QUALITY OF LIFE IN INDIVIDUALS WITH NIHL & RELATIONSHIP TO THE AUDIOLOGICAL CHARACHTERISTICS

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This Dissertation is submitted as part fulfilment for the Degree of Master of Science (Audiology)

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September, 2021

CERTIFICATE

This is to certify that this dissertation entitled **'Quality of life in individuals with NIHL & relationship to the audiological characteristics'** is a bonafide work submitted as a part for the fulfilment for the degree of Master of Science (Audiology) of the student Registration Number: 19AUD022. This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
September, 2021

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DECLARATION

This is to certify that this dissertation entitled **'Quality of life in individuals with NIHL & relationship to the audiological characteristics'** is the result of my own study under the guidance of Dr. Sreeraj Konadath, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
September 2021

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THIS

DISSERTATION IS

DEDICATED TO

“SONA”

&

“NANIMAA”

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“Only perfect practice make difference; you must strive for progress and not perfection”.

“Feeling gratitude and not expressing it is like wrapping a present and not giving it”. There is always something to be thankful for “Not what we say about our knowledge we gain, but we use them, is the true measure of our thanksgiving”.

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Abstract

Background: Noise-related hearing loss can be avoided but cannot be prevented. The most prevalent cause of hearing loss is noise at work. Noise-induced hearing loss (NIHL) is an impairment ensuing from exposure to loud sounds. NIHL is a progressive onset leads to physiological changes in the inner ear, these changes can be manifested in various audiological evaluation. However what duration of exposure causes what degree or pattern of hearing loss of clinical presentation is not very clear or there is curiosity of literature in this aspect. Hearing loss is calculated in audiogram results. Frequently, hearing loss is calculated in audiogram results; however, the degree of hearing loss does not predict a person's quality of life outcome.

Aim: The study aims to assess the quality of life in individuals with NIHL and its relationship to audiological characteristics.

Method: A total 50 individuals with history of noise exposure and reduced hearing sensitivity between mild to severe sensorineural hearing loss in the age range of 18-45 years participants were taken along for the study. WHO-QOL-BREF questionnaire were administered to assess the quality of life of individuals with NIHL.

Results: Results of this study revealed that almost all the participants had bilateral mild sloping sensorineural hearing loss due a history of noise exposure. Additionally, it was found that the severity of hearing loss adversely affected an individual's quality of life in the aspects of physical, psychological, social and environmental. However, the duration of noise exposure and configuration of audiogram did not have significant impact on quality-of-life measure.

Conclusion: The higher the degree of hearing loss shows lower the quality of life in all aspects of domain. Its indicate that degree of hearing loss has a greater impact on quality of life (Physical health, psychological health, social and environmental).

Keywords: Noise induced hearing loss, Quality of life, WHO-QOL questionnaire.

Chapter 1

Introduction

Alberti (1992) describes Noise-Induced Hearing Loss (NIHL) as an impairment ensuing from exposure to loud sounds. People may experience a loss of perception of a specific frequency range or poor perception of sound, which includes sensitivity to sound or tinnitus. Apart from its definition, it can be simply and generally defined as continuous exposure to loud sound, which can damage sensitive inner ear structures and cause noise-induced hearing loss (NIHL). The noise causes cochlear damage, which is typically associated with tinnitus from mild to moderate hearing loss.

NIHL has been reported as one of the most commonly occurring and distressing otologic condition, that interferes with the quality of life as it causes various physiological and psychological disorders. The most prevalent cause of hearing loss is noise at work. Predictably, 1.1 million people who are prone to excessive noise at work will be seriously damaged in the ears as a result of the noise (South, 2004). Prevalence of NIHL reported by Alberti (1979) accounts to 12% or more of the world's population. “According to recent studies, 22 million U.S. workers are continuously exposed to excessive noise levels in the workplace, and 25% of U.S. workers have experienced occupational noise exposure at some point in their careers” (Kerns et al., 2018).

The most common cause of noise induced hearing loss is noise exposure (Le and colleagues, 2017). Occupational noise has been established as the source of 16% of significant hearing loss in adults in developed countries. (Nelson et al., 2005). Hearing loss is more common in men than women (Thorne et al., 2008). Despite its prevalence, noise-induced damage to humans is still under discussion (Westerberg, 2017). The NIHL leads to damage to cochlear hair cells at the level of basal turn, and damage can occur through multiple causes i.e., mechanical, ischemia, and metabolic

(Hawkins and Schacht, 2005). Humans are unable to regenerate the hair cells, regardless of the mechanism to hair cell death; consequently, once the hair cells are damaged, it will lead to permanent hearing loss (Le et al., 2017).

Exposure to sound effects frequent and prolonged exposure or unexpected stimuli can gradually lead to hearing loss, which can be short and loud. Loud noise can cause weakening of the ear cells in both structures leading to permanent damage or cell death. When impaired in this way, hearing in humans will not be recovered (Henderson,1976). The initial negative effects of NIHL can be problem to hear conversation in noisy background (Agius, 2006).

Hearing loss involves two stages in its impact on speech perception. The primary stage is reduced audibility, which is characterized as the reduction and perception of overall volume. Consonants are initially weakened, due to high-frequency involvement (Agius et al., 2006). For example, for the hearing impaired, it is very difficult to hear the "S" and "T" sounds to affect speech clarity. NIHL affects one or both ears. Unilateral hearing loss can cause localization and directional difficulty and also the ability to reduce hearing ability from sound sources (Lowth, 2013).

Initially, sound exposure promotes only temporary hearing loss, known as a temporary threshold shift (TTS). When the auditory frame is too long, it does not recover, and prolonged noise exposure usually leads to permanent change (PTS). Repeated exposure to high-pitched noise can severely damage the hearing system. The typical appearance of TTS gives the impression that no major damage is done when the limit returns to normal (Kujawa & Lieberman, 2009).

The World Health Organization (WHO) states that noise sensitivity is not associated with all hearing loss cases. Repeated exposure to noise can cause ear injuries, which can impair hearing and cause tinnitus (Bethesda, 1990). Frequent exposure to noise and cochlear damage can lead to tinnitus and hearing loss (Masterson, 2016). Noise is an unwanted environmental hazard with worldwide implications. In our industrial society, a large percentage of people are exposed to daily noise, resulting in negative health impacts and a considerable economic impact. A variety of studies have been done on the mechanism of NIHL. According to Seidman (2010) there is a significant deterioration in quality of life since it disturbs sleep, causes cognitive impairment, and has several non-auditory negative health impacts. NIHL has an impact on quality of life in several aspects that go beyond symptoms and hearing ability.

The negative effects of NIHL on the human ability to communicate, connect with people, and communicate with society are often undetectable. Often, hearing loss is not just a problem of sound; people may have difficulty interpreting what is said on the radio, when many people are talking at the same time, in a wide room, or when the speaker's face is not visible (Dewane,2010). Subsequently, unpleasant social experiences may contribute adversely to diminished self-esteem, shame, and anxiety. This can be felt more acutely by those who suffer early in life hearing disability or loss, rather than later when it is more socially acceptable (Tambs, 2004). These psychosocial states can contribute to social alienation regardless of age, which is known to have a detrimental effect on one's mental health and well-being (Campbell, 2011). Such psychological and social conditions, regardless of age, can lead to social isolation, which is known to have a detrimental effect on everyone's health and well-being (Campbell, 2011). Depression can also occur with concomitant effects (Tambs, 2004), especially if hearing damage contributes to tinnitus (Chen, 2013). Research suggests that those with hearing impairment or loss may be at greater risk of declining quality of life (Gopinath, 2012). As described by Helen Keller quote: "Blindness cuts us off from things, but we are cut off from people by deafness” (Sowden, 2013).

Frequently, hearing loss is calculated in audiogram results; however, the degree of hearing loss does not predict a person's quality of life outcome (Newman, 1990). “The WHOQOL-BREF was developed by the World Health Organization (WHO) and published in 1995”. Multiple statements on the quality of life, health, and well-being of people with and without the disorder, as well as health professionals, have prompted the concerns. It has been tested in terms of reliability and validity.

