COMPARISON OF SELF-ASSESSMENT MEASURES FOR TINNITUS HANDICAP WITH QUALITY OF LIFE AND ITS RELATION TO PSYCHOACOUSTIC FACTORS

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CERTIFICATE

This is to certify that this dissertation entitled **'Comparison of self-assessment measures for tinnitus handicap with quality of life and its relation to psychoacoustic factors'** is a bonafide work submitted in part fulfilment for degree of Master of Science (Audiology) of the student Registration Number: 16AUD020. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
April, 2018

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CERTIFICATE

This is to certify that this dissertation entitled **'Comparison of self-assessment measures for tinnitus handicap with quality of life and its relation to psychoacoustic factors'** has been prepared under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **'Comparison of self-assessment measures for tinnitus handicap with quality of life and its relation to psychoacoustic factors'** is the result of my own study under the guidance a faculty at All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru,
April, 2018

Registration No. 16AUD020

Dedicated to

All the things that have made me:

Family

Friends

Harry Potter

Queer as Folk

Supernatural

&

EXO

사랑하자!

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Abstract

There is still a need to develop and standardize an optimal test battery strategy that is efficient in reporting the extent of one's discomfort due to tinnitus in detail and also sensitive and responsive to treatment-related change. Using such a standardized core set of outcome measures would further allow for efficient comparison of data across centres; clinical audits and the demands of managed health care; will help improve communication among clinical providers and scientists; and provide standardization of national and international epidemiological studies.

Aim: *The study aims to compare existing self-assessment tinnitus handicap questionnaires with the perceived quality of life, and how well it can relate across subjective and psychoacoustic aspects of tinnitus. Objectives included comparing the Self-Assessment Questionnaires scores with those seen on Quality of life Questionnaires (same/similar categories). The relation between the psychoacoustic aspects of the tinnitus, relation between the age, gender and duration of tinnitus was also seen.*

Subjects: *The subjects for this study were 60 adults in the age range of 16 to 70 years of age that reported to the institute with the primary or secondary complaint on tinnitus with sensorineural hearing loss. Out of the 60 subjects, groups were based on degree of hearing loss i.e. Group 1 – normal to minimal hearing loss, Group 2, mild to moderate hearing loss and Group 3- Greater than moderate degree of hearing loss; all having 20 subjects each.*

Method: *The complete hearing evaluation with the psychoacoustic evaluation of tinnitus was done for all subjects. The questionnaires administered*

for the study were the Tinnitus Handicap Questionnaire, Tinnitus Functional Index and Self-Report Tinnitus Handicap Questionnaire. For the assessment of quality of life, the World Health Organisation Quality of Life – BREF and Short Form 36 questionnaires were used. The 8 subscales for the tinnitus handicap questionnaires that were selected across which comparisons and correlations were made are Intrusive, Sense of Control, Cognition, Sleep, Auditory, Relaxation, Emotional and Quality of Life.

The Quality of Life questionnaires were compared and correlated under the subscale scores of Physical, Psychology, Social and Environment.

***Results**: No significant gender effect (males (n = 32) and females (n = 28) hence, the scores were combined for further assessment. Results suggest that overall the SF-36 questionnaire shows a better correlation to the tinnitus handicap questionnaires than the WHOQOL-BREF. Most of the subscale scores across the self-assessment questionnaires showed no correlation with the actual psychoacoustic factors of tinnitus. The analysis revealed no significant correlation with the duration on tinnitus and weak correlation with age of the individuals in the greater than moderate hearing loss groups. Both degree and configuration of hearing loss showed significant positive correlation effect on the tinnitus handicap questionnaire subscale scores. These Based on these findings we can conclude that individuals tended to have higher handicap scores on tinnitus handicap questionnaire as their degree of loss increased.*

***Conclusion:** There is a need to better understand and explore the relation of not just the overall questionnaire scores with the subjective factors and psychoacoustic factors of tinnitus but to assess which subscales seem to correlate to changes across these factors as well, as done in this study. This can help*

clinicians judge which questionnaire maybe more sensitive for their clients and can track the improvement better than others.

Chapter 1

Introduction

McFadden (1982) has quoted tinnitus as "conscious expression of a sound that originates in an involuntary manner in the head of the owner or may appear to him to do so." Apart from its definition, it can be informally and generally described as a continuous, disturbing sound in one's ear. It is commonly heard as a ringing or buzzing kind of sound but people have reported to have various other types of tinnitus as well.

It has been reported as one of the most commonly occurring and distressing otologic problem, that interferes with the quality of life as it causes various somatic and psychological disorders (Yetiser, Tosun, Satar, Arslanhan, Akcam, & Ozkaptan, 2002). Prevalence of tinnitus reported by Shargorodsky, Curhan, and Farwell (2010) over a period of one year in the U.S. suggested that approximately 50 million adults reported of having frequent tinnitus. The number was higher when compared by age, for the percentage reported around 14.3% for older adults (age range 60-69 years). Many other prevalence studies have reported for the percentage of population affected by tinnitus to range from 7.1 % to 14.6% (National Center for Health Statistics, 2016). These findings were consistent with most other countries, that have reported a range of 10.2% to 15.1% (Moller, 2011). The prevalence of tinnitus has been reported to be inconsistent in case of children, from 4.7% to 62.2%, which was suggested was could be due to the differences in way that the questions were asked, the way it was explained, differences in the study design, age of the child, etc. (Nemholt-Rosing, Hvass-Schmidt, Wedderkopp, & Baguley, 2016).

A South Indian study by Manche, Madhavi, Meganadh and Jyothy in 2016, talks about prevalence of tinnitus in South Indian regions. They reported that 29.3% (956) of the total study subjects had tinnitus as one of their primary complaints. This percentage was reported higher for adults more than 40 years of age. A higher risk factor was noted in cases of middle and inner ear diseases, while 96.9% (n = 927) had associated hearing loss as well. Other commonly occurring factors reported were otitis media (60.9%), presbycusis (16.6%) and otosclerosis (14.3%) which all led to tinnitus in the study population.

Another study by Thirunavukkarasu and Geetha (2015), has reported a percentage of 5.24% with, no gender differences, in case of children. Out of these, 79.63% of children also had hearing loss along with the reported tinnitus. Additionally, most cases had mild hearing loss (30.23%), followed by minimal and even lesser cases of moderate hearing loss. Conductive pathology was more common than sensorineural or mixed pathologies. Chances of occurrence of tinnitus was studied to be up to 20.7% higher in ratio of population that had a history such as smoking, reduced sleep (≤ 6 hours), stress, depression, thyroid disease and even more commonly in reported cases of tympanic membrane abnormality, unilateral or bilateral hearing loss, noise exposure from earphones, noise exposure in or outside of the workplace and brief noise exposure (Park et al., 2014).

Tinnitus quantification and evaluations are all subjective, hence, it becomes difficult to evaluate objectively due to the subjective differences seen in terms of its perception. It occurs most commonly as a secondary symptom to some otologic disorder, noise induced hearing loss being the most common factor for most, but it can also have other causes (Dobie & Snow, 2004). Several therapeutic approaches to

tinnitus have produced varied results, and hence it is assumed to have diverse physiological causes (Baguley, 2002).

Even though, tinnitus is common, sufferers have found it to be debilitating and have troubles coping with a continuous tinnitus in their daily life. A survey to evaluate the experience of members suffering from tinnitus was conducted by American Tinnitus Association (2014), in which 62% of persons reported it as bothersome and highly noticeable. They reported problems such as anxiety (13%), reduced sleep (18%), poor concentration (16%), social isolation (7%), Depression (7%) and complete inability to work in extreme cases (2%).

Bhatt, Bhattacharyya, and Lin (2017) have found a close link between tinnitus, lesser hours of sleep, anxiety and depression and an overall more number of missed work days in tinnitus sufferers. The study reported that 26.1% of persons with tinnitus, reportedly, also had anxiety problems within the previous 12 months, compared to the 9.2% of those without tinnitus. Additionally, depression was also reported by 25.6% of persons with tinnitus, compared to 9.1% of those without.

Other studies have tried to correlate tinnitus frequency and intensity with the handicap score and the rating on the scale of depression but there was only moderate correlation between tinnitus frequency and the depression scale rating while the rest were uncorrelated (Temugan et al., 2016).

A more detailed exploration in terms of emotional distress as part of the psychological aspects of tinnitus were reported by Jakes, Hallam, Chambers and Hinchcliffe (1985) which led them to develop the Tinnitus Effects Questionnaire to help gauge complaints of tinnitus sufferers. It was a fairly broad instrument including items such as any distress symptoms that the subject may report, self-made statements and thoughts and the description of their tinnitus. Hallam, Jakes, and Hinchcliffe

(1988) reported poor internal consistency and reliability of data for the Tinnitus Effect Questionnaire. Kuk, Tyler, Russell, and Jordan, (1990) developed the Tinnitus Handicap Questionnaire to assess the effects of tinnitus. It focuses on the effects of tinnitus on the emotional, social and behavioral aspects (factor 1), the combined effect of both tinnitus and hearing loss on the same (factor 2) and the subject's outlook on their own tinnitus (factor 3). Newman, Wharton, and Jacobson (1995) reported that factor 3 had poor psychometric adequacy and yielded low internal consistency and low test to retest reliability. Thus, as an independent measure, THQ was questionable.

Faced with the limitations of previously developed questionnaires (Newman, Jacobson, & Spitzer, 1996) developed the Tinnitus Handicap Inventory (THI). It was developed in order to meet and include the following characteristics (1) it should be brief in order to be used easily and frequently, even in busy set-ups; (2) easy to administer and interpret; (3) it should have a broad scope, must adequately reflect the effect of tinnitus on everyday functioning; and (4) it should be psychometrically robust to demonstrate adequate reliability and validity.

They attempted to find correlation between the THI scale and the subjective tinnitus pitch and loudness judgements. Although no significant correlation was found, majority of tinnitus sufferers reported high degree of annoyance, sleep disruption, depression and poor concentration. No significant age or gender effects were observed. Thus, THI is a brief self-report handicap measure that can be easily administered to assess the handicap in various domains caused or affected by one's tinnitus.

Landgrebe et al. (2012) proposed THI for routine use, as part of the international standards for tinnitus research and assessment. It is widely used to help select patients with tinnitus requiring an immediate intervention.

Meikle et al., in 2012, after studying about the drawbacks of existing tinnitus self-report handicap questionnaires, developed the Tinnitus Functional Index (TFI). It reports about the symptoms associated with tinnitus, helps assess the severity and classify it on a scale of 'not a problem' to 'very big problem' and is also reported to be sensitive to changes in severity along the treatment. Thus, it has been used in numerous newer studies as a means of baseline assessment of tinnitus (Henry, Frederick, Sell, Griest, & Abrams, 2015; Krings et al., 2015; Michiels, De Hertogh, Truijen, & Van de Heyning, 2014; Shekhawat, Searchfield, & Stinear, 2014; Wilson et al., 2015). It shows good test to re-test agreement and has shown to have good stability over time. Earlier studies have suggested that the THI global scores could moderately correlate with the emotional subscale of the TFI (Baguley, Humphriss, & Hodgson, 2000; Kennedy, Wilson, & Stephens, 2004; Newman et al., 1996; Kuk, Tyler, Russell, & Jordan, 1990). Global scores also showed positive correlations between TFI and THI. Although, if the TFI was to be used as a primary measure, it is still required to be standardized and adapted through translation across languages and cultures.

