Noise Induced Hearing loss: its effects and awareness on city bus drivers

CHANDAN R

16AUD008

This Dissertation is submitted as part fulfillment for the Degree of Master of Science in Audiology University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING

MANASAGANGOTHRI, MYSURU-570 006

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CERTIFICATE

This is to certify that this dissertation entitled ***"Noise Induced Hearing loss: its effects and awareness on city bus drivers"*** is a bonafide work submitted in part fulfilment for degree of Master of Science (Audiology) of the student Registration Number: 16AUD008. 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

Dr. S R Savithri
Director
All India Institute of Speech and Hearing
Manasagangothri, Mysuru-570006

CERTIFICATE

This is to certify that this dissertation entitled ***"Noise Induced Hearing loss: its effects and awareness on city bus drivers"*** 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.

Mysuru
April, 2018

Guide
Dr. Rajalakshmi K
Professor
Department of Audiology
All India Institute of Speech and Hearing
Manasagangothri, Mysuru-570006

DECLARATION

This is to certify that this dissertation entitled ***"Noise Induced Hearing loss: its effects and awareness on city bus drivers"*** is the result of my own study under the guidance of Prof. Rajalakshmi K, Department of Audiology, 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 **Registration No. 16AUD008**

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Dedicated to my

Appa, Amma,

Guide

&

All bus drivers

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Abstract

Noise annoyance is especially spread across the urban cities in developing and industrially growing countries like India. One such group of professional who are prone to noise induced hearing loss are the bus drivers. Hence the aim of the study was to do audiological profiling of bus drivers by comparing the hearing outcome with the noise effect and awareness questionnaire. Fifty city bus driver were recruited for the study from various bus depot across mysuru city and were administered with questionnaire followed by screening of hearing thresholds at 500, 1000, 2000 and 4000 Hz along with immittance and reflexometry measure at 500, 1000 and 2000 Hz. The results of the present study reveals that almost all the bus drivers lacked awareness regarding the ill effects of noise on both auditory and health along with poor knowledge regarding the HPD's. Hence, there is a need to educate these professionals about hazardous effect of noise exposure and importance of hearing protection devices. Further identified person should be referred for detailed audiological evaluation to rule out the involvement of peripheral and central auditory system. Hence, they must be educated to minimize the health‐related hazard due to noise exposure. Audiologist has to create awareness in city bus drivers by implementing education and training programs about the hearing protectors.

Key words: Noise induced hearing loss, Bus drivers, Occupational hearing loss

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Chapter 1

Introduction

Loud noise can be very damaging to hearing. It is well known that long-term exposure to loud sounds on a daily basis can result in hearing loss, which is commonly referred to as Noise Induced Hearing Loss. Risk for noise-induced hearing loss is influenced by many factors including the sound's loudness and the length of time that one has been exposed to. As per Occupational Safety and Health Administration, 1983, sounds louder than 85 dB A may cause damage on listening for 8 hours or more. Prolonged exposure to loud noise or even a single loud sound blast or explosion, known as impulse or impact noise can cause injury to the auditory system.(Leon Bluhm, Berglind, Nordling, & Rosenlund, 2007; Lisa Goines, RN; Louis Hagler, 2007) have documented the non-auditory effects of noise on sleep, concentration, communication, and recreation. Thus, it can be noted the consequences of noise exposure include both auditory and non-auditory aspects.

Noise annoyance is especially spread across the urban cities in developing and industrially growing countries like India. The major responsible cause of the higher prevalence in the annoyance of noise is the growing network transportation. One such group of professionals who are prone to noise induced hearing loss are the bus drivers. (Fong, Wong, & Huang, 2018) reported the prevalence of bilateral NIHL in bus drivers to be 18.1%. Kumar et al. (2005) reported high prevalence of hearing loss in tractor drivers. A study by Lopes, Otowiz, de Barros Lopes, Lauris, and Santos (2012) on drivers showed that the occurrence of hearing loss in the absence of complaints. Public transport drivers were exposed to excess noise on roads and 65% of them were suffering from NIHL as reported by Azizi (2010).

Today's society has dependent on the Urban bus transportation and is an indispensable service to the community according to Jarzab, Lightbody, and Maeda (2002). Thus, this profession plays a significant role in our industrialized society. It is common that these professionals are exposed to a series of aggregative factors that may adversely affect their health such as high exposure to noise, air pollution, anxiety, stress, and overloads because of postural positions (Portela & Zannin, 2010).

Long route bus drivers were typically exposed to noise level of more than 82 dB (A) affected by noise pollution while driving for longer duration is also noted by several researchers.

When used in the population of bus drivers it provides a valuable insight on their audiological and general health environmental health impact assessments. This also gives awareness to the individual on the effects of the noise on their hearing and general health. Conducting standardized noise questionnaires would serve as a promising approach. Among other sources of noise to which drivers are exposed, one can cite the poor maintenance of vehicles, lack of soundproofing of the engine and exhaust, tire friction with the asphalt, poor conservation of the paving of roads, and finally the horns. It should also be noted that there are other causative agents of occupational hearing loss that, regardless of noise exposure or interaction with this, potentiate its effects on the hearing: in the case of bus drivers it can be cited the exposures to carbon monoxide and whole-body vibrations(Guardiano, Chagas, & Slomp Junior, 2014).

Van Kempen et al. (2002) reported that exposure to road traffic noise has resulted in both increasing risk for myocardial infraction as well as a possible total ischemic disease.

Bruno, Marcos, Amanda, and Paulo (2013) also reported the possible effect on health of bus drivers and annoyance evaluation and have reported that bus drivers had a greater level of noise annoyance and result in their general health effects because of which there is an immense need to explore how well these bus drivers are aware of health-related issues. This can be serious due to the exposure of high-level noise on day-to-day life and there is a need to study the self-assessment of hearing quality, annoyance evaluation, noise-related attitude, and knowledge in bus drivers in Indian context. Some of studies that have reported that prolonged exposure to noise in bus drivers can have both audiological (Aslam, Aslam, & Batool, 2008; Martins, Alvarenga, Bevilacqua, & Costa Filho, 2001; Pushpa, Girija, & Veeraiah, 2013) and health related consequences (Chaudhary, Nagargoje, & Kubde, 2014). Thus, it is understood that the effects of noise exposure on the auditory sense as well as on other health aspects is well documented.

Various studies have been carried out around the world in understanding this relationship. However, there is a dearth of knowledge on how this is quantified on the bus drivers or people who are exposed to such noises in the environment in Indian context. Especially in making a decisive policy in the area of controlling the excessive and higher noise levels in the environment, it is vital to understand the relationship of the annoyance levels and how they are associated with the noise exposure level and duration.

1.1 Need for the study

Though the effects of noise on the hearing system is being researched since decades, authors have reported that awareness regarding consequences to noise exposure, measures to overcome and prevent them is limited amongst bus drivers (Fuente & Hickson, 2011; Pushpa et al., 2013). Lopes et al. (2012) reported the occurrence of hearing loss in bus drivers even in the absence of any presenting complaints or audiological symptoms. Thus, there is a need to develop self-assessment questionnaires in order to improve awareness of these individuals regarding the negative effects of noise exposure. Further obtaining audiological profiles of these individuals will help validate the efficacy of such questionnaires.

