Early Detection and Prevention of Hearing Impairment in School Going Children

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ABSTRACT

Hearing impairment substantially affects the child's ability to normally acquire the spoken language, school performance, cognitive, social and emotional growth. The aim of this research is to study the prevalence of hearing disorders in school going children. In this research study, 2000 school going children of age group 4 to 15 years are screened by a specially designed questionnaire and affected children are scientifically observed and tested by otoscope, audiometer and tympanometer.

Results show that middle ear diseases are the main cause of hearing impairment in school going children, especially in low and middle socio-economic status. Therefore, it is recommended to include hearing screening of school-age children in annual school health programs.

INTRODUCTION

Hearing loss is the most common sensory deficit, and constitutes a public health concern globally, especially among low and middle-income countries (WHO, 2013a). Despite the high incidence of hearing loss among developing nations, there is limited information available about hearing and hearing loss (Stevens et al., 2013). This study's goals were to gather data, investigate the hearing loss caused in school going children. Hearing loss affects a high percentage of society. It may be due to diseases affecting the middle or inner ear, it may be congenital, age related or due to noise exposure. From the various hearing related studies done so far in India most of them showed that the main cause of hearing loss in school going children is middle ear diseases and it mainly affects the rural area or low socioeconomic class, which are highlights of this study.

Hearing statistics in India

The statistics are staggering. Hearing impairment (HI) is a global problem, and the WHO (2013) estimated that 360 million people (including 32 million children) have disabling hearing impairment. Most patients live in low-income and middle-income countries, and 25% are born with or acquire HI during childhood. This constitutes that a substantial 5.3% of the world's population is suffering from hearing loss. The prevalence and incidence of hearing impairment in India are also substantially high. According to WHO (2018) data, the prevalence of hearing impairment (HI) in India is around 6.3% (63 million people suffering from significant auditory loss). The estimated prevalence of adult-onset deafness in India is 7.6% and childhood-onset deafness is 2%. The National Sample Survey (NSS) 58th round (2002) surveyed disability in Indian population and found that hearing disability was the 2nd most common cause of disability and top cause of sensory deficit. In urban areas, hearing loss was 9% of all disabilities and in rural areas, it was 10%. Hearing handicapped is defined by the Rehabilitation Council of India Act (1992). In India, it is defined as HI of 70 dB and above in the better ear or total loss of hearing in both ears. According to PWD Act, 1995, a disability means a person suffering from more than 40% of any disability as certified by a medical authority. However, investigators have documented that even a minimal and mild hearing loss can place youth at risk for academic learning problems (Daud, Noor, Rahman, Sidek & Mohamad, 2010). As a result, hearing loss of even 15 dB HL can create hearing disability in the children and, consequently, impairment in their mental growth may be at risk for negative academic and learning implications of unidentified or untreated hearing loss. The National Sample Survey Organization (NSSO was set up by the government of India in 1950) Government of India, 1991 report shows that in rural India 2.7 % children are with hearing impairment in the age group 0 to 14 years. In the same age group, the urban statistics are 3.0 % and for speech disability it is 8.9% and 8.3% of the rural and urban areas respectively. The cause of hearing loss may be due to impacted wax, any type of infection in the ear (otitis media, labyrinthitis), growths in the ear, noise induced hearing loss, progressive or late onset genetic hearing loss, injury, viral infections (mumps, measles, bacterial meningitis), oto-toxicity, trauma, auto immune disease or sudden deafness of unknown aetiology. The percentage of milder degrees of hearing loss

and unilateral hearing loss is larger. The major causes of hearing loss and ear diseases in school going children in India have been listed by a survey of WHO (2013):- ear wax (15.9%) was the most common cause of reversible hearing loss, middle ear infections such as CSOM (5.2%) and serous otitis media (3%) are the next leading causes of hearing loss. The other causes include dry perforation of tympanic membrane (0.5%) and genetic and congenital deafness (0.2%).

Main causes of childhood hearing loss in India

While the prevalence of unilateral, minimal and mild hearing loss (UMMHL) is not reported in low and middle- income countries, still disabling hearing loss (DHL) is nearly double that of high income nations (WHO 2015b; WHO, 2013b). The high incidence of DHL in these nations is primarily due to insufficient health care (Duthey, 2013). Limited resources in ear and hearing care, a shortage of national attention to assistance programs, few professionals in the field, poor personal hygiene, overcrowding, and a lack of access to medical interventions all contribute to the inadequacy of healthcare available in low- and middle-income nations (Duthey, 2013).The prevalence and incidence of hearing impairment in India is high due to the following reasons:

1) India is a developing country, so in comparison to developed countries, India's economy is low. Hearing loss is the most common sensory deficit, especially among low and middle-income countries (WHO, 2013a). Two-thirds of people in India live in poverty. Sixty-eight-point eight percent of the Indian population lives on less than $2 a day. Over 30% even have less than $1.25 per day available, they are considered extremely poor. More than 800 million people in India are considered poor. Most of them live in the countryside and keep visit with odd jobs. The lack of employment which provides a liveable wage in rural areas cause many Indians to migrate into rapidly growing metropolitan areas such as Bombay, Delhi, Bangalore or Calcutta. There, most of them expect a life of poverty and live in the mega-slums.

2) Shortage of human resources to address the issue of deafness. The estimated number of ENT specialists and otologists in India are 7000 and 2000 respectively. The audiometrist and population ratio is 1:500000 and the ratio of speech therapist to the deaf population is1:200.

3) India 2020 population is estimated at 1,380,004,385 people at middle of the year, according to UN data (2020). India population is equivalent to 17.7% of the total world population. India ranks number 2 in the list of countries (and dependencies) by population.

4) India has the largest population of illiterate adults in the world – 287 million, which is 37% of the global total.

Limited deafness prevention program in India

Among ENT diseases, hearing loss is the most common sensory deficit in humans today. Worldwide, it is the second leading cause for "Years lived with Disability", the first being depression (Davey, Maheshwari, Raghav, Singh, Muzammil, & Pandey, 2018). In India, there is a large number of hearing impaired young people, and this hearing impairment is the main causing of low productivity, both physical as well as

economic. As NSSO (1991) report shows a large percentage of children between the ages of 0 to 14 years are suffering from significant auditory impairment.

The practice of screening school age children has been in existence for more than 50 years in western India (Kumar, D'Mello, 2006). In India, school screening programs have been conducted since 1965 as a study of hearing loss in school children in India was done by Kapur in 1965. However, hearing health has not been given due importance by a majority of the school authorities (Kumar, D'Mello, 2006). The importance of hearing screening is to identify the children at risk, which may hamper their scholastic performance, and to refer them for detailed investigation and intervention.