A Self Report Tinnitus Handicap Questionnaire (SR-THQ), was developed at All India Institute of Speech and Hearing (AIISH), by Jayashree (2002)**,** as a tool for tinnitus evaluation. It has 25 questions that the subject is supposed to rate as 'yes', 'sometimes' or 'no'. It was analyzed to check for its psychometric function, validity and reliability was adequate and also if it shows any correlation to the perceived subjective tinnitus loudness and pitch. The functional subscale was the most

representative of the subscales in SR-THQ. Certain questions in different subscales were scored higher than the rest which determined the overall subscale scores making it evident that the factors most affected were those that represent the subjects' quality of life more specifically. High correlation was also seen in terms of the duration of tinnitus and the overall scores of the questionnaire, while a low correlation was seen for the subjective pitch.

These self-assessment questionnaires show overlap but are good indicators of psychological distress related to tinnitus; although, they are not detailed enough to assess the overall quality of life. Due to the perceived handicap, those suffering from tinnitus have also been reported of having scored poorly on quality of life assessment questionnaires.

For that purpose, the following quality or life questionnaires have been researched upon and standardized based on large population studies. These are general questionnaires that help assess patient's overall outlook towards their own health and social functioning but are not specific for tinnitus sufferers only.

Health-related Quality of Life, as a concept, was described as 'individuals' perceptions of their position in life in the context of culture and value systems in which they live and in relation to their goals, expectations, standards and concerns by the World Health Organization (1997). The WHO Quality of Life Questionnaire (WHOQOL-BREF) was developed by the WHOQOL Group in 1998 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 relationships, and environment.

A number of studies worldwide have used WHOQOL-BREF along with other Self-Assessment Outcome Measures for subjects suffering from tinnitus. There was significant variance when WHOQOL-BREF scores were compared with subjective tinnitus loudness, THI total-score and THI subscales. The audiometrically measured psychoacoustic features of tinnitus were not directly correlated with WHOQOL-BREF. It was noted that different features of tinnitus were associated with the HRQOL and depressive symptoms but not directly by the psychoacoustic aspects (Weidt et al., 2016).

Conclusively, it was preferred to evaluate THI total plus sub scores separately along with the subjective tinnitus loudness and pitch evaluations to help identify those suffering more and requiring immediate intervention as opposed to those who were not. Good early support can help prevent development of depressive symptoms which can lead to better QOL perception.

WHOQOL-BREF scores have also been reported to moderately correlate with the Quality of life subscale of the TFI. Global scores correlations of TFI correlations to WHOQOL-BREF global item scores were also studied (Fackrell, Hall, Barry, & Hoare, 2016).

The Short Form 36 is another generic health survey questionnaire consisting of 36 questions. Developed by the Medical Outcomes Trust, Boston, it generates eight-scale profile of scores as well as physical and mental health summary measures. The 8 subscale categories include physical functioning, role/physical, bodily pain, general health, vitality/energy, social functioning, emotional and mental health. It has been used to compare general and specific populations in terms of relative burden of diseases and improvements seen with treatments (Shiely, Bayliss, & Keller, 1996). In 1996, an upgraded version of SF 36, version 2.0 (the international version) was

introduced. It reflected improvements in psychometric studies underlying scale construction and scoring, and it has been translated, as part of International Quality of Life Assessment project, in more than 40 countries (Ware & Kosinski, 1996). In a survey conducted by Gandek, Sinclair, Kosinski and Ware Jr., (2004) high internal consistency and reliability (0.83 to 0.93) for the eight sub scales and also for the physical and mental component summary measures (0.94 and 0.89 respectively) was reported. The psychometric functions have been noted to be more consistent with results from Asian countries over United States which could to accounted to the cultural differences (Ngo-Metzger, Sorkin, Mangione, Gandek, & Hays, 2008).

In comparison to version 1.0, version 2.0 also had simpler instructions and questionnaire items, 5 level response choice instead of 2, more compatible to translations and cultural adaptations and thus, was an overall improved self-administered version (Ware, 2000). The only major drawback reported was that it did not account for sleep disturbances caused due to the diseases or ill health.

It has been used to assess quality of life in factory workers suffering from tinnitus due to noise exposure in turkey (Muluk & Oğuztürk, 2008). Results suggest lower scores in general mental health and role limitation domains primarily due to emotional problems faced by them. In another study conducted in tinnitus sufferers in Nigeria (Adoga, Kokong, Nimkur, & Okwori, 2015), they recorded overall low quality of life scores in all domains except pain levels, irrespective of the participant's age or gender, for 69.4% of participants (n=49). It also showed a positive correlation for all domains for all patients ($p = 0.5$).

The SF-36 and WHOQOL-BREF have been used interchangeably when measuring the generic QOL. However, according to a study conducted in Taiwanese

population to compare the 2 questionnaires, these instruments were reported to measure different QOL constructs and have an overall weak correlation (Huang, Wu, & Frangakis, 2006). They also report that SF-36 seems to measure health related QOL, while the WHOQOL-BREF measures global QOL. Thus, researchers must be careful when selecting the questionnaire to use.

1.1. Need of the study

As tinnitus is an invisible condition, the impact that it has is often underestimated, and research in this area is key to improving quality of life in people with tinnitus. The impact of tinnitus is difficult to judge, based on its psychoacoustic aspects (tinnitus pitch and loudness) only. Despite of there being similarities, perception of their own tinnitus matters more. Thus, there are various self-report measures to assess the handicap one may suffer because of tinnitus. With many measures available, it becomes difficult to choose the one that may be needed for the client, or judge which would provide a better and more accurate representation of the client's complaints. Questionnaires are extensively used in tinnitus research to either distinguish the participant population, to help compare across studies with some uniformity and to help evaluate effects of experimental intervention (e.g. Hoare, Searchfield, El Refaie, & Henry, 2014; Song, Punte, De Ridder, Vanneste, & Van de Heyning, 2013). They are also used in order to try and draw correlations between self-reported tinnitus severity and psychoacoustic and biological aspects of the tinnitus observed (Song et al., 2013; Szczepek, Haupt, Klapp, Olze, & Mazurek, 2014).

THI, despite of being a helpful initial diagnostic tool (Newman, Jacobson, & Spitzer, 1996b; McCombe et al., 2001), has been criticized for lacking sensitivity to change. When used for follow up of individuals undergoing therapy or treatment for

their tinnitus reduction it is a poor indicator of small improvements (Meikle et al., 2007).

The tinnitus specific handicap questionnaires may miss out on aspects addressed by the questionnaire. The Quality of Life questionnaires, on the other hand, are more generic and can better assess any additional problems (physical, psychological, emotional, etc.) caused due to their tinnitus. There is a lack of studies that can correlate the handicap measure scores and the psychophysical aspects of tinnitus, hence, there are no studies supporting the use of any particular quality of life questionnaire for individuals suffering from tinnitus.

Thus, there is still a need to develop and standardize an optimal test battery strategy that is efficient in reporting the extent of one's discomfort in detail and also sensitive and responsive to treatment-related change. A standardized methodology for assessing psychoacoustic aspects of tinnitus along with a disease specific and a generic health measure together must be a part of the required test battery for tinnitus assessment. In combination, these would help provide complementary evidence underlying the assessment of tinnitus impairment, activity limitation, and participation restriction. Using such a standardized core set of outcome measures would further allow for efficient comparison of data across centres; clinical audits and the demands of managed health care; will help improve communication among clinical providers and scientists; and provide standardization of national and international epidemiological studies (Goldstein, 1997; Langguth, Landgrebe, Kleinjung, Sand, & Hajak, 2011).

Such uniformity in assessment across centres would make it easier to track improvement for all individuals. It will also be easier for the clinician to assess across patients as well as across different setups.

1.2. Aim of the study

The study aims to compare existing self-assessment tinnitus handicap questionnaires with the perceived quality of life, and how well it can relate across subjective and psychoacoustic aspects of tinnitus.

1.3. Objectives

1. To compare Self-Assessment Questionnaires scores with those seen on Quality of life Questionnaires (same/similar categories).
2. To study the relation between the psychoacoustic aspects of the tinnitus and the Self-Assessment Questionnaires.
3. Study the relation between the age, gender and duration with self-assessment scores (general QOL and tinnitus handicap questionnaires).
4. Relation between degree and configuration of hearing loss with Self-Assessment questionnaire scores (general QOL and tinnitus handicap questionnaires).

1.4. Null Hypotheses

1. There is no difference or relation across the Self-Assessment Questionnaires scores with those seen on Quality of life Questionnaires (same/similar categories).
2. There is no relation between the psychoacoustic aspects of the tinnitus and the Self-Assessment Questionnaires.

3. There is no effect of age, gender and duration of tinnitus on the Self-Assessment scores (general QOL and tinnitus handicap questionnaires).
4. There is no effect of degree and configuration of hearing loss on the Self-Assessment questionnaire scores (general QOL and tinnitus handicap questionnaires).

Chapter 2

Review of Literature

2.1. Tinnitus Characteristics and Mechanism

Tinnitus has been characterized as the perception of internal noises, mainly originating involuntarily within the head, in the absence of external acoustic stimuli (Hallam, Rachman, & Hinchcliffe, 1984). A clear definition of what is tinnitus and its

characteristics, is important to allow us to make uniform comparisons for description and/or intervention purposes.

Tinnitus can be either subjective or objective in nature with a number of causes. It can range from a low intensity background noise to being loud enough to interfere in understanding speech or other loud external sounds. The objective type of tinnitus, also referred to as the somato-sound, refers to an actual sound in the ear (generally the ear canal) that can be perceived by not just the sufferer but is audible to other persons as well. It is considered to be associated with cochlear/middle ear fluids and other vascular related problems in the ear (Dobie, 2004).

Tinnitus, in general, is used to refer to the subjective type of tinnitus, i.e. in the absence of an actual sound. Commonly these sounds have been described as train like whistling, analogous to the sounds made by insects such as crickets or cicadas, escaping steam, running water and so on (Han, Lee, Kim, Lim, & Shin, 2009). There may be a number of conductive pathologies that can cause tinnitus, such as blocking of the ear due to wax, a perforated tympanic membrane, presence of fluid in the middle ear or, most commonly, in cases of otosclerosis.

The pathophysiology of tinnitus is still not completely understood, and several ideas have been stated to explain the physiological mechanism of tinnitus, most of these reasons being attributed to a spontaneous increase in the activity at the nerve fibres at a cochlear or retrocochlear level (Eggermont, 2003).

In the review of studies by Baguley, 2002, on the mechanisms causing tinnitus, several models have been proposed under the general heading of has cochlear and non-cochlear in origin. All models that considered the cochlea in isolation as the origin of tinnitus from the rest of the auditory are considered

inadequate, but in some situations cochlear dysfunction at the level of outer hair cells has been implicated in tinnitus generation.

Jastreboff in 1990, suggested discordance in damage of OHCs and IHCs, as IHCs are more resistant in cases of ototoxicity or noise induced hearing loss. It suggests as the site of origin of tinnitus being the area along the basilar membrane where the OHCs are damaged but the IHCs are intact. The theory was supported in a few high frequency hearing loss cases where patients matched their tinnitus frequency to the frequency where their loss starts (Hazell & Jastreboff, 1990; Hazell, 1987).