1.2 Aim:

The aim of the study was to obtain an audiological profile of city bus drivers by using basic clinical audiological tests along with newly developed questionnaire.

1.3 Objectives:

- To develop a questionnaire, which assesses self-perceived difficulty in hearing in city bus drivers along with creating an awareness to city bus drivers about exposure to noise and its consequences.
- To compare and validate the results of the questionnaire to results of audiological evaluations such as PTA and Immittance.

Chapter 2

Review of literature

Hearing is one of the most important senses of human beings. It is one of the ways in which we communicate and interact with the society. There are a multitude of factors that can affect the hearing of an individual. Of the various factors, Noise is one of the major factors which have adverse effect on the auditory system. Based on the physical properties, it is defined as a sound, that is random in nature and spectrum which does not exhibit defined frequency composition (Behar, Chasin, & Cheesman, 1999). Noise has adverse effect on both auditory and non-auditory system.

2.1 Auditory effects of noise

The auditory effects of noise induce various physiological changes at the level of inner ear includes loss of greater number of outer hair cells than the inner hair cell at the region at or around 9mm to 13mm at level of cochlear duct (McGill & Schuknecht, 1976), detachment or displacement of the stereocilium from its rootlet (Hirokawa & Tilney, 1982), hair cell damage where in the sensory epithelium of outer hair cells, dieter cells, Hensen cell were displaced from the basilar membrane (Hamernik, Turrentine, Roberto, Salvi, & Henderson, 1984), loss of spiral ganglion cells and myelinated fibers within osseous lamina (Bohne, Yohman, & Gruner, 1987), and also leads to focal lesion at the level of cochlea confined to narrow lesion (Kim, Morest, & Bohne, 1997). In contrast to the lesion at the level of cochlea there are research findings revealing some amount of reorganization at the level of central auditory pathway (Salvi, Saunders, Gratton, Arehole, & Powers, 1990), damage to the spiral ganglion cell whose central

processes form the auditory nerve (Nadol & Xu, 1992). Due to noise exposure there is some amount of degeneration occur at the level of higher auditory system includes the cochlear nuclei, superior olivary complex and inferior colliculus (Kim et al., 1997).

These changes are reflected as a change in one's hearing sensitivity in pure tone audiometry (Fowler, 1929; Mantysalo, 1984; Hétu, Riverin, Lalande, Getty, & St-Cyr, 1988; Emmerich, Rudel, & Richter, 2008) along with amplitude reduction in otoacoustic emission measures (Reshef, Attias, & Furst, 1993); Robinette & Glattke, 2000; (Attias, Horovitz, El-Hatib, & Nageris, 2001), and also elevated auditory brainstem threshold (Attias et al., 1996; Attias, Perez, Freeman, Cokhen & Sohmer, 2002; Santos & Junior, 2009; Kujawa & Liberman, 2009).

McGill and Schuknecht, (1976) in their research work on 14 ears with NIHL for histopathological findings report of a changes majorly in the 9mm to 13 mm region at the level of basilar membrane with greater loss of IHC than that of OHC which in turn provide information regarding the anatomical lesion behind the hearing loss at particular frequency on behavioural measures.

Hirokawa and Tilney, (1982) examined the effect of noise on Alligator lizards in which the lizards were exposed to broad band noise of 105 dB intensity for duration of 24 hours. After the 24 hours of exposure they reported lesions in the actin filament which accounts for the hearing loss. This actin filament basically present at the base of stereocilium which makes contact with the cuticular plate hence loss of this filament leads to displacement of tallest stereocilium.

Hamernik et al., (1984) carried out a research work on Chinchilla's for morphological changes in the organ of corti for blast waves at an intensity level of

160 dB peak SPL in which electron microscopy was used to follow up the morphological changes in the organ of corti for a period of 30 days and they observed a complete separation of sensory epithelium of 5 – 7 mm conjoint to lesion at OHC, dieter cell and hensen cells along the basilar membrane with IHC being intact at some region for several days. And also a study by bohne et al, (1987) on Chinchilla's using an octave band noise interrupted with 3 different schedules of rest between successions of 6 hours of exposure was compared with continuous noise exposure. The result of this study reveals intermittent noise exposure induce less lesion at the organ of corti compared to that of continuous noise and also increased hour of succession revealed lesser damage to the cochlea.

2.2 Non auditory effects of noise

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

In humans also research work reveals a diastolic blood pressure elevation due to acute noise stimulation (Lennart Andrén, Hansson, Björkman, & Jonsson, 2009). Even chronic occupational noise exposure of at least 85 dB had shown to exhibit increased blood pressure than those who are not exposed to noise. (Basner et al., 2014). Long term noise exposure leads to cardiovascular system deficit in turn causes hypertension, ischemic heart disease and myocardial infarction (Munzel, Gori, Babisch, & Basner, 2014) . Andrew and Smith, (2007) reported that noise increases the probability of many illnesses and leads to an increase in visits

to the doctor and increased use of drugs (Grandjean et al. 1973), increase in deaths to stroke or cirrhosis. Anderson 2007, increased incidence of nervous complaints, nausea, headaches, instability, argumentativeness, and changes in mood and anxiety (see Cohen 1969, Miller 1974).

2.2.1. Effect of noise exposure on cardiovascular system. Jansen (1961) in his research wok revealed an increase in social conflicts at home for those who were exposed to occupational noise and also in some laboratory study it was observed that due to increased noise exposure at working environment leads to grater changes in peripheral vasoconstriction (Andrén, Lindstedt, Björkman, Borg, & Hansson, 1982). Occupational noise exposure of more than 80 dBA on workers exhibit a increased blood pressure (van Dijk, Verbeek, & de Fries, 1987)and also study by Jonsson and Hansson (1977) on systolic and diastolic blood pressure of industrial workers showed a highly significant effect along with NIHL.

However in contradiction to earlier study on hypertension research work by Delin (1984, 1988) & (Dijk et al., 1987) found no relationship between noise-induced hearing loss and hypertension.

Knipschild (1977) also in his study assessed relationship between noise exposure and cardiovascular deficits revealed approx. 50% of individual whore were exposed to high level aircraft noise exposure exhibited cardiovascular deficit along with increased hypertension with no effect of age, sex, smoking habits, height/weight.

2.2.3. Effect of noise on exposure excretory system. Arguiller (1967, 1976) found an increase of hydro-corticoids in plasma and urine, with an increase in urinary secretion of nor adrenaline during an hour exposure to sound.Noise is a stressor and it acts both as a stress marker and an indicator of

modified sympathetic nervous system reactivity. Markiewicz (1973) states that many studies have found increased excretion of catecholamines in urine due to high intensity noise, especially when it comes on unexpectedly and is short-lasting.

Buczyński and Kedziora, (1983) report that acoustic stimulation of 100-120 dB considerably increased the concentrations of adrenalin and noradrenalin in the blood. Cavatorta *et al* (1987) found that noradrenalin, adrenalin, and vanilmandelic acid levels were increased in workers exposed to 90 dB (A), but that noise exposure had no effect on serum dopamine, cortisol or homovanillic acid. Frankenhaeuser and Lundberg (1974) found that adrenalin excretion was greatest after the noise exposure, not at the time of exposure

2.2.4. Effect of noise on exposure sleep and behaviour. There are research work carried out on the effect of noise on sleep which was assessed across different stage of sleep showed an increase in frequency of awakening and change in sleep stage is affected with sleep latency being more for individual who were exposed to occupational noise when compare to age matched control who were not exposed to noise and there is an increased percentage of time spent in State 1 sleep with no change in other stages of REM sleep. (Nakagawa 1987).