The World Health Organization (1996) explains mental wellbeing quality of life as an individual's perspective of their life status in relation to their objectives, expectations, standards, and problems in the environment of the culture and value system in which they live. The WHO Quality of life Questionnaire (WHOOQOL-BERF) was developed by the group in 1996 to assess the subjective perception of health by the WHOQOL Group. It has four main domains associated with quality of life, physical health, psychological health, social relationship, and environment.

These self-assessment questionnaires show overlap but are good indicators of psychological distress related to NIHL, although they are not detailed enough to assess the overall quality of life. Due to the perceived handicapped, those suffering from noise-induced hearing loss have also been reported of having scored poorly on the quality of life assessment questionnaire. For that purpose, the following quality of life questionnaire has been researched upon and standardized based on large population studies. These are general questionnaires that help assess patient's overall outlook towards their health and social functioning.

1.1 Need for the study

NIHL can increase sound sensitivity at any time in people of all ages, including infants, adolescents, youth, the elderly, and adults. Workplace exposures have become the greatest strain of NIHL; however, noise-induced hearing loss can also be attributed to unhealthy noise exposures related to recreational, residential, social, and military service (Saunders, 2009). A small number of audio sources do not cause hearing loss; instead, over time, exposure to any sound source can cause a high level of hearing loss.

Psychosocial states can contribute to social alienation regardless of age, which is known to have a detrimental effect on one's mental health and well-being (Campbell, 2011). Such psychological and social conditions, regardless of age, can lead to social isolation, which is known to have a detrimental effect on everyone's health and well-being (Campbell, 2011). Depression can also occur with concomitant effects (Tambs, 2004), especially if hearing damage contributes to tinnitus (Chen, 2013). Research suggests that those with hearing impairment or loss may be at greater risk of declining quality of life (Gopinath, 2012) as described by Helen Keller quote: "Blindness cuts us off from things, but we are cut off from people by deafness” (Sowden, 2013).

Middle-aged individuals are the working force of the society; there is a need to explore how NIHL impacts them. Sporadic proof exists, but the picture is not very clear. It is, therefore, important for an audiologist to understand this phenomenon and provide an audiological perspective about the pathophysiology of NIHL. Further, this will help in understanding the audiological characteristics of NIHL cases visiting All Institute of Speech and Hearing, along with their quality of life.

NIHL is a progressive onset leads to physiological changes in the inner ear, these changes can be manifested in various audiological evaluation. However, what duration of exposure causes what degree or pattern of hearing loss of clinical presentation is not very clear or there is curiosity of literature in this aspect. Hearing loss is calculated in audiogram results; however, the degree of hearing loss does not predict a person's quality of life outcome. Hearing impairment or loss may be at greater risk of declining quality of life. No study in the Indian context, extricate the link between the quality of life in NIHL, hence this study is taken up.

1.2 Aim of the study

The study aims to assess the characteristics of hearing loss and quality of life in individuals with occupational noise exposure.

1.3 Objectives

1. Identify the type, degree, pattern of audiogram, and changes in an audiogram with respect to duration of noise exposure.
2. Assessing the impact of hearing loss caused by noise in quality of life using the World Health Organization Quality of Life-BREF questionnaire.
3. Correlate the audiological findings with the quality-of-life scores obtained on the World Health Organization Quality of Life-BREF questionnaire.

Chapter 2

Review of Literature

This section gives an overview of the topic on the quality of life of NIHL and their audiological characteristics. The review has been divided into the following section.

2.1 Definitions of Noise-induced hearing loss

2.2 Characteristics of NIHL

2.3 Pathophysiology of NIHL

2.4 Auditory and non-auditory effects of NIHL

2.5 NIHL effects on Quality of Life

2.1. Definitions of Noise-induced hearing loss.

Hearing is a mechanical sense in human beings. It represents how we communicate and interact with society. Hearing plays a very important role in the development of speech-language, communication. Even a minimal amount of hearing loss can have a detrimental influence on the development of speech, language communication, and other aspects of life. Multiple factors can affect the hearing of an individual. Of the various factors, one of the major factors that have a negative impact on the auditory system is noise. The negative effect on the auditory system is termed as Noise-induced hearing loss, NIHL is a type of sensory neural deafness caused by prolonged exposure to loud noise.

Noise-induced hearing loss can be defined as a partial or complete hearing loss or both ears as a result of an individual's occupations (Nandi & Dhatrak, 2018). "Noise-induced hearing loss results from damage to the ear from sounds of sufficient intensity and duration that produces a temporary or permanent sensorineural hearing loss. The hearing loss may result in tinnitus and is cumulative over a lifetime" (Noise and Hearing loss Consensus Conference, 1990). NIHL is a specific condition with established symptoms and objective findings (Morata, 2007). "It refers to SNHL in subjects exposed to environmental noise when other causes of hearing loss are excluded" (Pyyko et al., 2007).

Noise is a major environmental pollutant that poses a threat to our health and economy. An increasingly urban, industrial, and mechanized society is the prime contributor for this evidence shows that exposure to excess noise over prolonged periods can provide physiological as well as psychological changes in human beings. Noise has been found to interfere with our activities at three levels. 1). Audiological level -interfering with the satisfactory performance of the hearing mechanism, 2). Biological level interfering with the biological functioning of the body and 3). Behavioral level affecting the social behavior of individuals (Trivedi & Raj, 1992).

2.2 Characteristics of NIHL

NIHL is one of the most observed public health issues that are mostly preventable and probably more pervasive. Noise-induced shows inner ear deformity and their audiological profile represent the bilateral mild to moderate degree of sensorineural, symmetrical hearing loss with underlying tinnitus; however, there were a significant number of patients who had reported asymmetrical thresholds as well as severe to profound hearing loss (Le et al., 2017).

Noise causes sensory damage to hair cells. Furthermore, the main characteristics show a significant reduction in high frequencies between 3 and 6 kHz, despite normal fundamental speech frequencies (0.5-2 kHz). Hearing loss frequently occurs at 4 kHz or 6 kHz, causing a notch or V-shaped dip. This V shape dip and Notch pattern is the identification mark of NIHL. This main characteristic V-dip or notch was also known as the boilermaker's notch or aviator's notch since it was established in cases of occupational hearing loss. (Borg & Engström, 1983).

The review of studies by Hong (2005), the purpose of this study was to identify the characteristics of hearing loss on among engineers in the American construction sector ` who run heavy construction machinery. Audiometric tests were administered to 623 workers. The results show that over 60% of the workers had 4kHz - 6kHz loss in the noise-sensitive higher frequencies and the rate of hearing loss was more among workers who reported longer years of working in the industry. The characteristics of the worker showed significantly poorer hearing in the left ears, a typical characteristic of NIHL i.e., 4 kHz notch. Thirty-eight percent of people reported tinnitus and difficulty in underrating speech in a noisy environment. The study concluded significant characteristics of NIHL include tinnitus, difficulty in understanding the conversation and speech. After being exposed to loud noise in the environment, speech or other sounds become distorted that demonstrates lower frequencies began to deteriorate as the higher frequency hearing loss increases. As a result, noise has a longer time to affect lower frequencies (0.5 - 2 kHz) than higher frequencies (3 - 6 kHz). If the person had a long duration of noise exposure, it would affect both the higher and lower frequencies, so that the notch will convert in the flat configuration.

In advanced cases of NIHL, the workers who have a history of noise exposure for many years without any proper hearing protection. Their audiological profile demonstrates V-shaped notch at 4 kHz or 6 kHz, and the audiogram begins to slope downwards at low frequencies, which is a typical audiometric characteristic of NIHL. The V-shaped dip or notch at 4 or 6 kHz can be used to anticipate a person's susceptibility to noise and the risk of hearing loss extending to lower frequencies (Suter, 2002).

