were divided into a high hearing loss (HL) group ($n = 214$; average hearig loss values (HLVs) ≥ 30 decibel [dB] at 4 kHz or 6 kHz bilaterally; 83.1 ± 4.9 A-weighted decibel (dBA), a median HL group ($n = 302$; $15 \leq$ average HLVs < 30 dB at 4 kHz or 6 kHz bilaterally; 83.1 ± 4.4 dBA) and a low HL group ($n = 274$; average HLVs < 15 dB at 4 kHz or 6 kHz bilaterally; 82.2 ± 5.1 dBA) based on the results of pure tone audiometry, they used multivariate logistic regressions to estimate the risk of hypertension between groups. The prevalence rates of hypertension were significantly higher in the high HL (43.5%; $p = 0.021$) and median HL (42.1%; $p = 0.029$) groups than in the low HL group (33.2%). The high HL and median HL workers had 1.48-fold (95% confidence interval [95%CI] = 1.02-2.15; $p = 0.040$) and 1.46-fold (95%CI = 1.03-2.05; $p = 0.031$) higher risks of hypertension relative to the low HL workers. Employment duration was significantly and positively correlated with the risk of hypertension among workers with average HLVs ≥ 15 dB at 4 kHz ($p < 0.001$) and 6 kHz ($p < 0.001$) bilaterally. They concluded in their findings that high-frequency hearing loss is a good biomarker of occupational noise exposure and that noise-induced hearing loss may be associated with the risk of hypertension.

In California, increased auditory thresholds at 4000Hz were found among smokers (Siegelalub, Friedman, Adour & Seltzer 1974) while in Malaysia such thresholds were found at 6000Hz (Noorhassim & Rampal, 1998). Another study concluded that smoking workers exposed to noise are more predisposed to acquiring hearing losses at 3000 and 4000Hz (Wild, Brewster & Banerjee, 2005). In a another recent study by Sandra, Martin, Monique, Jelle and Lenore (2002), current smoking was associated with reduced cognitive function, whereas moderate alcohol consumption seemed to be related to better cognitive function. Cruickshanks, Klein and Klein (1998), used a population-based, cross-sectional study design, reported that current smokers were 1.69 times more likely to have a hearing loss relative to non-smokers.

In Japan, even after workers received noise protection education, little effect is reported in terms of an increased usage rate of noise protectors (Yoshioka, Taniyama, Okazaki, Ito & Hyakukei, 2004). In a study conducted among 442 noise exposed and 83 non-noise exposed workers in the Klang Valley, although hearing protection devices were provided for 80.5% of the workers, only 5.1% wore them regularly (Maisarah & Said, 1993). Moreover, Ariyoshi (2007) reported that the rate of wearing earplugs was 57% among noise-exposed workers. Similar findings are also reported in other countries (Williams, Purdy, Murray, Dillon, LePage, Challinor & Storey 2005).

In Nigeria, Ologe, Akande and Olajide (2005) conducted a study on 116 workers, 99% of the respondents had worked in the factory for between 10 and 29 and had spent a mean of 12 years in their current work area. All but four workers worked 8 hour a day for 5 days a week. Overall, 93% demonstrated awareness of the hazard of noise to hearing and 92% had awareness of methods of prevention of noise induced hearing loss but only 27% possessed hearing protectors and only 28% of these stated that they used them all the time. Twelve of the workers (10%) complained of hearing loss and 10 (9%) complained of tinnitus. With regard to the proper use, Ito, Iki and Kurumatani (1994) reported that in many cases earplugs were improperly used.

Miyauchi , Imamiya and Tanaka (2000) reported that 29% of workers did not wear the earplugs correctly. Toivonen, Paakkonen, Savolainen and Lehtomaki (2002) also showed that 28% of subjects in an untrained group wore ear plugs improperly. Shulter (1984) discovered that more training is reportedly required to wear earplugs properly than to wear earmuff . WHO

(1997) reported that developing countries often lack both effective legislation against noise and program to prevent noise-induced hearing loss. Despite 26.2 % of the workers claimed that they tried to avoid being exposed to noise as much as possible when thay are working only 11.9% of them used earplugs. Although it is a reported practice, it is higher than those reported in the study by Maisarah and Said (1993) whereby only 5.1 % of exposed factories workers used hearing protection devices. Reasons for not wearing include discomfort, and most importantly, the danger of not using it is not apparent (Maisarah & Said, 1993).

In a study by Abiodun and Elemukan (2005), the result of their study showed a significant difference in those that used protective devices and non – users in both right and left ears, that is, there was a better hearing in the group that wore protective devices. The result of Abiodun and Elemukan (2005) was in line with the study of Shaikh (1996), where he compared the effect of noise on polyester workers and found that those who wore ear protectors have better hearing than those who did not wear ear protectors.

Bakare (1980) embarked on a study to determine whether noise level generated in some of the Nigerian Industries exceed the damage risk criteria in 10 industries. These include canning factories, tobacco companies and large bottling companies. Noise level measurements were carried out to estimate the amount of noise in decibels (dB) generated by the machines and to estimate whether they have exceeded the oto-destructive level. Hearing evaluation were also carried out on 100 factory workers employed to work in these noisy environments and another 100 workers engaged in other less noisy parts of the factories. It was found out that the mean average noises generated by the machines range between 104 and 113 dB, with the loudest noise produced by a machine at the cigarette making department. Also, 66% of the workers employed to operate these machines have medically significant hearing losses, that is above 15 dB in one or more of the audiometric frequencies tested, only 3% of workers employed in the administrative and other sections with less noise have medically significant losses, 10% of the machine operators who were employed between 2-5 years have significant losses while 4% of workers employed under 2 years have medically significant losses. A recent extension of this study to some agrimotors and farm machines revealed that some of these farming equipment generate noise above the damage risk criterion. For example the Gaspardo planting machine recorded a noise level measure of 103 dB and the Farm Mobile with a five horse power engine that has no casing generated a noise level of 99 dB. Some other typically noisy sections of the farm industry have also been identified as having capable oto-destructive tendencies (Bakare 1980).

Owolawi (2004) conducted a study to find out the audiometric patterns in noise exposed Nigerian aviation workers. His findings suggested that there were significant differences in the hearing threshold sensitivity between a group of exposed and non-exposed airport workers ($p<0.05$). Average audiometric tone loss of 35 dB HL was recorded among the aero-engineers. This exposition on aero-engineers may not be unconnected with the high degree of exposure as a ground crew who are often bombarded by every aircrafts that descend and ascend (landing and taking off). Owolawi (2004) also revealed 6000 Hz notch particularly among flight attendants, pilots and air-traffic controllers and a gross erosion of auditory sensitivity at the higher frequency of 8000Hz in addition to 3000Hz, 4000Hz, and 6000Hz in aero-engineers was observed. Flight attendants and the administrative staff were found to have had relatively normal audiograms (15 dB and 10 dB respectively). He concluded that the case of administrative airport staff is well expected because of the very low dose of acoustic insult.

Abe (2005) in his study of impact of acoustic trauma on hearing ability of blacksmiths with different years of noise exposure in Ondo State-Nigeria, found out that blacksmiths had deficit hearing abilities as a result of single loud noise than the normal listeners. He also discovered that there is a significant difference between the performances of the blacksmiths of the same group with different sound level exposure. That is, the blacksmiths of 0-5 years exposure duration of 85 dB permissible exposure level had a better hearing ability than the blacksmiths of 86 dB and above on the Pure Tone Audiometric test for right and left ears. The findings indicated that the blacksmiths even though, all of them had deficits in hearing abilities in the three diffent groups (0-5 years, 6-15 years and 16-25 years), yet the findings confirmed better hearing among 0-5 years duration than blacksmiths of 6-15 years while the blacksmiths of 16-25 years of exposure had worst hearing loss than the two other groups.

Moreso, in a study by Osibogun, Igweze and Adeniran (2000), 204 textile workers were selected randomly from all sections (including the non-production areas), The subjects were divided into 3 groups, based on the noise levels observed at their worksites using a Bruel and Kjaer type 2225 (integrating) sound pressure level meter viz: the noise-exposed group (noise levels > 90 dBA); the less-noise-exposed group (noise levels 85-90 dBA); and the non-noise-exposed group (noise levels < 85 dBA). A comparative analysis of the data on hearing threshold levels of the 3 groups showed that the noise-exposed group had significantly ($p < 0.05$) elevated hearing threshold levels at all frequencies and in each age group, although the maximal threshold shifts were observed at the 4000 Hz frequency. Also, the hearing threshold levels for the noise-exposed group increased with the duration of noise exposure. The study clearly showed the deleterious effects of uncontrolled occupational noise exposure on unprotected workers. A very high prevalence rate of noise-induced hearing loss (79.8%) was recorded for the noise-exposed group. The less-noise-exposed group recorded a comparatively low figure of 11.3%. The weaving section alone recorded the highest prevalence rate of 84.5%, followed very closely by the spinning section with 71.0%. The lowest prevalence rate (2.9%) was recorded for the administrative staff. In another study by Ologe, Akande and Olajide (2006) in a steel rolling mill in Nigeria, 150 participants were randomly selected for the study. The workers were exposed to noise levels varying from 49 to 93 dBA. About 28.2% of the 103 who had their audiogram analysed had mild to moderate sensorineural hearing loss in their better ear and 56.8% of them had mild to moderate sensorineural hearing loss in their worse ear. The pure-tone average and the average hearing thresholds at 4 kHz for the groups significantly increased with an increasing noise exposure level. They concluded that the prevalence of sensorineural hearing loss among the study population is high.

2.18 Appraisal of Reviewed Literature

In this chapter, related theoretical and empirical literature were reviewed on general concepts of hearing loss, noise exposure, diabetes mellitus and hypertension among the elderly patients.

While noise in high enough doses produces permanent damage to the auditory system, it can lead to significant hearing loss, it also produces stress and interferes with the ability to communicate (Michael & Byrne 2000). The studies by Owolawi (2004) and Abe (2005) supported a significant correlation between noise and hearing loss. Rosen, Bergman, Plester , El-Mofty and Satti (1962) conducted a study in the Sudan and found that those members of the population over 70 years of age did not show any appreciable decrease in hearing acuity as did similar group in the United States of America. Since research studies have confirmed no racial differences in the ability of ears to withstand loud noises, they concluded that the elderly in Sudan had better hearing because the people lived in a relatively noise-free environment.

In occupational settings with noise levels above 85 A-weighted decibels (dBA), the association between noise exposure and hypertension is inconsistent. Some studies have suggested that occupational noise exposure is associated with a sustained elevation of blood pressure (Lee, Kang, Yaang, Choy & Lee, 2009; Tomei, Fioravanti, Cerratti, Sancini, Tomao, Rosati, Vacca, Palitti, Di Famiani, Giubilati, De Sio & Tomei, 2010), but other studies have not revealed any significant interaction (Wu, Shen, Ko, Guu, Gau, Lai, Chen & Chang, 1996; Inoue, Laskar & Harada, 2005). The difference between these studies may be due to the variable use of personal protective equipment among workers in high-noise environments. Thus, outer-ear measurements of noise levels alone may be a source of exposure bias because they do not reflect the true intensity of inner ear exposure.

Linking hypertension and hearing loss, Brohem, Caovilla and Gananca (1996), Chen and Ding (1991), observed a relationship between hearing loss and arterial hypertension in the elderly population. Rosen, Bergman, Plester, El- Mofty and Satti (1962), in a study carried out with hypertensive patients in the USA, said there was a correlation between high blood pressure and hearing loss in high frequencies. However, such correlation was not seen by the same author in a later study carried out with a Sudanese native population. Similarly, Rey, Morello-Castro and Curto (2002) tested 59 patients hearing levels with mean age of 75 years and reported a significantly negative relationship with hypertension. With the above opinions, it is clear that researchers have contrary opininons to relationship between hypertension and hearing loss, however, it can be deduced that individual presdisposing factors (structural or metabolic) may, in isolate cases, cause hearing loss, which does not represent a habitual development in chronic hypertensive patients.

Concerning diabetes and hearing loss, the link between diabetes and auditory decline has long been hypothesized. Studies have shown that people with diabetes show signs of hearing loss at younger ages than those without it (Nancy, 2004). While the connection between diabetes and susceptibility to vision loss is well known, unfortunately the statistics of diabetes related hearing loss among diabetics is not well established. Studies have suggested that diabetics are susceptible to hearing problems because this disease may damage the nerves and blood vessels of the inner ear. However, some authors have concluded that there is no relationship between hyperglycemia and hearing loss while some literature supports a poorly defined association. The link between diabetes and sensorineural hearing loss makes intuitive sense, given the documented neuropathic and microvascular complications of diabetes and the complex blood supply of the inner ear. Cullen and Cinnamond (1993) showed no difference in speech discrimination scores among diabetic patients and a normal population. The effects of different variables such as duration of diabetes, blood sugar control, and presence of end-organ damage on hearing loss have not yet been clarified, despite several studies on this topic. Part of the difficulty in identifying the effects of diabetes on hearing is the presence of comorbidities, such as hypertension and atherosclerosis, which could potentially affect hearing. (Venkata, Robert & Hinrich, 2003).

As can be seen in this review of the literature, the reported results regarding noise exposure, diabetes mellitus, hypertension and hearing loss among the elderly have been inconsistent and difficult to amalgamate into a distinct picture. Moreover, to the best of this researcher's knowledge, no known research combining the exact variables in this study has been carried out in this country. It is expected therefore, that the present study would help to bridge this gap in literature.

2.19 Conceptual Model of Elderly Patients with Noise Exposure, Diabetes Mellitus and Hypertension in South-West, Nigeria

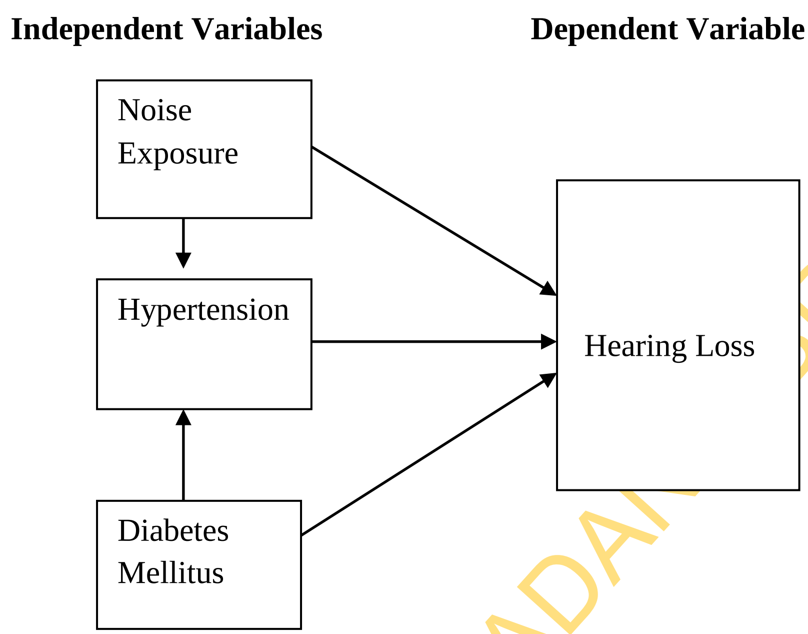


Figure 16: CONCEPTUAL MODEL FOR THE STUDY

CHAPTER THREE

RESEARCH METHODOLOGY

In this chapter, the various methods adopted in arriving at effective research decisions are presented. The research design, variables in the study, population, sample and sampling technique, research instruments, validity and reliability of the instruments, procedure for data collection and the statistical analyses of data are described and discussed.