Noise would have negative influence on man's psychic wellbeing including change of behavior and way of life in a direction experienced as negative by the individual (Retetor, 1975). The psychological changes could be in term of mental stress, maladjustment, chronic fatigue, neurotic complaints and introversion

2.2.5 Occupational noise exposure and its effect on hearing and health on bus drivers. There are quite a lot research works were carried out on revealing the effect of noise on hearing and health die to their occupation. There was a study by Patwardhan, Kolate, and More, (1991) on bus driver from sangli depot in which

hearing threshold were assessed and also before analysis of hearing two groups were separated based on their working environment as those in office as control who had exposed to occupational noise from 50 to 62 dB and experimental group (the drivers) exposed to 89 to 106 dB noise throughout their working hours which reflected as abnormality in audiograms being 89% driver had hearing loss with 19% from control group too.

In a study by Rodrigues et al., (2002) on estimating the prevalence of occupational NIHL and arterial hypertension on city drivers, 108 drivers were employed in the study on which questionnaire regarding the job history and working schedules were taken prior to the audiological evaluation and the results showed a 32.7 % prevalence of NIHL with 6 kHz affected at 61.3% and 38.7% at 4 kHz with hypertension prevailing 13.2%. And also estimated that those who had a working experience of 6 years and odd has a greater chance of developing hearing loss.

Pushpa (2013) in her research work on analysing relationship between exposure to noise and its effect on hearing on 30 male drivers working in Bangalore Metropolitan Transport Corporation (BMTC), Bangalore, and found a significant lowering of threshold at high frequency as the number of years of working in the noise exposure is more and also supported their finding by emphasising on the fact of lack of awareness among the participants regarding the ill effect of noise and efficacy of using HPD's. Similar kind of study on Kolkata city bus driver on the effect of noise exposure on hearing revealed a similar results as of earlier studies being the effect of noise on hearing is more with increase in the duration of work and with their working experience. (Majumder, Mehta, & Sen, 2009)

Sanju and Kumar, (2016) in their research work using noise related questionnaires on bus drivers revealed 60% of individual had good hearing in spite

of noise exposure being no awareness regarding the existence of HPD's. Nearly 30 – 50% individual exhibited more problem on their sleep.

Chapter 3

Method

In brief, the study involved audiometric profiling and administration of a newly developed questionnaire related to noise induced hearing loss on a selected number of Karnataka State Road Transport Corporation city bus drivers in various depots of Mysuru city, Karnataka State. All the city bus drivers are exposed to 9 hours of work per day.

3.1 Participants:

Inclusion criterion

- 50 city bus drivers in the age range of 18 to 60 years (mean age: 42.2 ± 9.32) were included for the study.
- Bus drivers working for more than 8 hours daily were taken for the study.
- Bus drivers who had working experience of more than 2 years were included in the study.
- All the participants were selected based on convenient sampling methods and based on their willingness to participate in the study.

Exclusion criterion

- Participants with history of ear discharge and neurological problems were excluded.

  Informed consent was obtained from all the participants before carrying out the testing procedure. The questionnaire was given to them and their responses were collected.

3.2 Test Environment:

The complete test procedure was performed in a relatively quiet room at the respective bus depot from where the city bus drivers were recruited.

3.3 Equipment:

1. Calibrated two channel portable PROTON Dx-5screening audiometer with Telephonics TDH-39 supra aural headphones housed in MX-41 AR ear cushions and Radioear B-71 bone vibrator was used for pure tone threshold estimation.

2. Calibrated MADSEN OTOFLEX 100 screening Immittance meter with a 226Hz probe tone frequency was used for tympanometry and ipsi-contra reflexometry was carried out using 500Hz, 1000Hz, 2000Hz, 4000Hz reflex eliciting stimulus.

3.4. Study Design and Procedure:

The study involved a cross sectional study design. Firstly, case history was obtained from all the bus drivers available in the city bus depot and those who fulfilled the study criteria were briefed about the study and were invited to participate in the study. Signatures were obtained in the Informed consent sheet from all the participants who volunteered to participate in the study.

This study was carried out in two stages. The first stage of the study included development and validation of questionnaire and the second stage included administration of questionnaire along with other audiological diagnostic test.

3.4.1 Stage I: **Development of the questionnaire.** In the first stage, questionnaire was developed following the guidelines given by Diem (2002). This questionnaire includes 2 parts i.e. part 1 with questions related to hearing difficulties and part 2 with questions related to noise exposure, its effects and awareness regarding the same. Questions were taken from already existing questionnaires in English based on the outcome of a focused group discussion involving 5 audiologists with clinical experience more than 3 years.

Following this, the questions selected were translated to the South Indian language, Kannada. The translation was carried out following the well accepted American Academy of Orthopedic Surgeons (AAOS) guidelines (Beaton, Bombardier, Guillemin, & Ferraz, 2000). The guidelines suggest forward-backward translation method. The guidelines put forth five stages: : i) forward translation; ii) synthesizing common translation; iii) backward translation; iv) expert committee review; v) pre-final testing.

Two Kannada English bilingual adult translators whose first language is Kannada were recruited for independent translations. Translators recruited were experienced audiologists with 5 years of research experience. An expert audiologist with experience of more than 15 years in field of Audiology was requested to compare both the translations and obtain a common translation based on linguistic style and preference for words, the easier, clearer and more colloquial of the two versions. This version of questionnaire was given for a backward translation to a bilingual linguist who has knowledge of Audiology for detecting inaccuracies in forward translations. An expert was involved in the identification of such inaccuracies after reviewing all forward and backward translations

Further, the questionnaire was validated by audiologists for their appropriateness of questions and context. In addition, the questionnaires was given to 10 bus drivers and 5 audiologists to find out their opinion about the interpretation of questionnaire. For this, the participants were asked to rate the questionnaire in 'yes' or 'no' response about its simplicity, clarity, relevancy and comfort. The responses were analyzed to check for correctness and necessary changes were incorporated to prepare the final version of the questionnaire.

3.4.2 Stage II: Administration of the questionnaire along with other audiological tests

This stage included the direct administration of the developed questionnaire on the study participants along with the other audiological tests including pure tone audiometry and Immitance using a portable screening audiometer and an Immitance meter.

Pure tone audiometry- Pure tone thresholds were obtained for frequencies 500 to 4000Hz for air conduction and 250 to 4000Hz for bone conduction thresholds using modified Hugson-westlake procedure (Carhart & Jerger, 1959). The mid octave frequency threshold was also determined in case of a difference exceeding 20dB HL between the adjacent octave frequencies.

Immittance evaluation- Tympanometry and reflexometry were carried out on 50 subjects using 226Hz probe tone to know the status of the middle ear. The participants were seated comfortably and were told not to swallow and avoid any head movements during the testing. Initially tympanometry was done using 226Hz probe tone at 85dB SPL by varying pressure from +200 to -400 daPa.

The reflexometry was carried out using same probe tone frequency along with reflex eliciting stimulus of 500,1000,2000,4000 Hz in both ipsi and contralateral conditions.