Chéry-croze, Truy, and Morgon in 1994, suggested afferent inhibition from a few damaged OHCs that lead to the reduction in corresponding efferent inhibition of the damaged as well as the surrounding active OHCs as a reason for tinnitus generation at the cochlear level. Hence, the undamaged neighboring OHCs with reduced efferent inhibition may rise to a highly active area of the basilar membrane, resulting in tonal tinnitus. Patuzzi in 2002, noted an increase in the release of the neurotransmitter glutamate from the IHCs with an increase in endocochlear potential. Thus, tinnitus maybe caused due to the increased rate of glutamate released and was termed as ‘rate tinnitus’ and was predicted to have a hiss-like quality. Contrary to cochlear origin theories, most recent studies have proposed neural mechanisms of tinnitus generation and persistence.

Jastreboff (1990) has given the Jastreboff neurophysiological model which considers ‘signal recognition and classification circuits’ in persistent tinnitus. It involves the auditory perceptual, emotional and reactive systems involved in tinnitus, was published in 1996 and in slightly more detailed form in 1999. The emotional system gets involved due to the connection of the auditory efferent system with the

reticular formation within the brainstem which causes attuned to even the intermittent sounds in the auditory pathway for the tinnitus to be perceived as problematic (Hazell & Jastreboff, 1990). According to the model it is not necessary for a lesion to be actually present along the auditory system for the generation of sound, which can be used as an explanation for presence of tinnitus in normal hearing individuals. This model has application in treatment of tinnitus.

Similarly, other theories of tinnitus generation were based on increase in spontaneous activity of the cochlear nerve. Contrary to this assumption, experiments have shown that induced chronic cochlear pathology resulted in a reduction in spontaneous activity.

Eggermont, 1984 proposed the mechanism of tinnitus to be due increased synchronized activity in a small group of nerve fibres peripherally. This may be caused to an ephaptic coupling of these fibres due to compression and breakdown of the myelin sheath leading to the phenomenon of ‘cross talk’ or schotastic firing from these fibres which can be perceived as sound. This concept can be applied to the cochlear-vestibular nerve, which being covered in myelin sheath is vulnerable to compression from blood vessels or retrocochlear tumors that impinge upon the nerve.

Evans, Wilson, and Borerwe in 1981, experimented on animals and noted that increase in salicylate doses in cats, equivalent to blood concentration known to induce tinnitus in humans (300-400 mg/l) resulted in increase in the spontaneous neural activity. This study was also seconded by Tyler in 1984, wherein he too found similar results with increased salicylate concentration in blood.

Based on these findings, Langner and Wallhäusser-Franke, in 1999, proposed a new model for tinnitus generation. They noted a decreased activity in the Ventral

Cochlear Nucleus after administration of salicylate which they attributed to an increased afferent activity from the cochlear nerve and not due to any increase in efferent inhibition (Zhang & Kaltenbach, 1998).

Although, in some cases altered activity of the Dorsal Cochlear Nucleus (DCN) has also been reported supposedly resulting due to increased efferent activity from the inferior colliculus (IC) or the cortex. Based on this a mechanism of disinhibition at the level of IC and DCN has also been proposed (Eggermont, 1984, 2000).

Eggermont (1984) has also talked about the effect of the efferent system on the perception of tinnitus intensity perceived and the annoyance caused with it based on how techniques like biofeedback may help reduce tinnitus. Same was also suggested by Hazell & Jastreboff, 1990 where they considered that the efferent system could help modulate the tinnitus perception in a cochlear mechanism causing tinnitus.

Goodhill (1950) was the first to suggest an analogy between tinnitus and phantom limb pain as a possibility to understand tinnitus perception. Similar to what is seen in cases of phantom limb pain, a cortical re-organization may occur in the auditory cortical regions following a damage or change at the peripheral level. This possibility was further reviewed by Meikle, 1995 and Salvi, Lockwood, and Burkard in 2000.

Conclusively, a number of ‘possible’ tinnitus generation mechanisms and models have been proposed but studies show that none of these are consistently present or absent across all tinnitus sufferers. Even a multiple potential mechanism of

tinnitus may exist which could further account for the heterogeneity evident across the clinical population.

2.2. Objective Assessment of Tinnitus

After having a better understanding of the possible mechanisms of tinnitus generation, we can better understand by what means can we carry out the assessment of tinnitus.

Kemp (1978) tried to identify spontaneous outer hair cell activity from the cochlear following the cochlear origin of tinnitus models in the ‘hope that they corresponded to their owner’s tinnitus and thus, at long last, we could measure tinnitus objectively’. The results were not consistent across the clinical population with most of them having absent otoacoustics emissions. Also, with the advent in more retrocochlear theories of origin, recording OAEs.

A number of fMRI and PET imaging studies aimed to identify the neural correlates of tinnitus. The record the hemodynamic response to neural activity which may be caused by the modulation of tinnitus and, in some cases, may even identify abnormal steady-state activity associated with tinnitus (Lanting, de Kleine, & van Dijk, 2009). But the overall results from this study were poor as the PET and fMRI have a limited spatial (1 mm) and temporal (2 s) resolution which limits their use for assessing of determining any small-scale changes in the neural activity to be identified as specific responses caused by presence of tinnitus e.g. neural synchrony mechanism if tinnitus (Eggermont, 2007). Although the study conducted did show an abnormal neural activity in tinnitus patients at various levels in the brain.

Specifically, cortical and sub-cortical auditory brain areas show a correlation between blood flow and tinnitus loudness. However, Lanting et al. in 2009 in their

study have concluded by saying that direct assumptions of tinnitus being the sole cause for them cannot be made, they could be a result of the peripheral loss, hyperacusis or even age-related differences.

Hallam, Rachman, and Hinchcliffe, in 1984, hypothesized tinnitus to be more of a bodily symptom to which people may pay more attention to compared to others. Assuming this theory is correct, the tinnitus patients would have a deficit of habituation which can possibly assessed objectively as well. The mismatch negativity (MMN) test is a procedure that facilitates the study of habituation deficits as it is the electrical response to an oddball stimulus and can thus, be used as an objective assessment for tinnitus sufferers (Hall, 2007).

A study was conducted by Holdefer, Oliveira, and Ramos Venosa, in 2013 to assess this hypothesis. Results showed that there was a statistically significant difference in MMN latency between the study group and the control group ($p = 0.022$) when both ears were considered. The mean amplitudes on the other hand showed no statistically significant difference between the groups ($p = 0.682$). They concluded by saying that MMN could be used as a useful method for objective tinnitus identification and assessment, as well as for monitoring treatment progress.

Weisz, Voss, Berg, and Elbert, 2004 used MMN to evaluate 15 people with tinnitus and hearing loss and compared them with a control group of 15 people with normal hearing. Their findings showed that tinnitus is a more complex phenomenon than pure reorganization of neural responses in the auditory cortex after damage to the receptors. They suggest the involvement of regions responsible for emotions and attention in tinnitus perception.

2.3. Subjective Assessment of Tinnitus

The subjective assessment of tinnitus can be done in two ways, one, by assessing the exact pitch, type and loudness of the tinnitus perceived by the subject and second, by assessing the subjective problems (emotional and physical) faced by the person due to his tinnitus. The following procedures and questionnaires have been specifically devised for the assessment of the same, although, there still seems to be some variability across these measures.

2.3.1. Tinnitus pitch and loudness.

As the objective tests do not provide us with any consistent results to assess tinnitus, our assessment of tinnitus is mostly done through subjective testing. This includes an assessing the tinnitus pitch and loudness and some questionnaires that can help us understand their associated problems caused due to tinnitus.

Tinnitus pitch and loudness matching refers to the procedure where the subject is asked to match the perceived pitch and loudness of their tinnitus to the externally presented stimuli, presented by the tester. Tyler and Conrad-Armes in a study conducted in 1983, compared the three procedural methods that were used for tinnitus pitch matching i.e. an Adaptive Method (Bracketing), a Method of Limits (ascending and descending), and the Method of Adjustment. Each one of these procedures was repeated up to 7 times for all subjects to check for reliability of the all procedures. They noted that there was no statistically significant difference for the means and the standard deviations for the three methods. Some differences among the procedures included that the method of limits look the longest to record. On the other hand, the test to retest reliability for some subjects was poor as they matched pitch varied by up

to an octave with repeated measures which was regardless of what procedure was being used to assess them.

From research and clinical management point of view, it is important that the subject can reliably match their tinnitus pitch and loudness. This makes follow up during and after therapies as well as follow up assessments to be judged better. Hoare, Edmondson-Jones, Gander, and Hall (2014) examined the agreement and reliability of tinnitus loudness matching and pitch likeness ratings when using a computer- based method to measure the tinnitus. They noted that time between the testing had a significant difference in loudness matching across subjects maybe due to either procedural or perceptual learning. Rating of pitch, on the other hand, showed no systematic effect of time and was inherently more variably matched within the subject. When dominant tinnitus pitch assessments were separated by three months, acceptable agreement was achieved only for group mean data, not for individual estimates.

The tinnitus pitch and loudness itself provide us with very less information for clinicians to judge the extent of distress that might be caused to the subjects. Although, a majority of the find it bothersome, but there is no direct correlation to the loudness of pitch of the tinnitus perceived. Hence, it is recommended to make use of the tinnitus specific handicap questionnaires that provide us with symptom- specific handicap outcome measures in order to better understand who is suffering more and in what domains. This can further help us plan their treatment and counselling that best suits the individual and can help address and relieve the problems at the earliest.

The questionnaires used in this study are currently the ones most commonly used across countries for clinical and research based purposed to assess the degree of handicap one may suffer due to their tinnitus.

2.3.2. Tinnitus Handicap Inventory (THI).

The Tinnitus Handicap Inventory (THI) is a self-report measure developed by the British Association of Otolaryngologist, Head and Neck surgeons to measure the handicap caused by tinnitus and the impact it has on one's daily living conditions by quantifying them. Originally consisting of 50 questions, it was modified into a beta version and published by Newman, Jacobson, and Spitzer in 1996. It is still considered one of the best tinnitus measuring tools having been developed subsequent to previously developed scales and questionnaires that were used to classify tinnitus. It judges the subjects on 3 categories of functional, emotional and catastrophic reactions to their tinnitus.

Analyses suggested that the THI had excellent internal consistency reliability (Cronbach's alpha = 0.93) and adequate convergent and construct validity. High correlations were obtained between test and retest administrations of the total and subscale THI scores over approximately a 3- week interval. Each correlation exceeded the statistical criteria ($r > 0.80$) considered acceptable for clinical purposes. Additionally, each of the subscales and total THI met the criterion (95% of the observed differences falling within ±2 SD) established by the British Standards Institution (1981) for a test to be considered an acceptably repeatable clinical measure (Newman, Sandridge, & Jacobson, 1998).

They attempted to find correlation between this scale and the subjective tinnitus pitch and loudness judgements. Although no significant correlation was

found, majority of tinnitus sufferers reported high degree of annoyance, sleep disruption, depression and poor concentration. No significant age or gender effects were observed. There were weak associations between the THI and the Beck Depression Inventory scores as well as between THI scores and perceived discomfort for tinnitus pitch and loudness. Thus, THI is a brief self-report handicap measure that can be easily administered to assess the handicap in various domains caused or affected by one's tinnitus. Landgrebe et al. (2012) proposed THI for routine use, as part of the international standards for tinnitus research and assessment. It is widely used to help select patients with tinnitus requiring an immediate intervention. Furthermore, it has also been adapted and standardized to a number of Indian languages including Kannada (Zacharia, Naik, Sada, Kuniyil, & Dwarakanath, 2012), Tamil (Ramkumar & Swaminathan, 2011), Malayalam (Aithal, Pillai, Zacharia, & Rajashekhar, 2013) and Urdu (Aqeel & Ahmed, 2018). In all the adapted versions the Cronbach-alpha test and correlation for reliability measures showed that it was a standard and reliable tool for use.

