

## Hearing Screening in Primary School Children: An Overview

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### Abstract

**Background:** Hearing impairment is very commonly encountered in school going children, if not identified early it can lead to deviation of the neural topography of the child along with social, behavioral and communication problems. The aim of this research is to conduct a screening program for primary school going children to provide sufficient reliable data on the occurrence of hearing impairment and its relationship to age and gender. **Materials and methods:** In this cross sectional study a convenient sample consisting of 1516 primary school going children from Bikaner were screened for hearing loss. Subjects were divided in four grades viz. Grade 1: 423 children (3-11 yrs), Grade 2: 393 children (5-13 yrs), Grade 3: 302 children (6-12years) and Grade 4: 398 children (6-14 years). Primary information was obtained through case history then otoscopy examination, Pure Tone screening, tympanometric screening and DPOAES screening performed on the subjects. Data was obtained and analyzed by Pearson's chi-square test. **Results:** Finding revealed 13.7% males and 17.6% females with hearing impairment further refer rate was more for left ear compared to the right ear. Overall the refer rate was found more for females in both the ears at all screened frequencies and observed highest for the Grade 1. Pearson's chi-square test suggested statistically significant difference in refer rate among both gender and grades. **Conclusion:** The present study suggested that there is high prevalence of hearing loss in primary school going children which varies among different grades and gender. Negligence, lack of awareness and delay in promptness for pursuing regular hearing health care service are major causes for current findings. Data obtained from the present study emphasizes the role of annual hearing screening programs for school going children to promote the general health care, education, social and emotional adjustment.

**Key words:** Hearing screening, sensitivity, Prevalence, Otoscopy, Pure tone audiometry, Tympanometry, Otoacoustic Emissions

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### INTRODUCTION

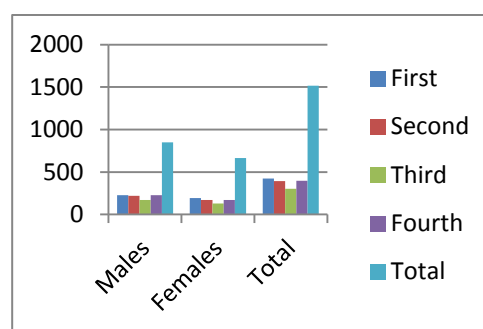
Conductive hearing impairment is very commonly encountered in school going years, extending from mild to moderately severe in degree and can be due to various causes mainly middle ear infections (otitis media, glue ear) and many other sequel associated with serous otitis media such as chronic otitis

media and cholesteatoma. Studies suggest that even a brief period of auditory deprivation caused due to a conductive or a fluctuating hearing loss can result in deviations of the neural topography of a child.<sup>1</sup> Because of the time spent with reduced hearing, children with more persistent or recurrent bouts of glue ear are at risk of delayed language, difficulties learning to read, gap in general knowledge, difficulty in reasoning ability and social, behavioral problems.<sup>2</sup> Jerger<sup>3</sup> estimated that

prevalence of otitis media with fluid ranges up to 30% and seldom less than 15%. Around 200,000 children suffer from repeated ear infections or glue ear each year in the UK.<sup>4</sup> Emerick<sup>5</sup> survey of 518 elementary school children between the age group of 5-11 years from 11 schools of the city reported 66 ears were involved with otitis media and 12 children had bilateral disease. In another survey on 1670 school going children (1030 rural and 640 urban) in the age range of 12-14 years reported incidence 6.31% in the urban group and 32.81% in the rural group.<sup>6</sup> Sanjay Kumar and D'Mello<sup>7</sup> conducted a preliminary survey on 6591 children studying in class I to IV to identify at risk for hearing loss and speech and language problems and found 15.96 % children with hearing loss. Early identification and secondary prevention of middle ear disorders and associated hearing impairment in school going children can be done effectively only through routine school hearing screening programs. Such programs also provide valuable data pertaining to occurrence, incidence and prevalence, which is the main prerequisite in formulating nationwide strategies for identification and intervention. In India, school hearing screening programs are practically non-existent. No nationwide school screening program is available in the country. In a large and multi-cultural country like India, there could be a number of barriers which prevent the identification of hearing impairment. Some of these are lack of awareness and ignorance on part of parents regarding seriousness of hearing disorders, feasibility issues in terms of time and transportation, poor socioeconomic status and poor lifestyles which make such problems least significant, especially in the school going population. Further, the medical and health care services available are most often limited in the rural areas. In Bikaner and the adjacent towns and villages, the hearing health care services are in the juvenile stage or not at all available and there is no implementation of hearing screening programs such as UNHS (Universal Newborn Hearing screening) or school screening programs to identify the occurrence of hearing impairment in different age groups. Hence, this study was undertaken with the main aim of conducting a screening program for primary (grade 1 to 4) school going children, So as to provide sufficient reliable data on the occurrence of hearing impairment in this population and compare the screening outcomes for history taking, otoscopic examination, audiometric screening, tympanometry screening and OAEs screening for the school going population.