The audiological results obtained from Pure Tone Audiometry and Immitance evaluation was compared with the self-perceived hearing difficulties reflected in part 1 of the questionnaire.

Chapter 4

Results and Discussion

The present study was conducted with the aim of obtaining an audiological profile of city bus drivers by using basic clinical audiological tests along with newly developed questionnaire. To achieve this the participants were subjected to audiological evaluation (pure tone audiometry, immitance, and reflexometry) and a newly developed questionnaire was administered on them. The participants of the study included city bus drivers from different depots in Mysuru of the Karnataka State Road Transport Corporation. A total of 50 individuals with an age range of 18 years to 60 years participated in the study.

Table 4.1 represents the demographic details of all the participants showing mean age and their working experience in years.

Table 4.1

Demographic details of all the city bus drivers participating in the study

.**Demographic details of Participants**	**Value**
Age (in years) M, (SD)	42.2±9.32
Gender	
Males	50
Females	0
Working experience (in years) %	
2-<10 years	22.0
10-<20 years	40.0
20-<30 years	22.0
30-<40 years	16.0

4.1. Part 1 (questions related hearing difficulty) questionnaire:

Table 4.2:

Ratings of individuals on questions related to hearing difficulty.

	QUESTIONS RELATED TO HEARING DIFFICULTY									
	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)	Q6 (%)	Q7 (%)	Q8 (%)	Q9 (%)	Q10 (%)
NEVER	58	50	38	46	46	50	68	76	68	78
RARELY	12	8	14	12	18	16	8	8	12	4
SOMETIMES	10	22	22	20	14	10	12	6	6	8
OFTEN	12	8	14	12	14	14	6	4	8	4
ALWAYS	8	12	12	10	8	10	6	6	6	6

Table 4.2 reveals that most of the individuals reported ‘never’ followed by ‘rarely’ for all the questions. The individuals who rated as sometimes, often and always were lesser.

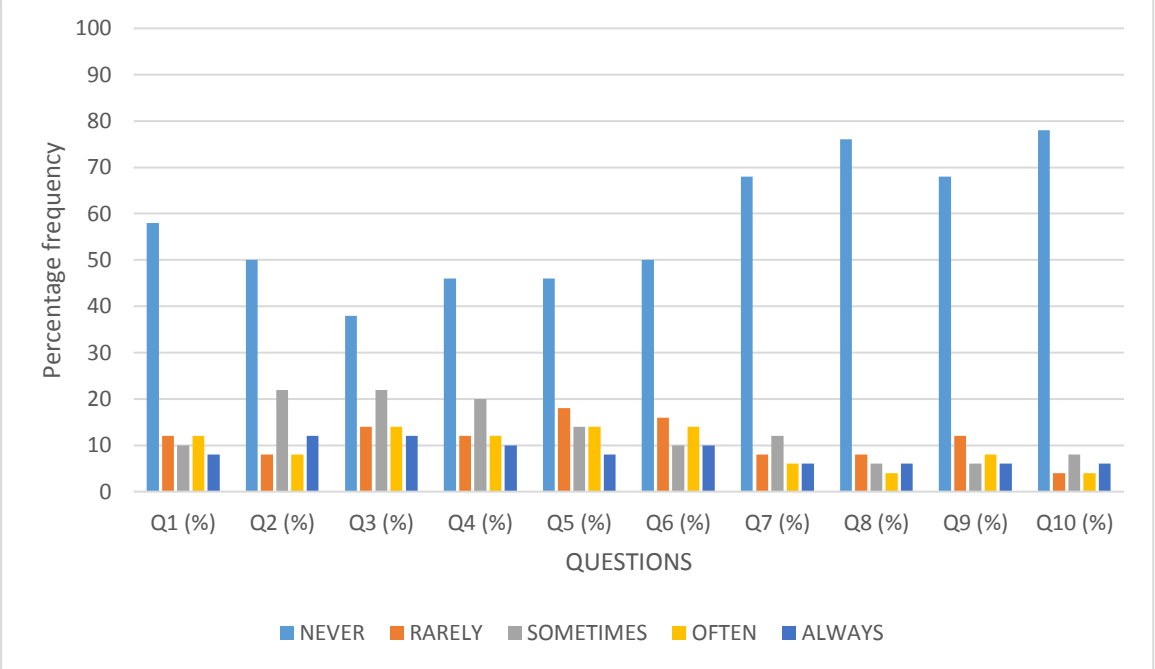

Figure 4.1. Percentage representation of individuals for questions related to hearing difficulty.

The following trend is also observed in the figure 4.1 depicted. The figure shows percentage of individual rating as never for most of the questions. Nearly 80 % for question 8 (Do you have difficulties hearing the tweeting of birds?) and question 10 (Do you struggle to hear mainly when women or children speak?) rated that they never faced difficulties. Similarly all the individuals also reported they never faced difficulties for all the other questions. The individuals reporting the hearing related difficulties as rarely, sometimes, often and always were lesser.

Fowler, (1929); Mantysalo, (1984); Hetu, Riverin, Lalande, Getty & Stcyr, (1988); Reshef, Attias & Furst, (1993); Robinette & Glattke, (2000) in their studies have reported regarding changes in one's hearing sensitivity in PTA, along with amplitude reduction in otoacoustic emission measures and also elevated auditory brainstem threshold (Attias et al., (1996); Attias, Perez, Freeman, Cokhen & Sohmer, (2002).

The findings in the present study suggests that the hearing difficulties among the individuals of the study showed that the individuals had any significant hearing related difficulties. There could be a possibility that the individuals hearing difficulties might not have been expressed suggesting to their lack of awareness regarding the hearing care and also general health problems faced due to noise. It is well known that from previous studies that Noise has adverse effect on both the auditory and non auditory system.

4.2. Part 2 questionnaire (Questions related to Noise Exposure, its Effects):

Question 3 (What do you think is the usual level of noise at your work place?) focused on self-perceived intensity of noise exposure at work place. This was rated on 5 point rating scale from very low (1) to very high (5) which is depicted in the table 4.2 and graphically represented in the Figure 4.2.

Table 4.3

Representation of self-perceived intensity of noise exposure at working environment

Intensity of noise exposure	**Percentage (%)**
Low	8.0
Medium	60.0
High	30.0
Very high	2.0

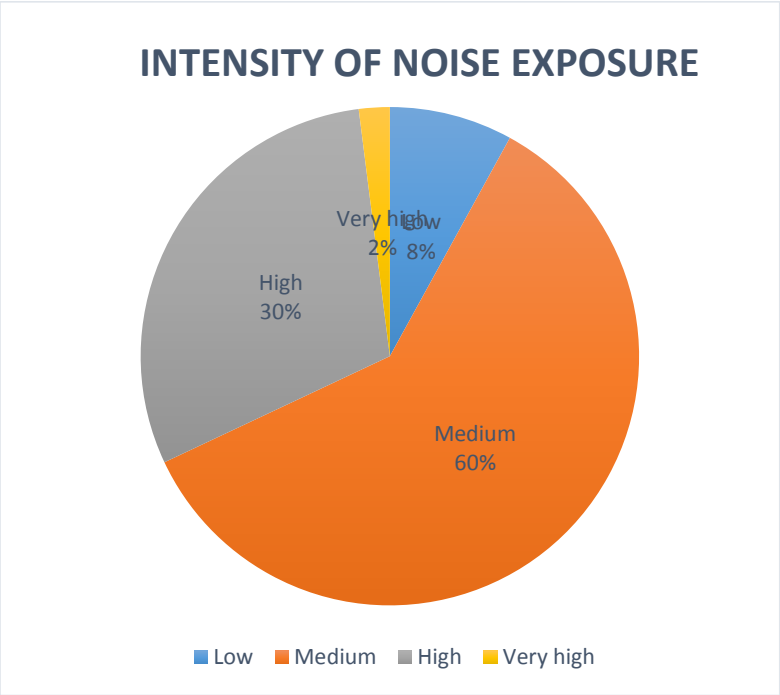

Figure 4.2: Graphical representation of intensity of noise exposure

From table 4.2 and the graphical representation of figure 4.2 it is clear that at least more than 30% of individuals perceived it to be ‘high’ and ‘very high’.