2.3.3. Tinnitus Functional Index (TFI)

It is important for these self-report handicap questionnaires be sensitive enough so that not just for initial evaluation but they can also be used to track any changes due to treatment outcomes. In 2012, Meikle et al., designed TFI that would additionally to assessment of the severity of tinnitus would help in tracking treatment related changes as well. In the final TFI, Cronbach's alpha was 0.97 and test-retest reliability 0.78, with good convergent validity ($r = 0.86$ with Tinnitus Handicap Inventory [THI]; $r = 0.75$ with Visual Analog Scale [VAS]). The final TFI was successful at detecting improvement with moderate to large effect sizes.

Fackrell, Hall, Barry, and Hoare in 2016 conducted research to assess the psychometric properties of TFI and found that the 'auditory' factor showed poor correlation along with the increase in the at high levels 'functional impact of tinnitus'. Reproducibility consistency was high overall for TFI assessments (a = 0.80) and extremely high reliability (ICC = 0.91). It also showed high correlations with when compared with other questionnaires scores TFI and THI (r = 0.82) and THQ (r ¼ 0.82), moderate correlations with quality of life assessment scales like VAS-L (r = 0.46), PR-A (r = 0 .58), BDI (r = 0.57), BAI (r = 0.39) and WHOQOL (r = -0.48). Floor effects were also noted for more than 50% of the items.

So far TFI has been adapted to Bengali (Kumar, Kumar, Chatterjee, Hota, & Kumari, 2017) with good correlation when compared to THI-Bengali and TFI-English. Test-retest reliability also showed high correlation amongst all the conditions on all the eight sub-scales.

2.3.4. The Self-Report Tinnitus Questionnaire (SR-THQ).

Till date, none of the tinnitus handicap assessment questionnaires have been developed in India, only adapted from the western correlates. The Self-Report Tinnitus Handicap Questionnaire (SR-THQ), was developed at All India Institute of Speech and Hearing (AIISH), as part of an independent project by Jayashree (2002)**,** as a tool for tinnitus evaluation with a format similar to that of THI.

It was analyzed to check for its psychometric function, validity and reliability was adequate and also if it shows any correlation to the perceived subjective tinnitus loudness and pitch. The Cronbach's alpha of 0.93 was obtained which indicates good internal consistency. The functional subscale was the most representative of the subscales in SR-THQ. Certain questions in different subscales were scored higher

than the rest which determined the overall subscale scores making it evident that the factors most affected were those that represent the subjects' quality of life more specifically. High correlation was also seen in terms of the duration of tinnitus and the overall scores of the questionnaire, while a low correlation was seen for the subjective pitch. It also showed high degree of correlation was with THI (r = 0.92).

2.4. Effect on Quality of Life

All the tinnitus handicap assessment questionnaires have a subscale asking about the quality of life of the tinnitus sufferer but it doesn't cover all the aspects that may be affected in as much detail as Quality of Life questionnaires would. There are quite a few quality of life questionnaires available, choosing an appropriate quality of life measure for these individuals, therefore, can help identify the problem areas which need to be addressed within the rehabilitation process, as well as allowing a means of monitoring progress and evaluating outcome of the rehabilitation process and, especially, of particular types of therapies.

2.4.1. WHO Quality of Life Questionnaire (WHOQOL-BREF).

The most commonly used is the WHO Quality of Life Questionnaire (WHOQOL-BREF) developed by the World Health Organization (1997). There was significant variance when WHOQOL-BREF scores were compared with subjective tinnitus loudness, THI total-score and THI subscales. The audiometrically measured psychoacoustic features of tinnitus were not directly correlated with WHOQOL-BREF (Weidt et al., 2016).

WHOQOL-BREF scores show moderate correlation (r = 0.48) with the Quality of life subscale of the TFI. This also demonstrates acceptable discriminant validity and

is concluded to measures construct(s) that are distinct from those measured by more general health domains.

The WHOQOL has also been translated and adapted to a number of Indian languages including Hindi (Meena, Sen, Behra, Tripathy, Aggrawal, & Rajoli, 2015; Saxena, Chandiramani, & Bhargava, 1998), Tamil, Kannada and Malayalam (Menon, Cherkil1, Awasthy, Unnikrishnan, & Rajani, 2012). All of them have reported good reliability and validity for the adapted versions as well.

2.4.2. Short Form 36.

The Short Form 36 or is another generic health survey questionnaire consisting of 36 questions developed by the Medical Outcomes Trust, Boston, in the year 1994 (Ware, Kosinski, & Keller, 1994). It has been used to compare general and specific populations in terms of relative burden of diseases and improvements seen with treatments (Shiely, Bayliss, & Keller, 1996).

In 1996, an upgraded version of SF 36, version 2.0 (the international version) was introduced. It reflected improvements in psychometric studies underlying scale construction and scoring, and it has been translated, as part of International Quality of Life Assessment project, in more than 40 countries (Ware & Kosinki, 1996). In a survey conducted by Gandek, Sinclair, Kosinski, Ware, and Jr. (2004) high internal consistency and reliability (0.83 to 0.93) for the eight sub scales and also for the physical and mental component summary measures (0.94 and 0.89 respectively) was reported. Reportedly, the SF-36 questionnaire has more consistent results from Asian countries over United States which could to accounted to the cultural differences and should thus be preferred over WHOQOL-BREF (Ngo-Metzger, Sorkin, Mangione, Gandek, & Hays, 2008).

It has been adapted by Sinha, van den Heuvel, and Arokiasamy in 2013 to make it suitable for administration in the Indian population. Similar adaptations have also been done while translating SF-36 for use in other countries in order to preserve the conceptual meaning of the original question to make it relevant within each country and language.

Research comparing the two has also shown poor correlation between the two constructs. For both questionnaire the Cronbach's alpha coefficients (a = 0.7) was acceptable for all subscales. Pearson correlations showed weak correlation (< 0.3) among subscales of both instruments that were hypothesized to measure similar constructs (I. C. Huang, Wu, & Frangakis, 2006). They also report that SF-36 seems to measure health related QOL, while the WHOQOL-BREF measures global QOL.

Thus, the selection of the quality of life questionnaire must be done with some reasoning and not to be used interchangeably.

Conclusively, there are quite a few number ways that tinnitus and its effects can be assessed but not all of them can used together and a more uniform, reasoned approach is required. In order to arm ourselves with the best measures of assessment, it is necessary that we make judgements across the domains that these questionnaires claim to measure, with related psychoacoustic and other subjective factors from individuals suffering from tinnitus.

Chapter 3

Methods

This study aimed to compare existing self-assessment tinnitus handicap questionnaires with the perceived quality of life, and how well it can relate across subjective and psychoacoustic aspects of tinnitus sufferers.

It included the objectives such as comparison of Self-Assessment Questionnaires scores with those seen on Quality of life Questionnaires (same/similar categories), relation between the psychoacoustic aspects of the tinnitus and the Self-Assessment Questionnaires, relation between the age, gender and duration with self-assessment scores (general QOL and tinnitus handicap questionnaires) and relation between the degree and configuration of hearing loss with self-assessment scores (general QOL and tinnitus handicap questionnaires). Based on the aforementioned aims and objectives the following method was used to conduct the study.

3.1. Selection of participant

Sixty individuals in the age range of 18-70 years that reported to the institute with a primary or secondary complaint of tinnitus were taken as participants for the study. The age grouping was done according to the availability of participants. The following criteria was used to define the sub-group of the study, based on their Pure Tone Averages (PTA) calculated by averaging the pure tone thresholds at 500, 1000, 2000 and 4000 Hz (Ref: four frequency PTA at 500, 1000, 2000 and 4000 Hz):

- 20 individuals having tinnitus with less than mild degree of hearing loss (0-25 dB HL).
- 20 individuals with tinnitus with hearing loss between mild to moderate degree (26-55 dB HL).
- 20 individuals with tinnitus and having a hearing loss of greater than moderate degree (greater than 55 dB HL).

All participants were required to fill the written informed consent form before testing, which specifies the willingness of participants to take part in the study.

Further, as a criterion for selection, subjects selected must have reported of tinnitus as their primary complaint or secondary complaint to hearing loss at the time of audiological evaluation. The tinnitus was continuous since at least past 3 months for all participants. Further, only those diagnosed as having a sensorineural hearing loss were eligible.

3.1.1. Exclusion criteria. Participants who presented with one or more of the following were excluded from the study:

- Any history or presence of middle ear disorders.
- Any other somatosensory or other conditions those are typically associated with tinnitus (vestibular schwannoma or Meniere's Diseases).
- Any history or presence of psychological problems.

3.2. Test environment

Psychophysical assessment of tinnitus was carried out in an acoustical treated audiometric room where the ambient noise levels were within the permissible limits as specified by ANSI S3.1(1999) (R2008).

3.3. Procedure

3.3.1. Preliminary evaluations. Pure tone thresholds were obtained using calibrated dual channel audiometer through modified Hughson and Westlake procedure (Carhart & Jerger, 1959). This was carried out across frequencies ranging from 250 Hz to 8000 Hz for air conduction thresholds and 250 Hz to 4000 Hz for bone conduction thresholds.

Speech recognition thresholds were obtained by using Kannada paired words and speech Identification Scores (SIS) were obtained using the PB word lists in Kannada language developed by Yathiraj and Vijayalakshmi, (2005). Immittance Evaluation was carried out on all individuals. Tympanometry and Acoustic reflex using 226 Hz probe tone at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz was assessed using GSI-Tympstar middle ear analyzer. Based on the results of the above tests, only those participants who satisfied the selection criteria were included for further study.

3.2.2. Assessment of tinnitus

To assess the predominant tinnitus, i.e. in cases reporting with bilateral tinnitus or multiple tinnitus; the tinnitus which is most bothersome to the subject was assessed. The assessment of tinnitus pitch and loudness was done according to the common procedure followed and described by Graham and Newby, 1962:

Assessment of tinnitus pitch. The predominant pitch of the tinnitus is assessed using 2 alternate force choice method until an approximate pitch was obtained. Two tones, in alternating manner, were presented and the client was asked to choose one of the two which closely matches the pitch of his /her tinnitus. This continued till the pitch match is made. For presentation, pure tones or narrow band noise can be used. The presentation level was 10 dB above the subject's pure tone thresholds.

Assessment of tinnitus loudness. Once the approximate pitch was determined the subject was asked to match the loudness of the presented sound to the loudness level of their tinnitus so that they perceived as equally loud. The level changes were done in 5 dB steps.

3.2.3. Administration of Tinnitus Assessment Questionnaires. The following self-report outcome measurement questionnaire was administered for the subjective evaluation of tinnitus and any related discomfort caused due to it.

Tinnitus Handicap Inventory (TFI) (Newman et al., 1996b)**.** This questionnaire contains a set of 25 questions that will help identify difficulties experienced by the subject caused due their tinnitus. They were required to answer in terms of 'yes', 'sometimes' or 'no' for every question. The scoring was done by allotting a score of 4 for yes, 2 for sometimes and 0 for no response every time. These scores were then added to obtain a total score, 100 being the maximum score that can be obtained. Based on the scoring a grade from 1-5 was assigned; i.e. slight, mild, moderate, severe or catastrophic.