## MATERIAL AND METHODS

The present study involved conducting a convenient sample consisting of 1516 children from nine primary schools both private (6 schools) and government (3 schools) from Bikaner. Communication about the present study was sent to 25 schools in Bikaner and nine schools gave consent for participating in the study. Children from grades one to four were included in the study. Children unable to provide behavioral response for pure tone screening and those with any medical condition that contraindicated participation in the screening were excluded. Subjects were divided in four groups based on the grades. Grade 1: 423 children (3-11 yrs) Grade 2: 393 children (5-13 yrs) Grade 3: 302 children (6-12years) and Grade 4: 398 children (6-14 years)



**Figure 1. Grade wise and gender wise distribution of subjects included in the study**

## TOOLS USED:

As per ASHA<sup>8</sup> and American Academy of Audiology<sup>9</sup> screening tools were used. Data was collected in a quiet room Detailed history was taken after taking proper consent from the parents and with due permission of school management. Case history revealed that most of these children belonged to middle class families and don't have any significant natal, medical or developmental history.

**Otosopic Examination:** To examine ear canal and tympanic membrane a handheld Otoscope was used. Subjects were classified as 'Pass' if no abnormality detected and 'Refer' if ear abnormalities such as obstructions, impacted cerumen, foreign bodies, blood or other drainage, stenosis, atresia, otitis externa, perforation, or other abnormalities of the tympanic membrane were present in one or both ears.

**Pure Tone Screening:** Pure Tone screening was performed using a single channel calibrated clinical audiometer, (ELKON EDA GIGA3) with standard headphones. Screening was conducted at

four frequencies viz. 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz at an intensity level of 25 dB HL for both ears separately. The result was recorded as 'Pass', if response was obtained at three out of the four screened frequencies and 'Refer', if no response was obtained at two or more screened frequencies.

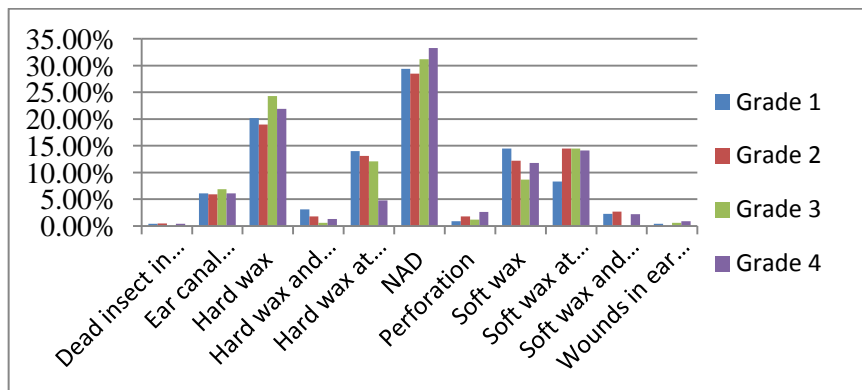
**Tympanometric Screening:** A calibrated diagnostic GSI TYMPSTAR Version 2 Middle Ear Analyzer was used. Tympanometric screening was performed to find out Ear Canal Volume, Static Admittance and Tympanometric Peak Pressure. The results were recorded as a 'Pass', if the Static admittance measure ranged from 0.3 mmho to 1.75 mmho with tympanometric peak pressure ranged between -100 daPa to +60 daPa described as A type tympanograms. and 'Refer', for static admittance less than 0.3 mmho or greater than 1.75 mmho and Tympanometric peak pressure less than -100 daPa or greater than +60 daPa. Different obtained 'refer' conditions were described as 'As', Ad, 'C', 'Cs', 'Cd', 'A+', 'As+'tympanograms.