The management of ear diseases in rural areas of India nowadays is guided and motivated by Indian Public Health Standards (IPHS) since 2012 for National Program for Prevention and Control of Deafness (NPPCD) from rural health facilities such as Sub-Center (SC), Primary Health Centre (PHC), and Community Health Centre (CHC) (Davey, Maheshwari, Raghav, Singh, Muzammil, & Pandey, 2018). However, even despite the existence of IPHS, the coverage and quality impact of IPHS on ear care from primary care level are still questionable and not yet been studied till now.

Background of this study

Hearing loss may not be considered as a priority in developing nations, it is nevertheless a serious concern for children (Yammah, Mabrouk, Ghorab, Ahmady & Abdulsalam, 2012). According to the WHO (2013a, 2013b), approximately 32 million children (< 15 years of age) globally live with disabling hearing loss (DHL) and the majority of these cases are preventable or treatable. Among children, the WHO defines DHL as unilateral or bilateral hearing loss greater than 30 decibels hearing level (WHO, 2013a). Although the WHO defines DHL in children as greater than 30 dB HL, unilateral, minimal and mild hearing loss (UMMHL) of 15-25 dB HL is also detrimental (Bess, Dodd-Murphy, & Parker, 1998). Eighty-nine percent of children with DHL live in low- and middle-income countries (WHO, 2012). While little is known about children in developing countries, they are most likely at risk as well. In some countries, untreated hearing loss is especially significant as it can limit education options. Consequently, limited opportunities for education may negatively impact employment and the economy at the level of the individual, the local community and the country (WHO, 2013b). Individuals with disabilities, including hearing loss, have a much higher unemployment rate due to limited resources and access to services (WHO, 2013a). Effective early identification and management of hearing loss can significantly diminish its impact (WHO, 2013a).

Hearing loss can cause a delay in the development of speech and language resulting in negative implications on academic learning and social development. Specifically, delays in spoken language development can limit access to communication and hinder interactions with others, which may cause feelings of isolation and loneliness (ASHA, 2015). These factors impact career choices and adversely affect quality of life outcomes (ASHA, 2015). According to the WHO, "public health measures" can successfully reduce the incidence and impact of DHL (WHO, 2013a).

Problem statement

This study was done to find the causes of hearing impairment among school going children in the western region of India (Rajasthan). In Rajasthan, it is believed that the prevalence of hearing impairment in school going children is more as a result of chronic suppurative otitis media, especially in low socio-economic society due to lack of awareness on the ear issues, financial problems and shortage of trained personnel in ear service.

Logical value of the study

Early detection, treatment and rehabilitation are important to mitigate some of the negative effects and maximize functioning for affected individuals. Fifty percent of deafness and hearing impairment can be avoidable through prevention, early detection and management (Smith, 2003). The current study can be justified on the following grounds:

First, the current research will help to deepen awareness of prevalence of hearing impairment in western India (Rajasthan). The research will highlight the reason of hearing loss in school going children in the western region and its effect on children. It will qualify or quantify, assess the value cost to the society. The data will be used to design intervention strategies as well as policies directed towards prevention. The study will help to raise awareness amongst opinion leaders, health planners, decision makers and the general public. Secondly, the study will motivate health planners and health professionals to reorient their thinking and activities along a public health path to address the situation of hearing impairment in the region. In India, there is a shortage of appropriate and effective intervention in the field of hearing impairment. In addition, the study will help in the establishment of an impact database required for future needs and developments. For example, this study will motivate health workers of the private and government sector, and school administration as well as parents to protect the child hearing by avoiding middle ear diseases (otitis media).

Finally, the result of the current study will encourage, assist and justify the allocation of resources to develop the management of hearing impairment in low socio-economic society of the Bhilwara district of Rajasthan (western India) with regards to prevention and treatment of individuals with hearing impairment due to middle ear infections.

Profile of the study area

Rajasthan state is located on the north western side of India, where it comprises most of the wide and in hospitable Thar desert (also known as the "Great Indian Desert") and shares a border with the Pakistani provinces of Punjab to the northwest and Sindh to the west. The state covers an area of 342,239 square kilometres or 10.4 percent of the total geographical area of India. It is the largest Indian state by area and the seventh largest by population. Bhilwara is one of the districts of Rajasthan. It falls between the districts of Ajmer (in the north) and Chittorgarh and Udaipur (in the south). Bhilwara is the textile city of Rajasthan and known as the “Manchester of Rajasthan”. There is a government hospital known as Mahatma Gandhi Hospital and one private ENT Hospital called Dev ENT Hospital. All patients of Bhilwara with hearing impairment are referred to these hospitals for treatment and rehabilitation.

Base of research

The research is based on signs of hearing loss present in toddlers and school going children. In classroom, a teacher can easily notice how a student is receiving and understanding the information and level of comprehension, like: speech is delayed or not clear, speaks differently than other children of her or his age, inattentiveness in classroom, inappropriate responses to questions, doesn't reply when call his or her name, has difficulty in understanding what people are saying, often says, “Huh?” and “What?”, has trouble in following directions and turns up the TV volume incredibly high or sits very close to the TV to hear at home etc.

Scope of the study

Hearing impairment is a very serious health dilemma. Hearing loss is detrimental to human development at all ages. However, children are more affected as their development is impacted in several ways. By establishing the prevalence and risk factors of hearing loss in children, it is hoped that parents will be educated on how to avoid or minimize exposure of their children to hearing loss and its negative effects. There are many causes of hearing loss in school going children (Figure 1): congenital causes(genetic, idiopathic, non-genetic-anoxia, hypoxia, oto-toxicity, TORCH) and acquired causes (meningitis, measles, mumps, influenza, chicken pox, head injury, noise exposure, middle ear infections, ear wax). The study was limited to the prevalence of hearing impairment in school going children age of 4 to 15 years due to middle ear infection (otitis media) and relation of these middle ear infections with socio-economic level.

Figure 1.

Causes of hearing loss

OBJECTIVES

The primary objectives of this research are to (1) find the incidence of hearing impairment in school going children, (2) determine the main cause of hearing impairment in school going children, (3) find relation of childhood hearing impairment with socio - economic class. And the secondary objectives are to (4) create the awareness in society about consequences impairment, and (5) educate the parents for prevention of hearing impairment and importance of early interventions.

(1) To find out the incidence of hearing impairment in school going children.

The first primary objective of this study is to find the incidence of hearing loss and speech

and language problems in school going children. It would help stakeholders in the health care sector, including policy makers to carve out policies. In India, school screening programs have been conducted since 1965. However, hearing health has not been given the due importance by a majority of the school authorities. The importance of hearing screening is to identify the children at risk, which may hamper their scholastic performance, and to refer them for detailed investigation and intervention.

By considering the unpredictable difficulties, the best way to identify them would be individual assessment of children at risk. Due to the lack of knowledge and low cooperation of many parents, one of the appropriate times for prognosis of the so-called hearing screening is the school age, because, at this age, the majority of children gather in academic centres and they can all be examined.