Several studies support the above findings. A study carried out in Brazil by Zannin in 2006 reports that various countries around the world adopt 85 dB (A) for monitoring workplaces considering noise emission. They also report that the noise was highly uncomfortable, for an exposure of noise above 65 dB (A) for 8 hours with greater problems if the bus is relatively old and the engine is mounted front.Supportive to this a study carried out in Mysuru city with respect to different noise levels in various situation mentions the noise levels exposed by bus drivers. The exposed noise levels measured was highest for bus drivers (80.42 dB A) according to Bhaskar, Anil, Mahadeva, & Konadath (2017).

Question 4 (Do you think that the noise at your work place can have a negative effect on your health?) focused on the awareness of individuals about the negative effects of noise on health on a 4 point rating scale with least value depicting 'yes' and highest being 'I don't know'. This is represented as percentage value in the table 4.3 and in the figure 4.3.

Table 4.4

Representation of awareness on negative effect of noise on health

Rating	**Percentage (%)**
Yes	8.0
May be	56.0
No	32.0
I do not know	4.0
Total	100.0

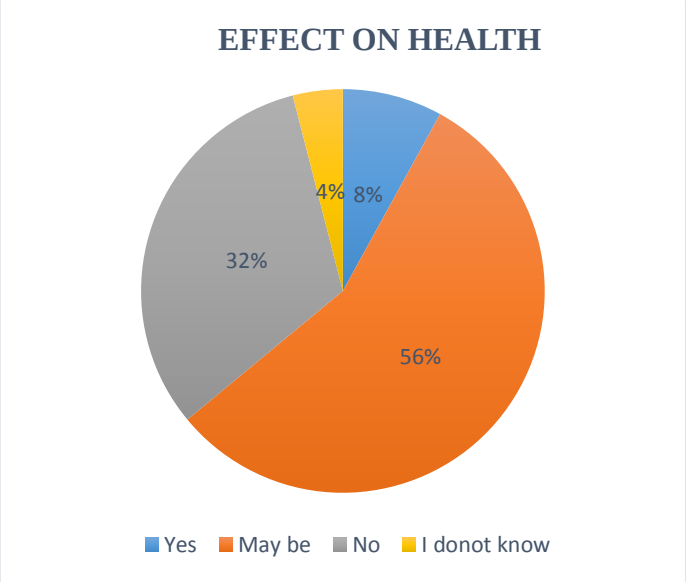

Figure 4.3: Graphical representation of awareness on negative effects of noise on health

From table 4.3 it is clear that only 56% of the participants had partial awareness that the noise exposure has a negative effect on one's health condition. However 32% of individuals report no awareness about the negative effect of noise on their health.

Question 5 (Have you experienced any of the following issues due to continuous or excessive noise exposure at your work place?) from the part 2 of the questionnaire focuses on both auditory and non-auditory symptoms related to noise exposure under 11 parameters rated on a 5 point rating scale with least rating (1) being 'never' to highest being always (5) and is depicted in table 4.4 and figure 4.4.

Table 4.5

Representation of participant's perception regarding the auditory and non-auditory symptoms dues to noise exposure

Symptoms	TTS	Tinnitus	Headache	Tolerance	Fatigue	Anxiety	Sleep disturbance	Heartrate	Giddiness	Vomiting	Ear pain
Never	86.0	72.0	68.0	92.0	70.0	28.0	56.0	92.0	96.0	92.0	88.0
Rarely	2.0	6.0	16.0	2.0	20.0	26.0	12.0	8.0	2.0	4.0	8.0
Sometimes	6.0	14.0	16.0	6.0	10.0	40.0	30.0	0.0	2.0	4.0	4.0
Often	4.0	6.0	0.0	0.0	0.0	6.0	2.0	0.0	0.0	0.0	0.0
Always	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

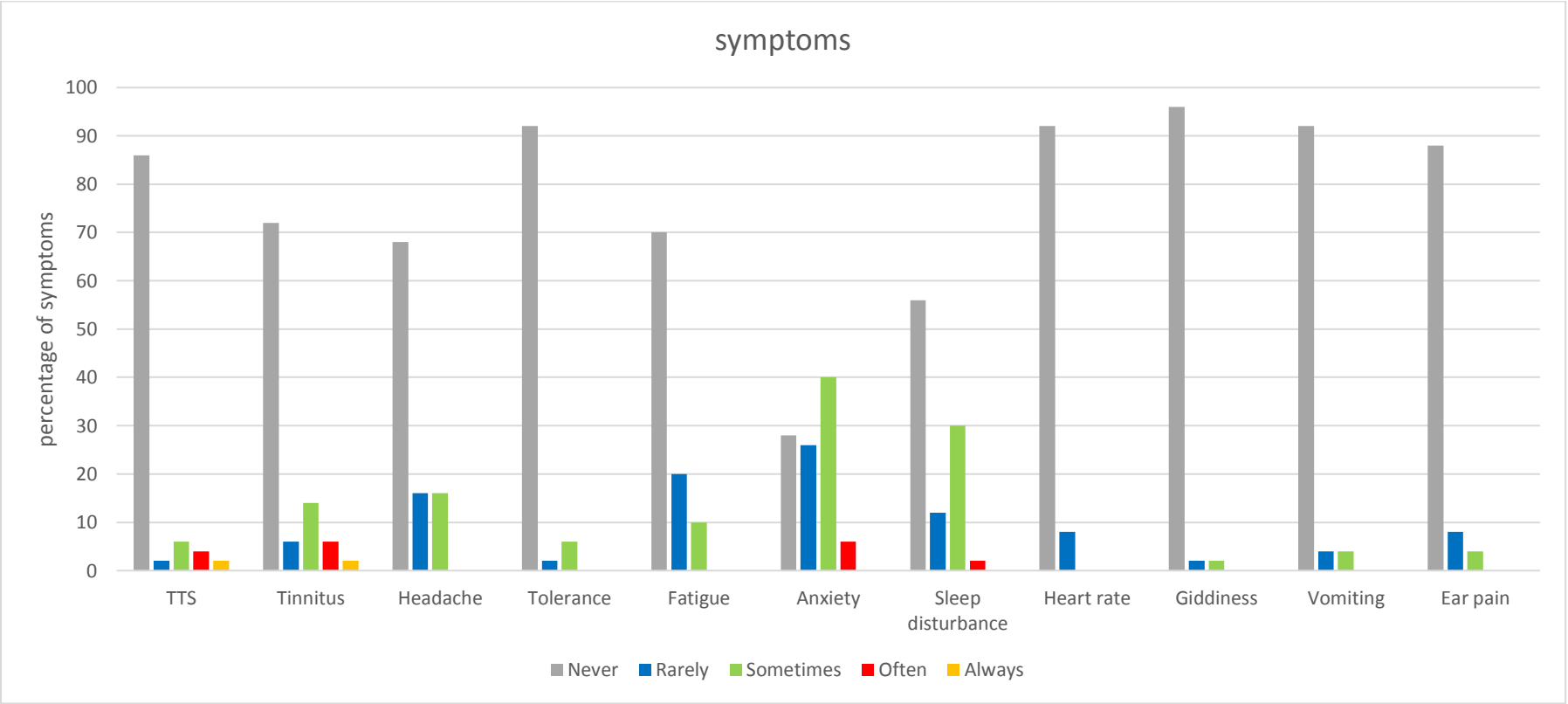

Figure 4.4: Graphical representation of participant's perception regarding the auditory and non-auditory symptoms dues to noise exposure