Tinnitus Functional Index (TFI) (Meikle, 2012)**.** TFI contains 25 items that map the following 8 functional subscales: intrusive, sense of control, cognitive, sleep, auditory, relaxation, quality of life and emotional. The client was asked to rate the item on 11- point rating scale scoring it from 0 to 10 ranging from never/none to always/all the time.

Table 3.1
Subscales across the tinnitus handicap questionnaires, questions within each subscale and scoring.

SUBSCALES	QUESTIONS INCLUDED FROM THE QUESTIONNAIRE			TYPE OF QUESTIONS
	TFI	THI	SR-THQ	

INTRUSIVE	1, 2, 3	-	1, 2, 3, 4	How strong/loud is your tinnitus?
SENSE OF CONTROL	4, 5, 6	4, 5, 8, 19, 23	10, 24	Do you feel in control/ can you cope with your tinnitus?
COGNITION	7, 8, 9	1, 15, 18	12, 21	Do you have any difficulty in concentrating or thinking clearly?
SLEEP	10, 11, 12	7	19, 21	Does your tinnitus make it difficult for you to fall/stay asleep?
AUDITORY	13, 14, 15	2	11, 20	Does your tinnitus make it difficult for you to hear?
RELAXATION	16, 17, 18	9, 20	5, 13, 15	Does it cause any interference with your peace or relaxation time?
EMOTIONAL	19, 20, 21, 22	11, 12, 13, 17, 24	8, 9, 14, 18, 25	Do you feel upset/depressed/angry because of your tinnitus?
QUALITY OF LIFE	23, 24, 25	3, 6, 10, 14, 16, 21, 22, 25	6, 7, 16, 17, 22	Has your tinnitus affected your enjoyment of life and social activities?
TOTAL	25	25	25	
SCORING	11-POINT RATING SCALE (0 TO 10)	3-POINT RATING SCALE (0, 2 AND 4)	3-POINT RATING SCALE (0, 2 AND 4)	

Note. The questionnaires are given in the Appendix i-iii.

In case of ambiguous rating an average was taken of the rating. For overall scoring all the valid ratings provided were added for each item, divided by the number of items and then multiplied by 10 to get a score between 0-100 range. Each of the 8 subscales were scored individually the same way except the Quality of Life subscale, which has 4 items out of which 1 was eliminated before scoring.

Self-Report Tinnitus Handicap Questionnaire (SR-THQ) (Jayashree, 2002). The SR-THQ is scored identical to THI, the 25 items are rated as ‘yes’, ‘sometimes’

and ‘no’ and scored as it is in the THI with scoring being 4, 2 and 0 respectively. The subscales include Functional (17 items), Emotional (6 items) and Catastrophic (2 items).

WHO-Quality of Life Questionnaire (The World Health Organization Quality Of Life (WHOQOL)-BREF). It consists of 26 questions which, except the first two, are divided in to one of the following 4 domains which represent the individual’s perception of their quality of life under each domain. The domains being physical health, psychological, social relationships and environment.

All domain scores were made to be scaled in the positive directions so higher score means higher quality of life. Thus, for items 3, 4 and 26 they are scored opposite to their rating (i.e. 5=1 and 1=5). To calculate the scores, first the mean was calculated for each domain and multiplied by 4 to make them comparable to scores used in WHOQOL-100 (range between 4 to 20). For cross comparisons across other questionnaires these scores were transformed into 0-100 range scale according to the WHOQOL-BREF manual.

Table 3.2
Subscales across the Quality of Life questionnaires, the questions within each subscale and scoring.

SUBSCALES	QUESTIONS INCLUDED FROM THE QUESTIONNAIRE		TYPE OF QUESTIONS
	WHOQOL-BREF	SF-36	
PHYSICAL HEALTH	3, 4, 10, 15, 16, 17, 18	3, 7, 11	Does their tinnitus affect their physical activities?
PSYCHOLOGY	5, 6, 7, 11, 19, 26	5, 9	Do they feel worried/anxious/depressed because of their tinnitus?

ENVIRONMENT	8, 9, 12, 13, 14, 23, 24, 25	4, 8	Does their environment limits them in any was because of their handicap?
SOCIAL	20, 21, 22	6, 10	Is their social life affected because of their tinnitus?
TOTAL	23	8	
SCORING	5-point rating scale	2-point, 3-point, 5-point and 6-point rating scales for different questions	

Note. The questionnaires are given in the Appendix iv and v.

Short Form-36 Health Survey (Ware & Kosinski, 1996)**.** The 36 items of this questionnaire are divided under 8 subscales i.e. physical functioning, role/physical, bodily pain, general health, vitality/energy, social functioning, emotional and mental health, and into two overall summary measures. The items and dimensions were scored using the Likert method. The raw score for each domain was derived by summing the item scores and converted to a value for the dimension from 0 (worst possible health state measured by the questionnaire) to 100 (best possible health state). The raw score was then re-calculated into transformed scale using the provided formula.

3.3. Comparison across Questionnaires

For comparison and correlation across the Tinnitus handicap questionnaires, the domain scores as well as the overall scores were calculated. The comparison was done firstly across the overall scores obtained, and then across the similar/same subscales under the 3 questionnaires.

To compare the Tinnitus handicap questionnaires with the Quality of life questionnaires, the overall quality of life score achieved on Quality of Life questionnaires was compared to the quality of life domain scores achieved in the Tinnitus handicap questionnaires. Comparisons were also drawn between the 2 quality

of life questionnaires used on the basis of their overall score as well as separate domain scores achieved.

Comparisons were also made between the Tinnitus handicap and Quality of Life (overall and subscale) scores with the differing subjective factors- age, gender, perceived tinnitus pitch, perceived tinnitus intensity, duration of tinnitus, degree of hearing loss; to help draw correlations between them, if any. All the scores obtained across the different domains and questionnaires were first converted to percentage scores before drawing the comparisons and analyses.

3.8. Statistical Analysis

The obtained data was tabulated and analysed using SPSS. Statistical analysis of correlation of total and subscale scores was done as follows:

1. Test of normality and distribution of data was analysed. Data was found to have non-normality distribution; therefore, non-parametric tests were used to evaluate the data.
2. Kruskal-Wallis test was done to see if there were significant differences across the groups of degree of hearing loss.
3. Mann-Whitney U test was done to see if the male and the female sub groups showed any significant difference in their set of scores, thus, if the data for the two needs to assessed separately.
4. Friedman's test of differences among repeated measures was done within each degree of hearing loss to see if there is a significant difference across which subscale scores.
5. The Wilcoxon Signed Ranks test was conducted to compare all 5 subscale scores for comparison across the quality of life subscale and the Quality of Life

questionnaire scores. It was also used to compare the subscales with significant difference on the tinnitus handicap questionnaires.

6. Spearman's correlation test was also performed to check correlation of quality of life scores, age, duration of tinnitus, degree and configuration of hearing loss with the all the subscale scores across all the Self-Assessment Questionnaires.

Chapter 4

Results and Discussion

All the data obtained was analyzed using statistical package of social science (SPSS) software version 20.0. The Shapiro-Wilk test of normality was administered to check whether the raw data is normally distributed or not. It was checked separately for males (n = 32) and females (n = 28) to see if gender had any effect on the scores. No significant differences were found on the Mann-Whitney U test scores between the two groups. Hence, the data was combined and analyzed for all factors.

All the tests conducted were thus, non-parametric as the data does not follow normal distribution.

The following tables (Table 4.1 to 4.3) show the distribution of the data, i.e., the mean, standard deviation and the median across the 8 subscales on the tinnitus handicap questionnaires.

Table 4.1
Group 1- Normal to minimal hearing loss
Mean, Median and Standard Deviation across all subscales of tinnitus handicap questionnaires

Subscales	Questionnaire	Mean	Std. Deviation	Median
Intrusive	TFI	50.16	23.10	51.66
	SR-THQ	38.75	21.42	43.75
Sense of control	TFI	39.66	24.70	41.66
	THI	39.00	28.07	30.00
	SR-THQ	30.00	28.79	25.00
Cognition	TFI	36.50	28.80	36.66
	THI	29.99	34.02	16.67
	SR-THQ	27.50	34.31	0.00
Sleep	TFI	31.33	32.19	26.66
	THI	41.25	43.88	37.50
	SR-THQ	27.50	31.30	25.00
Auditory	TFI	21.36	25.61	11.66
	THI	32.50	43.75	.00
	SR-THQ	27.50	34.31	12.50
Relaxation	TFI	31.01	30.49	23.33
	THI	21.25	28.41	.00
	SR-THQ	24.16	24.46	16.67
Emotional	TFI	41.83	35.81	36.66
	THI	38.72	31.20	43.75
	SR-THQ	38.00	31.72	40.00
Quality of life	TFI	31.49	27.21	33.33
	THI	26.00	25.21	20.00
	SR-THQ	32.00	28.94	25.00

Table 4.2
Group 2- Mild to moderate hearing loss
Mean, Median and Standard Deviation across all subscales of tinnitus handicap questionnaires

Subscales	Questionnaire	Mean	Std. Deviation	Median
Intrusive	TFI	56.16	23.77	53.3
	SR-THQ	49.36	28.22	40.0
Sense of control	TFI	52.33	24.11	53.3
	THI	51.21	32.73	55.0

	SR-THQ	47.50	25.52	50.0
Cognition	TFI	46.66	21.87	46.67
	THI	40.83	19.84	41.66
	SR-THQ	42.50	27.02	50.00
Sleep	TFI	45.28	31.95	41.66
	THI	55.00	39.40	50.00
	SR-THQ	51.25	36.70	50.00
Auditory	TFI	36.83	27.28	31.66
	THI	47.50	41.27	50.00
	SR-THQ	40.00	37.52	25.00
Relaxation	TFI	46.01	22.76	55.00
	THI	46.25	23.33	50.00
	SR-THQ	54.16	24.10	58.33
Emotional	TFI	62.83	21.03	61.66
	THI	59.66	22.32	59.37
	SR-THQ	57.00	20.28	50.00
Quality of life	TFI	51.16	23.07	48.33
	THI	42.83	22.76	40.00
	SR-THQ	40.50	21.63	40.00

Table 4.3

Group 3- More than moderate degree of hearing loss

Mean, Median and Standard Deviation across all subscales of tinnitus handicap questionnaires

Subscales	Questionnaire	Mean	Std. Deviation	Median
Intrusive	TFI	68.6685	20.12715	71.6650
	SR-THQ	76.2495	21.42176	75.0000
Sense of control	TFI	60.8350	27.29114	50.0000
	THI	74.5000	23.27750	90.0000
	SR-THQ	56.2500	30.21306	50.0000
Cognition	TFI	53.8335	24.66790	53.3300
	THI	65.8330	31.74901	75.0000
	SR-THQ	73.7500	34.86346	100.0000
Sleep	TFI	48.4995	30.73088	60.0000
	THI	65.0000	40.06574	75.0000
	SR-THQ	56.2500	35.23885	62.5000
Auditory	TFI	67.4980	28.77503	63.3350
	THI	87.5000	27.50598	100.0000
	SR-THQ	72.5000	26.77882	75.0000
Relaxation	TFI	63.8340	31.18137	66.6700
	THI	68.7500	30.21306	62.5000
	SR-THQ	68.3335	29.06968	66.6700
Emotional	TFI	78.1665	23.40691	83.3300
	THI	76.8750	24.76036	87.5000

	SR-THQ	73.5000	27.00390	70.0000
Quality of life	TFI	60.8335	34.70682	65.0000
	THI	60.0000	26.75424	70.0000
	SR-THQ	56.5000	27.77257	60.0000

The distribution of data for the Quality of Life questionnaire subscales is given in the following table (Table 4.4).