(2) To determine the main cause of childhood hearing impairment (otitis media)

Ear infections are common in childhood. The main aim of this study is to find, if the main cause of hearing loss in school going children is middle ear infections (otitis media). Otitis media is an infection of middle ear, it happens often in young children because the tubes that connect the middle ear to the nose, called Eustachian tube is smaller and more nearly horizontal in children than in adults. Therefore, it can be more easily blocked by conditions such as large adenoids and infections. The infections occur in middle ear due to bacteria (Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, Staphylococcus aureus, Streptococcus pyogenes and Pseudomonas aeruginosa). The accumulation of effusion and mucus produces hearing loss, feeling of pressure, otic plenitude and even mild pain. The main types of otitis media are:

1) Acute otitis media (AOM): It is an inflammation process of the middle ear whose resolution occurs in a period not exceeding three weeks.

2) Recurrent acute otitis media (RAOM): It is the succession of AOM, in which the patient develops three or more episodes of AOM in a period of 5 to 6 months or more episodes in a year.

3) Chronic otitis media (COM): Chronic otitis media is an inflammation of the middle ear whose duration exceeds three months.

The most common symptoms of otitis media are: unusual irritability, difficulty in sleeping, tugging or pulling at one or both ears, fever, fluid draining from ear, loss of balance, hearing difficulties, ear pain. In addition to the symptoms of otitis media listed above, untreated otitis media can cause infection in other parts of the head, permanent hearing loss, problems with speech and language development.

Treatment for otitis media will be determined by child's physician or an ENT doctor based on child's age, extent of the condition. Treatment may include antibiotic medication, medication for pain and grommet insertion.

(3) To find the correlation between socio-economic status and hearing loss.

In this study, the data of hearing loss of school going children is collected and analysed as well as the correlation between socio-economic status and hearing loss in school going children. As it is cleared, little

is known about hearing and hearing loss among children in developing countries. Despite the limited data available, the World Health Organization (WHO) has deemed hearing loss to be a global burden with substantial social and economic ramifications (Duthey, 2013).

The prevalence and incidence of hearing impairment cases in India are also substantially high. Mostly hearing impairment patients are related to low-income and middle-income families. In this research study criterion for selecting socio economic status is chosen on the basis of monthly income of the child's parent. Children whose parent's monthly income is more than 50 thousand were included in upper socio-economic class, whose parent's monthly income is between 30 to 50 thousand were included in middle class and less than 20 thousand monthly income were included in low socio-economic class.

(4) To create awareness in society about consequences of hearing impairment

Children learn speech and language from listening to other people talk. The first few years of life are especially critical for this development. If a hearing loss exists, a child does not get the full benefit of language learning experiences.

Otitis media without infection presents a special problem because symptoms of pain and fever are usually not present. Therefore, weeks and even months can go by before parents suspect a problem. During this time, the child may miss out on some of the information that can influence speech and language development.

Hearing loss causes delay in the development of receptive and expressive communication skills. Communication difficulties often lead to social isolation and poor self-concept. It may have an impact on vocational choices. These disabilities can cause behavioural complications in six functional areas: mental maturity, perception, speech and speaking, cognition and general intelligence, academic achievement, and interpersonal behaviours. There are five major ways in which hearing loss affects children:

1) Hearing loss can make it harder to talk with others. Children may not want to talk or play with other kids. Children with hearing loss may feel alone and like they have no friends, being unhappy in school.

2) Children with hearing loss have trouble in school. Reading and math may be the hardest for them. Children with mild to moderate hearing loss may fall one to four grade levels down without help. Children with hearing loss do not do as well as children with normal hearing. The gap between them grows over time.

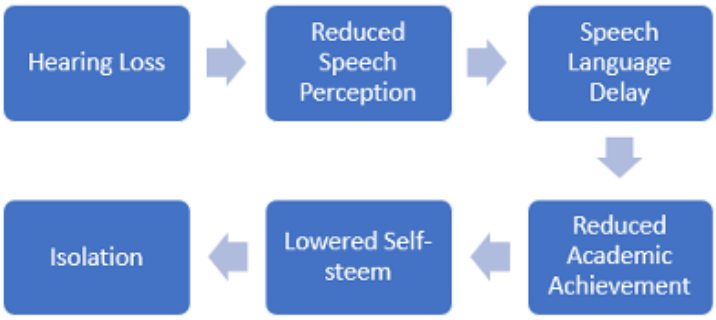
3) Children with hearing loss may have trouble understanding and using sentences. They have problems with more complex sentences. They may not use clauses in their sentences. They may not use passive voice.

4) Children with hearing loss have poor academic performance due to cognitive deficit.

5) Social isolation and poor self-concept because of lack of communication skills.

Figure 2.

Effects of hearing loss



(5) To educate the parents for prevention of hearing impairment and importance of early intervention.

The fifth objective of this study is to educate the parents for prevention of deafness in children as we know that early intervention and hearing loss treatment is a must for child development. Studies have shown that early intervention is the key to fostering peer level academic performance as well as healthy social interactions in kids with hearing loss. It is important to remember that hearing loss can occur at any time of life. In particular, recurring ear infections may negatively affect language development because of the resultant fluctuating hearing loss, lack of steady auditory input, necessary for speech and language development. Early intervention services are a must, it can change a child's developmental path and improve outcomes for children, families, and communities.

No single treatment or intervention is the answer for every child or family. Good intervention plans will include close monitoring, follow-ups and any changes needed along the way.

MATERIAL AND METHODS

In this research, the prevalence of hearing impairment was conducted in the Northern Western region of India (Rajasthan). Research study was designed to screen children of age 4 to 15 years from the primary and middle primary schools around the district Bhilwara for data collection. The purpose of the study was to determine the occurrence of hearing impairment among the school going children and to find the main cause of hearing impairment in this age. Methodology of this research includes the study design, study area, study population, sampling design, data collection, instruments and data analysis.

Study design

The research design used for the study was a cross sectional research design. The design contemplates at determining the prevalence of hearing impairment, the main cause of hearing impairment and the relation of this hearing impairment with their socio-economic status, in school going children in the Bhilwara district of Rajasthan (Northern-Western region of India).

Study area and sampling design

Schools are selected for this research because teachers may have opportunity for closer observation of each individual student, in classroom a teacher can easily notice how a student is receiving and understanding the information and level of comprehension. Two thousand school going children of age group 4 to 15 years, irrespective of sex, religion and socio economic status are screened by specially designed questionnaire and affected children are scientifically observed and tested by

otoscope, pure-tone audiometer and impedance audiometer (tympanometer).

The sampling design employed for this study was cluster random sampling. Cluster sampling is a sampling technique in which the entire subject of interest is divided into groups, or clusters, and a random sample of these clusters is selected. Six schools are selected from different regions of the Bhilwara district for this research study by cluster sampling.