3.1 Research Design

This study adopted the descriptive survey design. Since the variables of interest have already occurred, they were studied *expost-facto*. Thus, the variables were not manipulated in any way in the course of this study.

3.2 Variables in the Study

The following are the variables in the study:

1. Independent variables:

(a) Noise exposure

(b) Diabetes mellitus

(c) Hypertension

2. Dependent variable:

Hearing loss

3.3 Population

The target population for this study were all the elderly patients in South-West, Nigeria (65 years old and above) in six teaching hospitals in South West Nigeria.

3.4 Sample

The sample for the study comprised four hundred and sixty nine (469) elderly patients aged 65 years and above with hearing loss and history of noise exposure, diabetes mellitus or hypertension in six teaching hospitals in South-West, Nigeria. Demographic data of the sample taken are as follows:

Table 7: Health Institutions Selected for the Study

Health Institutions Selected for the Study	Sample Taken	Percentage
University College Hospital, Ibadan (UCH)	59	12.6
Obafemi Awolow Teaching Hospital, Ile-Ife (OAUTH)	112	23.8
Ladoke Akintola University of Technology Teaching Hospital, Osogbo (LAUTECH)	88	18.8
Lagos University Teaching Hospital (LUTH)	82	17.5
Lagos State University Teaching Hospital (LASUTH)	80	17.1
Olabisi Onabanjo University Teaching Hospital (OOUTH)	48	10.2
Total	**469**	**100**

Table 8: Patients' Age in Years

N	Minimum	Maximum	Mean	Std. Deviation
469	65	94	73.02	6.21

Table 9: Sex Distribution of the Patients

Sex	Frequency	Percent
Male	279	59.5
Memale	190	40.5
Total	**469**	**100.0**

Table 10: Descriptors of Hearing Loss

Descriptors of Hearing Loss	Frequency	Percent
Unilateral Hearing Loss	35	7.5
Bilateral Hearing Loss	434	92.5
Total	**469**	**100.0**

3.5 Sampling Procedure

Purposive sampling technique was used to select the participants for the study because of the nature of the study.The inclusion criteria are age, noise exposure, diabetes mellitus, hypertension and hearing loss. Age was one of the exclusion criteria used in this study. That is, patients below 65 years were not eligible to participate in the study. Also, those patients that had normal hearing thresholds bilaterally were excluded even though they were exposed to noise, had diabetes mellitus or hypertension. The sample of 469 elderly patients were selected over the period of three years (2008-2010) in the following teaching hospitals in South-West, Nigeria:

Oyo State

1. University College Hospital, Ibadan – Oyo State.

Osun State

2. Obafemi Awolowo Teaching Hospital, Ile-Ife, Osun State.
3. Ladoke Akintola University of Technology Teaching Hospital, Osogbo – Osun State.

Lagos State

4. Lagos University Teaching Hospital, Lagos State.
5. Lagos State University Teaching Hospital, Lagos State.

Ogun State

6. Olabisi Onabanjo University Teaching Hospial, Sagamu – Ogun State.

3.6 Research Instruments

The following instruments were used for data collection in this study:

(a) Audiograms

(b) Case notes (Patients' medical records)

Equipment used in collecting data in the study are:

(a) Audiometers

(b) Sound pressure level meter

Description of the Instruments

(a) Audiogram

An Audiogram is the graphical representation of a person's hearing. The audiogram shows the lowest decibel (sound intensity) a person can hear at each frequency (pitch) in each ear. The charting of the hearing sensitivity on the audiogram which is refered to as hearing configuration brings out the patient's degree, type and pattern of hearing.

(b) Case Notes (Medical records)

A patient's medical record contains information regarding the patient's entire case history.The contents are written by medical and or health providers.The medical history is a longitudinal record of what has happened to the patient since birth. His chronicles diseases, major and minor illnesses, as well as growth landmarks. It gives the clinician a feel for what has happened before to the patient. As a result, it may even give clues to current disease states. The medical history include surgical history, obstetric history, medications and medical allergies, family, social history etc. The medical notes are documented after the history had been taken or machine tests have been ascertained.

Description of the Equipment

(a) Audiometer

An audiometer is a machine used to test the hearing level of an individual at different frequencies. It is an electrical equipment which produces sounds of known pitches (frequencies) and intensity (loudness). The operator by manipulating a control, chooses a particular frequency which is fed into the patient's ear by means of a headphone or headband for air and bone conduction tests respectively. Another control allows the operator to change the degree of loudness until it is heard by the individual being tested and that intensity which calibrated in decibels is recorded for the testee as his threshold. The same procedure is applied to the other ear. Clinically, the better ear is tested before the poorer ear. The test result is configured (charted) on a graph called the audiogram.

(b) Sound Pressure Level Meter

A sound pressure level meter is a device for measuring the intensity of noise, music, and other sounds. It consists of a microphone for picking up the sound and converting it into an electrical signal, followed by electronic circuitry for operating on this signal so that the desired characteristics can be measured. The indicating device is usually a metre calibrated to read the sound level in decibels (dB; a logarithmic unit used to measure the sound intensity).

3.7 Validity and Reliability of the Equipment

Calibrated diagnostic audiometers were used to determine the hearing thresholds (degrees of hearing), types and patterns of hearing among the elderly patients. The audiometers were designed to test the hearing levels of patients, detect hearing loss, determine the degree of hearing loss and reveal the patterns of hearing loss that indicate the likely cause of hearing loss in individual patients. The testing environments were devoid of noise, the elderly patients were tested in sound proof booths so that environmental noise would not alter test results, thus, the test results on the audiograms were valid and reliable. The technical data of each audiometer are discussed below:

University College Hospital, Ibadan – Oyo State

Diagnostic Audiometer AD 226
DK-5610 Assens Denmark
Technical Specifications
Standards: EN 60601-1, Class 1, Type B
Using UPS 400
Medical CE-Mark:
The CE-Mark indicates that interacoustics A/S meets the
Requirements of Annex II of the Medical Device Directive
93/42/EEC. Approval of the quality system is made by
TUV-Identification no 0123

Obafemi Awolowo Teaching Hospital, Ile-Ife, Osun State

Diagnostic Audiometer AD 28
Technical Specifications
Standards: IEC 645-1-1992, ANSI 3.6-1989
Safety IEC 601-1

Ladoke Akintola University of Technology Teaching Hospital, Osogbo – Osun State

M A 53 Diagnostic Audiometer
The M A 53 Audiometer is an active, diagnostic medical product according to the class 11a of the EU medical directive 93/42/EEC

Standards: IEC 645-1/EN 60645-1:	Type 2
IEC 645-2:	Type A
ANSI 53. 6-1996:	Type 1 HFA

Lagos University Teaching Hospital, Lagos State

Amplaid A 137
Type 3 EN 60645-1, 1994
Type 3 ANSI SS. 6, 1996
Manufactured by Amplifon S. P. A
Via Ripamonti, 133-20141-Millan, Italy.

Lagos State University Teaching Hospital, Lagos State

Amplivox 270 Diagnostic Audiometer
Type 2 [. E. N60645-1]
Manufactured by Amplifox Ltd, 29-30
Station Approach Kidlington Oxford ox51jd,
England.

Olabisi Onabanjo University Teaching Hospial, Sagamu – Ogun State

The GSI 67 Diagnostic Audiometer is an IEC60645 Type 3 Audiometer and meets the following standards:
IEC 60645-1 (1992)
IEC 60645-1 (1993)
ISO 389
IEC 60601-1
ISO 8253-1
The CE mark on the product indicates it conforms with provisions noted in 93/42/EEC Medical Devices Directives.

Equipment used to Measure Sound Levels

HS5633 Sound Pressure Level Meter
Technical specifications:
HS5633 digital sound pressure level meter
New standard of national sound meter

Stable performance
With "A" sound levels and "Max. maintenance",
"Sound level set, high and low range",
Digital display of overload
AC and DC signal output
Suitable for measuring environmental noise, traffic noise,
mechanical noise, electric noise acoustic and electro acoustic
It accords with the requirements
of IEC61627 (Sound Pressure Level Meter) standard.

3.8 Procedure for Data Collection

Ethical approvals were obtained from the research ethics committees of the selected teaching hospitals before embarking on the study. This was done by obtaining an introductory letter from the Head of Department, Special Education, University of Ibadan to the selected teaching hopitals. Also, research proposals were submitted to the health institutions selected for the study. Two certified audiologists (research assistants) assisted in data collection for the study. The patients' bio data (age, sex, occupation, religion, ethnicity, address etc), data on previous and present medical history (diabetes, hypertension, ear diseases, drugs taken etc) and data on family and social history (history of hearing loss in the family, noise exposure, alcohol, cigarette etc) were collected. Hearing thresholds of the elderly were determined through Pure Tone Audiometry and the thresholds of hearing, types, degrees and patterns of hearing loss of the patients were cautiously and systematically recorded from the audiograms.

3.9 Data Analysis

The statistical techniques used in analysing the data in this study were both descriptive and inferential statistics. The descriptive statistics used were mean, standard deviation, simple percentage and frequency distribution while the inferential statistics employed was multiple regression analysis.

CHAPTER FOUR

PRESENTATION OF RESULTS

This chapter presents the results from the research questions and hypotheses generated for the study. The results were presented in tables and graphs. Data collected were analysed using descriptive and inferential statistics.

4.1 Presentation of Results and Hypotheses Testing

Research Question 1: What are the patterns of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?

Table 11: Patterns of Hearing Loss in the Right Ear of Elderly Patients

Patterns of Hearing Loss	Frequency	Percent
Normal	12	2.6
Flat	56	11.9
Sloping	268	57.1
Rising	8	1.7
Trough	12	2.6
Peaked	50	10.7
Notched	30	6.4
Precipitous	18	3.8
high frequency Loss	15	3.2
Total	**469**	**100.0**

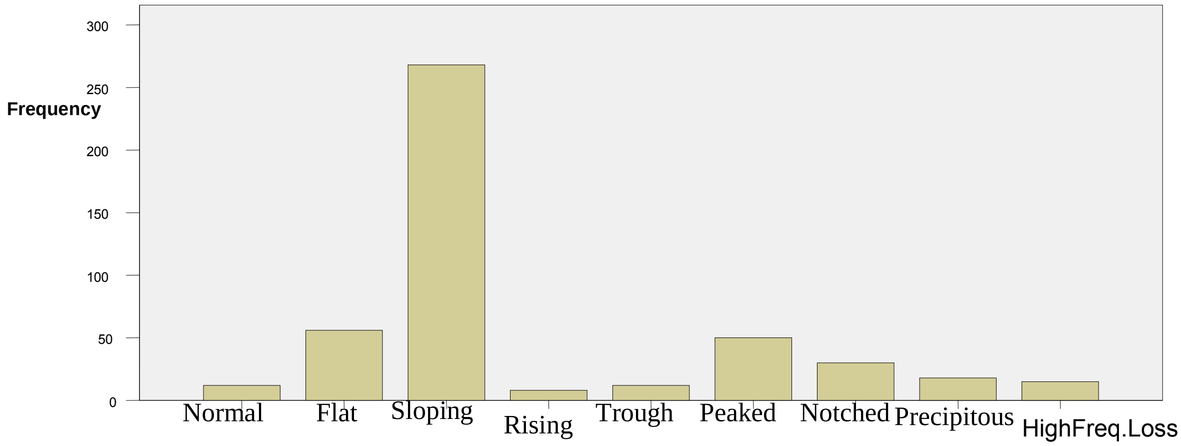


Figure 17: Patterns of Hearing Loss in the Right Ear of Elderly Patients

Table 11 reveals that 12 (2.6%) elderly patients had normal audiometric configurations in the right ears, 56 (11.9%) elderly patients had flat configurations, 268 (57.1%) elderly patients had sloping configurations, 8 (1.7%) elderly patients had rising configurations, 12 (2.6%) elderly patients had trough configurations, 50 (10.7%) elderly patients had peaked configurations, 30 (6.4%) elderly patients had notched configurations, 18 (3.8%) elderly patients had precipitous configurations and 15 (3.2%) elderly patients had high frequency loss configurations (see chapter 2, pages 54-63 for audiogram of each of the patterns).

Table 12: Patterns of Hearing Loss in the Left Ear of Elderly Patients

Patterns of Hearing Loss	Frequency	Percent
Normal	21	4.5
Flat	49	10.4
Sloping	256	54.6
Rising	8	1.7
Trough	19	4.1
Peaked	48	10.2
Notched	30	6.4
Precipitous	19	4.1
High Freqeuncy Loss	19	4.1
Total	**469**	**100.0**

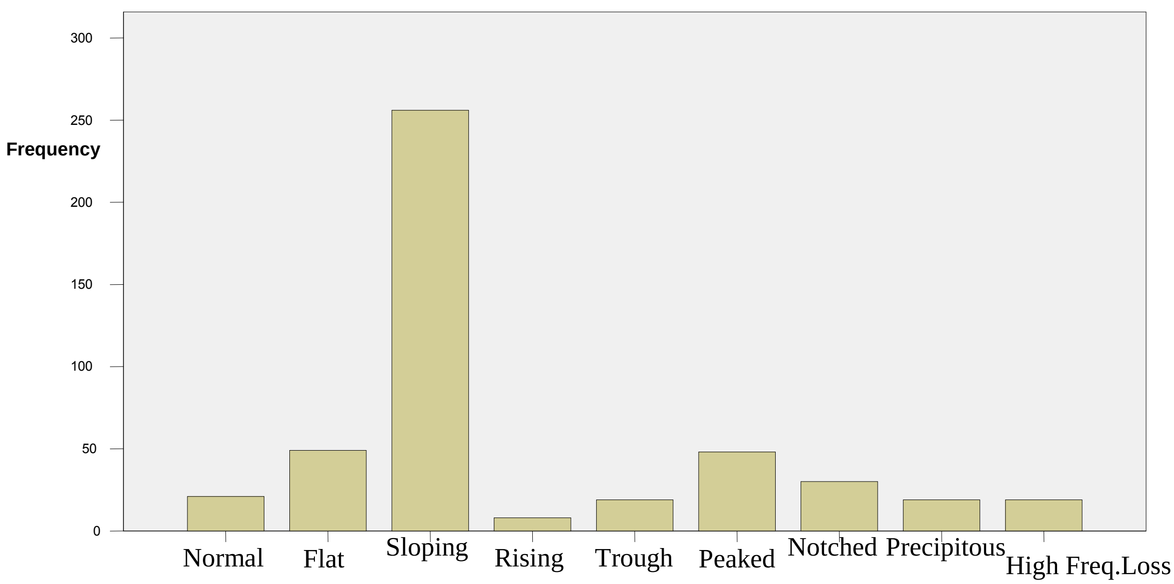


Figure 18: Patterns of Hearing Loss in the Left Ear of Elderly Patients

Table 12 reveals that 21 (4.5%) elderly patients had normal audiometric configurations in the left ears, 49 (10.4%) elderly patients had flat configurations, 256 (54.6%) elderly patients had sloping configurations, 8 (1.7%) elderly patients had rising configurations, 19 (4.1%) elderly patients had trough configurations, 48 (10.2%) elderly patients had peaked configurations, 30 (6.4%) elderly patients had notched configurations, 19 (4.1%) elderly patients had precipitous configurations while the remaining 19 (4.1%) elderly patients had high frequency loss configurations (see chapter 2, pages 54-63 for audiogram of each of the patterns).