According to Hong (2015) there are various possible explanations for left ear hearing being significantly worse than their right ear in operational engineers. According to the explanation, directional noise exposure may be the cause of hearing loss in the left ear. Most operating engineers peer over their right shoulder when operating heavy construction equipment, exposing their left ear to the noise produced by the heavy equipment's engine.

Speech understanding ability was assessed in train drivers in whom hearing sensitivity was normal (Kumar et al., 2017). A total of 118 participants who were exposed to continuous noise more than 8 hours of 80 dB A. Speech recognition assessed in multi-talker babble presented at -5dB SNR. The results demonstrated a significant major effect of subject groups on speech scores, and they also observed that individuals with NIHL had a reduced ability to identify speech in the presence of noise than the control group. They concluded that long-term noise may have an adverse impact on brain function and behaviors, even if peripheral hearing sensitivity is within the normal range.

Individuals with NIHL also reported vestibular symptoms such as vertigo, dizziness especially in those individuals who are chronically exposed to different occupational noises. Studies also reported symptoms like Meniere’s disease among individuals with occupational hearing loss (Ylikoski, 1988).

Ylikoski (1988) studied the effect of noise exposure in guinea pigs with an impulse noise of 1.1 kHz at 158 dBSPL, which found that excessive noise levels lead to severe damage to the cochlea and vestibular system. Similarly, Ylikoski et al. (1988) also reported the excessive effect of noise exposure on individuals with different degrees of hearing loss. These individuals found all significant audiological characteristics of NIHL with vestibular issues.

2.3. Pathophysiology of NIHL

The histopathological changes are seen in the cochlea and central auditory system due to noise exposure. And it can be described as follows

1. Mechanical changes
2. Biochemical changes
3. Vascular changes
4. Ionic changes

Several studies have been conducted to support the mechanisms that lead to noise-induced hearing loss. The main cause of NIHL is damage to the cochlear hair cells. The inner ear can sustain one of two types of injury depending on the intensity and duration of noise exposure, the types of noise injury is temporary threshold shift (TTS) or permanent threshold shift (PTS). Excessive sound or noise exposure can cause either temporary or permanent threshold shifts, as well as changes in the new alternatives of auditory nerve function

Exposure to hazardous noise levels initially results in a temporary threshold shift in which the threshold returns to the pre-exposure level. However, with continued noise exposure, the threshold shift becomes permanent. The magnitude of permanent threshold shift depends on the acoustic characteristics of noise (such as intensity, duration, spectrum, and temporal aspects) and an individual’s susceptibility. The area which is most vulnerable to damage as a result of noise exposure is the organ of Corti within the inner ear. A variety of anatomical changes have been observed. These include alterations to the outer and inner hair cells stereocilia, cell bodies, cuticular plate, nerve endings, nerve fibers, and supporting cells (Canlon, 1987).

McGill and Schuknecht (1976) in their research work on 14 ears with NIHL for histopathological findings reported morphological changes to consist mainly of hair cells loss, which is more severe in the 9 mm to 13 mm region at the level of the basilar membrane with greater loss of IHC than that of OHC which in turn provide information regarding the anatomical lesion behind the hearing loss at a particular frequency on behavioral measures. Hirokawa and Tilney, 1982 examined the effect of noise on Alligator lizards in which the lizards were exposed to broadband noise of 105 dB intensity for a duration of 24 hours of exposure they reported a lesion in the actin filament which accounts for the hearing loss. This actin filament presents at the base of stereocilium which contacts the cuticular plate hence loss of this filament leads to displacement of the tallest stereocilium.

Hamernik et al., (1984) carried out research work on Chinchilla's for morphological changes in the organ of Corti for blast waves at an intensity level of 160 dB SPL in which electron microscopy was used to follow up the morphological changes in the organ of Corti for a period of 30 days and they observed a complete separation of the sensory epithelium of 5-7 mm conjoint to the lesion at OHC, dieter cell and Hensen cells along the basilar membrane with IHC being intact at some region for several days. A study by Bohne et al. (1987) on Chinchilla's using an octave band noise interrupted with 3 different schedules of rest between successions of 6 hours of exposure was compared with continues noise exposure. The result of this study reveals intermittent noise exposure induced less lesion at the corti compared to that of continuous noise and increased hours of succession revealed lesser damage to the cochlea.

Bohne and Yohman (1987) did a study on chinchillas exposing the organ of Corti to both interrupted and continuous noise (HFN). Results indicated that with equal energy exposure to the high-frequency noise, interrupted noise exposure produces considerably fewer hair cells than continuous exposure. The effect was seen through the microscopic outer hair cells wipe out degeneration of stria vascularis, myelinated nerve fibers degeneration, loss of outer pillars exceeded the loss of inner pillars.

Harding et al. (2000), studies to determine whether noise damage in the Corti organ differed in low- and high-frequency regions of the cochlea. studies to determine whether noise damage in the Corti organ differed in low- and high-frequency regions of the cochlea The chinchillas were exposed to low and high frequency octave bands of noise between 47 dB to 95 dB SPL for 2 to 432 days. The chinchilla's cochlea auditory threshold was determined before, during and after, the noise exposure and microscopic examination were done to see the mechanical changes of the cochlea. The results revealed that damage by high-frequency noise typically appears selective losses in outer hair cells in the 4-8 kHz range.

The damage deteriorated with time, involving the excision of an entire segment of the organ of Corti, as well as surrounding myelinated nerve fibers. The damage increased with duration, involving the excision of an entire portion of the Corti organ. When low-frequency noise was present, primary damage manifested as outer hair cell loss diffused across a wide area at the apex. With prolonged exposure, additional apical outer hair cells deteriorated, although supporting cells, inner hair cells, and nerve fibers remained intact. They conclude that the patterns of cochlear damage in noise-exposed chinchillas and their relationship to functional measures of hearing are similar to those seen in noise-exposed humans.

Weiser et al. (2006), experimented in guinea pigs, to see how vitamin A deficiency impacts guinea pigs. Noise-induced transient threshold shift (TTS) was assessed after briefing acoustic overstimulation with a moderate (90 dB) broad-band white noise. Researchers also discovered that a vitamin A deficiency increases the risk of noise-induced hearing loss by increasing the sensitivity of the inner ear to noise.

Konishi et al. (1979), in this study, healthy guinea pigs were exposed to broadband noise at various levels from 95 to 115 dBA for one week, on this study they compared the experimental and control animals. Experimented animals demonstrated a significant increase in K+ and Cl- concentrations while decreasing in Na+ concentration and also, they found that perilymph was normal, and the concentrations of K+, Na+, and Cl- in the perilymph were not significantly affected by noise exposure. They also measured rate constant in noise-exposed animals to normal animals, and found that the value of the rate constant for K+ was significantly lower in noise-exposed animals.

These findings suggest that changes in the endolymph-perilymph barrier's ionic permeability play a role in the physiological mechanisms causing noise-induced hearing loss.

2.4. Auditory and non-auditory effects of NIHL.

2.4.1. Auditory Effect of NIHL. One of the most common types of sensorineural hearing loss is noise-induced hearing loss. It is damaging to both auditory and non-auditory functions.The auditory effects of noise-induced hearing loss shows various physiological changes at the level of inner ear which includes more loss of outer hair cells than inner hair cells.(McGill & Schuknetcht,1976). detachment or displacement of the stereocilium from its rootlet (Hirokawa & Tliney, 1982). Hair cells damage wherein the sensory epithelium of outer hair cells, dieters' cells, Hensen cells, were displaced from the basilar membrane (Hamernik et al,1984), loss of spiral ganglion cells and myelinated fibers within osseous lamina (Bohne et al, 1987), and also leads to the focal lesion at the level of the cochlea these are research findings revealing some amount of reorganization at the level of central auditory pathways (Salvi et al,1990). These changes are reflected as a change in one's hearing sensitivity in pure tone audiometry (Fowler,1992, Mantysalo, 1984). Along with amplitude reduction in otoacoustic emission measures (Reshef et al, 1993), and elevated auditory brainstem threshold (Attias et al,1996).