It can be inferred from the table 4.4 that most of the participants reported that they never faced any of the auditory and non-auditory symptoms and few rated that rarely and sometimes with more being at the anxiety, sleep TTS, tinnitus, head ache, heart rate, ear pain, tolerance, fatigue, giddiness and vomiting. However, few participants rated TTS, tinnitus, anxiety and sleep disturbance as often and some rated always for TTS, and tinnitus.

Sanju and Kumar (2017) reported that there was a significant impact of noise on their daily activities majorly affecting quality of life. There was association of tinnitus with uncomfortable loud sounds and annoyance. Bruno *et al*. in 2013 reported that in bus drivers it was observed that there was a considerable level of noise annoyance. Similarly Omidvari and Nouri (2009) reported that noise pollution not only results for damage in terms of their behavioral condition but also on their personal assessments. Agarwal and Swami (2011) reported that about 52% of population reported frequent irritation and 67% people suffered noise‐related problems such as headache, giddiness or loss of sleep. This study also showed that 51.25% of the bus drivers reported poor quality of sleep after work, because of exposure to occupational noise during work. Other effects of noise reported in previous articles are on cardiovascular system. Jansen (1961), abnormal birth or increased complication during delivery. Tausher (1978) reported increased hypertension with no effect of age, sex, smoking habits, height/weight

Question 6 (Are you exposed to any other noisy environments other than your regular work setup?) focused on whether they are exposed to any other noise apart from the one in their work set up. None of the individuals reported that they are exposed to any other noise apart from the noise exposed at work.

Question 7 (Have you taken any measures to protect your ears from noise?) focused on whether they have taken any measures to protect their ears from noise and how do they protect, if they report yes to this question. It was found that none of the individuals had taken any measure to protect their ears from exposure to noise.

Question 8 (Do you know that there are devices available to protect your ears?) dealt regarding awareness of the individuals to the various devices which are available to protect their ears including hearing protective device. None of the individuals reported that they use or know about the hearing protective devices.

Similar to the results of the present study, various studies have also shown lack of awareness among bus drivers to EPD's. Bhaskar, Anil, Mahadeva, and Konadath (2017) suggest that the lack of awareness in city bus drivers is an alarming observation. Sanju and Kumar (2017) reported the same findings that 100% of the bus drivers lacked awareness to EPD's.

Gupta, Mittal, Kumar and Singh (2014) on their questionnaire‐ based study also concluded that all the professionals working in the traffic atmosphere namely the traffic police, auto drivers, and bus drivers reported that the honks made by them were the major reason for maximum distress.

4.3. Correlation between the two parts of questionnaire and individual part of the questionnaire with the audiological and immitance evaluation

Based on the questionnaire analysis both the parts in the questionnaire were subjected for correlation with the audiological outcomes of the participants. Each part of the questionnaire was subjected to correlation with individual audiometric results for both the ears separately along with reflex threshold for frequencies 500

Hz, 1000 Hz and 2000 Hz. Correlation was also carried out between different parts of questionnaire and this is depicted in the table 4.6.

Table 4.6 Correlation within 2 subset in the questionnaire and between subset in the questionnaire and hearing threshold

	Effect and awareness of noise on health related questions	**Right ear pure tone threshold**	**Left ear pure tone threshold**	**Right ear reflex 500**	**Right ear reflex 1000**	**Right ear reflex 2000**	**Left ear reflex 500**	**Left ear reflex 1000**	**Left ear reflex 2000**
Hearing difficulty related questions	0.488**	0.422**	0.599**	0.275	0.331*	0.231	0.248	0.195	0.102
Effect and awareness of noise on health related questions		0.600**	0.646**	0.249	0.308	0.360*	0.208	0.218	0.180

** indicates $p<0.01$ and * indicates $p<0.05$

It was observed that all the individuals revealed A type immitance results. Further Table 4.5 reveals high positive correlation between Part 1 of the questionnaire with audiometric threshold for both the ears and right ear reflex at 1000 Hz. However, no correlation was found for part 1 of the questionnaire with rest of the reflexometry frequency. Similarly part 2 questionnaire also revealed a high positive correlation with audiometric threshold for both the ears and right ear reflex at 2000 Hz. A high correlation between part 1 and part 2 of the questionnaire was observed.

4.4. Correlation between working experience with part 1 questionnaire and with audiological evaluation

The results revealed no significant correlation between working experience and individual's awareness on auditory and non-auditory effects of noise. However, number of years of working showed positive correlation with audiometric findings and reflexes at all frequencies except in the left ear at 2000 Hz.

Table 4.7 Correlation between years of working experience and subset in the questionnaire and hearing threshold

	Effect and awareness of noise on health related questions	**Right ear pure tone threshold**	**Left ear pure tone threshold**	**Right ear reflex 500**	**Right ear reflex 1000**	**Right ear reflex 2000**	**Left ear reflex 500**	**Left ear reflex 1000**	**Left ear reflex 2000**
Working years of experience	0.086	0.519*	0.494*	0.451*	0.423*	0.465*	0.454*	0.428*	0.257

* indicates $p<0.05$

Various studies have also accepted that the link between excess noise and hearing loss. However, this problem is reported to be different for different categories of occupations, or particularly noisy occupations. Waitzman, Smith, (1960); Hessel (2000) have shown that there is a strong association between noise and NIHL and also it is reported that NIHL increases with increase in duration and magnitude of exposure. Higher levels of noise for short time can also lead to noise induced hearing impairment but generally a 10 years of exposure could result in significant hearing impairment. (Dobie , 1990). The study reported that bus drivers were driving for 10-12 hours per day (42%) concluded that the more they were exposed to noise the more was the damage resulted. It was also noted that adding to the burden on their ears was to the fact that most of the subjects (62%) were driving for 7 days a week revealing that working duration clearly resulted in more damage.