Research Question 2: What are the degrees of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?

Table 13: Degrees of Hearing Loss in the Right Ear of Elderly Patients

Degrees of Hearing Loss	Frequency	Percent
Normal	12	2.6
Mild	105	22.4
Moderate	104	22.2
Moderately-severe	119	25.4
Severe	90	19.2
Profound	39	8.3
Total	**469**	**100.0**

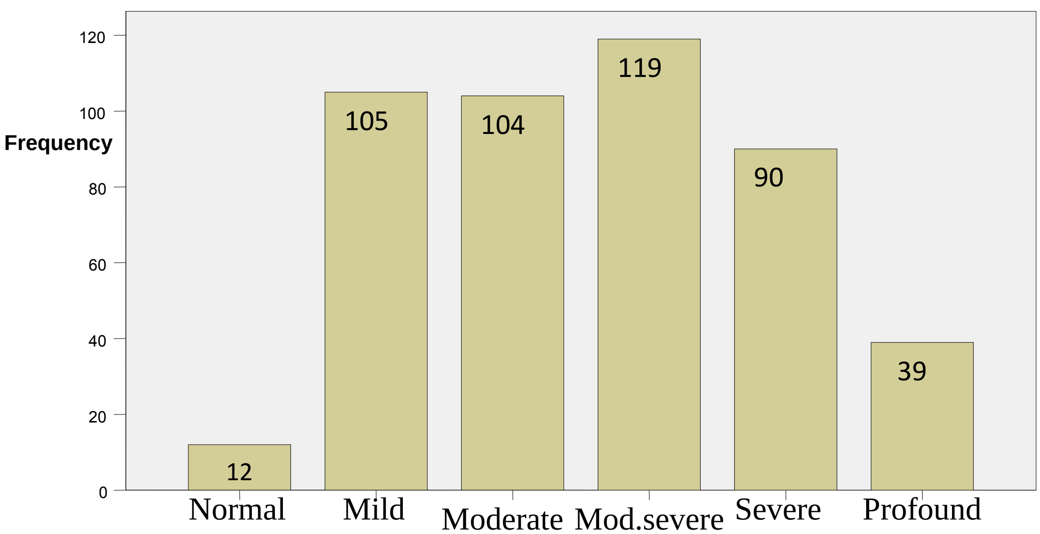


Figure 19: Degrees of Hearing Loss in the Right Ear of Elderly Patients

Table 13 shows that 12 (2.6%) elderly patients had normal hearing thresholds in the right ears, 105 (22.4%) elderly patients had mild hearing loss, 104 (22.2%) elderly patients had moderate hearing loss, 119 (25.4%) elderly patients had moderately-severe hearing loss, 90

(19.2%) elderly patients had severe hearing loss and the remaining 39 (8.3%) elderly patients had profound hearing loss.

Table 14: Degrees of Hearing Loss among the Elderly in the Left Ear

Degrees of Hearing Loss	Frequency	Percent
Normal	21	4.5
Mild	101	21.5
Moderate	109	23.2
Moderately-severe	119	25.4
Severe	85	18.1
Profound	34	7.2
Total	**469**	**100.0**

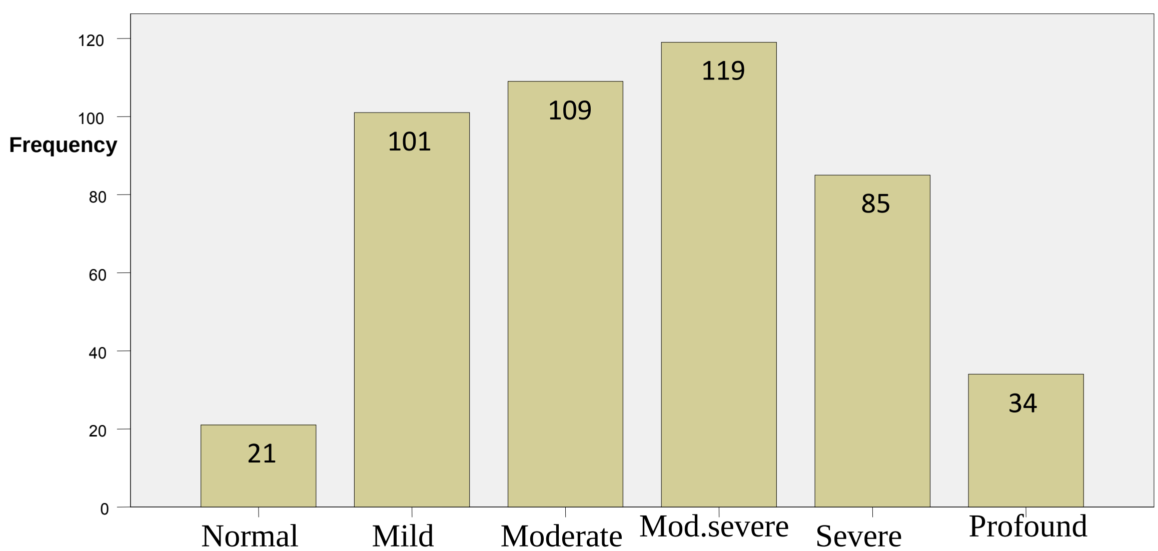


Figure 20: Degrees of Hearing Loss in the Left Ear of Elderly Patients

Table 14 reveals that 21 (4.5%) elderly patients had normal hearing thresholds in the left ears, 101 (21.5%) elderly patients had mild hearing loss, 109 (23.2%) elderly patients had moderate hearing loss, 119 (25.4%) elderly patients had moderately-severe hearing loss, 85(18.1%) had severe hearing loss while the remaining 34 (7.2%) had profound hearing loss.

Research Question 3: What are the types of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?

Table 15: Types of Hearing Loss in the Right Ear of Elderly Patients

Types of Hearing Loss	Frequency	Percent
Normal hearing	12	2.6
Conductive hearing loss	46	9.8
Sensorineural hearing loss	308	65.7
Mixed hearing loss	103	22.0
Total	**469**	**100**

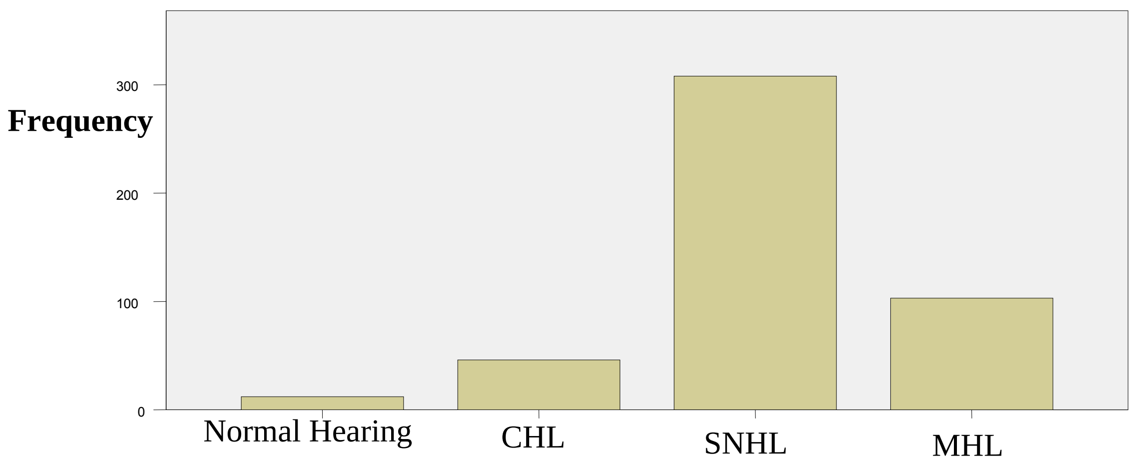


Figure 21: Types of Hearing Loss in the Right Ear of Elderly Patients

Key: **CHL**- Conductive hearing loss

SNHL- Sensorineural hearing loss

MHL- Mixed hearing loss

Table 15 revealed that 12 (2.6%) elderly patients had normal of hearing in the right ears, 46 (9.8%) elderly patients had conductive hearing loss, 308 (65.7%) elderly patients had sensorineural hearing loss while 103 (22.0%) had mixed hearing loss.

Table 16: Types of Hearing Loss in the Left Ear of Elderly Patients

Types of Hearing Loss	Frequency	Percent
Normal hearing	21	4.5
Conductive hearing loss	38	8.1
Sensorineural hearing loss	300	64.0
Mixed hearing loss	110	23.5
Total	**469**	**100**

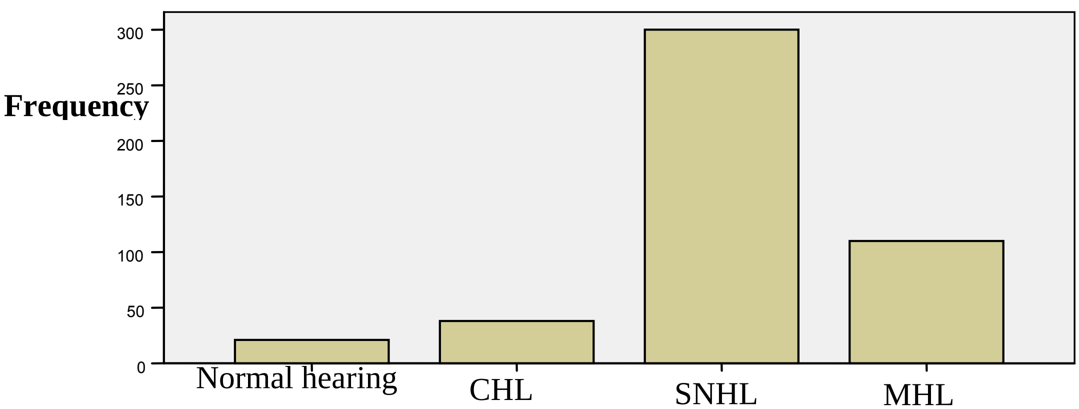


Figure 22: Types of Hearing Loss in the Left Ear of Elderly Patients

Key: **CHL**- Conductive hearing loss

SNHL- Sensorineural hearing loss

MHL- Mixed hearing loss

Table 16 shows that 21(4.5%) elderly patients had normal hearing in the left ears, 38 (8.1%) elderly patients had conductive hearing loss, 300 (64%) elderly patients had sensorineural hearing loss with 110 (23.5%) elderly patients having mixed hearing loss.

Hypothesis 1: There is no significant joint prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 17: Multiple Regression Analysis Table Showing Noise Exposure, Diabetes Mellitus and Hypertension as Joint Predictors of Hearing Loss in the Right Ear

Model	Sum of Squares	Df	Mean Square	F	R	R^2	Sig.	Remarks
Regression	71061.06	3	23687.02	72.05	0.56	0.32	0.00*	Significant
Residual	152870.10	465	328.75					
Total	223931.10	468						

*significant at p<.05

The result in table 17 reveals that the predictor variables (i.e. noise exposure, diabetes mellitus and hypertension) showed significantly joint prediction of hearing loss in the right ears ($F(3, 465) = 72.05$; $R = 0.56$; $R^2 = 0.32$; $p<.05$). The predictor variables jointly accounted for 32% variance of hearing loss in the right ears. The remaining 68% could be due to the effect of extraneous variables. Therefore, the exogenous variables prediction of hearing loss was not due to chance or error. The result did not support hypothesis 1, and therefore was rejected.

Hypothesis 2: There is no significant independent prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 18: Multiple Regression Analysis Table Showing Noise Exposure, Diabetes Mellitus and Hypertension as Independent Predictors of Hearing Loss in the Right Ears.

Model	**B**	**STD Error**	**ß**	**T**	**Sig.**	**Remarks**	**Ranking**
Noise	18.11	1.75	0.41	10.33	0.00*	Significant	1st
Diabetes	11.40	2.07	0.23	5.52	0.00*	Significant	2nd
Hypertension	4.71	1.77	0.11	2.65	0.01*	Significant	3rd

*significant at p<.05

The result in table 18 reveals the independent contributions of noise exposure (ß = 0.41); diabetes mellitus (ß = 0.23) and hypertension (ß = 0.11) to hearing loss in the right ears. In addition, noise exposure contributed most to the explained variation of hearing loss and was distantly followed by diabetes mellitus and hypertension. The table also shows that noise exposure (B=18.11; t = 10.33; p<.05), diabetes mellitus (B=5.52; t = 5.52; p<.05) and hypertension (B=2.65; t = 2.65; p<.05) revealed significantly independent prediction of hearing loss in the right ears. Hence, hypothesis 2 is rejected.

Hypothesis 3: There is no significant joint prediction of hearing loss in the left ears among elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 19: Multiple Regression Analysis Table showing Noise Exposure, Diabetes Mellitus and Hypertension as Joint Predictors of Hearing Loss in the Left Ears

Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**R**	**R^2**	**Sig.**	**Remarks**
Regression	52878.19	3	17626.06	51.71	0.50	0.25	0.00*	Sigificant
Residual	158511.40	465	340.89					
Total	211389.60	468						

*significant at p<.05

The result in table 19 reveals that the predictor variables (i.e. noise exposure, diabetes mellitus and hypertension) showed significantly joint prediction of hearing loss in the left ears ($F(3, 465) = 51.71$; $R = 0.50$; $R^2 = 0.25$; $p<.05$). The exogenous variables jointly explained 25% variance of hearing loss in the left ears. The remaining 75% may be due to the effect of extraneous variables. Therefore, the joint prediction of hearing loss in the left ears by the independent variables did not occur as a result of chance or error. The result did not support hypothesis 3, and therefore was rejected.

Hypothesis 4:There is no significant independent prediction of hearing loss in the left ears among elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 20: Multiple Regression Analysis Table showing Noise Exposure, Diabetes Mellitus and Hypertension as Independent Predictors of Hearing Loss in the Left Ears

Model	**B**	**Std Error**	**ß**	**t**	**Sig**	**Remarks**	**Ranking**
Noise	15.28	1.78	0.36	8.57	0.00*	<.05	1st
Diabetes	13.07	2.11	0.27	6.21	0.00*	<.05	2nd
Hypertension	0.63	1.81	0.02	0.35	$0.73^{n.s}$	>.05	3rd

*significant at p<.05

n.s = Not significant at p>.05

The result in table 20 reveals the independent contributions of noise exposure (ß = 0.36;) Diabetes Mellitus (ß = 0.27) and Hypertension (ß = 0.02) to hearing loss. Moreover, noise exposure contributed most to the explained variation of hearing loss in the left ears than other variables and was followed by diabetes mellitus and hypertension. Also, only two variables: noise exposure (B=15.28; t = 8.57; p<.05) and diabetes mellitus (B=13.07; t = 6.21; p<.05) could independently and significantly predict hearing loss in the left ears. However, since hypertension (B=0.63; t = 0.35, p>.05) could not independently predict hearing loss in the left ears, the result partially supported hypothesis 4 and therefore was partially accepted.