Team of research study

One Audiologist (trained in audiometry and tympanometry), two trained ENT nursing staff (trained in physical examination and otoscopy) and one ENT doctor participated in this research study. Before employing data collecting instruments, they were explained about goals of study and all their questions and or concerns about the study were answered before data collection begins. Anonymity and confidentiality of the participants and children were ensured, since there will be no insertion of any identifiers and or any condemnatory information on participants. After completion of study, they were thanked for their kind participation. All hearing impaired children, who need further treatment were referred to district government hospital and Dev ENT hospital.

The study team comprised of:

1. Trained audiologist 1
2. Trained ENT Nurses 2
3. ENT doctor 1
4. Assistant (helper) 1

Study limitations

Prevalence studies have their strength in presenting a snapshot picture of early detection and prevention of hearing impairment in school going children and this hearing impairment in school going children is due to middle ear infections and the incidence of these cases is higher in low and middle socio-economic status. This could draw the attention of policy makers, health workers of private and government sector, teachers and parents. The study shall not address aspects such as poverty, illiteracy and other related issues that may not necessarily fall within the concentration of the study.

Assumptions

– Respondents are honest and frank with their response.

– Team workers work adequately.

– All audiological equipment is properly calibrated.

– Sampling of data is done with proper cluster random method.

Data collection technique

A specially designed questionnaire is used for data collection in this study. Questionnaire-based screening by teachers and parents has been used for children in developing countries. This data collection technique is easy, fast and low cost effective. In this research study, the decision of hearing screening by instrument is based on data collected by questionnaires .

(See ANNEX 1.)

The questionnaires were distributed to children in various schools selected by cluster random sampling in Bhilwara city through their class teacher and school administrative authorities.

The questionnaires are filled up by their parents or class teacher and are collected from their class teachers. These questionnaires are scrutinized by team of research at Dev ENT Hospital, Bhilwara. Any "YES" answer in the questionnaires is taken as positive case and that child is included in this study. The ear of positive case is examined by the research team with the help of instruments. "No" answer in the questionnaires for all the questions are excluded from the study. The study is conducted under following headings:

1) Bio-data: Complete Bio-data of children including name, age, sex, school name, socioeconomic status (monthly income of parent's), contact number and address are recorded in the questionnaires.

2) Symptomatology of present illness: The presenting complaints like diminished hearing, recurrent attacks of common cold, ear ache, air fullness/blocking sensation of ear, ear discharge, delayed speech, inattentiveness, and mouth breathing are recorded in the questionnaires.

3) Physical examination: External auditory canal is examined to find out wax, any discharge from middle ear, congestion, retraction & perforation of tympanic membrane.

Research instruments

For the credibility of the research, there were used three different tools to examine the patients after collection of data through questionnaires. The research instruments employed were all regulated tools, which have been tested for validity and reliability. The research tools consist of the following:

(1) Otoscope

(2) Audiometer

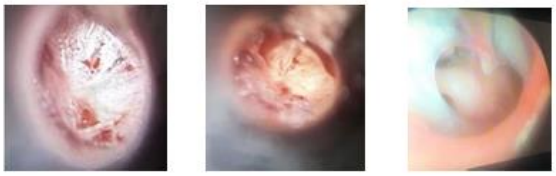
(3) Tympanometer

Otoscope

External ear canal was examined through otoscope, the audiometry and tympanometry test should not be carried out in case of wax, acute suppurative otitis media and chronic suppurative otitis media. So before performing any test, ear canal was examined by otoscope. Congestion, retraction, perforation of tympanic membrane was also examined by otoscope.

Figure 3.

Different otoscopic pictures of tympanic membrane which were taken during research



Portable Audiometer (Kosmic- 103)

In this research study, a portable audiometer (kosmic-103) was used to measures the softest, or least audible, sound that a child can hear. During the test, children wore earphones and heard a range of sounds directed to one ear at a time. The loudness of sound is measured in decibels (dB). Results from a hearing test are displayed on an audiogram.

Figure 4.

Portable audiometer (Kosmic 103)

Tympanometer AT-235 (Inter-Acoustic)

In this study, AT-235 (Inter-Acoustic) tympanometer is used. The procedure of tympanometry was explained to the child at first so he or she can sit comfortably in a relaxed position. Instructions were given to children, that extraneous head & mouth movement as well as speaking should be avoided during the test. Swallowing should also be avoided.

Figure 5.

Portable tympanometer (AT 235h)

Figure 6, 7.

Procedure of tympanometry and audiometry

RESULTS

The title of the present study is “Early Detection and Prevention of Hearing Impairment in School Going Children” is based on hypothesis “Middle ear infection is the main cause of hearing impairment in school going children and incidence of these

cases is higher in middle & low socio-economic community". This study is done by scientific observation of 2000 school going children by distributing questionnaires and screened children's ear were further observed by otoscope, audiometer, and tympanometer. The results according to data are collected by questionnaires and after performing hearing tests are as follows:

1) Total number of questionnaires were distributed and recollected

In this presented study, questionnaires were distributed to 2000 school going children, through the class teacher and school administrative authorities. These questionnaires were recollected, scrutinized, and found 680 children replied "YES" answer in questionnaires.

Table 1.

Numbers of questionnaires are distributed

	NUMBER	PERCENTAGE
Questionnaires distributed to children	2000	
Questionnaires received	1980	99.00%
Questionnaires found blank	10	00.50%
Questionnaires scrutinized	1970	98.50%
Questionnaire found "YES" answer	680	34%

2) Distribution of recollected questionnaires according to age wise

Table 2.

Age wise received "yes" replied

Age Group (Years)	No. of Questionnaires Received	No. of children replied "yes"	Percentage (out of 680)
4 - 6	495	240	35.29
7 – 9	493	255	37.50
10 - 12	490	101	15.44
13 - 15	492	80	11.76
Total	1970	680	100.00

According to the above Table 2, 680 children were scrutinized, out of these the highest number of positive responses were found in the age group 7 to 9 years, this group consisted of 255 children (37.50%), this was followed by 4 to 6 years, which included 240 children (35.29%) and 10 to 12 years age group which included 105 children (15.44%). Finally, 13 to 15 years age group consisted of 80 children (11.76%).

Seventy three percent (73%) of the children with positive response observed in this study were in the age group 4 to 9 years. This observation shows that children related to age group of 4 to 9 years have the highest number of hearing problems in these schools.

3*) Distribution of recollected questionnaires on the basis of socio-economic status*

Table 3.

Distribution of recollected questionnaires on the basis of socio-economic status

Socio-economic class	Test distributed	Test received	"YES" answer	% (out of 680)
Upper	600	595	136	20
Middle	700	692	250	36.7
Lower	700	693	294	43.23
Total	2000	1980	680	100.00

Above Table 3, shows that the highest numbers of positive responses are from lower socio-economic class (43.23%) and the lowest numbers of positive responses are from upper socio-economic class (20%) while 36.76% positive responses are from middle socio-economic level.