Pushpa (2013) conducted research on the association between noise exposure and its effect on hearing on 30 male drivers working at the Bangalore Metropolitan Transport Corporation (BMTC) in Bangalore. The results revealed a significant lowering the threshold at high frequency as the number of years of working in the noise exposure is more and supported their findings by emphasizing on the fact of lack of awareness among the participants regarding the ill effect of noise on hearing.

2.4.2. Non-Auditory effect of NIHL. Non-auditory systems, such as the cardiovascular, neuroendocrine, and psychological systems, are more sensitive to noise. Quantifying the non-auditory impacts of noise can be difficult due to a lack of verified scientific evidence and statistical data, and there are frequently acceptable alternate explanations for the results. Several research have been conducted to investigate the relationship between noise, blood pressure, and cardiac dysfunction.

There is recent evidence regarding the impact of noise being induced not only on hearing but also on one health condition i.e., non-auditory effects of noise. Whenever if there is stress associated along with the noise exposure which in turn creates or increases once hypertension, anxiety, etc. was revealed using a research work on rats (Yeakel et al, 1948).

In humans, research work reveals a diastolic blood pressure elevation due to acute noise stimulation (Andren, et al, 2009). Even in chronic occupational noise exposure of at least 85 dB had shown to exhibit increased blood pressure than those who are not exposed to noise (Basner et al, 2014). Long-term noise exposure leads to cardiovascular system deficit, which in turn, causes hypertension, ischemic heart disease, and myocardial infarction. Andrew and Smith (2007) according to research noise has been associated with increment in the risk of a number of symptoms or illness. Anderson (2007) reported increased occurrence in emotional symptoms such as an increase in nausea, headache, instability, argumentativeness, and mood and anxiety changes, and overall impact of quality of life (Cohen 1996; Miller 1974).

Van Kempen et al. (1999) conducted a review of research that looked at the relationship between noise exposure and high blood pressure and ischemic heart disease. Noise has a stronger impact on the human non-auditory system, as well as the human psychological system, which includes sleep disturbance, stress, fear, and disrupted sleep. Overall, noise has a negative impact on human quality of life.

Hearing loss was the most common occupational health issue in the Department of Defense (DoD), according to a report by the United States Government Accountability Office on noise, 2011. Hearing loss is one of the top three most frequent health disorders associated with disability in the world, according to the World Health Organization (WHO, 2011.)

Although not life-threatening, the effects of occupational NIHL on the individual can be severe. Hearing loss impairs a person's capacity to communicate with others, which can result in increased social stress, depression, awkwardness, low self-esteem, and relationship issues are all possible outcomes. In difficult listening situations, such as environments with considerable background noise, the social handicap induced by communication difficulties is exacerbated. Hearing loss has also been associated with cognitive, memory, and attention deficit disorder. several longitudinal studies, emphasizing the relevance of hearing loss prevention and treatment.

2.5. NIHL effects on Quality of Life

Noise is defined as an unpleasant sound or a combination of sounds that has a negative impact on health. Through a variety of mechanisms, these impacts can manifest in the form of physical or psychosocial impairment. In some frequency ranges, a long duration of noise exposure can cause permanent hearing loss and permanent threshold shifts. Approximately 10 million people, including 5.2 million children, in the United States, suffer permanent noise-induced hearing loss, and 30 million people in everyday circumstances are exposed to the dangerous level of noise. Although the mechanism of noise-induced hearing loss is still unknown, many investigations have contributed to our understanding of the condition.

Psychological impacts of noise exposure are commonly misunderstood and underestimated. However, their effect can be equally overwhelming and may include hypertension, tachycardia, increased cortisol release, and increased physiologic stress. These effects, considered collectively, may have a significant adverse effect on daily life and impact global development. There are quite a lot of research works carried out on revealing the effects of noise on the quality of life.

Several literatures acknowledge that annoyance and sleep disruptions are the most likely causes of noise-induced health problems. On the other hand, the relative importance of noise characteristics, personal attributes, and cultural variables have yet to be established. In the case of annoyance, the studies indicate that noise level accounts for just 10 to 15% of the variability in evaluations A variety of overlapping qualities and contextual factors, such as age, noise source and attitude toward the noise source, personality, mental functioning, time of day, and noise sensitivity, are likely to explain the remaining diversity.

Clark and Paunovic (2018) conducted a systematic review that evaluates the data from research on the impact of environmental noise ("road traffic noise, aircraft noise, railway noise, and wind turbine noise") on quality of life, wellbeing, and mental health. The researchers looked at quantitative studies on the impact of noise on adults' quality of life published between January 2005 and October 2015. The wellbeing and mental health questionnaire were administered to see the impact of quality of life. The results showed that 90% of people are suffering from depression and anxiety and some people showed emotionally impaired.

Clark (2020) did a review on assessment of the quality of the evidence for environmental noise effects on mental health, wellness, and quality of life. The questionnaire was used to be administered to see the effect of noise on the quality of life. The finding showed that there is the detrimental effect of environmental noise (road traffic, factory, etc.), and interview measures findings show people who are mostly induced with long-duration noise shows several negative behaviors like depression, anxiety, stress, annoying, restlessness, cranky, etc. Conclusively noise affects mental health, wellbeing, and as well as the quality of life.

Packer et al. (2016) studied the impact of hearing impairment and noise-induced hearing loss on quality of life in active-duty soldiers. The study's main goal was to evaluate the relevant information on the impact of hearing loss on quality of life (QOL) among active-duty military personnel in the United States. The impact of hearing loss on quality of life has been assessed using QOL tools. The study concluded that the noise-induced civilian population has a negative impact on their social, psychological, cognitive, and health effects and lifestyle.

Chapter 3

Method

The main aim of the study is to assess the quality of life of individuals with noise-induced hearing loss and their audiological characteristics. For this study, the assessment was carried out in individuals with occupational noise exposure. Fifty people who had a history of noise exposure with noise-induced hearing loss were included in the study. Selected individuals' quality of life was assessed using the WHOQOL-BERF checklist.

Further, audiological findings of selected participants were correlated with obtained quality of life scores on the WHOQOL- BREF questionnaire, which was also taken up as an objective. The following methods were used to carry out the study based on the aforementioned objectives.

3.1 Selection of participants

The case files were obtained from AIISH, department of Audiology, based on the information from the case file confirmed cases of NIHL and those patients reported between January 2019 to December 2020 were reviewed. Fifty individuals who had a history of noise exposure with reduced hearing loss were selected for the study. The study involved individuals in the age range of 18 to 45 years and all were young adults.

For the Selection of participants, individuals were required to have a history of noise exposure with reduced hearing sensitivity, having unilateral or bilateral sensorineural hearing loss between mild to a severe degree. Furthermore, those who fulfilled the criteria were interviewed for assessing theire quality of life with the help of the WHO-QOL questionnaire.

3.1.1 Eligibility criteria

Participants fulfilling the following eligibility criteria and willing to provide informed consent were considered for the study.

1. Individuals with a history of noise exposure having unilateral, bilateral, or asymmetrical sensorineural hearing loss between mild to severe degree confirmed by the most recent/latest audiological report.

2. No psychiatric symptoms or comorbidities prevent them from answering the questions in QOL questionnaire appropriately.

3. Educational qualification of 10th standard or above, and one who can comprehend conversational English.

3.2 Test Environment

World Health Organization Quality of Life- BREF (WHOQOL-BREF) was administered and assessed through the phone interview.

3.2.1 Material Used

1. Review of case file/ Analysis of Case file.

2.WHO-QOL BREF questionnaire.

3.3 Test Procedure

A complete audiological finding from the cases diagnosed with mild to severe sensorineural hearing loss with configuration and history of noise exposure was considered for profiling. The OPD register in the Department of Audiology and Department of Ear, Nose, and Throat (ENT) was reviewed for a total number of cases reported during the period as mentioned above (24 months).

The audiological information was taken from the case files and the following criteria were used for the diagnosis and analysis of the data.