4.2 Summary of Findings

The findings of this study are summarised as follows:

1. The elderly patients possessed bilateral moderately severe hearing loss.
2. It was also seen in the study that elderly patients possessed bilateral sensorineural hearing loss.
3. The study also revealed that elderly patients possessed bilateral sloping pattern of hearng loss.
4. The contributions of independent variables were in the following order: noise exposure, diabetes mellitus and hypertension.
5. Noise exposure, diabetes mellitus and hypertension could predict hearing loss in the right ears while only two factors: noise exposure and diabetes mellitus could predict hearing loss in the left ears of elderly patients.

CHAPTER FIVE

DISCUSSION, IMPLICATION AND RECOMMENDATION

This chapter essentially discusses the findings from the study. The study was designed to investigate the types of hearing loss, degrees of hearing loss and patterns of hearing loss among the elderly. The study also investigated noise exposure, diabetes mellitus and hypertension as predictors of hearing loss among the elderly patients.

5.1 DISCUSSION OF RESULTS

Research Question One

What are the patterns of hearing loss that could be found among elderly patients with noise exposure, diabetes mellitus and hypertension?

Table 11 showed that 12 (2.6%) elderly patients had normal audiometric configurations in the right ears, 56 (11.9%) elderly patients had flat configurations, 268 (57.1%) elderly patients had sloping configurations, 8 (1.7%) elderly patients had rising configurations, 12 (2.6%) elderly patients had trough configurations, 50 (10.7%) elderly patients had peaked configurations, 30 (6.4%) elderly patients had notched configurations, 18 (3.8%) elderly patients had precipitous configurations and 15 (3.2%) elderly patients had high frequency loss configurations. In the left ears, table 12 revealed that 21 (4.5%) elderly patients had normal audiometric configurations, 49 (10.4%) elderly patients had flat configurations, 256 (54.6%) elderly patients had sloping configurations, 8 (1.7%) elderly patients had rising configurations, 19 (4.1%) elderly patients had trough configurations, 48 (10.2%) elderly patients had peaked configurations, 30 (6.4%) elderly patients had notched configurations, 19 (4.1%) elderly patients had precipitous configurations while the remaining 19 (4.1%) elderly patients had high frequency loss configurations.

The result of this study showed that sloping pattern of hearing loss predominated the hearing pattern among the elderly bilaterally. These findings on these tables 11 and 12 were contrary to the study by Kelly et al. (2009) on the prevalence of specific audiometric configuration in a healthy, otologically screened population. They found that flat audiograms were most dominantly represented followed by high frequency gently sloping audiograms. However, the findings of this study reported on tables 11 and 12 corroborated with the study of Ahmad et al. (2007) which reported that most of the elderly patients showed sloping (68.1% for

RE & 64.7% for LE) and also supported the study by Maggi et al. (1998) which revealed that the shape of audiogram which is regarded as reflector of the pathology underlying presbyacusis are slope and ski-slope type curves. This means that age related hearing loss is caused by cochlea degeneration, most pronounced in the basal cochlea coil and the most common audiometric configuration is a gently sloping audiogram, above all affecting the high frequencies bilaterally.The most common form of hearing loss associated with ageing results from degeneration of a part of the inner ear which contains micropscopic blood vessels. With ageing, there is a decrease in the number of neurons in the cochlea nuclei and auditory centres of the brain. There is also a reduction in the size of cells and changes in the neurochemical make up of the cells. This is associated with a decline in the ability of the central auditory system to process sound. Some of the changes in the central auditory system may be attributable to the effects of the loss, or attenuation, of neural input from an impaired peripheral auditory system and these effects combine with general biological ageing within the brain produce the difficulties seen.

Research Question Two

What are the degrees of hearing loss that could be found among the elderly patients with noise exposure, diabetes mellitus and hypertension?

Table 13 showed that 12 (2.6%) elderly patients had normal hearing thresholds in the right ears, 105 (22.4%) elderly patients had mild hearing loss, 104 (22.2%) elderly patients had moderate hearing loss, 119 (25.4%) elderly patients had moderately severe hearing loss, 90 (19.2%) elderly patients had severe hearing loss and the remaining 39 (8.3%) elderly patients had profound hearing loss. On the left ears, Table 14 revealed that 21 (4.5%) elderly patients had normal hearing thresholds, 101 (21.5%) elderly patients had mild hearing loss, 109 (23.2%) elderly patients had moderate hearing loss, 119 (25.4%) elderly patients had moderately severe hearing loss, 85(18.1%) had severe hearing loss while the remaining 34 (7.2%) had profound hearing loss. The results in table 13 and 14 showed that moderately severe hearing loss was prevalent in this study. Thus, the result of this study was similar to the study of 63 patients with a median age of 79 years by Wu, Chin and Tong (2004) in which 54% of the participants had moderately-severe hearing loss. The results of this study also agreed with the study by Ramkissonon and Cole (2011) in which 60% of the elderly patients were found to have severe hearing impairment. The impact of moderately severe hearing loss goes beyond its immediate effects. Apart from the expected problems with hearing and speech recognition even with loud speech, the elderly people may also have difficulty in processing and integrating hearing with other sensory modalities. This will have implications for the elderly beyond the immediate effects of the loss of hearing and can cause difficulties with everyday tasks such as driving or interacting in complex social or physical environments. Severe hearing loss may also be associated with a decreased quality of life, depression, reduced functional status and social isolation.

Research Question Three

What are the types of hearing loss that could be found among the elderly patients with noise exposure, diabetes mellitus and hypertension?

In asking what type of hearing loss that could be found among the elderly, table 15 revealed that 12 (2.6%) elderly patients had normal of hearing in the right ears, 46 (9.8%) elderly patients had conductive hearing loss, 308 (65.7%) elderly patients had sensorineural hearing loss while 103 (22.0%) had mixed hearing loss. In the left ears, table 16 showed that 21(4.5%) elderly patients had normal hearing, 38 (8.1%) elderly patients had conductive hearing loss, 300 (64%) elderly patients had sensorineural hearing loss with 110 (23.5%) elderly patients having mixed hearing loss. The findings in tables 15 and 16 showed that sensorineural hearing loss was prevalent in this study and this was in line with the study by Lui and Yan (2007) which reported that hearing loss due to age is usually a progresive bilateral sensorineural type. This implies that hearing loss due to age affects the inner ear rather than the outer or the middle ear. This is attributable to the preferential loss of hair cells at the basal turn of the cochlea, which transduce the high frequency sounds such as consonants and word endings that are required for decoding speech. The phenomenon of recruitment whereby adjacent cochlea hair cells are activated to compensate for damaged or dysfunctional cells, seen with age related hearing loss, may mean that the elderly person with hearing loss paradoxically complains of sounds being uncomfortably loud. Tinnitus, which means ringing in the ear, frequently a cause of discomfort and distress, may accompany hearing loss in the elderly people. Often, patients present with difficulty in understanding speech rather than an inability to hear because loss of hearing in the higher frequencies (sensorineural hearing loss) usually cause problem of discrimination of voiceless consonants (t, p, k, f, s and ch) and high pitched sounds such as women and children voices. Even with amplification, speech might be difficult to understand in some cases.

Hypothesis One

There is no significant joint prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 17 reveals that the independent variables (i.e. noise exposure, diabetes mellitus and hypertension) showed significantly joint prediction of hearing loss in the right ears ($F(3, 465) = 72.05$; $R = 0.56$; $R^2 = 0.32$; $p<.05$). This led to the rejection of hypothesis one.The independent variables jointly accounted for 32% variance of hearing loss in the right ears. The remaining 68% could be due to the effect of extraneous variables. Therefore, the exogenous variables prediction of hearing loss was not due to chance or error. It means that noise exposure, diabetes mellitus and hypertension correlated positively with hearing loss in the right ear. In other words, there is a synergistic effect of the three factors on the dependent variable. This is supported by Takala et al. (1977), who concluded that high frequency hearing loss is associated with noise exposure. Duck et al. (1977) also found an association between diabetes mellitus and hypertension in the pathogenesis of sensorineural hearing loss. Owolawi (2004) and Abe (2005) also found noise exposure to be strongly associated with hearing loss. Moreso, the result of this study about noise exposure as predictor of hearing loss corroborated with studies by Osibogun, Igweze and Adeniran (2000); Ologe, Akande and Olajide (2006) which showed the deleterious effects of uncontrolled occupational noise exposure on the hearing of unprotected workers.

Hypothesis Two

There is no significant independent prediction of hearing loss in the right ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

The result in table 18 reveals the independent contributions of noise exposure (ß = 0.41); diabetes mellitus (ß = 0.23) and hypertension (ß = 0.11) to hearing loss in the right ears. In addition, noise exposure contributed most to the explained variation of hearing loss and was distantly followed by diabetes mellitus and hypertension. The table also shows that noise exposure ($B=18.11$; $t = 10.33$; $p<.05$), diabetes mellitus ($B=5.52$; $t = 5.52$; $p<.05$) and hypertension ($B=2.65$; $t = 2.65$; $p <.05$) revealed significantly independent prediction of hearing loss in the right ears. This led to hypothesis two being rejected. This implies that there is a relative relationship between hearing loss and the three independent variables; noise exposure, diabetes mellitus and hypertension.

Indeed in some earlier studies, strong association had been reported between these three variables (noise exposure, diabetes mellitus and hypertension) and hearing loss while some studies revealed a contradictory picture. That is, some discovered a weak association, while some even reported that there was no link at all. Diaz de Leon-Morales et al. (2005) reported a strong link between diabetes mellitus and hearing loss, also, NIH (2008) reported that the link between diabetes mellitus and hearing loss was evident across all frequencies, with a stronger association in the high frequency range. The result of this study on diabetes mellitus as a predicor of hearing loss is also in line with the study of Tay et al. (1995) who also reported an association between diabetes mellitus and hearing loss. Konrad-Martin et al. (2009) found an association between diabetes mellitus and hearing loss only with patients with insulin-dependent diabetes. Their conclusion is that diabetes appears to affect hearing and brainstem function but these effects appear somewhat independent. The result on hypertension as a predictor of hearing loss also agreed with the studies by Rosen et al. (1962), although such correlation was not seen by the same authors in a later study carried out with a Sudanese native population. Hansen and Denmark (1968) do not relate arterial hypertension to hearing loss in their study. Rey, Morello-Castro and Curto (2002) reported a significantly negative relationship with hypertension. However, the result of this study is in line with the results from studies by Markova (1990), Nazar, Otarola and Acevedo (1992), Brohem, Caovilla and Gananca (1996) and Chen and Ding (1991) who all found a positive correlation between hypertension and hearing loss. Concerning noise exposure and hearing loss, the result of this study also concurred with the studies by Owolawi (2004) and Abe (2005) who reported that noise exposure has a strong link with hearing loss.

Hypothesis Three

There is no significant joint prediction of hearing loss in the left ears of elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 19 reveals that the independent variables (i.e. noise exposure, diabetes mellitus and hypertension) showed significantly joint prediction of hearing loss in the left ears ($F(3, 465) = 51.71$; $R = 0.50$; $R^2 = 0.25$; $p<.05$). Hence, hypothesis three was rejected.The exogenous variables jointly explained 25% variance of hearing loss in the left ears. The remaining 75% may be due to the effect of extraneous variables. Therefore, the joint prediction of hearing loss in the left ears by the independent variables did not occur as a result of chance or error. It means that noise exposure, diabetes mellitus and hypertension correlated positively with hearing loss in the left ear. That is, there is a significant effect of the three factors (noise exposure, diabetes mellitus and hypertension) when combined together on the dependent variable (hearing loss). This is in line with the study by Takala et al. (1977), who concluded that high frequency hearing loss is associated with noise exposure. The result from this hypothesis three is also supported by Duck et al. (1977) who found an association between diabetes mellitus and hypertension in the pathogenesis of sensorineural hearing loss. Owolawi (2004) and Abe (2005) also found noise exposure to be strongly associated with hearing loss.

Hypothesis Four

There is no significant independent prediction of hearing loss in the left ears of the elderly patients with history of noise exposure, diabetes mellitus and hypertension.

Table 20 reveals the independent contributions of noise exposure (ß = 0.36;) diabetes mellitus (ß = 0.27) and hypertension (ß = 0.02) to hearing loss. Moreover, noise exposure contributed most to the explained variation of hearing loss in the left ears than other variables and was followed by diabetes mellitus and hypertension. Also, only two variables: noise exposure (B=15.28; t = 8.57; $p<.05$) and diabetes mellitus (B=13.07; t = 6.21; $p<.05$) could independently and significantly predict hearing loss in the left ears. hypertension (B=0.63; t = 0.35, $p>.05$) could not independently predict hearing loss in the left ears, hence hypothesis four was partially accepted.

The above result supported the results from the studies by Diaz de Leon-Morales et.al (2005); NIH (2008) and Tay et al. (1995). They found that diabetes mellitus correlated positively with hearing loss. Seemingly, the results of this study is in line with studies by Owolawi (2004) and Abe (2005)who found a positive correlation between noise exposure and hearing loss. Contrary to the result in the right ear on independent prediction of hearing loss by hyperension, the result in this study did not find a significant prediction of hearing loss by hypertension in the left ear and this supports the studies by Hansen and Denmark (1968), Rey et al. (2002) who found no relationship between arterial hypertension and hearing loss.

This may be due to the fact that hypertension in the elderly could be systemic or vascular. Systemic diseases are diseases that involve many organs or the whole body. Vascular disease is a form of cardiovascular disease primarily affecting the blood vessels.Vascular disease includes any condition that affects the circulatory system. As the heart beats, it pumps blood through a system of blood vessels called the circulatory system. The vessels are elastic tubes that carry blood to every part of the body. Arteries carry blood away from the heart while veins return it.Vascular disease ranges from diseases of the arteries, veins, and lymph vessels to blood disorders that affect circulation. Like the blood vessels of the heart (coronary arteries), the peripheral arteries (blood vessels outside the heart) may also develop atherosclerosis, the build-up of fat and cholesterol deposits, called plaque, on the inside walls. Over time, the build-up narrows the artery. Eventually the narrowed artery causes less blood to flow and a condition called "ischemia" occurs. Ischemia is inadequate blood flow to the body's tissue. Hypertension may lead to perfusion or poor blood flow to the cochlea (cochlea ischemia). These mechanisms may be described as a “stroke” of the inner ear and if this poor blood flow affects only one side, then it results into unilateral hearing loss .

5.2 Implication of the Findings

The present study has some implications on the elderly patients. The implications of hearing loss go far beyond an inability to hear and can have significant effects on the quality of life and function of the person concerned. The clinical implication of bilateral sensorineural moderately severe and sloping pattern of hearing loss is that most elderly patients had loss of hearing in both ears in the inner ear, in a high degree and in the higher frequencies. The elderly patients may encounter problem in the discrimination of voiceless consonants (t, p, k, f, s and ch) and high pitched sounds such as women and children voices would be the most difficult to comprehend. The reason is that consonants are spoken more softly than vowels, they are higher pitched than vowels, they convey most of the word information and they are much more important to speech intelligibility than vowels. Since the elderly people have higher frequencies hearing loss, the behavioural implication is that the elderly may find it difficult to understand the following: whispering, telephone conversation, when several people are talking in a large room, when a speaker’s face is not seen, speech on the radio or television. Even with amplification, speech might be difficult to understand in some cases because volume is not necessarily the issue, difficulties with sound and word discrimination may be involved.