Chapter 6

Summary and conclusion

The noise is an unwanted sound which affects one's hearing ability when they are exposed to it for long duration of time due to their occupation etc. This will lead to deterioration not only on audition but also exhibit non auditory effects such as fatigue, annoyance, changes in heart rate, depression, impulsive behavior, and sleep disturbance etc. as reported by many researchers. Noise annoyance is especially spread across the urban cities in developing and industrially growing countries like India. The major responsible cause of the higher prevalence in the annoyance of noise is the growing network transportation. One such group of professionals who are prone to noise induced hearing loss are the bus drivers. Hence, the aim of the study was prepare an audiological profiling of bus drivers by comparing the hearing outcome with the noise effect and awareness questionnaire. Fifty city bus drivers were recruited for the study from various bus depot across Mysuru city and were administered with questionnaire followed by screening of hearing thresholds at 500, 1000, 2000 and 4000 Hz along with immittance and reflexometry measure at 500, 1000 and 2000 Hz. The results were subjected to statistical analysis using SPSS (version 21) where the individual mean from the part 1 of the questionnaire and part 2 regarding individual history related to noise exposure and the awareness were analyzed. The results revealed more of non-auditory symptoms with less awareness regarding it. The correlation measures were employed between the part 1 of the questionnaire with hearing outcomes and within the subset of the questionnaire also within subset of the questionnaire.

To conclude from the results of the present study:

1. Results reveal that almost all the bus drivers lacked awareness regarding the ill effects of noise on both auditory and health along with poor knowledge regarding the HPD's. Hence, there is a need to educate these professionals about hazardous effects of noise exposure and importance of hearing protection devices.
2. Further, the knowledge acquired from the results indicate that the individuals identified with problem should be referred for detailed audiological evaluation to rule out the involvement of peripheral and central auditory system. Hence, they must be educated to minimize the health‐related hazard due to noise exposure.
3. Audiologist has to create awareness in city bus drivers by implementing education and training programs about the hearing protection devices.

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Appendix

PART I **Questions related to Hearing difficulties**	ಎಂದಿಗೂ ಇಲ್ಲ **(0 points)**	ವಿರಳವಾಗಿ **(1 points)**	ಕೆಲವೊಮ್ಮೆ **(2 points)**	ಸಾಮಾನ್ಯವಾಗಿ **(3 points)**	ಯಾವಾಗಲು **(4. points)**
೧. ನಿಮಗೆ ಸಣ್ಣಶಬ್ದ ಕೇಳಿಸಿಕೊಳ್ಳಲು ತೊಂದರೆಯಾಗುತ್ತದೆಯೆ? (ಗಡಿಯಾರದ ಟಿಕ್,ಟಿಕ್ ಶಬ್ದ)					
೨. ಯಾರಾದರೂ ಪಿಸುಮಾತನಾಡಿದಾಗ ನಿಮಗೆ ಅದನ್ನು ಕೇಳಿಸಿಕೊಳ್ಳುವಲ್ಲಿ ತೊಂದರೆ ಇದಿಯೇ?					
೩. ನಿಮಗೆ ಗುಂಪಿನಲ್ಲಿ ಅಥವ ಗದ್ದಲದ ಸ್ಥಳಗಳಲ್ಲಿ ಮಾತನ್ನು ಅರ್ಥಮಾಡಿಕೊಳ್ಳಲು ಕಷ್ಟವಾಗುತ್ತದೆಯೆ?					
೪. ಯಾರಾದರೊಡನೆ ಫೋನಿನಲ್ಲ ಮಾತನಾಡುವಾಗ ಕಷ್ಟವಾಗುತ್ತದೆಯೇ?					
೫. ನೀವು ಟೀವಿ ನೋಡುವಾಗ ಅಥವ ರೇಡಿಯೋ ಕೇಳುವಾಗ ಅದರದ್ವನಿಯನ್ನು ಏರಿಸುತ್ತೀರ?					
೬. ನಿಮ್ಮಜೊತೆ ಮಾತನಾಡುವವರಿಗೆ ಜೋರುದ್ವನಿಯಲ್ಲಿ ಮಾತನಾಡಲು ಅಥವ ಮತ್ತೊಮ್ಮೆಹೇಳಲು ಹೇಳುತ್ತೀರ?					
೭. ನಿಮ್ಮಜೊತೆಗೆ ಮಾತನಾಡುವವರ ಪ್ರಶ್ನೆಯನ್ನು ನೀವು ತಪ್ಪುಅರ್ಥಮಾಡಿಕೊಂಡು ಅದಕ್ಕೆ ಸೂಕ್ತವಿಲ್ಲದ ಉತ್ತರವನ್ನು ನೀಡುತ್ತೀರ?					
೮. ಪಕ್ಷಿಯ ಚಿಲಿ–ಪಿಲಿ ಸದ್ದನ್ನು ಕೇಳಿಸಿಕೊಳ್ಳಲು ನಿಮಗೆ ತೊಂದರೆಯಾಗುತ್ತದೆಯೆ?					
೯. ಬಾಗಿಲಗಂಟೆ ಬಾರಿಸಿದಾಗ ಅಥವ ದೂರವಾಣಿಯಗಂಟೆ ಕೇಳಿಸಿಕೊಳ್ಳಲು ನಿಮಗೆ ಕಷ್ಟವಾಗುತ್ತದೆಯೆ?					
೧೦. ನಿಮಗೆ ಮುಕ್ಯವಾಗಿ ಹೆಂಗಸರು ಅಥವ ಮಕ್ಕಳು ಮಾತನಾಡುವುದನ್ನು ಕೇಳಿಸಿಕೊಳ್ಳಲು ಕಷ್ಟವಾಗುತ್ತದೆಯೆ?					

೧೧. ನಿವು ಬೇರೆಯಾವುದೆ ರೀತಿಯ ಕೇಳುವ ತೋಂದರೆಗಳನ್ನು ಅನುಭವಿಸುತ್ತಿದ್ದೀರ? ಹೌದು/ಇಲ್ಲ

- ಹೌದು ಎಂದರೆ ಅದನ್ನು ವಿವರಿಸಿ:

೧೨. ನಿಮಗೆ ಕೇಳಿಸಿಕೊಳ್ಳುವ ತೊಂದರೆಗೆ ಕಾರಣಗಳೇನಿರಬಹುದು?