**DPOAE Screening:** A calibrated handheld OAE screening instrument, INTERACOUSTICS OTOREAD, was used. DPOAE findings were recorded as 'Pass', if DPOAEs present on 3 out of 4 frequencies tested with SNR of +6dB. And 'Refer', DPOAEs not present on 3 out of four frequencies tested with SNR obtained less than +6dB. The obtained data was analyzed for occurrence of hearing impairment across gender and between different grades using Pearson's chi-square test.

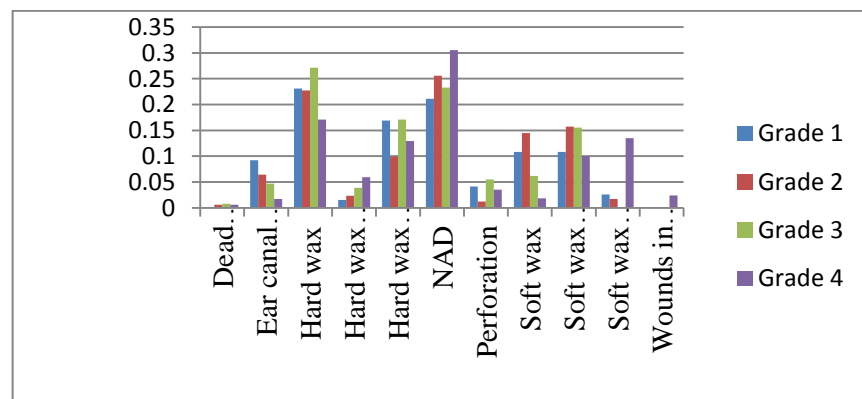
**RESULTS**

**Otoscope findings:**

Otoscope examination revealed normal findings and conditions such as presence of dead insects, hard wax, soft wax, ear infection and perforation with other conditions. Different external ear findings were present in 45.8% males and 48.1% females. Overall, 46.8% and 47.4% individuals in the