Internalizing these stereotypes and the resultant negative self-perception certainly contribute to emotional sequelae of hearing loss. Hearing loss can create a psychological solitary confinement. Yet many elderly people with hearing loss deny the disability or the impact it exerts on their quality of life. Sometimes hearing loss exerts a direct impact on mental health. Depression and adjustment disorder can occur as a natural response to hearing loss and its subsequent impact on the quality of life. Inability to hear and discern message and meaning can result in feelings of shame, humiliation, and inadequacy. It can be highly embarrassing to be unable to behave according to applicable social rules. Feeling inadequate, stupid, awkward, embarrassed, different, or abnormal are some of the negative emotions that plague the elderly with hearing loss when the condition manifests itself in an unpleasant way. The elderly with hearing loss may feel shame related directly to difficulties in understanding what is being said. Inability to understand verbal communication results into feelings of isolation, depression and may significantly worsen age related disabilities and dementia.

5.3 Limitations of the Study

This research work was hospital based due to the fact that many of the teaching hospitals are well equipped with hearing test facilities which helped in determining accurate hearing thresholds of the elderly patients. However, a community based should have given an actual prevalence of hearing loss among the elderly.

The study was also limited to Pure Tone Audiometry machine in the area of assessing the hearing thresholds of the elderly patients, whereas other equipment such as Auditory Brainstem Response (ABR) and Otoacoustic Emission (OAE) machines could be included in order to get full details about hearing loss among the elderly.

Also, this study adopted a descriptive survey design in which the variables of interest had already occurred. An experimental study would reveal a cause and effect relationship.

Another limitation of the study was paucity of published studies on geriatric population in developing countries especially in Nigeria. Most of the literature reviewed were from foreign countries. One of the reasons for scanty publications on the elderly people may be due to the fact that they are usually neglected. Another reason adduced for dearth of published literature on geriatric population may be because it is a special population whereby majority of people do not get to old age before they die especially in developing countries. This is seen in the CIA (2012) life expectancy table. The term life expectancy is a reflection of overall quality of life, it summarizes the mortality at all ages. It can also be thought of as an indication on the potential return on investment in human capital such as the quality of healthcare services in a particular country as well as other factors including wars, crises and HIV/AIDS infections. The current life expectancy estimation for Nigeria is 48.95 years for male and 55.33 years for female.

Lastly, the traditional manual form of keeping patients' medical records in Nigerian teaching hospitals made the data retrieval difficult and slow. Electronic mode of keeping patients' data would have made the data retrieval easy.

5.4 Conclusion

The purpose of this study was to investigate patterns of hearing loss, degrees of hearing loss and types of hearing loss among the elderly patients with noise exposure, diabetes mellitus and hypertension. The study also aimed at finding correlations between hearing loss in the elderly patients with noise exposure, diabetes mellitus and hypertension. In view of this, data were collected, collated and analysed, and the following conclusions were drawn:

The findings revealed that the elderly patients possessed bilateral sensorineural moderately-severe and sloping pattern of hearing loss.

Noise exposure, diabetes mellitus and hypertension significantly and jointly predicted hearing loss in the right ears and the contributions of these three factors to the dependent variable are in the following order: noise exposure, diabetes mellitus and hypertension.

In the left ears, the three factors also significantly and jointly predicted hearing loss but only two factors (noise exposure and diabetes melllitus) significantly predicted hearing loss.

5.5 Suggestions for Further Studies

Longitudinal study involving larger sample size and wider geographical area may be conducted among the elderly to confirm the results of this study. A longitudinal study would give room to monitor the lifestyles of the participants and also be able to perform Pure Tone Audiometry examination at intervals which would reveal any shift in the hearing thresholds.

Future research work may also be designed to replicate this study in different geo-political zones of the federation in order to give room for comparison.

Moreover, future research could be done among the youth.

A community based study that will give actual prevalence of hearing loss among the elderly patients is suggested.

Extensive study on the relationship between hearing loss and hypertension among the elderly is also suggested.

Other equipment for hearing assessment such as Auditory Brainstem Response (ABR) and Otoacoustic Emission (OAE) machines could be included to complement hearing test results from Pure Tone Audiometry. This would give full details about hearing loss among the elderly.

5.6 Contribution to Knowledge

This research work would contribute to the existing body of knowledge in the following ways:

This study revealed that elderly patients possessed bilateral, moderately-severe sensorineural and sloping pattern of hearing loss. This indicates that amplification is needed in managing moderately-severe sensorineural hearing loss and aural communication may be required as a form of therapy because of sloping pattern that is predominant among the elderly which mostly affect high frequencies. Elderly people with sloping pattern of hearing loss often ecounter problems in the discrimination of voiceless consonants (t, p, k, s and ch). The reason is that consonants are spoken more softly than vowels, they are higher pitched than vowels, they convey most of the word information and they are much more important to speech intelligibility than vowels. So, even with amplification, speech might be difficult to understand in some cases, thus, the elderly need aural communication which includes hearing aid orientation, listening strategies, speech reading, auditory training and total communication because volume is not necessarily the issue, difficulties with sound and word discrimination may be involved.

The study also revealed that noise exposure, diabetes mellitus and hypertension are predicting factors to hearing loss among the elderly. Although future studies would confirm the link between hypertension and hearing loss.

This study would also form part of the literature base for further studies among the elderly in Nigeria and beyond especially the synergistic effect of noise exposure, diabetes mellitus and hypertension on hearing loss.

5.7 Recommendations

Based on the findings of this study, the following recommendations are hereby made:

(a) **General Recommendations**

The elderly people should be encouraged to maintain good health with adequate diet.

Government should encourage the elderly people by making hearing test free. If routine hearing test is done at least once in six months, hearing loss could be detected early which could aid early intervention by Ear, Nose and Throat consultants and audiologists.

Government should provide public enlightment campaign through public enlightment bureau and mass media. This would go a long way in creating awareness on side-effects of old age.

Workshops and seminars should be organised frequently for the elderly and their care givers, as this would not only help the elderly but also expose the care givers to several management options and coping strategies with the elderly people and their conditions.

Government hospitals and health centers should be sufficiently equipped with modern-day hearing test equipment.

Provision of hearing aids should be an important item in any health care policy initiative for the elderly. At the present time, most elderly people in need are unable to afford this important device that may help improve their quality of life.

The findings in this study also suggest that hearing loss prevention (through modifiable risk factors reduction) and screening should begin in young adulthood.

(b) Specific Recommendations

Noise Exposure

Government should ensure that administrative control of noise through the enacted legislations are striclty adhere to by the populace, companies, churches, mosques and everybody that has anything to do with noise.

There should also be engineering control through sound barriers, sound diffusers and sound encloures.

Workers education should be given periodically. This would train and inform them about the use of ear protectors such as earplugs and earmuffs.

Baseline audiometry should be mandatory especially for workers in noisy workplaces with periodic audiological evaluation so as to detect temporary threshold shift and there should be noise monitoring by measuring noise level in work places or in any noisy area.

Diabetes Mellitus

The elderly should frequently undergo routine medical checkup.

Lifestyle modification is recommended for prevention and management of diabetes mellitus among the elderly. This include dietry modification, weight reduction and exercise.

Hypertension

Routine medical checkup is also advocated for the elderly patients with hypertension.

The elderly should also modify their lifestyle in managing hypertension.

Dietry Approaches to Stop Hypertension (DASH) eating plan and eating less salt, also called sodium is recommended for the elderly patients with hypertension.

REFERENCES

American Academy of Audiology 2008. Facts about Noise-induced Occupational Hearingloss.*http://www.audiology.org/resources/consumer/audiologyawareness/Documents/FSNIHL08.pdf* . Retreived on December 8, 2008.

American Academy of Otoloaryngology-Head and Neck Surgery 2007. Noise and Hearing Protection. *http://www.entnet.org/HealthInformation/hearingProtection.cfm* Retrieved on December 8, 2010.

Abe, O. T. 2005. Comparison of Impact of Acoustic-Trauma on Hearing Ability of Blacksmiths with Different Years of Noise Exposure in Ondo State, Nigeria. Ph.D Thesis. Department of Special Education, University of Ibadan, Ibadan, Oyo State, Nigeria.

Abiodun, K. and Elemukan, I. 2005. Noise Induced Hearing Loss as a Major Occupational Hazard among Workers of Ilorin Coca-Cola Bottling Company. *African Journal of Edul Studies* 3 (2).

Abubakar, A., Mabruok, M., Gerie, A., Dikko, A., Aliyu, S., Yusuf, T., Magaji, R., Kabir, M. and Adama, U. 2009. Relation of Body Mass Index with Lipid Profile and Blood Pressure in Healthy Female of Lower Socioeconomic Group in Kaduna Northern Nigeria. *Asian Journal of Medical Sciences*:1 (3): 94-96.

Abubakari, A. R. and Bhopal, R. S. 2008. Public Health Systematic Review on the Prevalence of Diabetes, Overweight/Obesity and Physical Inactivity in Ghanaians and Nigerians. *Public Health*: Volume 122, Issue 2, February 2008, Pages 173–182

American College of Occupational and Environmental Medicine 2003. Preventing Noise Induced Occupational Hearing Loss. *Position Statement.*

American Foundation for Ageing Research 2006. Theories of Ageing. *www.infoaging.org* Retrieved on 27th December, 2010.

Afolabi, O. A. and Ijaduola, G. T. A 2008. Pattern of Ear Diseases among Older People. *East and Central African Journal of Surgery*, Vol.13, No. 2, September, 2008, pp. 96-100.

Agrawal, Y., Platz, E. A. and Niparko, J. K. 2009. Risk Factors for Hearing Loss in Adults: Data from the National Health and Nutrition Examination Survey, 1999 to 2002. *Otol Neurotol*;30:139–45.

Ahmad, S., Abdulbari, B., Khalid, A., Lili, H. and Loida, G. 2007. Hearing Loss in Elderly Population: Experience in a Rapidly Newly Developed Country Qatar. *Middle East Journal of Age and Ageing.* Volume 4, issue 4.

American Hearing Research Foundation 2008. Noise Induced Hearing Loss. *http://www.american-hearing.org/disorders/noise-induced-hearing-loss* Retrieved on 4th December, 2010.

Alawode, A. J., Stephen, J. T. and Adeyemi, G. J. 2008. Health Safety and Environmental Issues in Nigerian Manufacturing and Processing Industries. *Journal of Engineering and Applied Sciences*, p. 636 www.mewlljournal.com Retrieved on 18 August, 2011.

Albernaz, P. L. M. 1995. Doenças metabólicas da orelha interna. *RBM –Otorrinolaringologia;* 1: 18-22.

American Diabetes Association. 2006. "Standards of Medical Care-Table 6 and Table 7, Correlation between A1C Level and Mean Plasma Glucose Levels on Multiple Testing over 2–3 months." *Diabetes Care*; Vol. 29 Supplement 1 Pages 51–580.

Angevaren, M., Vanhees, L., Wendel-Vos, W., Verhaar, H. J., Aufdemkampe, G., Aleman, A. and Verschuren, W. M. 2007**.** Intensity, but not Duration, of Physical Activities is Related to Cognitive Function**.** *Eur J Cardiovasc Prev Rehabil*, 14(6)**:**825-830.

Ariyoshi, H. 2007. Effect of the Improvement of the Method for Hearing Test on Increased Rate of Wearing Earplugs and Hearing Loss Protection. *Jpn Health Med Assoc J* 16, 39–43.

Axelsson, A. Lindgren, F. 1965. Is There a Relationship between Hypercholesterolemia and Noise-Induced Hearing Loss? *Acta Otolaryngol Suppl*;100:379-86

Babisch, W. 1998. Epidemiological Studies of Cardiovascular Effects of Traffic Noise. In:Noise Effects. Proceedings of the 7 th International Congress on Noise as a Public Health Problem. Carter N, Job SR, editors. Noise Effects Pvt Ltd: Sydney, Australia; pp. 221-9.

Babisch, W. 2002 The Noise and Stress Concept, Risk Assessment and Research Needs. *Noise Health,* 4:1-11.

Bachor, E., Selig, Y. K., Jahnke, K., Rettinger, G. and Kaemody, C. 2001. Vascular Variations of Inner Ear. *Acta Otolaryngol*;121:35-41.

Bakare, C. A. 1980. The Deleterious Effects of Agro-Industrial Noise on Hearing. *The Proceedings of the Annual Conference of Agricultural and Allied Workers Union of Nigeria.*

Balasubramanian, T. 2006. Presbyacusis. *http://ent.drbalu.co.in/mod/resource/view.php?id=13.* Retrieved on 21st May, 2009.

Barker, K. 1998. The Ageing Process. In Marr, J. and Kershaw, B. (Eds.) Caring for Older People: *Developing Specialist Practice*. London: Arnolds. pp10-35.

Becker, G., Flower, R. M., Glass, L. E. and Newcomer, R. J. 1984. The Management of Hearing Impairment in Older Adults. *OTA* contract No. 333-89700.

Belojevic, G. and Saric-Tanascovic, M. 2002. Prevalence of Arterial Hypertension and Myocardial Infarction in Relation to Subjective Ratings of Traffic Noise Exposure. *Noise Health*; 4:33-7.

Bennett, G. C. and Ebrahim, S. 1995. The Essentials of Health Care in Old Age (2nd ed.). New York: Oxford University Press Inc.

Berglund, B. and Lindvall, T. 1995. Community Noise. *Archives of the Centre for Sensory Research, Stockholm, Sweden,* 2 (1):3, 14-19.

Bethesda, M. D. 1996. Hearing and Hearing Impairment: National Strategic Research Plan. *National Institute on Deafness and Other Communication Disorders, National Institutes of Health, US Dept of Health and Human Services;33-34.*

Borg, E. 1982. Noise-Induced Hearing Loss in Normotensive and Spontaneously Hypertensive Rats. *Hear Res*;8:117-30.

Borg, E. and Viberg, A. 1987. Age-related Hair Cell Loss in Spontaneously Hypertensive and Normotensive Rats. *Hear Res*;30:111-8

Brohem, V. M., Caovilla, H. H. and Gananca, M. M. 1996. Dos sintomas e achados audiológicos e vestibulares em indivíduos com hipertensão arterial. *Acta Awho* 15(1):4-10.

Brookhouser, P. E. 1994. Prevention of Noise-Induced Hearing Loss. *Prev Med;*23:pp. 665-9.

Carolina, P. and Marisa, F. 2009. Cigarette Smoking as a Risk Factor for Auditory Problems. *Braz. j. otorhinolaryngol. (Impr.) vol.75 no.6 Sao Paulo http://dx.doi.org/10.1590/S1808-86942009000600021* Retrieved on 27th July, 2010.

Celik, O., Yalcin, S. and Celebi, H. 1996. Hearing Loss in Insulin Dependent Diabetes Mellitus. *Auris Nasus Larynx*;23:127–32.

Cervilla, J. A., Prince, M. and Mann, A. 2000. Smoking, Drinking, and Incident Cognitive Impairment: A Cohort Community Based Study Included in the Gospel Oak Project. *J Neurol Neurosurg Psychiatry*; 68:622–6.

Chacra, A. R. 2001. Diabetes Mellitus. Em: Prado, F. C. Ramos, J. A. Borges, D. R. Tratado de atualizaçao terapeutica. 20ª ed. Sao, Paulo: Artes Medicas: *Camara Publicadora do Livro*; pp. 375-89 http://www.scielo.br/scielo.php?script=sci_arttext&pid Retrieved on 27th July, 2010.