The case files were reviewed for the following details

- Demographic details, i.e., age, gender, and socioeconomic status.
- The ear-specific complaints of participants include reduced hearing sensitivity, ear pain, ear discharge, tinnitus, blocking sensation, itching, swelling, trauma, and other ontological complaints like vertigo/giddiness, headache, speech understanding difficulty, etc.
- Medical history like Diabetes, hypertension, cardiac issues, hypothyroidism, etc.
- Noise history: Duration of exposure and working hours.
- Provisional diagnosis for the degree and type of hearing loss.
- Results of tympanometry
- ENT findings, ontological findings.

Based on the data collected, such as the details of the clients and the interpretation of the audiological tests' results, and the provisional diagnosis based on results made by qualified audiologists, which has been mentioned above. These data as mentioned earlier of adult cases with noise-induced hearing loss were categorized and analyzed in terms of the degree of hearing loss, pattern, duration of noise exposure, and other associated problems mentioned above. Based on this data analysis eligible participants were selected for the study. Those who fulfilled the study criteria were briefed about the study and were invited to participate in this study.

This study was carried out in two-stage. The first stage of the study included analysis and selection of participants. The second stage included the administration of the WHO-QOL BREF questionnaire for quality of life assessment in selected participants.

3.3.1 Preliminary Evaluation.

The data in the case files were noted as a result of the following procedure. All the participants were subjected to detailed case history to rule out any pathological condition. Air (250 Hz to 8000 Hz) and bone conduction threshold (250 Hz to 4000 Hz) was obtained from all the octave frequencies using modified Hughson and Westlake procedure given by Carhart and Jerger, (1959) with a dual-channel diagnostic audiometer in a sound-treated room. A criteria 15 dB HL for pure tone average of 500 Hz,1000 Hz, 2000 Hz, and 4000 Hz was employed to rule out any peripheral hearing loss.

Kannada paired-word list (Vandana, 1998) was used to obtain Speech Recognition Threshold (SRT). Phonemically Balanced Kannada Word Test (Yathiraj & Vijayalakshmi, 2005 was used to obtained speech identification scores (SIS). Immittance Evaluation which includes tympanometry and acoustic reflex threshold test using a 226 Hz probe tone at 500 Hz,1000 Hz, 2000 Hz, and 40000 Hz was carried out using a calibrated middle ear analyzer to rule out any middle ear pathology.

3.3.2 Administration of quality of life Assessment Questionnaire.

World Health Organization Quality of Life -BREF (WHOQOL-BREF) Questionnaire was administered to assess the quality of life. The questionnaire consists of 26 questions that will subsidize the assessment of an individual's health and well-being. In this questionnaire, there were four domains in each of 24 aspects of quality of life. These domains represent the overall quality of life and general health facet (Table 3.1).

Question 1 asks about "an individual's overall opinion of the quality of life", whereas question 2 asks regarding "an individual's overall perception of their health". It's organized into four domain scores. These four domains' scores give the person's "profile and perception of quality of life", the four domains are representing a different aspect of health facet i.e., Physical health, psychological well-being, social relationships, and the environment.

The scaling of this domain score is from high to low in a positive direction (i.e., higher scores denote the higher quality of life). Question 3, 4, and 26 have a mean score that is the opposite of their rating (i.e., 5=1 and 1= 5) to come up with a domain score. To make the scores equivalent to those used in WHOOQOL-100, the mean for each domain was calculated and multiplied by four (range between 4 to 20). Table 3.2 represents a procedure for manually calculating individual scores. These scores were translated into a 0-100 range scale according to the WHO QOL-BERF guidelines for cross-comparisons with other questionnaires.

Table 3.1

WHOQOL-BREF domains with questions included from the Questionnaire

Domains	Facets incorporated within domains	Questions included from the questionnaire
1. Physical health	• Activities of daily living Dependence on medicinal substances and medical aids. • Energy and fatigue. • Mobility. • Pain and discomfort Sleep and rest. • Work Capacity.	Q 3, 4, 10, 15, 16, 17 and 18
2. Psychology	• Bodily image and appearance. • Negative feelings Positive feelings. • Self-esteem Spirituality / Religion /Personal beliefs.	Q 5, 6, 7, 11, 19 and 26

	• Thinking learning, memory and concentration	
3. Environment	• Personal relationships. • Social support. • Sexual activity.	Q 20, 21 and 22
4. Social	• Financial resources. • Freedom, physical safety, and security. • Health and social care: accessibility and quality home environment. • Opportunities for acquiring new information and skills. • Participation in and opportunities for recreation / leisure activities Physical environment (pollution / noise / traffic / climate). • Transport.	Q 8, 9, 12, 13, 14, 23, 24 and 25

Table 3.2.

Scoring procedure of the WHOQOL-BREF

	Equations for competing domain scores	Raw Score	Transformed score (4-20)
Domain 1	(6-Q3) +(6-Q4) +Q10+ Q15+ Q16+ Q17+ Q18	a=	b=
Domain 2	Q5+Q6+Q7+Q11+Q19+(6-Q26)	a=	b=
Domain 3	Q20+Q21+Q22	a=	b=
Domain 4	Q8+Q9+Q12+Q13+Q14+Q23+Q24+Q25	a=	b=

3.4 Statistical analysis

The data collected was subjected to appropriate statistical analysis using SPSS v.21 software based on the distribution of data. The details of statistical analysis are mentioned in chapter 4.

Chapter 4

Results

The present study aimed to evaluate the quality of life and audiological characteristics of individuals with noise-induced hearing loss. To achieve the aim of this study, all the data obtained were analyzed using statistical package of social science (SPSS) software 21.0. version. The Shapiro-Wilk test of normality was administered to check whether the raw data is normally distributed. The test revealed that the data followed a skewed and non-normal distribution curve, hence non-parametric tests were administered for analysis. The statistical tests administered are as follows;

1. Frequency distribution was checked to examine the audiological characteristics such as type and degree of hearing loss, configuration, and changes in the audiogram with respect to the duration of noise exposure.
2. Kruskal-Wallis test was administered to assess the impact of hearing loss caused by noise in quality of life using the World Health Organization Quality of Life-BREF questionnaire.
3. Spearman's coefficient correlation test was administered to check the correlation between quality-of-life scores and audiological characteristics.

4.1. Identification of Audiological characteristics.

To study this objective, frequency distribution analysis was performed. The following (Figures 4.1, 4.2, 4.3, and 4.4) show the organization of the data i.e., the frequency distribution of pattern, ear, duration of noise exposure, and degree of hearing loss.

Figure 4.1 represents the frequency distribution of configuration of hearing loss in participants. Among 50 individuals, 28 individuals were found to have a sloping pattern (56%), a notch pattern was found in 18 individuals (36%), and four individuals had a flat pattern (8%).

Figure 4.1

Frequency distribution of configuration of Audiogram

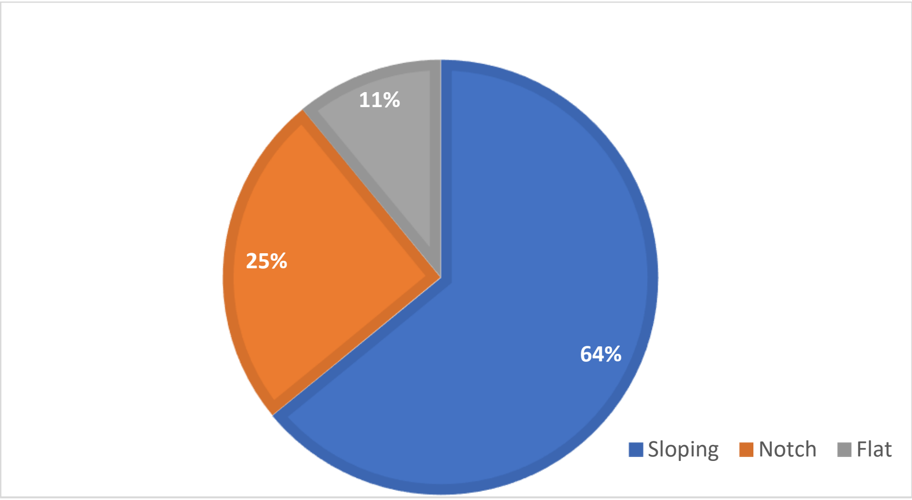


Figure 4.2. demonstrates the frequency distribution of the affected ears. Forty-three individuals who had bilateral hearing loss (86%), three individuals had hearing loss in the right ear (6%) and four individual's left ear was affected (8%).