QUESTIONNAIRE PART II: Questions related to Noise Exposure, its Effects					
೧. ಒಂದು ದಿನದಲ್ಲಿ ಸುಮಾರು ಎಷ್ಟುಗಂಟೆಗಳಕಾಲ ಹೆಚ್ಚು ಶಬ್ದವಿರುವ ವಾತಾವರಣದಲ್ಲಿ ಕೆಲಸಮಾಡುತ್ತೀರ?	☐0-2 ಘಂಟೆ	☐2-4 ಘಂಟೆ	☐4-6 ಘಂಟೆ	☐6-8 ಘಂಟೆ	☐>8 ಘಂಟೆ
೨. ಎಷ್ಟು ವರ್ಷಗಳಿಂದ ಶಬ್ದವಿರುವ ವಾತಾವರಣದಲ್ಲಿ ಕೆಲಸಮಾಡುತಿದ್ದೀರ?	..... ವರ್ಷ				
೩. ನೀವು ಕೆಲಸ ಮಾಡುವ ಸ್ಥಳದಲ್ಲಿ ಒಂದು ಅಂದಾಜಿಗೆ ಎಷ್ಟು ಪ್ರಮಾಣದ ಶಬ್ದವಿರಬಹುದು?	☐ಅತೀ ಕಡಿಮೆ	☐ಕಡಿಮೆ	☐ಸಾಧಾರಣ	☐ಹೆಚ್ಚು	☐ ಅತೀ ಹೆಚ್ಚು
೪. ನಿಮ್ಮ ಕೆಲಸ ಮಾಡುವ ಸ್ಥಳದಲ್ಲಿರುವ ಶಬ್ದವು ನಿಮ್ಮ ಆರೋಗ್ಯದ ಮೇಲೆ ಪರಿಣಾಮಬೀರುತ್ತದೆ ಎಂದು ಅನ್ನಿಸುತ್ತದೆಯೆ?	☐ ಹೌದು	☐ ಇರಬಹುದು	☐ ಇಲ್ಲ	☐ ನನಗೆ ಗೊತ್ತಿಲ್ಲ	
೫. ನಿಮ್ಮ ಕೆಲಸದ ವಾತಾವರಣದಲ್ಲಿರುವ ಶಬ್ದದಿಂದ, ಈ ಕೆಳಕಂಡ ಲಕ್ಷಣಗಳಲ್ಲಿ ಯಾವುದಾದರು ಲಕ್ಷಣವು ನಿಮ್ಮ ಗಮನಕ್ಕೆ ಬಂದಿದೆಯೇ?	**ಎಂದಿಗೂ ಇಲ್ಲ**	**ಅಪರೂಪಕ್ಕೆ**	**ಕೆಲವೊಮ್ಮೆ**	**ಆಗಾಗ್ಗೆ**	**ಯಾವಾಗಲು**
– ತಾತ್ಕಾಲಿಕವಾಗಿ ಕಿವಿ ಕೇಳುವುದರಲ್ಲಿ ತೊಂದರೆ – ಕಿವಿಯೊಳಗಡೆಯಿಂದ ಶಬ್ದ ಬರುವುದು – ತಲೆನೋವು – ಶಬ್ದವನ್ನು ಸಹಿಸಲಾಗದ ತೊಂದರೆ – ಆಯಾಸ/ಸುಸ್ತು – ಸಿಟ್ಟಾಗುವಿಕೆ – ನಿದ್ದೆಯಲ್ಲಿ ಅಡಚಣೆ – ಹೃದಯಬಡಿತ ಹೆಚ್ಚಾಗುವಿಕೆ – ತಲೆಸುತ್ತು – ವಾಂತಿ ಬರುವ ಹಾಗೆ ಭಾವನೆ – ಕಿವಿ ನೋವು – ಬೇರೆ ಏನಾದರು					

೬. ನಿಮ್ಮ ಕೆಲಸದಲ್ಲಿ ಇರುವ ಗದ್ದಲವನ್ನಿ/ ಸಬ್ದವನ್ನು ಬಿಟ್ಟು ಬೇರೆಯಾವುದಾದರು ಗದ್ದಲದ ಜಾಗಗಳಲ್ಲಿ ಒಳಗೊಂಡಿದ್ದೀರ?

If yes, provide details below.

Type of noise	**Average duration/day**	**Noise level** **(Very low/Low/Medium/High/Very high)**	**Number of years exposed**
1. …….	……hours/day	…….	……years
2. …….	……hours/day	……..	…..……years

ಒ ನಿಮ್ಮ ಕಿವಿಗಳನ್ನು ಶಬ್ದಗಳಿಂದ ತೊಂದರೆಗೊಳಗಾಗುವುದನ್ನು ತಡೆಗಟ್ಟಲು ಯಾವುದಾದರು ಕ್ರಮವನ್ನು ತೆಗೆದುಕೊಂಡಿದ್ದೀರ? ಹೌದು/ಇಲ್ಲ

ಹೌದು ಎಂದಲ್ಲಿ ನಿಮ್ಮ ಕಿವಿಗಳನ್ನು ಹಾನಿಕಾರಕ ಶಬ್ದಗಳಿಂದ ಹೇಗೆ ಕಾಪಾಡಿಕೊಳ್ಳುತ್ತೀರ?

ಙ. ಕಿವಿಯನ್ನು ರಕ್ಷಿಸಲು ಕೆಲವು ಸಾದನಗಳು ದೊರಿಯುತ್ತದೆಯೆಂದು ನಿಮಗೆ ತಿಳಿದಿದಿಯೇ?
ಹೌದು/ಇಲ್ಲ

ಹೌದು ಎಂದಲ್ಲಿ

ಅ) ಈಕೆಳಗೆ ಇರುವ ಯಾವುದಾದರು ಸಾದನಗಳನ್ನು ನೀವು ಬಳಸಿದ್ದೀರ?

ಕಿವಿಯ ಪ್ಲಗ್‌ಗಳು- ☐ ಎಂದಿಗು ಬಳಸಿಲ್ಲ ☐ ಒಮ್ಮೊಮ್ಮೆ ಬಳಸುತ್ತೇನೆ
☐ ಕೆಲವೊಮ್ಮೆ ಬಳಸುತ್ತೇನೆ ☐ ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸುತ್ತೇನೆ
☐ ಯಾವಾಗಲು ಬಳಸುತ್ತೇನೆ

ಕಿವಿಕವಚಗಳು- ☐ ಎಂದಿಗು ಬಳಸಿಲ್ಲ ☐ ಒಮ್ಮೊಮ್ಮೆ ಬಳಸುತ್ತೇನೆ
☐ ಕೆಲವೊಮ್ಮೆ ಬಳಸುತ್ತೇನೆ ☐ ಸಾಮಾನ್ಯವಾಗಿ ಬಳಸುತ್ತೇನೆ
☐ ಯಾವಾಗಲು ಬಳಸುತ್ತೇನೆ

ಆ) ಇವುಗಳನ್ನು ಉಪಯೋಗಿಸಿದಲ್ಲಿ, ಅವು ನಿಮ್ಮ ಕಿವಿಗಳನ್ನು ರಕ್ಷಿಸುವಲ್ಲಿ ಉಪಯುಕ್ತವಾಗಿವೆಯೆ?
ಕಿವಿಯ ಪ್ಲಗ್‌ಗಳು-
☐ಚೂರುಉಪಯುಕ್ತವಾಗಿಲ್ಲ ☐ಸ್ವಲ್ಪ ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಮಧ್ಯಮವಾಗಿ ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಸಾಕಷ್ಟು ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಬಹಳ ಉಪಯುಕ್ತವಾಗಿದೆ
ಕಿವಿಕವಚಗಳು –
☐ಚೂರುಉಪಯುಕ್ತವಾಗಿಲ್ಲ ☐ಸ್ವಲ್ಪ ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಮಧ್ಯಮವಾಗಿ ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಸಾಕಷ್ಟು ಉಪಯುಕ್ತವಾಗಿದೆ ☐ಬಹಳ ಉಪಯುಕ್ತವಾಗಿದೆ

ಇ) ನೀವು ಅದನ್ನು ಉಪಯೋಗಿಸದಿದ್ದಲ್ಲಿ, ಅದನ್ನು ಉಪಯೋಗಿಸದಿರಲು ಕಾರಣವೇನು?

☐ಲಭ್ಯವಿಲ್ಲ ☐ದುಬರಿ ☐ವಯಕ್ತಿಕವಾಗಿ ನನಗೆ ಇಷ್ಟವಿಲ್ಲ ☐ಅದನ್ನು ಧರಿಸಲು ಹಿತವಿಲ್ಲ ☐ ಇತರೆ ಕಾರಣಗಳು

ಇತರೆ ಕಾರಣಗನ್ನು ವಿವರಿಸಿ.