Chang, T., Liu, C., Huang, K., Chen, R., Lai, J. and Bao, B. 2011. High-Frequency Hearing Loss, Occupational Noise Exposure and Hypertension: A Cross-Sectional Study in Male Workers. *Environmental Health* Vol 10:35

Chen, Y. L. and Ding, Y. P. 1991. Relationship Between Hypertension and Hearing Disorders in the Elderly. *East Afr Med*; 76(6):344-7.

Chisolm, T. H., Willott, J. F. and Lister, J. L. 2003. The Ageing Auditory System: Anatomic and Physiologic Changes and Implications for Rehabilitation. *Int J Audiol*; 42:203-210.

Chobanian, A. V., Bakris, G. L., Black, H. R., Cushman, W. C., Green, L. A., Izzo, J. L., Jones, D. W., Materson, B. J., Oparil, S., Wright, J. T. and Roccella, E. J. 2003. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: *the JNC 7 report: JAMA.*

Churchill, 1989. Churchill's Illustrated Medical Dictionary, Churchill Livingstone Incorporated, New York, p. 1284.

Central Intelligence Agency 2012. The World Factbook https://www.cia.gov/library/publications/the-world-factbook/fields/2102.html Retrieved 10th January, 2012.

Clicia, S. M. and Carlos, A. H. 2005. Diabetes Mellitus as Etiological Factor of Hearing Loss. *Rev Bras Otorrinolaringol.* V.71, n.2, 208-14.

Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., Webb, A., Jerome, G. J., Marquez, D. X. and Elavsky, S. 2004. Cardiovascular Fitness, Cortical Plasticity and Ageing. *Proc Natl Acad Sci* USA, 101(9)

Cooper, R., Rotimi, C., Ataman, S., Mc Gee D. and Osotimilehin, B. 1997. The Prevalence of Hypertension in Seven Populations of West African Origin. *Am. J. Public Health*, 87: 160-168

Cowie, C. C., Rust, K. F., Byrd-Holt, D. D., Eberhardt, M. S., Flegal, K. M. and Engelgau M. M. 2006. Prevalence of Diabetes and Impaired Fasting Glucose in Adults in the U.S. Population: National Health and Nutrition Examination Survey 1999-2002. *Diabetes Care;*29:1263-1268.

Crosta, P. M. 2009. Hypertension. *MedicalNewsToday* *http://www.medicalnewstoday.com/sections/hypertension/* Retrieved on 4th December, 2010.

Cruickshanks, K. J., Klein, R. and Klein, B. E. 1998. Cigarette Smoking and Hearing Loss: The Epidemiology of Hearing Loss Study. *JAMA;*279:1715–19.

Cruickshanks, K. F., Wiley, T. L., Tweed, T.S., Klein, B. E., Klein, R., Mares-Perlman, J.A. and Nondahl, D. M. 1998. The Epidemiology of Hearing Loss Study. Prevalence of Hearing Loss in Older Adults in Beaver Dam, Wisconsin. *Am. J. Epidemiol.*, 148, 879-886.

Cullen, J. R. and Cinnamond, M. J. 1993. Hearing Loss in Diabetics. *J LaryngolOtol.*; 107(3):179- 82.

Cushman, W., Ford, C., Cutler, J., Margolis, K., Davis, B., Grimm, R., Black, H., Hamilton, B., Holland, J., Nwachuku, C., Papademetriou, V., Probstfield, J., Wright, J., Alderman, M., Weiss, R., Piller, L., Bettencourt, J. and Walsh S. 2002. Success and Predictors of Blood Pressure Control in Diverse North American Settings: The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT). *J Clin Hypertens (Greenwich)*.;4:393-405

Dalton, D. S., Cruickshanks, K. J. and Klein, B. E. 2003. The Impact of Hearing Loss on Quality of Life in Older Adults. *Gerontologist.* 43(5): pp. 661-8.

Dalton, D. S., Cruickshanks, K. J., Klein, B. K., Klein, R., Wiley, T. L. and Nondahl, D. M. 2003. The Impact of Hearing Loss on Quality of Life in Older Adults. *The Gerontologist*. Vol. 43, No. 5, 661–668

Dalton, D. S., Klein, R., Klein, B. E. K., Moss, S. E. and Cruickshanks, K. J. 1998. Association of NIDDM and Hearing Loss; *Diabetes Care 1998*; 21(9): 1540-4.

Darrat, I., Ahmad, N. and Seidman, K. 2007. Auditory Research Involving Antioxidants. *Curr Opin Otolaryngol Head Neck Surg.* 15(5): pp. 358-63.

Dewane, C. 2010. Hearing Loss in Older Adults - Its Effect on Mental Health *Social Work Today*: Vol. 10 No. 4 p. 18.

Dhingra, P. L. 2004. Hearing loss. Diseases of Ear, Nose and Throat Elsevier. IIIrd Edition, 38 - 52.

Diaz de Leon-Morales, L. V., Jauregui-Renaud, K., Garay-Sevilla, M. E., Hernande-Prado, J., and Malacara-Hernandes, J. M. 2005. Auditory Impairment in Patients with Type 2 Diabetes Mellitus. *Archives medical Research*, 36, 507–510.

Dobie, R. 1995. Prevention of Noise-Induced Hearing Loss. *Arch Otolaryngol Head Neck Surg*;121: pp. 385-91.

Dobie, R. A. 2008. Burdens of Age-related and Occupational Noise-Induced hearing loss in the United States. *Ear Hearing, 29*, 565-577.

Duck, S. W., Prazma, J., Bennett, P. S. and Pillsbury, H. C. 1997. Interactions between Hypertension and Diabetes Mellitus in the Pathogenesis of Sensorineural Hearing Loss. Laryngoscope;107:1596-605

Eades, M. R. and Eades, M. D. 1996. Protein Power: The High-Protein and Low-Carbonhdrate Way to Lose Weight, Feel Fit and Boost Your Health – in Just Weeks! Creative Paradox, LLC pp 307-308.

Earshen, J. J. 1986. Sound Measurement: Instrumentation and Noise Descriptors. In: Berger, E. H. Ward, W. D. Morrill, J. C. and Royster L. H. Noise and Hearing Conservation Manual, Akron, OH, *American Industrial Hygiene Assoc.*

Edgar, T. O. 1915. Klinische Untersuchungen uber die Erkrankungen des Gehororgans bei Diabetes Mellitus mit besonderer Berucksichtigung der Erkrankungen des inneren Ohres. *Mschr Ohrenheilk LaryngoRhinol*;49:225–60.

Ekere, A. U., Yellowe, B. E. and Umune, S. 2005. Mortality Patterns in the Accident and Emergency Department of an Urban Hospital in Nigeria. *Niger J. Clin. Pract*., 8. 14-18

Elwell, L. 1984. Hearing: Safeguarding an Endangered Resource. *Speech Delivered to the Oklahoma Alliance on Ageing*, Oklahoma City, OK, July 2, 1984.

ENTMAGS. 2009. What is the Ear and How does it Work? *http://www.entmags.org/ears.asp#1* Retrieved on 4th December, 2010.

Evans, R. J. 2009. A Comparison of Rural and Urban Older Adults in Iowa on Specific Markers of Successful Ageing. *Journal of Gerontological Social Work, 52*(4), 423–438.

Finch, C. E. 1990. Longevity, Senescence and the Genome. Chicago: Univ.

Franssen, E., van Wiechen, C., Nagelkerke, N. and Lebret, E. 2004. Aircraft Noise Around a Large International Airport and its Impact on General Health and Medication Use. *Occup Environ Med* 61:405–413.

Friedman, S. A., Schulman, R. H. and Weiss, S. 1975. Hearing and Diabetic Neuropathy. *Arch Intern Med*; 135: 573-6.

Fukushima, H., Cureoglu, S., Schachern, P. A., Paparella, M. M., Harada, T. and Oktay, M. F. 2006. Effects of Type 2 Diabetes Mellitus on Cochlea Structure in Humans. *Arch Otolaryngol Head Neck Surg*.;132(9):934-8.

Gates, G. A. and Mills, J. H. 2005. Presbyacusis. *Lancet.* 24-30;366(9491): pp. 1111-20.

Gates, G. A., Cooper, J. C. and Kannel, W. B. 1983. Hearing in the Elderly: The Framingham Cohort. *Ear Hear.*

Gates, G. A., Cooper, J. C., Kannel, W. B. and Miller, N. 1990. Hearing in the Elderly: The Framingham Cohort, 1983-1985. Part 1. Basic Audiometric Test Results. *Ear Hear*;11:247-256.

Glynn, K. 2009. Ear - Outer Ear, Middle Ear, Inner Ear. Science Encyclopedia Vol 2. http://science.jrank.org/collection/2/Gale-Encyclopedia-Science.html Retrieved on 4th December, 2010.

Gopinath, B., Flood, V. M. and McMahon, C. M. 2010. The Effects of Smoking and Alcohol Consumption on Age-related Hearing Loss: The Blue Mountains Hearing Study. *Ear Hear;31:277–82.*

Gordon, S. and Byron, B. 2004. Geriatric Otolaryngology, *Grand Rounds Presentation, UTMB*, Department of Otolaryngology.

Gosta, L., Niklas, B., Emma, N. and Mats R. 2007. Road Traffic Noise and Hypertension. *Occupational and Environmental Medicine*; Vol. 64, No.2, pp.122-126.

Govindarajan, G., Sowers J. R. and Stump, C. S. 2006. Hypertension and Diabetes Mellitus. *European Cardiovascular Disease.*

Gupta, M. and Gupta, M. 2008. Evaluation of Hearing Loss in the Elderly and its Management. *Journal of The Indian Academy of Geriatrics*; 4:115-122.

Gussekloo, J., de Bont, L. E., von Faber, M., Eekhof, J. A., de Laat, J. A., Hulshof, J. H., van Dongen, E. and Westendorp, R. G. 2003. Auditory Rehabilitation of Older People from the General Population-The Leiden 85-Plus Study. *Br J Gen Pract*. 2003 53: 536-40.

Hagar, L. D. 2011. Fit-testing Hearing Protectors: An Idea whose Time has come. *Noise Health*; 13, 147-151.

Hamza, A. D. 2008. Noise Pollution Regulatory Measures for Protection of Ecosystem. *Faculty of Law Journal*, University of Ilorin,vol. 4 p. 32.

Hansen, C. C. and Denmark A. 1968. Perceptive Hearing Loss and Arterial Hypertension. Arch Otolaryngol; 87(2): 119-22.

Harner, S. G. 1981. Hearing in Adult-Onset Diabetes Mellitus. *Otolaryngol Head Neck Surg*; 89:322–7.

He, J., Whelton, P. K., Appel, L. J., Charleston, J. and Klag, M. J. 2000. Long-Term Effects of Weight Loss and Dietary Sodium Reduction on Incidence of Hypertension. *Hypertension.* ;35:544-549.

Hetu, R., Getty, L. and Quoc, H. T. 1995. Impact of Occupational Hearing Loss on the Lives of Workers. *Occup. Med.*, 10, 495-512.

Hickson, L., Worrall, L. and Scarinci, N. 2007. A Randomized Controlled Trial Evaluating the Active Communication Education Program for Older People with Hearing Impairment. *Ear Hear*. 28(2): pp. 212-30.

Hill, R. D.1989. Residual Effects of Cigarette Smoking on Cognitive Performance in Normal Ageing. *Psychol Ageing;* 4:251–4.

Hilts, P. J. 1999. Life at Age 100 is Surprisingly Healthy, *The New York Times*, p. D7.

Hirai, A., Takata, M., Mikawa, M., Yasumoto, K., Iida, H. and Sasayama, S.1991. Prolonged Exposure to Industrial Noise Causes Hearing Loss but not High Blood Pressure: A Study of 2124 Factory Labourers in Japan. J Hypertens; 9: 1069-73.

Hooyman, N. R. and Kiyak, H. A. 2011. Social Gerontology: A Multidisciplinary Perspective (9th ed.). Upper Saddle River, NJ: Pearson.

Howarth, A. and Shone, G. R. 2006. Ageing and the Auditory System. *Postgrad Med J.*; 82(965):166–171.http://bestpractice.bmj.com/best-practice/evidence/background/0506.html Retrieved on 18th September, 2010.

Hull, R. H. 1977. HearingLmpairment AmongAgingPersons. *Lincoln, NE:* Cliff Notes.

Humes, L. E., Joellenbeck, L. M. and Durch, J. S. 2005. Noise and Military Service: Implications for Hearing Loss and Tinnitus. *The National Academies Press*: Washington D C, USA; pp. 72-115.

Ijaduola, G.T.A. 2010. Ear, Nose & Throat, Head and Neck Surgery Basics. Golden Gait Books.

Inoue, M., Laskar, M. S. and Harada, N. 2005. Cross-Sectional Study on Occupational Noise and Hypertension in the Workplace. *Arch Environ Occup Health*: 60:106-110.

Ising, H. and Kruppa, B. 2004. Health Effects Caused by Noise: Evidence in the Literature from the Past 25 Years. *Noise Health*: 6:5-13.

Ito, A., Iki, M. and Kurumatani, N. 1994. Real Ear Attenuation of Earplugs and their Efficiency in Noise Exposed Workers. *J Sci Labour;* 70, 45–56.

Jarup, L., Babisch, W., Houthuijs, D., Pershagen, G., Katsouyanni, K., Cadum E., Dudley, M., Savigny, P., Seiffert, I., Swart, W., Breugelmans, O., Bluhm, G., Selander, J., Haralabidis, A., Dimakopoulou, K., Sourtzi, P., Velonakis, M. and Vigna-Taglianti, F. 2008. Hypertension and Exposure to Noise Near Airports: The HYENA Study. *Environ Health Perspect*, 116:329-333.

Jarvis, J. F. and van Heerden, H. G. 1967. The Acuity of Hearing in the Kalahari Bushman: A pilot Study. *J Laryngol Otol*.; 81:63-68.

Jennings, C. R. and Jones, N. S. 2001. Presbyacusis. *J Laryngol Otol* 2001; 115: 171-178.

Jonsson, A. and Hansson, L. 1977. Prolonged Exposure to a Stressful Stimulus (Noise) as a Cause of Raised Blood Pressure in Man. *Lancet* 1: 86.

Jordao, A. M. 1857. Consideration sur un cas du Diabete.*Union Medicale duParis*;11:446

Jorgensen, M. B. and Buch, N. H. 1961. Studies on Inner Ear Function and Cranial Nerves in Diabetics. *Arch Otolaryngol*; 74:373-381.

Kakarlapudi, V. Sawyer, R. and Staecker, H. 2003. The Effect of Diabetes on Sensorineural Hearing Loss. *Otol Neurotol*. ;24(3):382-6.

Kawada, T. and Suzuki, S. 1999. Change in Rapid Eye Movement (REM) Sleep in Response to Exposure to All-Night Noise and Transient Noise. *Arch Environ Health* 54:336 – 340.

Kelley, G. A. and Kelley, K. S. 2000 Progressive Resistance Exercise and Resting Bood Pressure. *Hypertension*; 35:838-843

Kelly, D., Astrid V. W., Hendrickx, J. J., Ved, T. A., Erik, F., Lut, V. L., Guy, V. C. and Paul, V. H. 2009. Audiometric Shape and Presbycusis. *International Journal of Audiology*. Volume 48, pp. 222-232.