Figure 4.2.

Frequency distribution of affected ears

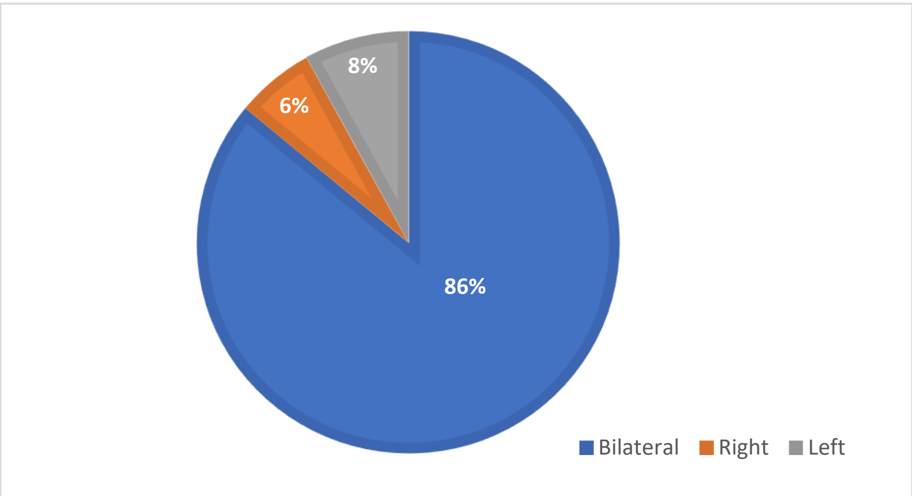


Figure 4.3. represents the frequency distribution of duration of noise exposure. In this distribution, 22 individuals (44%) had 15-20 years of noise exposure, 13

individuals had 20-25 years of noise exposure (26%), eight individuals had 10-15 years of exposure (16%), six individuals were found to have 5-10 years of exposure (12%) and one individual was found with less than five years of noise exposure (2%).

Figure 4.3

Frequency distribution of the duration of noise exposure of participants

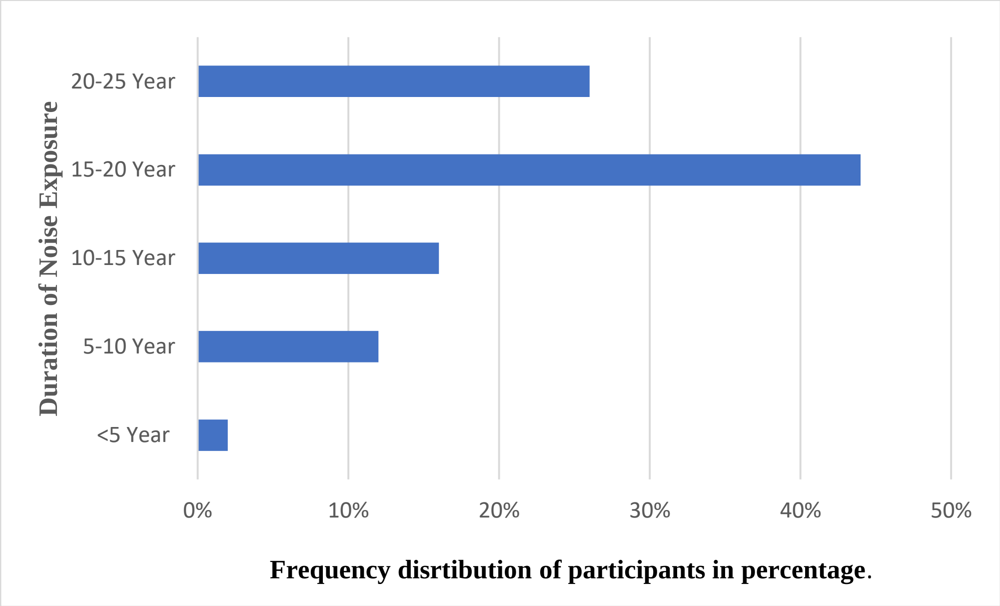
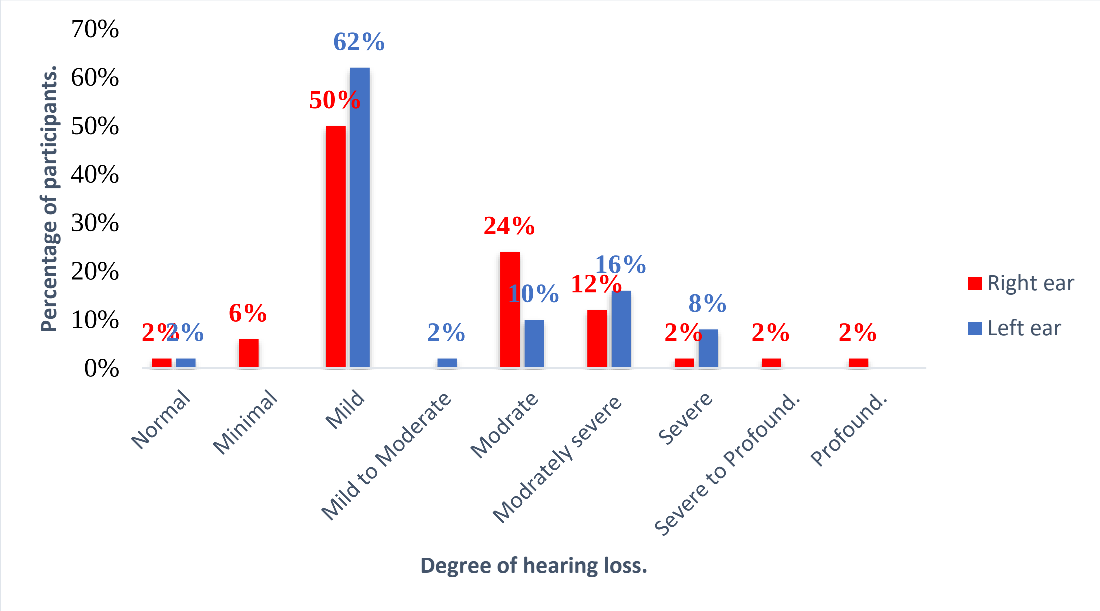


Figure 4.4. represents the degree of hearing loss. Twenty-five individuals had mild sensorineural hearing loss in the right ear (50%) and 31 individuals had mild SNHL in the left ear (62%), 12 individuals had moderate sensorineural hearing loss in the right ear (24%), five individuals were found as having moderate SNHL in the left ear (10%), and six individuals were found as moderately severe sensorineural hearing loss in the right ear (12%). Eight individuals had moderately severe SNHL in the left ear (16%).

Figure 4.4

Ear wise frequency distribution of degree of hearing loss in participants



4.2 Assessment of the impact of audiological characteristics on quality of life.

The second objective of the study is to assess the Quality of life in individuals with noise-induced hearing loss. For this objective, Kruskal-Wallis test was administered to see the impact of audiological characteristics (degree of hearing loss, the configuration of the audiogram, and duration of noise exposure) on quality of life.

4.2.1. Degree of hearing loss.

Table 4.1. represents the Kruskal-Wallis test scores with respect to degree of hearing loss in both the ears and the QOL scores. The test revealed that there is a significant difference ($p<0.05$) between the Quality-of-life score and degree of hearing loss in both ears. Furthermore, a Post hoc analysis i.e., a pairwise comparison test was administered to see the paired comparison between the different degrees and domains.