Criteria for socio-economic status: Children whose parent's monthly income is more than 50 thousand were included in upper socio-economic class, those whose parent's monthly income is between 30 to 50 thousand were included in middle class and those with less than 20 thousand monthly income were included in low socio-economic class.

4) Distribution of recollected questionnaires according to frequency of "yes" responses

Table4 shows the highest number of children who replied "yes" in more than two questions (43.38%) and the minimum number of children who replied "yes" in only one question (21.32%). These 680 children were examined by otoscope at first. In otoscope findings, 110 children had wax in their external auditory meatus. Wax was removed before audiometry and tympanometry procedure, for accurate diagnosis.

Table 4.

Frequency of replied "yes" answer

"YES" answer	No. of Children	%
Only one Question	145	21.32
Two Questions	240	35.29
More than two Questions	295	43.38
Total	680	100

5) Hearing assessment of suspected children by pure tone audiometer

Now these 680 children were examined by portable audiometer and found that 312 children had different degree of hearing loss. Two hundred fifty children (80.12%) had mild degree of hearing loss and 62 children (19.87%) had moderate degree of hearing loss.

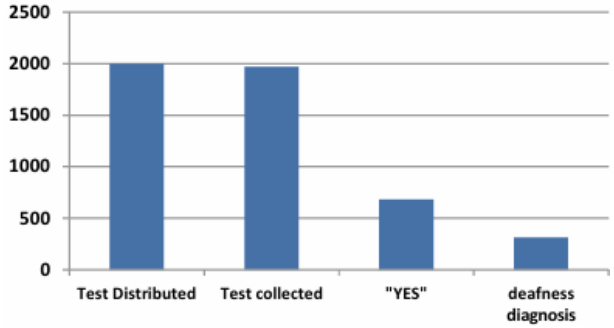
Table 5.

Hearing impairment cases diagnosed by audiometry

Level of deafness	Degree of deafness	No. of children	Percentage
Mild	15 – 30dB	250	80.12
Moderate	>30dB	62	19.87
Total		312	100

Figure 8.

Children diagnosed with hearing loss according to audiometry test.



6) Type of tympanometric curve obtained from suspected children (1360 ears)

Table 6.

Number of different types of tympanogram found

Type of curve	No. of ears	%
Type A	940	69.11
Type B	190	13.97
Type C	230	16.91
Total	1360	100.00

The six hundred and eighty children were examined by tympanometer after otoscopy and audiometry. A total of 1360 ears and 680 children were examined and diagnosed with a different type of tympanogram. Table6 shows that the numbers of ear presented with "type A" curve are 940 (69.11%), the numbers of ear presented with "type B" curve are (190) 13.97% while the 230 (16.91%) ear presented with "type C" curve. Table 5 shows that, according to the audiometry test, 312 children out of 680 had some degree of conductive and mixed hearing loss and after tympanometry test of those 680 children (1360 ears) found "Type B" 190(13.97%) & "Type C" 230(16.91%) tympanograms. The data obtained in audiometry test and in tympanometry test, shows that almost 300 children had a different degree of conductive hearing loss due to middle ear diseases, while 10 to 15 children had hearing loss due to other pathology.

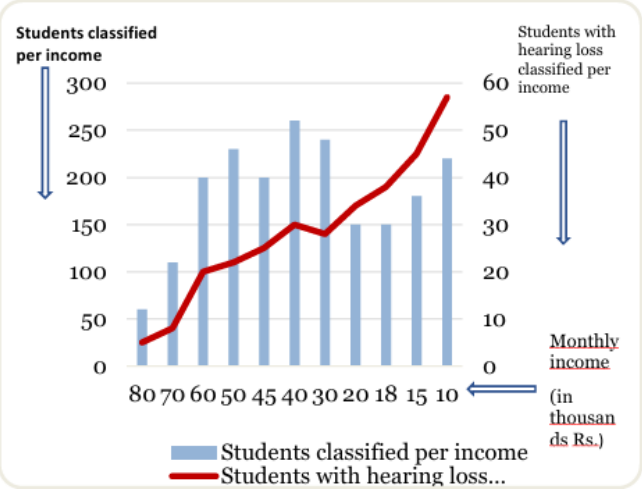
7) Diagnosed hearing impairment cases related to different socio-economic status

Three hundred and twelve hearing impairment cases were diagnosed out of 680 screened children. They were related to different socio-economic status, according to their parent's monthly income. One hundred and forty cases out of 312 cases of hearing impairment were from low socio economic, 117 cases were from middle socio economic and 55 cases were from upper socio economic class.

This research study shows that the incidence of hearing impairment cases was higher in low and middle socio-economic status (44.87% and 37.50%) while the incidence of these cases was lower in upper socio-economic status (17.62%).

Figure 9.

Correlation of hearing loss cases with monthly income.



8) Diagnosis of different middle ear diseases by ENT specialist

These 312 children of hearing impairment were referred to E.N.T. specialist for further treatment and surgery if required. ENT doctor of study team diagnosed different middle Ear diseases in those children, are categorized: -

Table 7.

Children diagnosed with various middle ear disease.

Type of Disease	Total No. of children	% out deaf children 312
Acute Suppurative otitis media	47	15.04
Chronic Suppurative otitis media	89	28.52
Secretory otitis media	51	16.34
Eustachian tube Catarrh	74	23.71
Adhesive otitis media	19	6.08
Other diseases	32	11.10
Total	312	100

SUMMARY OF RESULTS

In this research, data observation shows that middle ear diseases are the main cause of hearing loss in school going children and incidence of these cases are higher in low and middle socio-economic status.

1) In the present study, questionnaires were distributed to 2000 school going children for hearing screening, through the class teacher and school administrative authorities. These questionnaires were recollected, scrutinized, and found that 680 children replied "YES" (they have a problem) in questionnaires.

2) Seventy three percent (73%) children of positive responses were observed in the age group of 4 to 9 years. From the age group of 4 to 9 years, the highest numbers of positive responses were from to age group of 7 to 9 years.

3) The study shows the highest number of positive responses for hearing problem were from lower socio-economic class (43.23%) and the lowest number of positive responses were (20%) from upper class, while 36.76% were from middle socio economic level.

4) Otoscopy is done for all 680 children and 110 children were found to have wax, which was removed. They were all examined by portable audiometer and found 312 children had some degree of hearing loss. Two hundred and fifty children (80.12%) had mild degree and 62 children (19.87%) had moderate degree of hearing loss.