Knipschild, P. V. 1977. Medical Effects of Aircraft Noise: Community Cardiovascular Survey. *Int Arch Occup Environ Health* 40:185–190.

Koester, M., Eggemann, C. and Zorowka, P. 2002. 40% of Hearing Aids are Not Worn. Making Sure the Device doesn't Wind up in the Drawer. *MMW Fortschr Med*; 144(49):34-38.

Konrad-Martin, D., Austin, D. F., Griest, S., McMillan, G. P., McDermott, D. and Fausti, S. 2009. Diabetes-Related Changes in Auditory Brainstem Response. *Laryngoscope*.

Kyriazis, M. 1994. Age and Reason. *Nursing Times*, Vol 90, 61-63.

Lasisi, O. A., Abiona, T. and Gureje, O. 2010. The Prevalence and Correlates of Self-reported Hearing Impairment in the Ibadan Study of Ageing. *Trans R Soc Trop Med Hyg*.:104 (8): 518-523.

Lee, F., Matthews, L. J., Dubno, J. R. and Mills, J. H. 2005. Longitudinal Study of Pure-Tone Thresholds in Older Persons. *Ear & Hearing*;26(1):1-11.

Lee, J. H., Kang, W., Yaang, S. R., Choy, N. and Lee, C. R. 2009. Cohort Study for the Effect of Chronic Noise Exposure on Blood Pressure among Male Workers in Busan, Korea. *Am J Ind Med*; 52:509-517.

Leonid, A. and Natalia, S. 2006. Hand Book of the Biology of Ageing. Sixth Edition. Elsevier Academic Press.

Lewington, S., Clarke, R. and Qizilbash, N. 2002. Prospective Studies Collaboration: Blood Cholesterol and Vascular Mortality by Age, Sex, and Blood Pressure: A Meta-Analysis of Individual Data from 61 Prospective Studies with 55,000 Vascular Deaths. *Lancet.*, 360: (9349): 1903-1913.

Lewington, S., Clarke, R., Qizilbash, N., Peto, R. and Collins, R. 2002. Age-Specific Relevance of Usual Blood Pressure to Vascular Mortality. *Lancet*; 360:1903-1913.

Lim, D. P. and Stephens S. D. G. 1991. Clinical Investigation of Hearing Loss in the Elderly. *Clin Otolaryngol* 1991; 16: 288-293.

Lin, F. R. 2011. The Elderly: Dementia Symptoms Include Hearing Loss. *Journal of the American Medical Association.*

Lisette, C., Marieke W., Stefaan. H., Marianne, S. and Wija, A. 2004. Lifestyle, Nutritional Status, Health, and Mortality in Elderly People Across Europe: A Review of the

Longitudinal Results of the SENECA Study. *J Gerontol A Biol Sci Med Sci*; 59 (12): 1277-1284.

Liu, X. Z and Yan, D. 2007. Ageing and Hearing Loss. *J Pathol* ;211(2): pp. 188-97.

Loh, K. Y. and Elango, S. 2005. Hearing Impairment in the Elderly. *Med J Malaysia*. 60 : pp. 526-9.

Lonsbury-Martin, B. L. and Martin G. K. 1993. Auditory Dystunction from Excessive Sound Stimulation. 2nd Edn. In Cummings, C.W., Fedrickson, J. M., Harker, L. A., Krause, C. J. and Schuller, D. E. (Eds.) Otolaryngology – Head and Neck Surgery: Ear and Cranial Base. St Louis, Mosby-Year Book, 4: 2885-2886.

Mader, S. 1984. Hearing Impairment in Elderly Persons. *Journal of the American Geriatrics Society* 32(7):548-553.

Maggi, S., Minicuci, N., Martini, A., Langlois, J., Siviero, P., Pavan, M. and Enzi, G. 1998. Prevalence Rates of Hearing Impairment and Comorbid Conditions in Older People: The Veneto Study. *J Am Geriatr Soc*. ;46: pp. 1069-74.

Maisarah, S. Z. and Said, H.1993. The Noise Exposed Factories workers: The Prevalence of Sensori-neural Hearing Loss and their Use of Personal Hearing Protection Devices. *Medical J.* Malaysia; 48: 280-285.

Makishima, K. and Tanaka, A. K. 1971. Pathological Changes of the Inner Ear and Central Auditory Pathway in Diabetes. *Ann Otol Rhinol laringol*; 80(2): 218-28.

Manohar, B. 2007. Hearing and Ageing. Canadian Medical Association Journal: 176 (7)

Marchiori, L. L., Freitas, S.V. and Vieira, M. 2002. Análise de Prevalência das Queixas e Perdas Auditivas de Pacientes com Hipertensão Arterial Submetidos à Avaliação Audiológica. São Paulo: *Pancast Fono Atual* 2002;21(2):97-104.

Marchiori, L., Rego, F. and Matsuo, T. 2006. Hypertension as a Factor Associated with Hearing Loss. *Rev. Bras. Otorrinolaringol*. Vol 72, n.4, pp. 533-540

Margolis, R. H. and Saly, G. 2008. Asymmetric Hearing Loss: Definition, Validation and Prevalence. *Otol Neurotol* 29:pp. 422-431.

Markova, M. 1990. The Cochleovestibular Syndrome in Hypertension. *Cesk Otolaryngol*; 39(2): 89-97.

Matsui, T., Uehara, T., Miyakita, T., Hitamatsu, K., Osada, Y. and Yamamoto, T. 2004. The Okinawa Study: Effects of Chronic Aircraft Noise on Blood Pressure and Some Other Physiological Indices. *J Sound Vib;* 277:469–470.

Maurer, J .F. and Rupp, R. R. 1979. Hearing and Ageing:Tactics for lntervention: *NY:Grune &Stratton.*

Max, S. 2003. Diabetes Mellitus and Hearing. *www.audiologyonline.com* Retrieved on 2nd February, 2011.

McBride, D.I. and Williams, S. 2001. Audiometric Notch as a sign of noise Induced Hearing Loss. *J. Occup. Environ. Med. 58*, 46-51.

Michael, K., Tougaw, E. and Wilkinson, R. 2011. Role of Continous Monitoring in a Hearing Conservation Programme. *Noise Health*; 13, 195-199.

Michael, K. L. and Byrne, D. C. 2000. Industrial Noise and Conservation of Hearing. In: Harris R. L., ed. Patty's industrial hygiene. 5th ed. John Wiley & Sons, inc, New York, USA; pp. 757-811.

Mikovic-Kraus, S. 1990. Noise-Induced Hearing Loss and Blood Pressure. *Int Arch Occup Environ Health;* 62:259-60.

Miller, R. M., Groher, M. E., Yorkston, K. M. and Rees, T. S. 1993. Speech, Language, Swallowing and Auditory Rehabilitation – In Delisa J. A. and Gaus B. M. (eds). Rehabilitation Medicine-Principles and Practice (2nd ed.) Phladelphia J. B. Lippincot Company.

Miyauchi, H., Imamiya, S. and Tanaka, S. 2000. A study on the Effect of Training about Fitting Earplug Using the Earphone-Support Device. *J Jpn Safety Appl Assoc Safety & Health Digest* 46, 2–6.

Mohammed, J. A. 2008. Effect of Noise Pollution on Hearing of Public Transport Drivers in Lahore City. *Pakistan Journal of Medical Sciences*, Vol 24; 1, p 1.

Mozes, A. 2008. Centenarians offer long-life secrets. *U.S. News and World Report*. *http://health.usnews.com/healthnews/familyhealth/brainanbehavior/articles/2008/08/01/centenarians-offer-long-life-secrets.html* Retrieved on 4th December, 2010.

Nagahar, K., Fisch, U. and Yagi, N. 1983. Perilymph Oxygenation in Sudden and Progressive Sensorineural Hearing Loss. *Acta Otolaryngol* 1983;(Stockh) Suppl 96:57-68.

Nakanishi, N., Okamoto, M., Nakamura, K., Suzuki, K. and Tatara, K. 2000. Cigarette Smoking and Risk for Hearing Impairment: A Longitudinal Study in Japanese Male Office Workers. *J Occup Environ Med*.;42(11).

Nancy, V. 2004. Correlation between Diabetes and Hearing Loss. http://www.ama-assn.org/amednews/ Retrieved on 5th August, 2009.

National Health Policy for Physically Challenged Persons in Brazil 2002. *http://www.scielo.br/scielo.php?pid=S003472992007000500011&script=sci_arttext&tlg=en* Retrieved on 20th April, 2009.

Nazar, J., Otarola, F. and Acevedo, L. 1992. Audición del Paciente Hipertenso Crónico Controlado. *Rev Otorrinolaringol Cir Cabeza Cuello*;52(2):97-104.

Neal, B., MacMahon, S. and Chapman, N. 2000. Effects of ACE Inhibitors, Calcium Antagonists and other Blood-Pressure-Lowering Drugs. *Lancet*; 356:1955-1964.

Neeraj, N. M. 2009. Inner Ear, Noise-Induced Hearing Loss.
http://emedicine.medscape.com/article/857813. Retrieved 4th December, 2010.

Neghab, M., Maddahi, M. and Rajaeefard, A. R. 2009. Hearing Impairment and Hypertension Associated with Long Term Occupational Exposure to Noise. *Iranian Red Crescent Medical Journal*; 11(2):160-165.

Netz, Y. and Jacob, T. 1994. Exercise and The Psychological State of Institutionalized Elderly: A Review. *Percept Mot Skills*, 79(3 Pt 1)**:**1107-1118.

NIH 2008. National Institute of Health: Hearing Loss is Common in People with Diabetes. *http://www.nih.gov/news/* Retrieved on 29th December, 2009.

NIOSH 1996. National Institute for Occupational Safety and Health 1996. Preventing Occupational Hearing Loss. A practical Guide: pp 96-110.

NIOSH and CDC 2002. National Institute for Occupational Safety and Health & Centre for Disease Control. Dangerous Decibels.

NIOSH1998. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard: *Occupational Noise Exposure Publication* No. 98-126.

Noorhassim, I. and Rampal, K. G. 1998. Multiplicative Effect of Smoking and Age on Hearing Impairment. *Am J Otology*.;19(4):240-3.

NPC 2006. National Population Commission. Distribution of Population by Age Groups and Sex - National, Table DS 5.

Nwachukwu, J. 2011. Hypertension: Causes, Complications and Management. *Health Standard Journal*, Vol. 6, Series 54

Ogah, O. S. 2006. Hypertension in Sub-saharan African Populations: Burden of Hypertension in Nigeria. *Ethn. Dis*., 16, p.765

Ohinata, Y., Makimoto, K., Kawakami, M. and Takahashi, H.1994. Blood Viscosity and Plasma Viscosity in Patients with Sudden Deafness. *Acta Otolaryngol* 1;(Stockh) Suppl 114(6): 601-7.

Olivia, S.2009. Presbyacusis. *Patient UKEMIS http://www.patient.co.uk/showdoc.asp?doc=40024944* Retrieved on 4th December, 2010.

Ologe, F. E., Akande, T. M. and Olajide, T. G. 2006. Occupational Noise Exposure and Sensorineural Hearing Loss among Workers of a Steel Rolling Mill. *European Archives of Oto-Rhino-Laryngology*, Volume 263, Number 7.

Ologe, F. E., Akande, T. M. and Olajide, T. G. 2005. Noise Exposure, Awareness, Attitudes and Use of Hearing Protection in a Steel Rolling Mill in Nigeria. *Occupational Medicine*; 55:487–489.

Olusesi, B. 2004. Introduction to the Physiology of Hearing. *http://www.nanootology.org/hearbasic.htm* Retrieved on 23rd February, 2011.

Omokhodion, F. O., Adeosun, A. A. and Fajola, A. A. 2007. Hearing Impairment among Mill Workers in Small Scale Enterprises in South-West, Nigeria. *Noise Health*; 9:75-7.

Osibogun, A., Igweze, I. A. and Adeniran, L. O. 2000. Noise-induced Hearing Loss among Textile Workers in Lagos Metropolis. *Niger Postgrad Med J.*; 7(3):104-11.

Owolawi, W. O. 2004. Audiometric Pattern in Noise Exposed Nigerian Aviation Workers. *Nigerian Journal of Medical Rehabilitation (NJMR)*; Vol. 9, No 1&2, (Issue No 17).

Oyebola, M. 1997. Therapeutic Approaches to Speech and Hearing Problems Gab Publication pp 31 & 51.

Park, S., Johnson, M. A., Shea-Miller, K. and DeChicchis, A. R. 2007**.** Hearing Loss and Cardiovascular Disease Risk Factors in Older Adults. *Journal of Nutrition, Health and Ageing, 11(6),515-518.*

Pearson, J. D., Morrell, C. H., Gordon-Salant, S., Brant, L. J., Metter, E. J., Klein, L. L. and Fozard, J. L. 1995. Gender Differences in a Longitudinal Study of Age-Associated Hearing Loss. *J Acoust Soc Am;* 97(2):1196-205.

Pemmaiah, K. D. and Srinivas, D. R. 2011. Hearing loss in Diabetes Mellitus. *International Journal of Collaborative Research on Internal Medicine & Public Health*. 2011; 3(10):725-731.

Perls, T. T. and Silver, M. H. 1999. *Living to 100:* Lessons in Living to your Maximum Potential at Any Age. New York, NY: Basic Books.

Philips, L., Branch, W., Cook, C., Doyle, J., El-Kebbi, I., Gallina, D., Miler, C., Ziemer, D. and Barnes, C. 2001. Clinical inertia. *Ann Intern Med.;*135*:*825-*834*

Pramanik, K. K., Taous, A., Lodh, D., Rahim, M. and Alauddin, M. 2009. Hearing Status of Elderly People: Study in a Tertiary Level Hospital. *Mymensingh Med J.*;18(1 Suppl):S98-102.

Prince, M. M., Stayner, L. T., Smith, R. J. and Gilbert, S. J. 1997. A Re-Examination of Risk Estimates from the NIOSH Occupational Noise and Hearing Survey. *J. Acoust. Soc. Amer. 101*, 950-963.

Rabinowitz, P. 2000. Noise Induced Hearing Loss. *Am Fam Physician* 61: 2749 – 56, 2759 – 60.

Rajendran, S. A., Mythili, B. and Viswanatha, R. 2011. Evaluation of the Incidence of Sensorineural Hearing Loss in Patients with Type 2 Diabetes Mellitus. *Int J Biol Med Res*; 2(4): 982 – 987.

Ramkissoon, I. and Cole, M. 2011. Self-Reported Hearing Difficulty Versus Audiometric Screening in Younger and Older Smokers and Nonsmokers. *J Clin Med Res.*; 3(4): 183–190.

Rarey, K. E., Ma, Y. L., Gerhardt, K. J., Fregly, M. J., Garg, L. C. and Rybak L. P. 1996. Correlative Evidence of Hypertension and Altered Cochlea Microhomeostasis: Electrophysiological Changes in the Spontaneously Hypertensive Rat. *Hear Res;*102:63-9.

Report on the Conference on Acoustics and Societal Problems 1972. New York.

Rey, J. F., Morello-Castro, G. and Curto, J. L. 2002. Factores De Riesco Involucrados em la Presbiacusia. *Acta Otorrinolaringol Esp;*53:572-7.