Table 4.4
Mean, Median and Standard Deviation across degrees of hearing loss on all subscales of Quality of Life questionnaires

Subscales	Questionnaire	Degree of loss	Mean	S.D.	Median
Physical	WHOQOL-BREF	Normal to Minimal	64.61	16.04	63.00
		Mild to Moderate	67.25	22.60	66.00
		> Moderate	53.65	17.73	47.00
	SF-36	Normal to Minimal	76.92	18.36	78.98
		Mild to Moderate	71.60	17.0	73.82
		> Moderate	48.53	20.99	47.65
Psychology	WHOQOL-BREF	Normal to Minimal	62.50	11.02	63.00
		Mild to Moderate	65.75	15.85	69.00
		> Moderate	52.55	16.72	53.00
	SF-36	Normal to Minimal	69.08	17.77	70.83
		Mild to Moderate	63.50	19.97	62.50
		> Moderate	46.66	22.24	39.16
Social	WHOQOL-BREF	Normal to Minimal	68.50	19.49	69.00
		Mild to Moderate	57.40	21.38	56.00
		> Moderate	48.35	18.93	50.00
	SF-36	Normal to Minimal	68.75	28.20	62.50
		Mild to Moderate	65.50	25.88	66.25
		> Moderate	63.50	26.40	56.25

Environment	WHOQOL-BREF	Normal to Minimal	80.40	76.81	63.00
		Mild to Moderate	57.10	13.39	59.50
		> Moderate	48.50	19.63	47.00
	SF-36	Normal to Minimal	71.62	19.78	73.75
		Mild to Moderate	65.15	21.44	66.25
		> Moderate	41.05	22.81	40.00

4.1. Comparison of Quality of Life scores

For this objective, the quality of life questionnaire scores were compared with the quality of life subscale scores obtained on the tinnitus handicap questionnaires of TFI, THI and SR-THQ. These scores will be compared between the groups of degree of hearing loss as well, within each degree of hearing loss.

To compare across the quality of life subscales, the average of overall subscale scores (percentage) of the Quality of Life questionnaires was used. The distribution (mean, median and standard deviation) for these scores is given in the following table.

Table 4.5
Mean, Median and Standard Deviation of Quality of Life subscales in tinnitus handicap questionnaires (TFI, THI and SR-THQ) and overall scores of Quality of Life questionnaires (WHOQOL-BREF and SF-36)

Questionnaire	Mean	Median	Std. Deviation
TFI	47.83	50.00	30.81
THI	42.94	40.00	28.25
SR-THQ	43.00	40.00	27.82
WHO	59.30	58.75	15.76
SF	62.66	60.51	19.20

The average percentage of overall scores from the two quality of life questionnaires were compared with the average percentage of quality of life related questions from the tinnitus handicap questionnaires. The average percentage of the quality of life group of questionnaires from the tinnitus handicap questionnaires did

not show normal distribution on Shapiro-Wilk test of normality ($p < 0.05$). Additionally, the overall calculated standard deviation in relation to the mean was quite large (table). Hence, the non-parametric analysis was done.

Friedman's test of differences among repeated measures was done which gave a Chi-square value of 16.930, which was significant ($p < 0.05$). Following this, the Wilcoxon Signed Ranks test was conducted to compare all five groups in pairs. Out of these, all tinnitus handicap quality of life scores had significant difference when compared to WHOQOL-BREF and SF-36 ($p < 0.05$), while there was no significant difference between the two quality of life questionnaire scores or any of the tinnitus handicap questionnaire pairs ($p > 0.05$).

Spearman's correlation coefficient was then used to draw correlations between these scores and it showed a strong positive correlation ($\rho > 0.70$) (Taylor, 1990) across all tinnitus handicap questionnaires. A strong positive correlation ($\rho > 0.70$) was also seen between the two quality of life questionnaires. The WHOQOL-BREF showed weak negative correlations with TFI ($\rho = -0.47$) and THI ($\rho = -0.42$), and a moderate negative correlation with SR-THQ ($\rho = -0.51$). The SF-36 questionnaire showed moderate correlation across all the 3 handicap questionnaires i.e. TFI ($\rho = -0.54$), THI ($\rho = -0.52$) and SR-THQ ($\rho = -0.60$). Table 4.6 shows the correlation coefficient (ρ values) for the quality of life subscale scores across the tinnitus handicap questionnaires and the Quality of Life questionnaire scores.

Table 4.6
Correlation (ρ values) across average Quality of Life subscale scores in Tinnitus handicap questionnaires (TFI, THI and SR-THQ) and Quality of Life questionnaires (WHOQOL-BREF and SF-36)

	Correlation (ρ values) across questionnaires for Quality of Life scores				
	TFI	THI	SR-THQ	WHO	SF-36
TFI		0.784**	0.760**	-0.475**	-0.540**

	TH	0.78		0.83	-	-
I		4**		4**	0.416**	0.522**
	TH	0.76	0.83		-	-
Q		0**	4**		0.512**	0.599**
	W	-	-	-		0.70
HO		0.475**	0.416**	0.0512**		5**
	SF	-.054	-	-	0.70	
		0**	0.522**	0.599**	5**	

Note. WHO = WHOQOL-BREF. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

The correlation across the questionnaires was also checked under different degrees of hearing loss (grouped as mentioned in the method). In group 1, with normal to minimal hearing loss subjects, significantly ($p < 0.05$) strong positive correlation was seen among three handicap questionnaire scores. Although significant ($p < 0.05$), weak negative correlation was also seen between the SF-36 questionnaire and TFI ($\rho = -0.04$) and THI ($\rho = -0.48$).

In group 2, with mild to moderate hearing loss, significant positive correlation was again seen for all three handicap questionnaire scores, which was strongly positive for THI and SR-THQ ($\rho = 0.08$), along with a weak negative correlation between the SR-THQ and SF-36 questionnaire scores ($\rho = -47$).

In group 3, with greater than moderate degree of hearing loss, tinnitus handicap questionnaires showed significant ($p < 0.05$) strong positive correlation (r >0.07), except TFI and SR-THQ ($\rho = 0.062$). Significant ($p < 0.05$) moderate negative correlation was also found for all three handicap scores and SF-36 (table), while only TFI showed moderate negative correlation with WHOQOL-BREF.

Table 4.7a-c show the correlation coefficient (ρ values**)** for the quality of life subscale scores across the tinnitus handicap questionnaires and the Quality of Life questionnaire scores within each Group of degree of hearing loss.

Table 4.7a

Group 1- Normal to minimal degree of hearing loss

Correlation (ρ values) across average Quality of Life subscale scores in Tinnitus handicap questionnaires (TFI, THI and SR-THQ) and Quality of Life questionnaires (WHOQOL-BREF and SF-36) scores

	Correlation (ρ values) across questionnaires for Quality of Life scores				
	TFI	THI	SR-THQ	WHO	SF-36
TFI		0.80**	0.90**	-0.22	-0.46*
THI	0.80**		0.85**	-0.26	-0.47*
SR-THQ	0.90**	0.85**		-0.26	-0.38
WHO	-0.22	-0.26	-0.26		0.37
SF-36	-0.46*	-0.47*	-0.38		

Note. WHO = WHOQOL-BREF. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

Table 4.7b

Group 2- Mild to moderate degree of hearing loss

Correlation (ρ values) across average Quality of Life subscale scores in Tinnitus handicap questionnaires (TFI, THI and SR-THQ) and Quality of Life questionnaires (WHOQOL-BREF and SF-36) scores

	Correlation (ρ values) across questionnaires for Quality of Life scores				
	TFI	THI	SR-THQ	WHO	SF-36
TFI		0.48*	0.60**	-0.27	-0.25
THI	0.48*		0.80**	-0.06	-0.08
SR-THQ	0.60**	0.80**		-0.43	-0.47*
WHO	-0.27	-0.06	-0.43		0.84**
SF-36	-0.25	-0.08	-0.47*	0.84**	

Note. WHO = WHOQOL-BREF. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

Table 4.7c
Group 3- Greater than moderate degree of hearing loss.
Correlation (ρ values) across average Quality of Life subscale scores in Tinnitus handicap questionnaires (TFI, THI and SR-THQ) and Quality of Life questionnaires (WHOQOL-BREF and SF-36) scores

	Correlation (ρ values) across questionnaires for Quality of Life scores									
		TFI		THI		SR-THQ		WHO		SF-36
	TFI			0.75**		0.62**		-0.60**		-0.60**
	THI	0.75**				0.79**		-0.38		-0.63**
	SR-THQ	0.62**		0.79**				-0.42		-0.65**
	WHO	-0.60**		-0.38		-0.42				0.53*
	SF-36	-0.60**		-0.63**		-0.65**		0.53*		

Note. WHO = WHOQOL-BREF. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

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In this study, the two quality of life questionnaires also showed moderate correlations which is consistent with previous studies carried out for comparing WHOQOL-BREF and SF-36 in other health related factors by Huang, Wu and Frangakis (2006), Skevington, Carse and de C. Williams (2001) and Bech (2001) to name a few studies.

Results suggest that overall the SF-36 questionnaire shows a better correlation to the tinnitus handicap questionnaires than the WHOQOL-BREF. The results show negative correlation between the handicap scores and the quality of life questionnaires scores because the severity rating is oppositely scored for them i.e. is a higher score in

handicap questionnaires suggest poorer quality of life while a higher score in the quality of life questionnaires suggest a better quality of life.

This was also consistent across the different degree of hearing loss groups, with group 3 showing the highest degree of correlation across the handicap questionnaires and SF-36. Conclusively, we could say that the SF-36 is a better matched quality of life questionnaire than the WHOQOL-BREF with the tinnitus handicap questionnaires. But, these results only compare overall average percentage of scores for comparison, a further exploratory factor analysis may help understand how the subscales correlate across these questionnaires better.

Hence, the hypothesis, that there is no difference or relation across the self-assessment tinnitus handicap questionnaires with those seen on Quality of life Questionnaires has been rejected.

4.2. Relation between Psychoacoustic aspects of the tinnitus and the Self-Assessment Questionnaire scores.

The comparison was done across psychoacoustic aspects of the subject's perceived tinnitus which includes the tinnitus pitch and intensity across all the subscales of tinnitus handicap questionnaires. The pitch was measured in Hertz (Hz) and the intensity in the relative sensation levels (dBSL) of perceived loudness.

Table 4.8 shows the correlation coefficient (ρ values) of the tinnitus pitch and intensity across the subscales scores of tinnitus handicap questionnaire.

Table 4.8
Correlation (ρ values) of Tinnitus pitch and loudness with the subscale scores of tinnitus handicap questionnaire

	Tinnitus Pitch			Tinnitus Intensity		
	T] S			T] S		
	FI	HI	R-THQ	FI	HI	R-THQ

Intrusive	0.09	-0.06	-0.08	-	-	0.05
Sense of control	-0.03	-.04	-.06	0.15	-0.01	-0.11
Cognition	-0.09	-0.08	-0.21	-.01	0.02	-0.03
Sleep	0.20	-.18	-.26	-0.15	-0.06	-.04
Auditory	-0.27	-0.12	-0.15	-0.36*	-0.37*	-0.28*
Relaxation	-.05	-.00	-.08	-0.18	-0.18	-0.06
Emotional	-0.08	-0.03	-0.03	-0.23	-0.05	-0.10
Quality of life	-0.01	-0.11	-0.07	-0.26*	-0.08	-0.17

Note. * indicates significance of $p < 0.05$.