**Figure 2. Otoscopic findings of right ear across Males among different grades**



**Figure 3. Otoscopic findings of right ear across females among different grades**

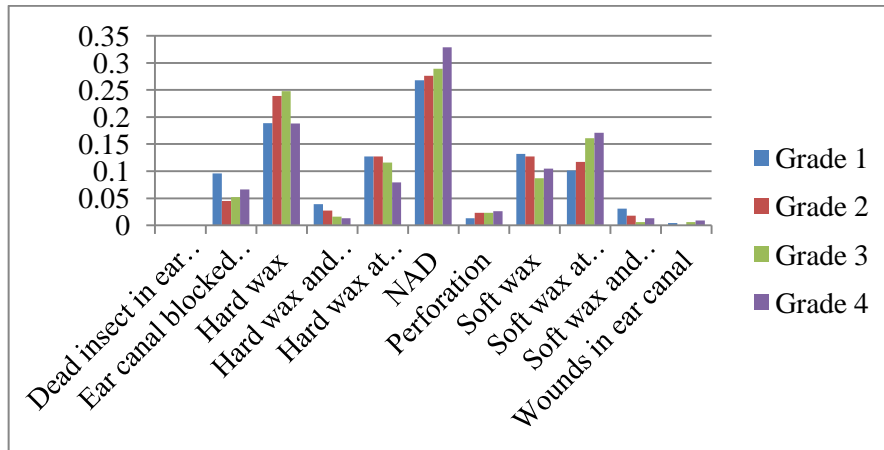


Figure 4. Otoscopic findings of left ear across males among different grades

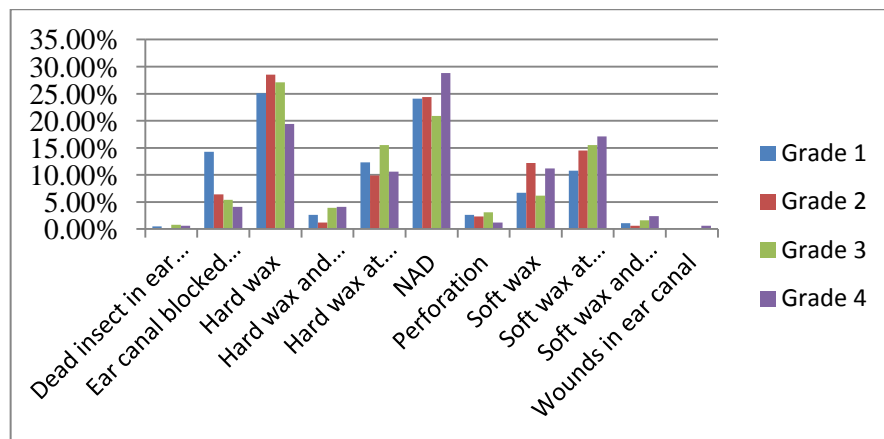


Figure 5. Otoscopic findings of left ear across females among different grades

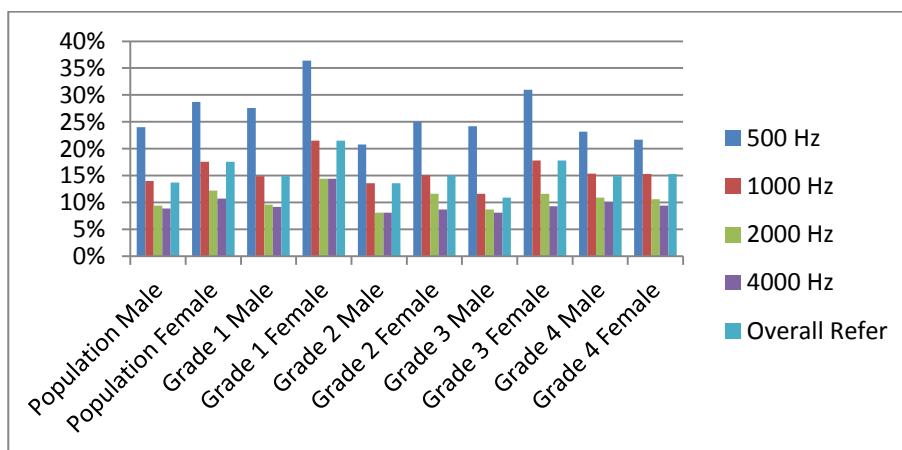
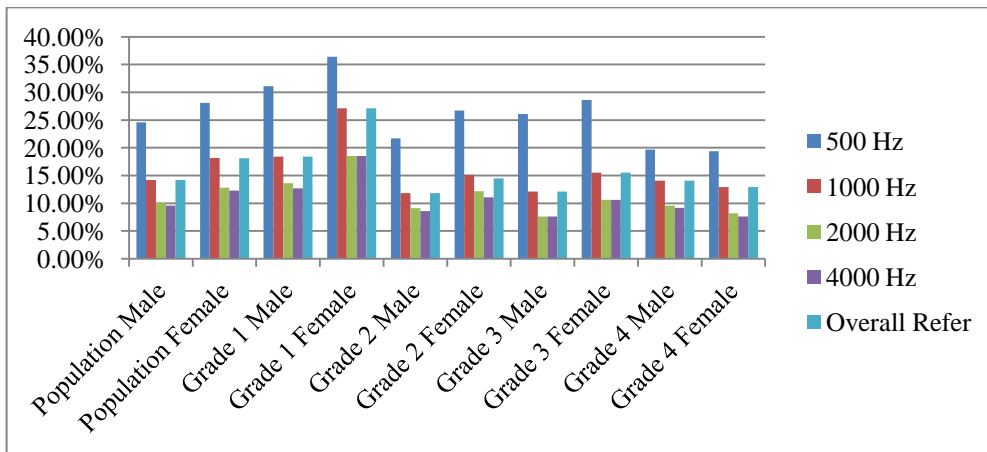
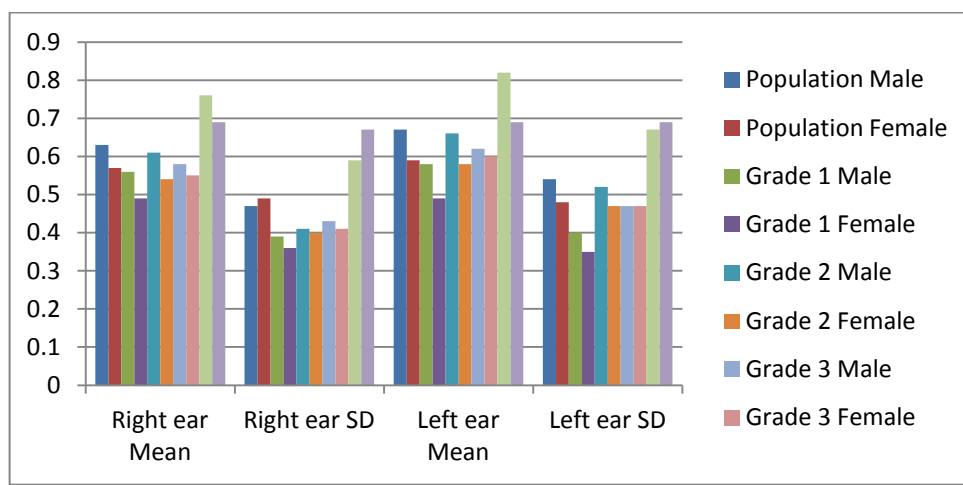