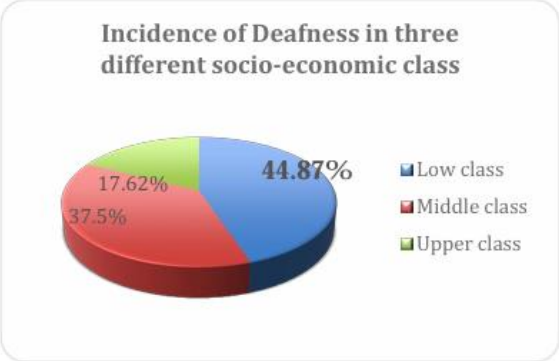
5) In tympanometry test, 190 (13.97%) ears presented with type B curve while the 230 (16.91%) ears presented with type C curve.

6) Three hundred and twelve children out of 680 had some degree of hearing loss according to audiogram test and in tympanometry test, were obtained 190 "Type B" and 230 "Type C" tympanogram. These data show that hearing loss in school going children was due to middle ear diseases.

7) Hearing loss was diagnosed in 312 children out of 680 screened children according to audiometry test. The incidence of hearing impairment cases was higher in low and middle socio-economic class (44.87% and 37.50%), while the incidence of these cases was low in the upper socio-economic class (17.62%).

Figure 10.

Hearing loss related to different socio economic status.

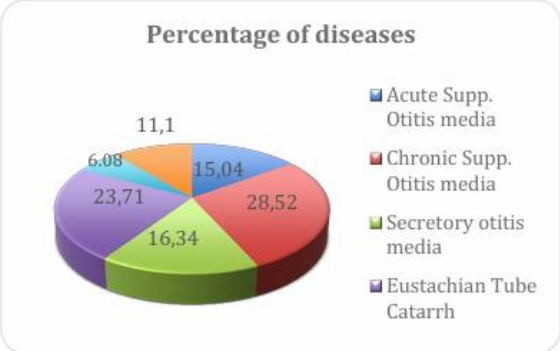


8) Finally, in this research study the following results were obtained: Chronic suppurative otitis media caused hearing loss in 28.52% children of total hearing impaired cases, Eustachian tube catarrh in 23.71% children, acute suppurative otitis media in 15.04% children, secretory otitis media in 16.34% children and adhesive otitis media in 6.08% children of total diagnosed cases. Deafness due to other reasons occurred in 11.10 % of children.

9) According to this research study, chronic suppurative otitis media was the most common cause of hearing loss in school going children of age 4 years to 9 years.

Figure 11.

Diagnosed middle ear diseases



The present research study shows that middle ear infections are the primary cause of childhood hearing loss. These middle ear infections are: acute suppurative otitis media, chronic suppurative otitis media, secretory otitis media, eustachian tube catarrh and adhesive otitis media. According to this research study the incidence of conductive hearing loss cases due to middle ear infections are more in low and middle socio-economic class.

DISCUSSION

This research study is done on school going children because high incidences of middle ear infections are present in this age and it causes hearing loss. This hearing loss is a major cause of delayed linguistic development and poor personality development. In this research study, the correlation of childhood hearing loss with middle ear infections and low socio-economic status were found. Through the observation of data collected by questionnaires and after examination through otoscope, audiometer and tympanometer, it was found that chronic suppurative otitis media is the most common middle ear disease, which causes hearing loss in school going children of age 4 years to 9 years. In this research study it was also found that the incidence of these cases is more present in middle and low socio-economic community.

According to a cross-sectional screening test which was done to determine the prevalence of otitis media with effusion amongst preschool children in two districts in Malaysia, namely Kuala Lumpur and Kuala Selangor. This study, involved 1097 preschool children and diagnosis of otitis

media effusion (OME) was based on abnormal otoscopic findings, "Type B" tympanogram and absence of ipsilateral acoustical reflex. The overall prevalence rate of OME was 13.8%, the prevalence in Kuala Lumpur was 17.9%, and in Kuala Selangor it was 9.48%. While this study showed lower prevalence of OME in lower socio-economic status.

Another community-based study showed mostly OME cases belong to middle and lower class (Siddartha, Bhat, Bhandary, Shenoy and Rashmi, 2011). It was a cross-sectional study which was conducted among 1,020 children of age ranging from 5 to 10 years from five schools of suburban areas of Dakshina Kannada district. In this study, they found 4% OME cases belong to upper class, 26% to upper middle class, 26% to lower middle class and 43% to lower class. The reasons for the higher number in lower socio-economic status might be the poor hygiene standards, overcrowding in these families and poor nutritional status of these children.

Results obtained through this research study are almost similar to these two studies of Malaysia and Dakshina Kannada (India), which are mentioned above.

There were some limitations also present in this research study. There were only assumptions that all instruments are properly calibrated, team worker will be honest with their work and children will fill the questionnaire with sincerity. During the data collection, many respondents may not answer certain questions because they are uncomfortable or do not want to answer the question. Lack of data can mislead the results. In this research study, only children of six schools (randomly selected) were screened and on the basis of their responses results were observed, then difficulties may exist in generalizing the results on larger populations, findings only can be suggestive. For the adequate results, still there is a need of government deafness prevention programs on a large scale, to screen all the school going children in whole district. Some limitations cannot be controlled by the researcher, some can be minimized like in this research study all instruments were properly calibrated and all team members of research study were qualified and expert in their field.

Still it is not proven that schools are the best places for the research studies but through schools we can educate the children and their parents about their hearing loss and can explain them how to cure and preserve their hearing by medically treatment at the right time, according to present pathology. In India, provision of services is made difficult due to the distance and lack of adequate number of professionals to provide all the intervention needed. Thus, training of other functionaries such as school teachers may be a worthwhile effort.

CONCLUSIONS

Hearing loss among school-going children in the developing world has been widely reported as a significant health problem. Unfortunately, school aged children are rarely screened for hearing loss during routine clinical examination and most school health authorities make no provision for audiometric assessment. This is usually attributable to low awareness among parents, school authorities and healthcare providers on the consequences of slight/mild hearing loss.

In recent times, with the widespread implementation of hearing screening programs all over the world, the awareness of hearing impairment has drastically improved as compared to older days. This means that it is increasingly possible to identify the problem early and offer appropriate solutions to the problems of children with hearing loss.

The goal of this hearing conservation program is to locate children with hearing problems so that they can be referred to medical treatment and educate the children and their parents on how to avoid the middle ear diseases. Raising awareness about healthy ear care practices can reduce the ear infections, like: avoiding insertion or instillation of any substance (e.g. a cotton bud) into the ear can help to decrease ear problems. Ensuring that children with ear pain are not treated with home remedies and consult a medical practitioner can prevent chronic ear infections and the associated hearing loss.

Such programs do not require an elaborated set up in terms of staff or equipment, yet it can be the most satisfactory and rewarding of all conservation and rehabilitation program. As the hearing impairment in childhood affects the linguistic and intellectual developments, the early diagnosis and treatment is essential for overall child development.

REFERENCES

Acuin J. (2004). Chronic Suppurative Otitis Media. Burden of Illness and Management Options. Geneva: World Health Organization.