Table 4.1

Comparison (p values) across QOL score and degree of hearing loss for each ear

Values	**Degree of Rt. Ear**	**Degree of Lt. Ear**
Domain 1	.005	.000
Domain 2	.000	.000
Domain 3	.002	.000
Domain 4	.021	.001

Table 4.2. represents, the Pairwise comparison of the degree of hearing loss in both ears with domain 1 scores. Four pairs revealed a significant difference for the right ear ($p<0.05$) namely, moderately severe - mild (.001), Moderately severe - minimal (.026), Moderately Severe - Normal (.032) and Moderate - mild (.045). The other pairs did not show any significant differences. Five pairs also revealed a significant difference for the left ear the combination which showed difference are Moderately severe - Mild (.004), Moderately Severe - Minimal (.025), Severe - Mild (.000), Severe - Normal (.005), and Mild to moderate - Normal (.041). Table 4.2. – 4.5 below mentions about all pairs were found significantly different.

Table 4.2.

Pairwise comparisons of degree of hearing loss in each ear with Domain 1

Pair	Sig. p-value of Right ear	Sig. p-value of Left ear
Moderately Severe – Mild	.001	.004
Moderately Severe – Minimal	.026	Na*
Moderately Severe – Normal	.032	.025
Moderate – Mild	.045	.158
Severe – Mild	.063	.000
Severe – Normal	.051	.005

Mild to moderate - Normal	Na*	.041

Na*- category comparison was not available.

Table 4.3

Pairwise comparisons of degree of hearing loss in each ear and Domain 2

Pair	Sig. p-value of Right ear	Sig. p-value of Left ear
Severe to Profound – Mild	.026	Na*
Profound – Mild	.026	Na*
Moderately Severe – Mild	.000	.001
Moderate – Mild	.009	.247
Severe – Mild	.167	.000
Mild to moderate – Mild	Na*	.033
Severe – Moderate	.639	.046

Na*- category comparison was not available.

Table 4.4

Pairwise comparisons of degree of hearing loss in each ear and Domain 3

Pair	Sig. p-value of Right ear	Sig. p-value of Left ear
Severe to Profound – Mild	.026	Na*
Profound – Mild	.026	Na*
Moderately Severe – Mild	.000	.001
Moderate – Mild	.009	.247
Severe – Mild	.167	.000
Mild to moderate – Mild	Na*	.033

Severe – Moderate	.639	.046

Na*- category comparison was not available

Table 4.5

Pairwise comparisons of degree of hearing loss in each ear with domain 4

Sample 1-Sample 2	Sig. p-value of Right ear	Sig. p-value of Left ear
Moderately Severe – Mild	.005	.0.23
Moderate – Mild	.025	.036
Severe – Mild	.080	.000
Severe – Normal	.113	.033

4.2.2 Duration of Noise exposure.

Kruskal-Wallis Test revealed that there is no significant comparison between duration of noise exposure and quality of life score (p>0.50). The Kruskal-Wallis Test results are provided in the table 4.6

Table 4.6.

Comparison across QOL score and duration of noise exposure

S.N.	Duration	Domain 1	Domain 2	Domain 3	Domain 4
01.	Value	.662	.919	.355	.766
02.	Significance	Ns	Ns	Ns	Ns

Ns*- not significant

4.2.3 Configuration of the audiogram.

The Kruskal-Wallis test revealed that there is no significant difference between the configuration of the audiogram and the quality-of-life score. The Kruskal-Wallis Test results are given in the table 4.7.

Table 4.7.

Comparison across QOL score and configuration of the audiogram.

S.N.	Configuration	Domain 1	Domain 2	Domain 3	Domain 4
01.	Value	.111	.140	.113	.518
02.	Significance	Ns*	Ns*	Ns*	Ns*

Ns*- not significant

4.3. Correlation of the audiological findings with the quality-of-life scores obtained on the World Health Organization Quality of Life - BREF questionnaire.

Spearman's correlation coefficient test was administered to study the correlation of audiological findings (i.e., degree of hearing loss, pattern, duration of noise exposure) with quality-of-life scores.

4.3.1. Degree of hearing loss.

A correlation was drawn to see if an increase in the degree of hearing loss shows correlated degree in the score of quality of life. Spearman's correlation shows a significant ($p<0.05$) strong negative correlation. This negative correlation indicates that a higher degree of hearing loss lowers the quality of life. The Spearman correlation test results are given in the table 4.8

Table 4.8

Spearman's correlation coefficient and respective p values for degree of hearing loss and quality of life scores

	Transformed scores for domain 1 (4-20)	Transformed scores for domain 2 (4-20)	Transformed scores for domain 3 (4-20)	Transformed scores for domain 4 (4-20)
Degree of hearing loss	Spearman's rho (-.663) and Sig. -.000	Spearman's rho (-.674) and Sig.-.000	Spearman's rho (-.648) and Sig.-.000	Spearman's rho (-.602) and Sig.-.000

4.3.2. Configuration of hearing loss.

Spearman's correlation was used to see the effect of the configuration of the audiogram on quality-of-life scores. In this analysis there was no significant correlation between configuration of hearing loss and quality of life scores. The Spearman correlation test results are mentioned in the table 4.9.

Table 4.9

Spearman's correlation coefficient and p values for the configuration of audiogram and QOL score.

	Transformed scores for domain1 (4-20)	Transformed scores for domain 2 (4-20)	Transformed scores for domain 3 (4-20)	Transformed scores for domain 4 (4-20)
Configuration of hearing loss	Spearman's rho (.211) and Sig-.142	Spearman's rho (.278) and Sig-0.51	Spearman's rho (.266) and Sig-0.61	Spearman's rho. (160) and Sig-.266

4.3.2. Duration of Noise Exposure.

Spearman correlation was performed to see if there is any correlation between duration of noise exposure and quality-of-life scores. This test revealed that there was no significant correlation between duration of noise exposure and quality of life scores. The Spearman's correlation test results mentioned in the table 4.10.

Table 4.10

Spearman's Correlation coefficient and p values for the duration of noise exposure and QOL score.

	Transformed scores for domain 1 (4-20)	Transformed scores for domain 2 (4-20)	Transformed scores for domain 3 (4-20)	Transformed scores for domain 4 (4-20)
Duration of noise exposure.	Spearman's rho (-.160) and Sig-.267	Spearman's rho (.057) and Sig-.692	Spearman's rho (.207) and Sig-.150	Spearman's rho (.085) and Sig-.556

Chapter 5

Discussion

The study assessed the quality of life in individuals with noise-induced hearing loss and their audiological characteristics. Further, the correlation between the quality of life and the audiological findings was established. The specific findings are discussed in subsequent sections.

5.1 Identification of audiological characteristics on individuals with NIHL

The present study attempts to describe the audiological characteristics of individuals with NIHL, which includes the severity of hearing loss, ear affected, duration of noise exposure, and configuration of the audiogram. Analysis of data in terms of the degree of hearing loss showed that the majority of the participants had bilateral mild sensorineural hearing loss, followed by moderate and moderately severe SNHL. This can be accounted for the damage at the level of hair cells due to the high intensity of noise.

This is in agreement with the study by Le et al. (2017) who reported that noise-induced hearing loss results in inner ear deformity leading to bilateral mild to moderate degree of sensorineural hearing loss. Edwards, A. L. (2009) study reported that characteristics of Noise-Induced Hearing Loss (NIHL) in gold miners of different adult ages and occupation types were examined, and the results indicate that as a subject group had symmetrical bilateral, mild sensorineural hearing loss. The finding supports the effects of mechanical overdrive of the cochlear hair cells may be the cause of the severity of the losses in these excessively high levels of noise. The factors of toxins, heat, and physical exercise may contribute to the severity of the degree of loss in these subjects.

Contrastingly a study conducted by Hong, 2015, reported there were a significant number of patients who had reported asymmetrical thresholds as well as severe to profound hearing loss. They explained that the individuals were exposed to pulsating noise and the loss was mostly unilateral in nature because of the posture of the head during work. According to Hong, 2015, there are several possible explanations for why operational engineers' left ear hearing is much worse than their right ear. The explanation says that directional noise exposure may be the cause of hearing loss in the left ear. Most operating engineers peer over their right shoulder when operating heavy construction equipment.