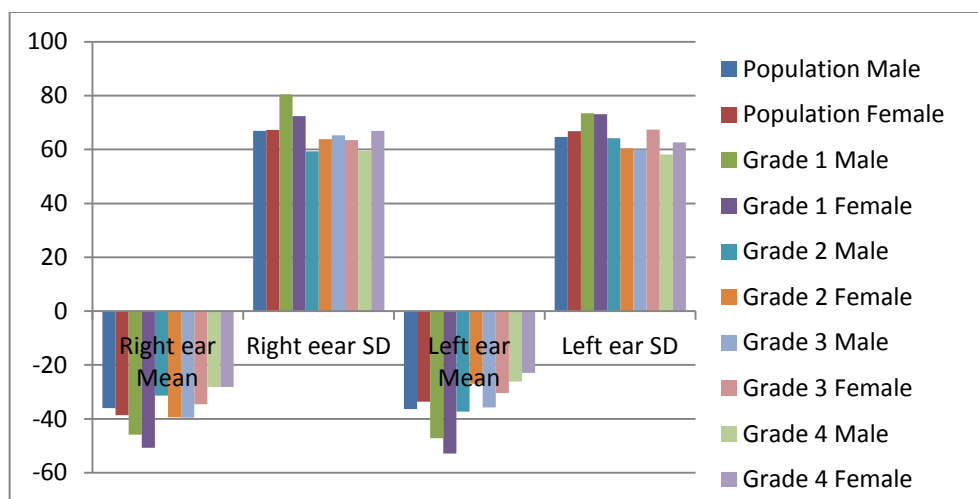
Figure 6. Refer rates for pure tone screening for right ear across gender among different grades



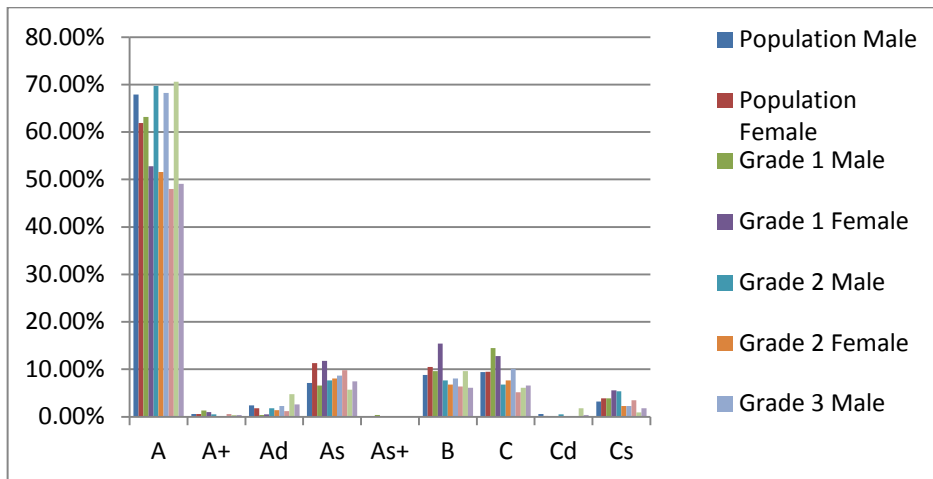
**Figure 7. Refer rate for pure tone screening for left ear across gender among different grades at test frequencies**