Spearman's correlation was used to see if the tinnitus pitch and intensity showed any correlation with the subscales across the tinnitus handicap scores and the quality of life questionnaires. For tinnitus intensity, significant ($p < 0.05$) weak negative correlation was seen in the auditory subscale for TFI ($\rho = 0.36$), THI ($\rho = -0.37$) and a very weak one for SR-THQ ($\rho = -0.28$). Only a weak negative correlation ($\rho = -0.269$) in the quality of life subscale of TFI ($p < 0.05$) was seen. Table 4.9 shows the correlation coefficient (ρ values) of the tinnitus pitch and loudness across the subscales scores of Quality of Life questionnaire.

Table 4.9
Correlation (ρ values) of Tinnitus pitch and loudness with the subscale scores of Quality of Life questionnaire

	Tinnitus Pitch		Tinnitus Intensity	
	WHO	SF-36	WHO	SF-36
Physical	-0.00	-.13	0.18	0.16
Psychology	-0.00	-.17	0.16	0.19
Social	-0.01	-.34*	0.10	0.18
Environment	-0.02	-.06	0.18	0.22

Note. * indicates significance of $p < 0.05$.

A significant ($p < 0.05$) mild positive correlation ($\rho = 0.34$) was also seen between the perceived sensation kevel of tinnitus and the social subscale of the SF-36. Questionnaire Tinnitus pitch only showed a weak positive correlation ($\rho = 0.034$) with the social subscale on the SF-36 questionnaire ($p < 0.05$).

This indicates that the subjects with lower sensation levels of tinnitus perception rated it to be more interfering with their hearing and troublesome than the subjects WHOQOL-BREF perceived it at a higher sensation level i.e. louder. Although, these results are contrary to the expectation that louder the perception of tinnitus more difficult it would before the individual to accept it (Han et al., 2009; Savitri & QadarPunagi, 2014), it shows that the acceptance may depend on the individual's ability to accept it. On the other hand, tinnitus pitch shows no correlation with their subjective perception on handicap which is also supported in literature. McCombe, Baguley, Coles, McKenna, McKinney & Windle-Taylor (2001), Han et al., (2009) and Savitri and QadarPunagi, (2014) all report that there is no correlation that can be drawn between the tinnitus pitch perceived and the subjective perception of handicap and quality of life.

Thus, a simple assessment of the client's tinnitus pitch and perceived intensity gives us no concrete basis to judge their degree of handicap due to their tinnitus. The effects of tinnitus on quality of life are highly individualized, and personality characteristics may predispose a person to experience tinnitus as 'distressing' symptom.

Hence, the hypothesis that there is no relation between the psychoacoustic aspects of the tinnitus and the Self-Assessment Questionnaires has been accepted.

4.3. Relation of subjective factors with the Self-Assessment Questionnaire scores.

Spearman's correlation was analyzed to study the correlation of the subjective factors, i.e. Age, Gender and the Duration of tinnitus across the subscale scores of the tinnitus handicap questionnaires and the Quality of Life subscale scores to better understand if a change in one of these factors affected the scores. This would help us understand if the severity rated on the questionnaires is actually more due to the subjective factor than the actual tinnitus perception as the psychoacoustic factors fail to show very strong correlation with these scores.

4.3.1. Age. The age of the 60 subjects that reported to the institute and were part of this study varied from 18 to 70 years of age with a mean age of 46.72 years. Spearman's correlation revealed that only a few subscales in the tinnitus handicap questionnaires had overall weak positive correlations that were significant ($p < 0.05$) across all degrees of hearing loss.

Table 4.10 shows the correlation coefficient (ρ values) of the subject's age across the subscales scores of tinnitus handicap questionnaire.

Table 4.10
Correlation (ρ values) of age and duration with the subscale scores of tinnitus handicap questionnaires

	Age			Duration		
	TFI	THI	TS R-THQ	TFI	THI	TS R-THQ
Intrusive	0.20	-0.34**	0.18	0.02	-0.02	0.03
Sense of control	0.24	0.20	0.06	0.08	0.03	0.16
Cognition	0.17	0.20	0.005	0.03	0.08	0.02
Sleep	0.01	0.02	0.120	0.24	0.12	0.36**
Auditory	0.35**	0.29*	0.06	0.09	0.08	0.13
Relaxation	0.24	0.11	0.06	0.11	0.01	0.21
Emotional	0.16	0.15	0.03	0.02	0.03	0.11

Quality of life	0.20	0.15	0.01	0.00	-0.11	-0

Note. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

The auditory subscale showed weak positive correlation across all three questionnaires. Intrusive in SR-THQ (ρ = 0.34) and sense of control in THI (ρ = 0.32) also showed weak positive correlations.

To see if the degree of loss also affected this factor, further analysis in terms of age was also done across these subscales but within different degree of hearing loss to see if the correlation could be seen better with the group.

Table 4.11 shows the correlation coefficient (ρ values) of the subject's age across the subscales scores of tinnitus handicap questionnaire within each Group of degree of hearing loss.

Table 4.11
Correlation (ρ values) of age with the subscale scores of tinnitus handicap questionnaires within each group of degree of hearing loss

	Normal to minimal Hearing loss			Mild to moderate hearing loss			More than Moderate hearing loss		
	FI	HI	R-THQ	FI	HI	R-THQ	FI	HI	R-THQ
Intrusive	0.23		.08	.03		0.04	0.22		.08
Sense of Control	0.31	0.10	0.20	.48*	.43	.37	0.30	0.10	0.20
Cognition	0.02	0.29	0.27	.24	.08	.05	0.02	0.29	0.27
Sleep	0.59*	0.66*	0.57*	0.02	.14	0.17	0.59*	0.66*	0.57*
Auditory	0.05	.03	.12	.58*	.36	.33	0.04	.03	.12
Relaxation	0.16	0.40	0.43	0.07	.42	0.21	0.15	0.40	0.43
Emotional	0.22	0.21	0.26	.19	.29	.09	0.22	0.21	0.26
QOL	0.17	0.19	0.15	.24	.11	.20	0.17	0.19	0.15

Note. QOL= Quality of Life subscale. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

In the Group 1, the sleep subscale showed a significant ($p < 0.05$) moderate negative correlation with age on all three tinnitus handicap questionnaires, i.e. TFI (ρ = -0.59), THI (ρ = -0.67) and SR-THQ (ρ = -0.58). Also, a weak positive correlation with sense of control (ρ = 0.48) and a moderate positive correlation with auditory (ρ = 0.58) also showed significance on TFI scale with group 2, mild to moderate hearing loss. No other significant correlations were seen.

In the normal to mild hearing loss, the negative correlation depicts that more of the younger age group individuals complained of sleep disturbances due to tinnitus than older individuals. Table 4.12 shows the correlation coefficient (ρ values) of the subject's age across the subscales scores of Quality of Life questionnaire.

Table 4.12
*Correlation (*ρ scores) *of age and duration with the subscale scores of Quality of Life questionnaires*

	Age		Duration	
	WHO	SF-36	WHO	SF-36
Physical	-0.28*	-0.39**	0.13	0.01
Psychology	-0.19	-0.27*	-0.03	-0.05
Social	-0.22	-0.26*	-0.01	0.07
Environment	-0.34*	-0.36**	-0.06	-0.05

Note. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

On the Quality of Life questionnaires, SF-36 questionnaire showed weak negative correlations across all subscales ($p < 0.05$). while, WHOQOL-BREF showed weak negative correlation across the physical (ρ = -0.29) and mild negative correlation on environment (ρ = -0.34) subscales only. When compared across the subscales within each Group of degree of hearing loss, only the social subscale on SF-

36 showed a significant ($p < 0.05$) moderate negative correlation within Group 2 i.e. mild to moderate hearing loss individuals.

Table 4.13 shows the correlation coefficient (ρ values) of the subject's age across the subscales scores of Quality of Life questionnaire within each Group of degree of hearing loss.

Table 4.13
*Correlation (*ρ values*) of age with the subscale scores of Quality of Life questionnaires within each group of degree of hearing loss*

	Normal to Minimal hearing loss		**Mild to moderate hearing loss**		**More than Moderate hearing loss**	
	WHO	**SF-36**	**WHO**	**SF-36**	**WHO**	**SF-36**
PHYSICAL	-0.29	-0.24	-0.24	-0.38	-0.08	-0.30
PSYCHOLOGY	0.00	-.01	0.01	-0.33	-0.19	-0.20
SOCIAL	-0.19	-0.37	-0.37	-0.56*	-0.17	0.05
EMOTIONAL	-0.12	-0.27	-0.27	-0.15	-0.43	-0.35

Note. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

Thus, with an increase in age the individuals tend to score themselves poor in terms of quality of life. These lower scores may then just be because of other age-related factors and not necessarily due to tinnitus only, especially for SF-36 questionnaire.

4.3.2. Gender. The effect of gender was compared across all the score obtained on the self-assessment questionnaires. Mann-Whitney U tests shows no significant ($p < 0.05$) difference between the scores of two groups except on one intrusive subscale of SR-THQ questionnaire. Thus, the scores are combined and used for all the assessments in this study.

4.3.3. Duration of tinnitus. Spearman's correlation was used to see if there was any correlation across the scores with respect to the duration since the onset of their tinnitus. Table 4.10 shows the correlation coefficient (ρ values) of the subject's duration of tinnitus across the subscales scores of tinnitus handicap questionnaire. Table 4.12 shows the correlation (ρ scores) of duration with the subscale scores of Quality of Life questionnaires. The analysis revealed no significant correlation with the duration on tinnitus ($p < 0.05$).

Hence, regardless of since when they may have tinnitus, the individuals neither showed higher nor lower scores across all subscales on tinnitus handicap questionnaires nor on the quality of life questionnaires. Sanchez, Mak, Pedalini, Levy, and Bento (2005) studies the effect of duration on individuals with tinnitus and have found that over mean time of 3.5 years, majority of the subjects showed change or improvement in their tinnitus, i.e. habituation may or may not happen over time for individuals.

Hence, the hypothesis, for our third objective, that there is no effect of age, gender and duration of tinnitus on the Self-Assessment scores (general QOL and tinnitus handicap questionnaires) has been rejected as age does seem to have an effect, but gender and duration of tinnitus not so much.

4.4. Relation between degree and configuration of hearing loss with Self-Assessment questionnaire scores.

Spearman's correlation coefficient was used again to see if the degree of hearing loss or the configuration of the hearing loss showed significant relation with the scores obtained on the self-assessment questionnaires.

4.4.1. Degree of hearing loss. Correlations were drawn to see if an increase in the degree of hearing loss shows a correlated difference in the scores of the

individuals having tinnitus. There are 20 individuals each in the 3 groups of degree of hearing loss, as stated in the method.

On the tinnitus handicap questionnaires, Spearman's correlation shows a significant ($p < 0.05$) positive correlation across all the subscales except cognition and sleep subscale on the TFI and the sleep subscale on the THI questionnaire.

Table 4.14 shows the correlation coefficient (ρ values) of the subject's degree of hearing loss across the subscales scores of tinnitus handicap questionnaires.