Analysis of the audiogram configuration in our study indicated that most of the participants had sloping type of configuration followed by the notch and flat type of configuration. A study conducted by Edwards, A. L., (2009) the characteristics of Noise-Induced Hearing Loss (NIHL) in gold miners' results showed a sloping configuration of audiograms in frequencies above 2000 Hz, and the loss did not demonstrate the expected "notch" at 4000 Hz that is usually found in NIHL. This may be a reason due to the pattern of hearing loss varies for the different occupation types with machine operators being the most severely affected.

Hearing loss is typically attributed to noise exposure if the configuration of the patient's audiogram is "notched", and the patient also reports a positive history of noise exposure. However, not all individuals identified as having an audiometric notch report a history of noise exposure, and not all individuals reporting a history of noise have an audiometric notch (Hong 2005; Nondahl et al. 2009; Osei-Lah and Yeoh 2010).

The study by Hong (2005) stated that the region in the cochlea responsible for lower frequencies deteriorates gradually as the degree of high-frequency hearing loss increases. As a result, "noise has a longer time to affect lower frequencies than higher frequencies. It will affect both the higher and lower frequencies so that the notch will convert to a flat configuration.

Analysis of data in terms of duration of noise exposure showed that (2 %) of individuals exposed to noise even for less than 5 years presented NIHL. The explanation for this finding is that the duration of the noise exposure per day and/or their occupation type differed from other participant's occupations. It is well known that exposure levels, duration, and spectrum of the noise depend on their occupation type which influences the NIHL.

Various studies have also accepted that the link between excess noise and hearing loss. However, this problem is reported to be different for different categories of occupations, or particularly noisy occupations. Weitzman, Smith, (1960). Hessel (2000) has shown that there is a strong association between noise and NIHL and it is reported that NIHL increases with increases in duration and magnitude of exposure.

Higher levels of noise for short time can also lead to noise-induced hearing impairment but generally, 10 years of exposure could result in significant hearing impairment. (Dobie, 1990).

Our Study does not directly give the information regarding the subjects' exact exposure history findings regarding exposure levels. The occupation type reported by a subject at the time of the interview was the assumed occupation type, but he may have been exposed to other occupation type noise during his working career. To the findings of this study would shed more light on the causes of the typical characteristics of hearing loss. The clinical implication is for more detailed case history taking to facilitate this type of research within the confines of practically.

5.2 Assessment of the impact of audiological characteristics on quality of life

The current study attempts to estimate the impact of audiological characteristics (duration of noise exposure, degree of hearing loss, configuration) on quality of life (across domains). The findings revealed that the duration of noise exposure and configuration did not show any significant impact on quality of life, but the degree of hearing loss had a significant effect on quality-of-life measure. On statistical analysis using one-way ANOVA, there was a significant difference across all domains with the degree of hearing loss. The findings from the post analysis revealed that pairs of different categories of hearing loss show a significant effect on the quality of life across all domains. This implicates those degrees of hearing loss have an impact on quality of life across all domains (Physical, Psychological, Social, and Environmental).

Supporting this study Cooper, S. P. et al, 2016 reported that the degree of hearing loss due to noise exposure decreases the quality of life. Seidman, M. D., & Standing, R. T. (2010), reported that noise-induced hearing loss have severe adverse effects and consequences on daily living and globally on economic production. Van Kempen et al. (1999) conducted a review and looked at the relationship between noise exposure and physical health, results revealed that noise has a stronger impact on the human physical and psychological system, which includes sleep disturbance, stress, fear, and anxiety. Overall, noise has a negative impact on human quality of life.

Hallberg, L. R. M., Påsse, U., & Jansson, G. (1999), aimed to describe coping, disability and handicap, and psychological general wellbeing (quality of life) among women with noise-induced hearing loss., and additional purpose was to explore psychological and audiological factors affecting quality of life in this female group. Results revealed that noise exposure creates hearing loss as well as limits the psychological wellbeing.

5.3. Correlation of the audiological findings with the quality-of-life scores

In the current study, correlation analysis revealed that there was a significant strong negative correlation between the degree of hearing loss in both the ears and quality of life; but no correlation was found between other characteristics, such as duration of noise exposure and configuration of hearing loss. This may be due to the significant effect of the hearing loss, as the severity of hearing loss increases a person's quality of life decreases in terms of different aspects of domain (mental, social, emotional, physical, and psychological).

Sanju et al. (2017) reported that there was a significant correlation of degree of hearing loss on their daily activities majorly affecting the quality of life. Bruno et al. (2003) observed that there was a considerable level of annoyance and disturbance due to their hearing loss in occupational workers.

Clark and Paunovic (2018) conducted a systematic review to evaluate the impact of environmental noise ("road traffic noise, aircraft noise, railway noise, and wind turbine noise") on quality of life, wellbeing, and mental health. The findings showed that people exposed to long-duration noise show several negative behaviors like depression, anxiety, stress, annoying, restlessness, cranky, etc. Conclusively noise affects mental health, wellbeing, and as well as the quality of life.

Several literatures acknowledge that annoyance and sleep disruptions are the most likely causes of noise-induced health problems. On the other hand, the relative importance of noise characteristics, personal attributes, and cultural variables are yet to be established. the studies indicate that noise level accounts for just 10 to 15% of the variability in evaluations. A variety of overlapping qualities and contextual factors, such as age, noise source and attitude toward the noise source, personality, mental functioning, time of day, and noise sensitivity, are likely to explain the remaining diversity. Future studies and research with various quality of life data are needed.

Overall findings suggest that NIHL had an adverse effect on a person's quality of life, and impact across all the main domains of quality of life (physical, environmental, psychological, and social).

Chapter 6

Summary and Conclusion

The noise is an unwanted sound that can affect one's hearing ability when they are exposed to it for a long duration of the period due to their occupation. This will lead to deterioration not only in hearing ability but also exhibit non-auditory effects such as fatigue, annoyance, sleep disturbance, depression, impulsive behavior, physical health, mental disturbances, emotional behaviors, negative feelings, and social disturbances. Overall, it will affect the individual's daily lifestyle.

The aim of the present study was to assess the audiological characteristics and quality of life of individuals exposed to occupational noise. The objectives included; identifying the type, degree and pattern of hearing loss in individuals with NIHL, assessing their quality of life using WHOQOL-BREF. Finally, correlating the audiological characteristics and their impact on quality of life scores. Fifty individuals with a history of noise exposure and having unilateral or bilateral sensorineural hearing loss between mild to a severe degree were recruited in this study. These individuals were interviewed for assessing their quality of life using WHO-QOL questionnaire.

Results of this study revealed that almost all the participants had bilateral mild sloping sensorineural hearing loss due a history of noise exposure. Additionally, it was found that the severity of hearing loss adversely affected an individual's quality of life in the aspects of physical, psychological, social and environmental. However, the duration of noise exposure and configuration of audiogram did not have significant impact on quality of life measure.

6.1. Implications of the study

1. The knowledge of impact of NIHL will help an audiologist in counselling the patients.

2. Knowing the characteristics of NIHL will help in future evaluation and management of hearing-impaired individuals with NIHL with history of noise exposure.
3. The WHOQOL-BREF questionnaire is found to be effective in gaining information regarding the impact of NIHL on quality of life. The same can be considered to be used in clinical practise.
4. The outcomes of the WHOQOL-BREF can be utilized to counsel the impact to the patients exposed to occupational noise.

6.2. Limitations of the study

The number of participants in the study was limited to 50, to generalize the findings a larger sample size would have been appropriate.

6.3 Future direction of the study

Middle-aged individuals are the working force of the society; there is a need to explore how NIHL impacts them. It is, therefore, important for an audiologist to understand this phenomenon and its impact on quality of life. Future experiments and research are required with other quality of life measures.

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