Alvord, L. S., & Davenport, T. (1992). Reference equivalent threshold levels for the Handtronix, Oto-Screener™. Journal of the Acoustical Society of America, 91, 234-235.

Amedofu, G.K., Awuah, P., Ocansey, G., &Antwi, B. (2003). Hearing impairment among secondary school students. Indian Journal of Clinical Practice (International Edition), 4(4), 17-20.

Amedofu, G. K., Opoku-Buabeng, J., Osei Bagyina, A. et al., (2003). Hearing loss Among School Children in Ghana. Ghana Medical Journal, 37, 148-152.

American Speech and Hearing Association (ASHA) (1975). Committee on Audiometric Evaluation: Guidelines for Identification Audiometry. ASHA

ASHA (1990). American Speech-Language Hearing Association, Guidelines for screening for hearing impairments and middle ear disorders, ASHA, 32, 17–24.

American Speech-Language Hearing Association (2015a). Better hearing & speech month: Parent poll. Honeoye Falls, New York: Crux Research, Inc.

American Speech-Language Hearing Association (2015b). Effects of

hearing loss on development. Audiology Information Series.

American Speech-Language-Hearing Association (2016). Scope of practice in speech language pathology.

Bayazit Y. A., Cable B. B., Cataloluk O., Kara C., Chamberlin P., Smith R. J., Kanlikama M., Ozer E., Cakmak E. A., Mumbuc S. and Arslan A. (2003). GJB2 gene mutations causing familial hereditary deafness in Turkey. International Journal of Pediatric Otorhinolaryngology, 67, 1331–1335.

Berg, A.L., Papri, H., Ferdous, S., Khan, N.Z., & Durkin, M.S. (2006). Screening methods for childhood impairment in rural Bangladesh. International Journal of Otorhinolaryngology, 70, 107-114. Pediatric

Berman, S. A., Balkany, T. J. and Simmons, M. A. (1978). Incidence and Epidemiology of Otitis Media in Neonates. In Press, Pediatrics.

Bess, F.H., Dodd Murphy, J., & Parker, R.A. (1998). Children with minimal sensorineural hearing: Prevalence, educational performance, and functional status. Ear and Hearing, 19, 339 354.

Carney, A. E. and Moeller, M. P. (1997). Treatment Efficacy: Hearing Loss in Children. Journal of Speech, Language and Hearing Research, 41, S61-S84.

Chambers, N., & Anderson, I. (1997). Teacher accuracy in the identification of pre-school pupils with hearing loss. South African Journal of Communication Disorders, 44, 25-30.

Choi, C. Y. & McPherson, B. (2005). Noise levels in Hong Kong primary schools: implications for classroom listening. International Journal of Disability, Development and Education, 52, 345-360.

Counter, S. A. (1986). Audiological screening of Amerindians of the Surinam rainforest Scandinavian Audiology, 15, 57-64.

Daud, M. K., M., Noor, R. M., Rahman, N. A., Sidek, D. S., & Mohamad, A. (2010). The effect of mild hearing loss on academic performance in primary school children. International Journal Pediatric Otorhinolaryngology, 74(1), 67-70.

Davey, S., Maheshwari, C., Raghav, S. K., Singh, N., Muzammil, K., & Pandey, P. (2018). Impact of indian public health standards for rural health care facilities on national programme for control of deafness in India: The results of a cohort study. Journal of family medicine and primary care, 7(4), 780–786.

Downs, M. P. (2004). Contribution of mild hearing loss to auditory learning problems. In R. J. Roeser& M. P. Downs (4th Ed). Auditory Disorders in School Children: the Law, Identification, Remediation (pp. 233-248). New York: Thieme.

Duthey, B. (2013). PriorityMedicines for Europe and the World. A Public Health Approach to Innovation.

Gell, F. M. and White E. McC. (1992). Practical Screening Priorities for Hearing Impairment Among Children in Developing Countries. Bulletin of the World Health Organization, 70, 645-655.

Gomes, M. & Lichtig, I. (2005). Evaluation of the use of a questionnaire by non-specialists to detect hearing loss in preschool Brazilian children. International Journal of Rehabilitation Research, 28, 171-174.

Gopal, R., Hugo, S. R., Louw, B. et al. (2001). Identification and Fellow up of Children with hearing Loss in Mauritius. International Journal Pediatric Otorhinolaryngology, 57, 99- 113.

Gordis, L. (2000). Epidemiology. Philadelphia, Pennsylvania: W.B. Saunders Company.

Haggard, M. and Hughes, E. (1991). Screening Children's Hearing. London: HMSO.

Harford, E. R. and Bess, F. H. (1978). Impedance Screening for Middle Ear Disease in Children. New York: Grune and Stratton.

Harrison, M., Roush, J., Wallace, J. et al. (2003). Trends in Age of Identification and Intervention in Infants with Hearing Loss. Ear and Hearing, 24, 89-95.

Healers Regarding Impairment. International Audiology, 44, 489-131. Hearing Journal of

Edejer, T. T. (2005). Cost Effectiveness Analysis of Strategies for Child Health in Developing Countries. British Medical Journal, 331, 1177 1182.

Kapur, Y. P. (1965). A study of hearing loss in school children in India. Journal of Speech and Hearing Disorders, 30 (3), 225-233.

Katz, J., Burkard, R. F., &Medwetsky, L. (2002). Handbook of Clinical Audiology. (5th Ed.). Philadelphia: Lippincott Williams & Wilkins.

Kennedy, C. R., McCann, D. C., and Campbell, M. J. (2006). Language Ability After Early Detection of Permanent Childhood Hearing Impairment. New England Medicine, 354, 2131-2141.

Kumar, S., D'Mello, J. (2006). Journal of Identifying Children At-Risk For Speech and Hearing Disorders. A Preliminary Survey Report from Hyderabad, India.

Kundu, C. L. (2000). Status of Disability in India (2000). New Delhi: Rehabilitation Council of India.

Kundu, C. L. (2003). Disability Status India (2003). New Delhi: Rehabilitation Council of India.

Lampty N. H., Amedofu G. K., Brown E. N. L. et al., (2004). School Screening for Hearing Impairment Among School Children in Sunyani District of Ghana. Hearing Network News.

Leung, W. H. & McPherson, B. (2006). Classrooms for children with developmental disabilities. International Jornal of Disability, Development and Education, 53, 287-299.

Lin, C. Y., Huang, C. Y., Lin, Y. H. (2004). Community- Based Newborn Hearing Screening Program in Taiwan. International Journal of Pediatric Otorhinolaryngology, 68, 185-189.

Maarse, A., Phouc N. T. M., McCracken W. et al. (2001). External Review: Project to Support the Development of Early Intervention for Hearing Impaired Children. Unpublished Report, Netherlands: Committee Twee.

McPherson, B., & Knox, E. (1992). Test-retest variability using the Liverpool screening audiometer in a field environment. British Journal of Audiology, 26, 139-141.