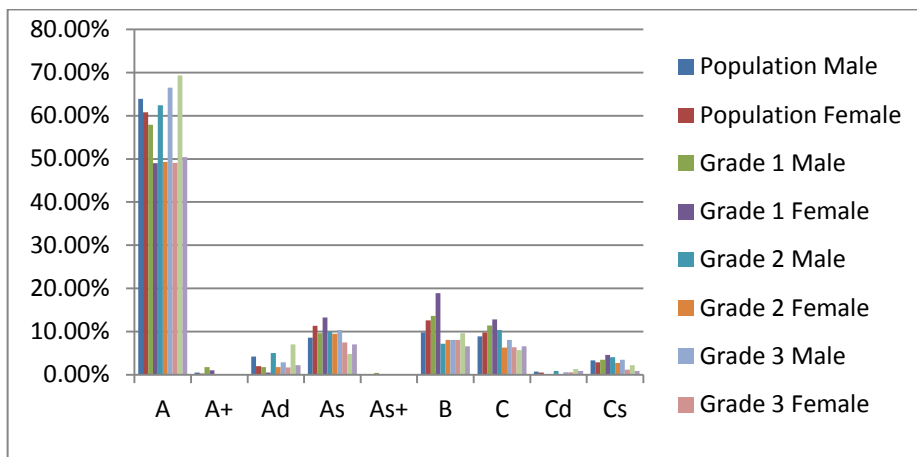
**Figure 8. Means and SDs of Compliance measures across gender and different grades**



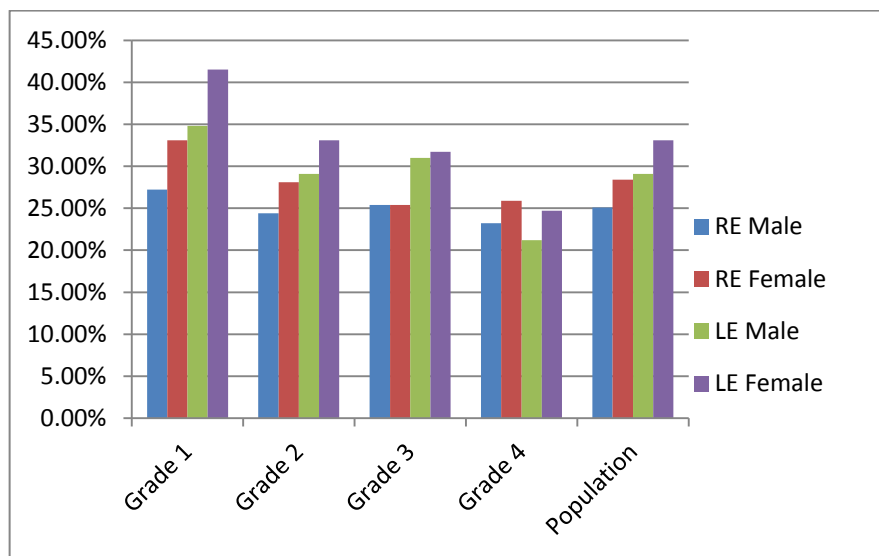
**Figure 9. Means and SDs of TPP measures across gender and different grades for right ear and left ear**



**Figure 10. Occurrence of different types of Tympanogram for right ear across gender among different grades**



**Figure 11. Occurrence of different types of Tympanogram in left ear across gender among different grade.**



**Figure 12. Ear specific Refer rate across gender among different grades for DPOAE screening**

screened population had presence of some external ear abnormality in right ear and left ear respectively. Thus data suggests that external ear abnormalities were more observed in females compared to the male population. Figure 2, Figure 3, Figure 4, and Figure 5 illustrate the ear specific otoscopic finding across male and female group among different grades.