Table 4.14
Correlation of degree and configuration of hearing loss with the subscale scores of tinnitus handicap questionnaires

	Degree of Hearing Loss			**Configuration of Hearing Loss**		
	TFI	**THI**	**S R-THQ**	**TFI**	**THI**	**S R-THQ**
INTRUSIVE	0.33*	-0.52*	0.12	0.30*		
SENSE OF CONTROL	0.27*	0.43*	0.34*	0.14*	0.33*	0.24
COGNITION	0.19	0.46*	0.53*	0.10	0.23	0.26*
SLEEP	0.21	0.20	0.30*	0.14	0.33*	0.24
AUDITORY	0.55*	0.50*	0.59*	0.33*	0.34*	0.32*
RELAXATION	0.44*	0.56*	0.44*	0.28*	0.35*	0.52*
EMOTIONAL	0.42*	0.48*	0.55*	0.34*	0.28*	0.38*
QUALITY OF LIFE	0.51*	0.52*	0.36*	0.29*	0.34*	0.31*

Note. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

On the Quality of Life scores as well, significant ($p < 0.05$) negative correlation was seen across psychology (ρ = -0.34) and social subscale (ρ = -0.37) on WHOQOL-BREF and physical (ρ = -0.50) and psychology (ρ = -0.41) subscales on SF-36.

Based on these findings we can conclude that individuals tended to have higher handicap scores on tinnitus handicap questionnaire as their degree of loss increased. Additionally, this correlation is seen more on the SR-THQ and THI than on TFI subscales, making this a drawback for these questionnaires compared to TFI. Table 4.14 shows the correlation coefficient (ρ values) of the subject's degree of hearing loss across the subscales scores of Quality of Life questionnaire. On the quality of life scores the psychological subscale also seems to be affected by the degree of hearing loss. A negative correlation indicates that as the degree of hearing loss increases the quality of life scores decrease. Thus, these factors may not show just the effect of tinnitus on the person's perceived handicap but a combined effect of both their degree of hearing loss with tinnitus. It is difficult to say which would affect more.

Similar results have also been reported by Holgers, Zöger, and Svedlund (2005), that show moderate degree of correlation between the overall tinnitus handicap reported in self-assessment scores with the increase in degree of hearing loss. Contrary to this, there are also studies, such as one by Ciminelli, Pinto, Sanchez, and Tomita (2010) which reports that there is no correlation of perceived tinnitus handicap based on the subject's self-assessment scores and the degree of hearing loss. Another study by Baskill and Coles (2002) has concluded by saying that such a correlation is uncertain and not always directly correlated.

In terms of Quality of Life, although our results don't suggest any significant difference on the Quality of Life questionnaires, studies suggest that individuals with higher degree of hearing loss reported more annoyance and are more frequently depressed due to their tinnitus, when compared to mild degree of hearing loss (Baskill & Coles, 2002; Holgers et al., 2005; McKinney, Hazell, & Graham, 2002).

4.4.2. Configuration of hearing loss. For configuration of hearing loss seen across the subjects include, flat, high frequency sloping and steeply sloping hearing loss. Significant weak positive correlation for most of the subscales was observed except intrusive, sense of control, cognition and sleep on TFI, cognition and sleep on THI, and sense of control and sleep on SR-THQ. Table 4.14 shows the correlation coefficient (ρ values) of the subject's configuration of hearing loss across the subscales scores of tinnitus handicap questionnaires. Table 4.15 shows the correlation coefficient (ρ values) of the subject's configuration of hearing loss across the subscales scores of Quality of Life questionnaire.

Table 4.15
Correlation of degree and configuration of hearing loss with the subscale scores of tinnitus handicap questionnaires

	Degree of Hearing Loss		**Configuration of Hearing Loss**	
	WHO	**SF-36**	**WHO**	**SF-36**
Physical	-0.23	-0.50*	-0.05	-0.24
Psychology	-0.34*	-0.41*	-0.17	-0.31*
Social	-0.37*	-0.78	0.13	-0.62
Environment	-0.35	-0.78	-0.26*	-0.24

Note. * indicates significance of $p < 0.05$, and ** indicates significance of $p < 0.01$.

On the Quality of Life questionnaires, only psychology (ρ = -0.31) subscale of SF-36 showed mild negative correlation and environment (ρ = -0.26) subscale of WHOQOL-BREF, showed weak negative correlation which were significant ($p < 0.05$). Negative correlation indicates with increase in the slope of hearing loss the subjects have reported worse in terms of their quality of life. But as only 2 of the

subscales show a very weak correlation, it cannot be considered that significant for the overall scores.

This concludes, that amongst the subjects, greater the slope of their hearing loss configuration higher was their distress rating on the tinnitus handicap questionnaires. This study finds support in another study conducted by Weisz, Voss, Berg, and Elbert, (2004) which also reported that individuals with tinnitus that had sloping hearing loss had a higher perceived severity of tinnitus.

Hence, the final hypothesis, that there is no effect of degree and configuration of hearing loss on the Self-Assessment questionnaire scores (general QOL and tinnitus handicap questionnaires) has also been rejected.

Chapter 6

Summary and Conclusion

The study aims to compare existing self-assessment tinnitus handicap questionnaires with the perceived quality of life, and how well it can relate across subjective and psychoacoustic aspects of tinnitus. Objectives included comparing the Self-Assessment Questionnaires scores with those seen on Quality of life Questionnaires (same/similar categories). The relation between the psychoacoustic aspects of the tinnitus, relation between the age, gender and duration and to achieve this aim, 60 individuals sub-grouped into 3 categories according to the pure tone thresholds within the age range of 18-70 years were taken for this. The sub-groups are, Group I include 20 individuals with 0-25 dB HL, 20 individuals with 26-55 dB HL, 20 individuals with >55 dB HL thresholds.

All the participants underwent detailed case history, pure tone audiometry, assessment of tinnitus and administration of questionnaires. Scores of all the subscales of the questionnaires were analysed. Mean and standard deviation were calculated for all the groups and the following statistical analysis was done.

Test of normality and distribution of data was analysed. Data was found to have non-normality distribution; therefore, non-parametric tests were used to evaluate the data. Kruskal-Wallis test was done to see if there were significant differences

across the groups of degree of hearing loss. Mann-Whitney U test was done to see if the male and the female sub groups showed any significant difference in their set of scores, thus, if the data for the two needs to assessed separately.

Friedman's test of differences among repeated measures was done within each degree of hearing loss which gave a Chi-square value of 16.93, which was significant ($p < 0.05$). The Wilcoxon Signed Ranks test was conducted to compare all 5 subscale scores for comparison across the quality of life subscale and the Quality of Life questionnaire scores.

Out of these, all tinnitus handicap quality of life scores had significant difference when compared to WHOQOL-BREF and SF-36 while there was no significant difference between the two quality of life questionnaire scores or any of the tinnitus handicap questionnaire pairs.

Spearman's correlation test was performed to check correlation of quality of life scores, age, duration of tinnitus, degree and configuration of hearing loss with the all the subscale scores across all the Self-Assessment Questionnaires. In this study, the two quality of life questionnaires also showed moderate correlations. Results suggest that overall the SF-36 questionnaire shows a better correlation to the tinnitus handicap questionnaires than the WHOQOL-BREF. The results show negative correlation between the handicap scores and the quality of life questionnaires scores because the severity rating is oppositely scored for them i.e. is a higher score in handicap questionnaires suggest poorer quality of life while a higher score in the quality of life questionnaires suggest a better quality of life. This was also consistent across the different degree of hearing loss groups, with group 3 showing the highest degree of correlation across the handicap questionnaires and SF-36.

It can be postulated that the SF-36 is a better matched quality of life questionnaire than the WHOQOL-BREF with the tinnitus handicap questionnaires. But, these results only compare overall average percentage of scores for comparison, a further exploratory factor analysis can help understand how the subscales correlate across these questionnaires better.

The comparison was done across psychoacoustic aspects of the subject's perceived tinnitus which includes the tinnitus pitch and intensity across all the subscales of tinnitus handicap questionnaires. Most of the scales showed no correlation with the actual psychoacoustic factors of tinnitus. Thus, a simple assessment of the client's tinnitus pitch and perceived intensity gives us no concrete basis to judge their degree of handicap due to their tinnitus. The effects of tinnitus on quality of life are highly individualized, and personality characteristics may predispose a person to experience tinnitus as 'distressing' symptom.

Spearman's correlation was analysed to study the correlation of the subjective factors, i.e. age, gender and the duration of tinnitus across the subscale scores of the tinnitus handicap questionnaires and the quality of life subscale scores to better understand if a change in one of these factors affected the scores. Overall, only some weak to mild correlations were seen, hence, within each group of hearing loss, further analysis was done to see if the degree of loss also affected this factor.

In the normal to mild hearing loss, the negative correlation depicts that more of the younger age group individuals complained of sleep disturbances due to tinnitus than older individuals. Thus, with an increase in age the individuals tend to score themselves poor in terms of quality of life. These lower scores may then just be

because of other age-related factors and not necessarily due to tinnitus only, especially for SF-36 questionnaire.

Spearman's correlation was analysed to see if there was any correlation across the scores with respect to the duration since the onset of their tinnitus. The analysis revealed no significant correlation with the duration on tinnitus. Hence, regardless of when they may have tinnitus, the individuals neither show higher or lower scores across all subscales on tinnitus handicap questionnaires nor on the quality of life questionnaires.

Both degree and configuration of hearing loss showed significant positive correlation effect on the tinnitus handicap questionnaire subscale scores. These Based on these findings we can conclude that individuals tended to have higher handicap scores on tinnitus handicap questionnaire as their degree of loss increased. Additionally, this correlation is seen more on the SR-THQ and THI than on TFI subscales, making this a drawback for these questionnaires compared to TFI.

On the quality of life scores the psychological subscale also seems to be affected by the degree of hearing loss. A negative correlation indicates that as the degree of hearing loss increases the quality of life scores decrease. Thus, these factors may not show just the effect of tinnitus on the person's perceived handicap but a combined effect of both their degree of hearing loss with tinnitus. It is difficult to say which would affect more.

6.1. Implications of the study:

1. There is a need to better understand and explore the relation of not just the overall questionnaire scores with the subjective factors and psychoacoustic factors of

tinnitus but to assess which subscales seem to correlate to changes across these factors as well, as done in this study. This can help clinicians judge which questionnaire maybe more sensitive for their clients and can track the improvement better than others.

2. The most commonly used Quality of Life questionnaire is the WHOQOL-BREF in studies that assess tinnitus handicap in individual with tinnitus. But most studies, including this, suggest that the SF-36 is a better Quality of Life Questionnaire that should be preferred and shows better correlation across the quality of life subscales scores across all the tinnitus handicap questionnaires.
3. On the other hand, within degree of hearing loss, age seems to have a significant affect on the perceived handicap and thus affect the scores. This is a weak point of the questionnaires as it does not only factor in the tinnitus specific effect but is also affected by the individual's age. Although, it can help us judge that the older individuals with a higher degree of hearing loss are bound to score more on the tinnitus handicap questionnaires, i.e., increased level of annoyance and discomfort is reported by them.
4. For configuration of hearing loss, as well, higher degree of handicap is reported in the tinnitus specific questionnaires as the slope of the hearing loss goes from flat to sloping. This provides us with some reliability that such individuals will score relatively high on some subscales of the tinnitus handicap scores.

6.2. Future direction: Thus, still further in-depth analysis and comparisons are needed with a larger group of subjects to see if these results can be generalized. We hope with such studies, initial and follow up assessments for individuals that report of having tinnitus can be done more reliably and uniformly across rehabilitation centres.

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