Mulwafu, W., Kuper, H., Ensink, R. J. H. (2015). Prevalence and causes of hearing impairment in Africa. Bulletin of the World Health Organization, 97, 654-662.

National Sample Survey Organization (1991). Disabled persons in India: NSS 47th round (July-December 1991). New Delhi: National Sample Survey Organization and Ministry of Statistics and Programme Implementation Government of India.

National Sample Survey Organization (2003). Disabled persons in India: NSS 58th round (July-December 2002). New Delhi: National Sample Survey Organization and Ministry of Statistics and Programme Implementation Government of India.

Nikam, S. (2003). Hearing Impairment. Status of Disability in India – 2003. C.L Kundu (Ed). New Delhi: Rehabilitation Council of India.

Kundu, C. L.(2003). Disability Status India (2003). New Delhi: Rehabilitation Council of India.

Nodar, R. H. (1978). Teacher identification of elementary school children with hearing loss. Language, Speech, and Hearing Services in Schools, 9, 24-28.

Northern, J. L. (1973). Hearing in Children. Baltimore, Maryland: The Williams & Wilkins Company.

Paparella, M. M. and Suguira, S (1967). The Pathology of Suppurative Labyrinthitis. Annals of Otolology, Rhinology and Laryngology, 75, 554 – 586.

Reynolds, D. C. (1982). The Validity of a Screening Test. American Journal of Optometry and Physiological Optics, 59, 67-71.

Rao, R. S. P., Subramanyam, M.A., Nair, N. S., &Rajashekhar, B. (2002). Hearing impairment and ear disease among children of school entry age in rural South India. International Journal of Pediatric Otorhinolaryngology, 64, 105-110.

Saim, A., Saim, L., Saim, S., Ruszymah, BHI. and Sani, A. (1997). Prevalence of otitis media with effusion amongst pre-school children in Malaysia. Int J PediatrOtorhinolaryngol, 41, 21 8.

Shaheen, M., Raquib, A. and Ahmad, S.M. (2011). Chronic Suppurative Otitis Media and its Association with

Social Economic Factors Among Rural Primary School Children of Bangladesh. Indian Journal of Otolaryngology in Head and Neck Surgery, 64, 36-41.

Siddartha, Bhat, V., Bhandary, S. K., Shenoy, V. and Rashmi. (2011). Otitis media with effusion in relation to socio economic status: a community based study. Indian J Otolaryngol Head Neck Surg, 64(1), 56-58.

Sideris, I., &Glattke, T.J. (2006). A comparison of two methods of hearing screening in the preschool population. Journal of Communication Disorders, 39, 391-401.

Smith, A. (2008). Demographics of Hearing Loss in Developing Countries. London: Nova Science Publisher, Inc.

Thorner, R. M. and Remein, Q. R. (1982). Principles and Procedures in the Evaluation of Screening for Disease. In J. B. Chaiklin, I. Ventry and R. F. Dixon (Ed.), Hearing Measurement. A Book of Readings (pp. 408-421). Reading, Massachusetts: Addison Wesley Publishing Co.

Vernon, M (1969). Tuberculous Meningitis and Deafness. Journal of Speech and Hearing Disorders, 32, 177-181.

Watkin, P. M., (2001). Neonatal Screening for Hearing Impairment.Seminars Neonatology, 6, 501-509. in

White, K. P. (2004). Early Hearing Detection and Intervention Programs: Opportunities for Genetic Services. American Journal of Medical Genetics, 130A, 29-36.

Wilson, J. M. G. and Jungner, G. (1968). Principle and Practice of Screening for Disease. Geneva: World Health Organisation Press.

World Health Organization (1971). Mass Health Examinations. Public Health Papers No. 45. Geneva: World Health Organisation Press.

World Health Organization (2002). State of the World's Vaccines and Immunizations. Geneva: World Health Organisation Press.

World Health Organization (2004). Guidelines for Hearing Aids and Services for Developing Countries.Geneva: World Health Organisation Press.

World Health Organization (1995). Prevention of Hearing Impairment.Resolution of the 48th World Health Assembly. Geneva: World Health Organisation Press.

World Health Organization (1991). Report of the Informal Working Group on Prevention of Deafness and Hearing Impairment Program Planning. WHO/PDH/91.1. Geneva: World Health Organisation Press.

World Health Organization / CIBA (1996). Prevention of Hearing Impairment from Chronic Otitis Media: Prevention of Blindness and Deafness. Report of a WHO/CIBA Foundation Workshop. London: World Health Organization Press.

68. WHO-Regional Office for South-East Asia. (1997). Multicenter Study on

the Magnitude and Etiology of Hearing Impairment. Report of a Meeting of Principal Investigators. Colombo, Sri Lanka.

World Health Organization (2005). Health and the Millennium Development Goals. Geneva: World Health Organization Press.

World Health Organization (2010). Deafness and Hearing Impairment. Fact Sheet No 300. Geneva: World Health Organization Press.

World Health Organization (2012). WHO global estimates on prevalence of hearing loss.

World Health Organization. (2013a). Millions of People Living in the World have Hearing

Loss that can be Prevented. Retrieved from www.who.int/pbd/deafness/news/Millionsliv ewithhearingloss.pdf

World Health Organization. (2013b). Multi country Assessment of National Capacity to Provide Hearing Care. Retrieved from http://www.who.int/pbd/publications/WHOR eportHearingCare_Englishweb.pdf

World Health Organization (2015a). 1.1 Billion People at Risk of Hearing Loss. Retrieved from www.who.int/mediacentre/news/releases/20 15/ear-care/en/

World Health Organization (2015b). Make Listening Safe Campaign. Retrieved from http://www.asha.org/uploadedFiles/ASHA/B uds/WHO-Make-Listening-Safe-Campaign Factsheet.pdf

World Health Organization (2018). Deafness and Hearing loss. Geneva: World Health Organization Press.

APPENDIX

ANNEX 1.

Format of questionnaire

Name of child ---------- Age ----------

Name of school ---------- class ----------

Parent's monthly income Contact no. ----------

In figure ---------- Address ----------

In digits ----------

1) Does your child have any hearing loss? YES / NO

(2) Does your child listen T.V. in high volume? YES / NO

(3) Does your child suffer from common cold very frequently? YES / NO

(4) Does your child feel blocking sensation in the ear? YES / NO

(5) Does your child feel recurrent earache? YES / NO

(6) Does your child take breath from mouth? YES / NO

(7) Does any discharge come from your child's ear? YES / NO

(8) Doesn't reply when call his or her name? YES / NO

(9) Does your child speech is delayed or not clear? YES / NO

(10) Does your child often say, "Huh?" and "What?" YES / NO

(11) Inattentiveness and inappropriate responses to questions in classroom? YES / NO

Signature of parent **Signature of teacher** **Signature of audiologist**

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