#### **Pure tone screening:**

Pure Tone screening finding revealed that among the total population, 13.7% males and 17.6% females obtained a refer result. Further for left ear 14.2% males and 18.1% females got refer result where as for right ear it was 17.6% females and 13.7% male. Among all grades it was observed that the refer rate decreased across frequencies from 500 Hz to 4000 Hz. Figures 6 and Figure 7 describe the ear specific and frequency specific refer rates for pure tones across gender among different grades. Overall the refer rate was found more for females in both the ears at all screened frequencies and observed highest for the Grade 1.

#### **Tympanometric screening:**

Tympanometric screening revealed low compliance in 19.5% males and 25.7% females, normal compliances in 77.4% males and 72.5% females and high compliances in 3.1% males and 1.8% females for right ear. For the left ear 21.9% male and 27% females revealed low compliance, 73.4% males and 70% females revealed normal compliance and 4.7 % males and 2.6% females revealed high compliance. Figure 8 illustrates Means and SDs of Compliance measures across gender and different grades. Data pertaining to tympanometric peak pressure reveals that for the right ear 13.8% of males and whereas 15.4% females had TPP values ranging from -400 to -105 daPa. TPP value between -100 to +60 daPa was observed in 84.7% males and 83.6% females. 1.5% males and 1% females were observed to have TPP in the range of +60 to +200 daPa. For left ear it is evident that 14.3% males and 14.4% females obtained TPP values in the range of -400 to -105 daPa. TPP value of -100 to +60 daPa was observed in 84.8% males and 83.9% females. Whereas 0.9% males and 1.7% females were observed to have TPP in range of +60 to +200. Figure 9 illustrates the Means and SDs of TPP measures across gender and different grades. Occurrence of different types of tympanogram in the right ear and left ear was also obtained among different grades. Refer rate for the overall population is 32.1% in males and 38.1% in females. Figure 10 illustrates gender specific Refer rate among different grades in right

ear. It is observed that across grade 1 to grade 4 the refer rate decreases from 30.3% to 29.4% in males and 47.1% to 34.1% in females. Figure 11 illustrates gender specific Refer rate among different grades in left ear. It is observed that from grade 1 to grade 4 the refer rate decreases from 42.1% to 30.7% in males and 50.8% to 32.4% in females. Paired comparisons were made using the Pearson's chi-square to find out if the difference in the tympanometric screening results between the different grades was statistically significant. There was a significant difference in refer rate for tympanometric screening in both right ear and left ear between grade 1 & 2, grade 1 & 3, and grade 1 & 4. The difference in the refer rates between grades 2 & 3, 2 & 4 and 3 & 4 were not significant. Figure 10 & Figure 11 suggest that the overall refer rate for tympanometric screening is more in the left ear (37.5%) than the right ear (34.8%). The refer rate was found to be more in the left ear for both males (36.1%) and females (39.2%). When considered across gender, the refer rate was higher in females for both right and left ear.

#### **Oto acoustic emission screening:**

DPOAE screening finding revealed that the refer rate for right ear and left ear was 25.1% in males, 29.1% in females and 28.4% in males, 33.1% in females respectively. Among grades, it is observed that the refer rate decreased from grade 1 to grade 4 for both female and male group. Among the overall population it was observed that the refer rate was more in the left ear for both genders. It is also seen that the refer rate was more in females than males, suggesting more females got refer in OAE screening. Pearson's chi-square test suggested that the difference between the DPOAE refer rate for gender and grade in right ear is not significant. But for left ear, there is a significant difference in refer rate for among both gender and grades 1 & 2, 1 & 3 and 1 & 4.

## **DISCUSSION**

WHO<sup>10, 11</sup> has provided 6.3% prevalence of hearing impairment in India of all ages with hearing loss > 41dBHL. However, the present study estimates occurrence of hearing impairment (thresholds above 25 dBHL) 15.7% in the age range of 3 to 14 years. This difference can be attributed to the difference in the protocol used in the two studies.