Royal National Institute of Deaf and Hard of Hearing People 2003. Facts and figures on Deafness and Tinnitus. *www.rnid.org* Retrieved on 7th June, 2009.

Robbins, S. L., Cotran, R. S. and Kumar, V. 1991. Pathologic Basis of Disease (3rd ed.) Philadelphia: W.B. Sauders Co.p.982-3.

Robert, H. M. and George L. S. Audiogram Classification System 2008. http://www.faqs.org/patents/app/20080221719. Retrieved on 16th June,2009.

Rosen, S. and Olin, P. 1965. Hearing Loss and Coronary Heart Disease. *Arch Otolaryngol*; 82:236-243.

Rosen, S., Bergman, M., Plester, D., El- Mofty, A. and Satti, M. 1962. Presbyacusis Study of a Relatively Noise- Free Population in the Sudan. *Annals of Otology, Rhinology and Laryngology*, Vol 71.

Rosenlund, M., Berglind, N., Pershagen, G., Jarup, L. and Bluhm, G. 2001. Increased Prevalence of Hypertension in a Population Exposed to Aircraft Noise. *Occup Environ Med* 58:769– 773.

Sacks, F., Svetkey, L., Vollmer, W., Appel, L., Bray, G., Harsha, D., Obarzanek, E., Conlin, P., Miller, E., Simons-Morton, D., Karanja, N., Lin, P., Aickin, M., Marlene, M., Moore, T., Proschan, M. and Cutler, J. 2001. Effects on Blood Pressure of Reduced Dietary Sodium and the Dietary Approaches to Stop Hypertension (DASH) Diet. *N Engl J Med.;344:3-10.*

Sampanis, C. and Zamboulis, C. 2008. Arterial Hypertension in Diabetes Mellitus: Theory to Clinical Practice. *Hippokratia* ; 12(2): 74–80.

Sandra, K., Martin, P., Monique, W., Jelle, J. and Lenore, J. 2002. Cigarette Smoking and Alcohol Consumption in Relation to Cognitive Performance in Middle Age *Am. J. Epidemiol. 156 (10): 936-944.*

Sangster, J. F., Gerace, T. M. and Seewald, R. C. 1991. Hearing Loss in Elderly Patients in a Family Practice. *Can Med Assoc J*;144: pp. 981-4.

Sawchuk, D. 2009. The Raging Grannies: Defying Stereotypes and Embracing Ageing through Activism. *Journal of Women & Ageing*, 21(3), 171–185.

Schuknecht, H. F.and Gacek, M. R. 1993. Cochlea Pathlogy in Presbyacusis. *Ann Otol Rhinol Laryngol*; 102:1-16.Shaikh, G. H. 1996. Problem in a Polyester Fiber Plant in Pakistan Industrial Health 34 (5) 427- 43.

Shapiro, S. L. 1964. Are You Smoking More but Hearing Less? *Eye Ear Nose and Throat Monthly*.;43: 96 -100.

Shulter, A. H. 1984. OSHA's Hearing Conversation Amendment and the Audiologist. *ASHA* 26, 39–43.

Siegelaub, A. B., Friedman, G. D. and Adour, K. Seltzer, C. C. 1974. Hearing Loss in Adults: Relation to Age, Sex, Exposure to Loud Noise and Cigarette Smoking. *Arch Environ Health*.; 29:107-109.

Sigsbee, W., Jiri, P., Scott, B. and Harold, C. 1997. Interaction between Hypertension and Diabetes Mellitus in the Pathogenesis of Sensorineural Hearing Loss. *The Laryngoscope;* Volume 107, Issue 12, pages 1596–1605.

Spreng, M. 2000. Central Nervous System Activation by Noise. *Noise Health*, 2:49-58.

Takala, J., Varke S., and Vaheri, E. 1977. Noise and Blood Pressure. *Lancet* 2:974.

Talbott, E. O., Findlay, R. C., Kuller, L. H., Lenkner, L. A., Matthews, K. A., Day, R. D. and Ishii, E. K.1990. Noise-Induced Hearing loss: A Possible Marker for High Blood Pressure in Older Noise-Exposed Populations. *J Occup Med*.; 32(8):690-7.

Talbott, E., Helmkamp, J., Matthews, K., Kuller, L., Cottington, E. and Redmond, E. 1985. Occupational Noise Exposure, Noise Induced Hearing Loss and the Epidemiology of High Blood Pressure. *Am J Epidemiol*;121:501-14.

Tarter, S. K. and Robins, T. G. 1990. Chronic Noise Exposure, High-Frequency Hearing Loss and Hypertension among Automobile Assembly Workers. J Occup Med; 32: 685-9.

Tay, H. L., Ray, N., Ohri, R. and Fronntko, N. J. 1995. *Diabetes Mellitus* and Hearing Loss. *Clin Otolaryngol*; 20: 130-4.

Taylor, I. G. and Irwin, J. 1978. Some Audiological Aspects of Diabetes Mellitus. *J Laringol Otol* 1978; 92(2): 99-113.

Taylor, R. A. 1984.,"What All that Noise is Doing to Our Lives," *U.S. News and World Report* 97(50).

Toivonen, M., Paakkonen, R., Savolainen, S. and Lehtomaki, K. 2002. Noise Attenuation and Proper Insertion of Earplugs into Ear Canals. *Ann Occup Hyg* 46, 527–30.

Tomei, F., Tomao, E., Papaleo, B., Baccolo, T. P. and Alfi,' P. 1991. Study of Some Cardiovascular Parameters after Chronic Exposure to Noise. *Int J Card* 33:393 – 400.

Tomei, G., Fioravanti, M., Cerratti, D., Sancini, A., Tomao, E., Rosati, M. V., Vacca, D., Palitti, T., Di Famiani, M., Giubilati, R., De Sio, S. and Tomei, F. 2010. Occupational Exposure to Noise and the Cardiovascular System: A Meta-Analysis. *Sci Total Environ,* 408:681-689.

Tsukimi, T. and Hisataka, S. 2008. A Trail of Individual Education for Hearing Protection with an Instrument that Measures the Noise Attenuation Effect of Wearing Earplugs. *Industrial Health*, 46, 393–396.

Tungdim, M. G., Kapoor, S. and Kapoor, A. K. 2002. Morphophysiological Changes amongst High Attitude Aged. *Indian J Gerontology*, 16: 329-343.

U.S. Census Data and Projections. 1994. U.S. Census Bureau. *www.census.gov* Retrieved on 20th April, 2009.

U.S. Congress, Office of Technology Assessment 1986. Hearing Impairment and Elderly People–A Background Paper, OTA-BP-BA-30. Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services, National Centre for Health Statistics 1981. *Unpublished Data from the 1981 Health Interview Survey.*

Van Kempen, E., Kruize, H., Boshuizen, H., Ameling, C., Staatsen B. and De Hollander, A. 2002. The Association Between Noise Exposure and Blood Pressure and Ischemic Heart Disease: A Meta-Analysis. *Environ Health Perspect* 110:307 – 317.

Vasan, R., Beiser, A., Seshadri, S., Larson, M., Kannel, W., D'Agostino, R. and Levy, D. 2002. Residual Lifetime Risk for Developing Hypertension in Middle-Aged Women and Men: The Framingham Heart Study. *JAMA.* ;287:1003-1010.

Venkata, K., Robert, S. and Hinrich, S. 2003. The Effect of Diabetes on Sensorineural Hearing Loss. *Otology & Neurotology* 24:382–386, Otology & Neurotology, Inc. Katz J. Tratado de Audiologia Clínica. Sao Paulo: Manole.

Veras, R. P. 2003 Em Busca de uma Assistência Adequada à Saúde do Idoso: *Revisão da Literatura e Aplicacao de um Instrumento. http://www.scielo.br/scielo.php?pid=S0034-72992007000500011&script=sci_arttext&tlng=en.* Retrieved on 20th April, 2009.

Victoria, A. V. and Paul R. K. 2007. International Population Reports on Population Ageing in Sub-Saharan Africa: *Demographic Dimensions*.

Vollmer, W. M., Sacks, F. M., Ard, J., Appel, L., Bray, G., Simons-Morton, D., Conlin, P., Svetkey, L., Erlinger, T., Moore, T. and Karanja, N. 2001. Effects of Diet and Sodium Intake on Blood Pressure. *Ann Intern Med.;*135:1019-1028.

Wallhagen, M. I., Strawbridge, W. J., Cohen, R. D. and Kaplan, G. A. 1997. An Increasing Prevalence of Hearing Impairment and Associated Risk Factors Over Three Decades of the Alameda County Study. *American Journal of Public Health* 87(3), pp. 440-442.

Walter, J. 2010. Audiology, Pure-Tone Testing *e medicine specialties. http://emedicine.medscape.com* Retrieved on 4th December, 2010.

Wayner, D. S. 2002. Hear What You've Been Missing. *Hearing Healthy Website: http://www.healthyhearing.com/* Retrieved on 20th April, 2009.

Weiss, W. 1970. How Smoking Affects Hearing. *Med Times*; 98:84-89.

Weng, S. F., Chen, Y. S., Hsu, C. J. and Tseng, F.Y. 2005. Clinical Features of Sudden Sensorineural Hearing Loss in Diabetic Patients. *Laryngoscope*; 115(9):1676-80.

World Health Organization 1989. Report of a WHO Expert Committee on Health of the Elderly: Demography and Public Health Aspects of Population Ageing. Washington, DC; Technical Report Series 779: pp. 14–17.

World Health Organization 1998. Population Ageing: A Looming Public Health Challenge. *Health Millions*; 24(5):20 - 22.

World Health Organization 1997. Prevention of Noise-Induced Hearing Loss. Strategies for Prevention of Deafness. *Hearing Impairment. Geneva*.

World Health Organization 1999. International Society of Hypertension (ISH) Guidelines for the Management of Hypertension. Guidelines Subcommittee. *J Hypertens*; 1**7**:151-83.

World Health Organization 2003. International Society of Hypertension (ISH) Statement of Management of Hypertension *J Hypertens* 21:1983–1992.

World Health Organization 2005. Constitution of the World Health Organization. In: World Health Organization, ed. *Basic Documents*. 45th ed. Geneva, Switzerland.

Wild, D. C., Brewster, M. J. and Banerjee, A. R. 2005. Noise-induced hearing Loss is Exacerbated by Long-Term Smoking. *Clin Otolaryngol*.; 30(6):517-20.

William, A. Y. 2000. The World We Hear: An Introduction. Fourth Edition. Academic Press. A Harcourt Science and Technology company: I 65-75.

Williams, W., Purdy, S. C., Murray, N., Dillon, H., LePage, E., Challinor, K. and Storey, L. 2005. Does the Prevention of Audiometric Test Data Have a Positive Effect on the Perceptions of Workplace Noise and Noise Exposure Avoidance? *Noise Health* 6, 75–84.

Wu, H. Y., Chin, J. J. and Tong, H. M. 2004. Screening for Hearing Impairment in a Cohort of Elderly Patients Attending a Hospital Geriatric Medicine Service. *Singapore Med J* Vol 45(2): p.79.

Wu, T. N., Shen, C.Y., Ko, K. N., Guu, C. F., Gau, H. J., Lai, J. S., Chen, C. J. and Chang, P. Y. 1996. Occupational Lead Exposure and Blood Pressure. *Int J Epidemiol* 1996, 25:791-796.

Xin, X., He, J., Frontini, M., Ogden, L., Motsamai, O. and Whelton, P. 2001 Effects of Alcohol Reduction on Blood Pressure. *Hypertension.*; 38:1112-1117.

Yoshioka, T., Taniyama, K., Okazaki, Y., Ito, A. and Hyakukei, H. 2004. Effect of Occupational Health Education on the Attitude Toward Earplug Wearing as a Protective Measure against Hearing Loss in Rotary Press Workers. *J Occup Health* 46, 359.

Zelenka, J. and Kozak, P. 1965. Disorder in Blood Supply of the Inner Ear as Early Symptom of Diabetic Angiopathy. *J Laryngol. Otol.*, 79.

Appendix I

Diagnostic Audiometer

Figure 23: Diagnostic Audiometer

Appendix II

Audiogram

Name: ____

Last Name First Name Other Name

Date of Birth: ____________________ **Sex:** ____________

Male Female

(day / month / year)

Audiometer: ____________________ **Examiner's Name:** ____________________

Date of Examination:

Frequency Hz

Decibel dB	125	250	500	1000	2000	4000	8000
10							
20							
30							
40							
50							
60							
70							
80							
90							
100							
110							
120							

IMPEDANCE TYMPANOMETRY

Ear	Canal Vol.	Peak Comp.Gradi	Pressure
RIGHT			
LEFT			

REFLEXOMETRY

Side Equals Probe Ear Ipsi

RIGHT Stim	500	1000	2000	4000
Contra				
LEFT Stim	500	1000	2000	4000
Ipsi				
Contra				

PURE TONE AVERAGE

(500-1000-2000 Hz)

Ear	Air Bone
RIGHT	
LEFT	

KEY TO SYMBOLS

Right (red)	0 <		
Left (blue)	x >		

TYPE OF HEARING LOSS

	Sensorineural	Conductive	Mixed
RIGHT **LEFT**			

Figure 24: Audiogram

Appendix III

Sound Pressure Level Meter

Figure 25: Sound Pressure Level Meter

Appendix IV

Hearing Protective Devices

Figure 26: A pair of Earplug

Figure 27: Earmuff

Appendix V

Hearing Aids

Figure 28: Behind The Ear Hearing Aid (BTE)

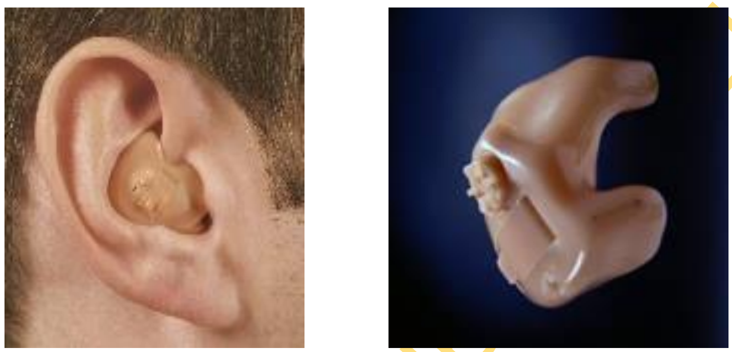


Figure 29: In The Ear Hearing Aid (ITE)

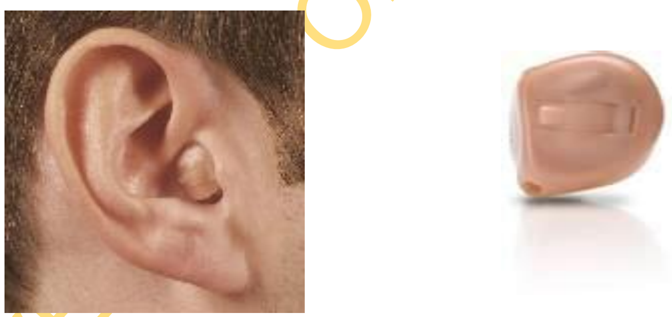


Figure 30: In The Canal Hearing Aid (ITC)

Figure 31: Completely In The Canal Hearing Aid (CIC)