WHO<sup>10, 11</sup> has also provided the prevalence of ear wax and dry perforation leading to hearing impairment in 18.7% and 0.5% population. In the present study hard wax was observed in 21.6% and 22.9% for right ears and left ear respectively

whereas occurrence of dry perforation was 2.2%. This increased occurrence may be attributed to the difference in the time period of prevalence data being surveyed and also an overall increase in hearing impairment from 250 million in 2001 to 600 million in 2011.<sup>12</sup> In the present study the refer rate for pure tone screening about 15.5 % (both ears) is almost similar to that reported by NSSO<sup>13</sup>. Sanjay Kumar and D'Mello<sup>7</sup> reported 15.96% hearing loss and 2.78% ear infection among 6951 children from grade 1 to grade 4 substantiating the refer rate of 15.7% in pure tone screening and 2.7% - 4.5% ear infection was found in the current study. Prevalence study on school entry age in rural areas found 11.9% hearing impairment and wax was the most common.<sup>14</sup> Current study estimates the refer rate among 1<sup>st</sup> grade as 20.2%. This increased refer rate might be due to difference in time period of prevalence rate being surveyed and an overall increase in the prevalence of hearing impairment. No previous data was obtained regarding the prevalence or occurrence of the various external ear abnormalities among various primary school grades and gender. Current study findings provide the occurrence rate of various external ear findings across grade and gender. It was observed that overall more external ear abnormalities were present in females than in males and across grades more abnormalities were found in grade 1. It was also obtained that the occurrence of abnormal external ear findings falls from grade 1 (58.9%) to grade 4 (44.9%). In the present study comparison among different grades revealed that highest refer rate was found for children in grade 1 and refer rate decreased from grade 1 to grade 4 which was in accordance with the otoscopy, tympanometry, and pure tone audiometry results among different age group children.<sup>15</sup> While comparing the type of tympanogram in referred population B type was most common found followed by C type and As type. A study on Otoacoustic emissions in a screening on school-age children reported that 20% children failed in both ears and 32% in at least one ear.<sup>16</sup> In the present study the refer rate was reported separately for the right (29.1%) and the left (33.1%) The difference in the two studies may be credited to the factors like awareness among the population, difference of geographical areas and availability of medical facilities. Thus it can be seen that the findings of the present study are in accordance with some earlier studies in terms of the refer rate for pure tone screening but the refer rates for tympanometric screening and DPOAE screening are observed to be higher than the other

studies. These differences may be attributed to several reasons including differences in the age range of the population studied, geographical areas, climatic conditions, socioeconomic conditions and lifestyles etc. Also, procuring of medical services for the various disease and disorders of external and middle ear, negligence and lack of awareness and promptness for pursuing regular hearing health care service are other major issues which serve as a contributing factor in the prevalence rate of hearing impairment. Major issues which act as hurdles for obtaining the medical and hearing health population in our country are Illiteracy, poverty, old customs and beliefs and scarcity of finance. These problems are more prevalent in the rural and suburban areas including small villages and towns where medical and audiological services are scarce in comparison to urban areas. Most of the population suffering from middle ear disorders is either not aware of the condition and its possible outcomes or has a tendency to pursue medical assistance when the disorder reaches at the chronic stage. People in the rural and suburban areas of the country still have a tendency towards seeking some domestic treatment (putting oil in the ear) which may upsurge the disease or disorder and lead to the proliferation of disease. This shows that there is no promptness in procurement of medical assistance in the initial, progressive or acute stages of disorder. The socio-cultural milieu is such that male children are provided more prompt attention for procuring medical facilities than the female child, which is reflected in the present study where refer rate has been observed more among the females than males. Current study also shows some atypical findings such as presence of dead insects in the ear canal in 0.5% children, wounds in ear canal in 0.9% children and blocked ear canal due to hard wax in 7.4% children. Overall there is lack of awareness of ear care and hygiene leading to such findings and further, ignorance towards personal ear care leads to spread of disorder towards tympanic membrane, middle ear and other associated structures. Therefore, it is very important to have authentic data for occurrence and prevalence rate of hearing impairment, which will assist in planning appropriate prevention strategies and management options for the hearing impaired population

## CONCLUSION

Hearing impairment is very commonly encountered in school going years; even a brief



period of auditory deprivation can result in deviations of the neural topography of a child and delay in speech and language. The present study suggested that there is high prevalence of hearing loss in primary school going children which varies among different grades and gender. Negligence, lack of awareness and lack of promptness for pursuing regular hearing health care service are other major issues. Data obtained from the present study emphasizes the role of annual hearing screening programs for school going children to promote the general health care, education and social adjustment.

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