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Recognition of High-Risk Registry in Hearing Screening Through Advanced Instruments

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ABSTRACT:

Introduction:Hearing loss is one of the largest sensory disabilities globally. Hearing loss in childhood can seriously affect speech, language, cognitive and social development. Hence early identification of hearing impairment in children is imperative for appropriate preventive and intervention strategies which can be done effectively by school hearing screening programs. Present study aimed to screen primary school going children using otoscopic, pure tone and immittance screening with the main objective of identifying the percentage of children at high risk for hearing loss and to assess the agreement between these tools. Method: For every participant, first otoscopic screening is done. Then pure tone and tympanometric screening was performed as per ASHA (1997) guidelines.If participant did not pass on any one or more screening tools in either ear, rescreening was done within three months of initial screening using same screening tools and parameters. If participant who did not pass either on otoscopy or immittance rescreening was referred to otolaryngologist.

Those who did not pass on pure tone rescreening were referred for detailed evaluation. Results: It was found that 39.5% children were at risk for hearing loss. After rescreening it was observed that referral rate on pure tone screening decreased as frequency increased. Results on screening tools were compared and a good agreement was found between otoscopic and immittance screening results. Conclusion:Hearing screening programs should be conducted regularly using sophisticated tools in schools to facilitate early identification and early intervention and also to avoid delay in normal speech, language and cognitive development because of hearing loss. This would further help to have a better quality of life.

(Keywords: Hearing screening, prevention, otoscopy, immittance, quality of life.)

INTRODUCTION:

The incidence of hearing loss is apparent internationally and nationally. World health organization (WHO) in 'world report on hearing' states that 1.5 billion (20%) people have some degree of hearing loss and the majority (1.16 billion) have mild hearing impairment.[1] On positive note, a large percentage is likely to get prevented and treated by early detection and proper management.[1]According to National Sample Survey Organization (NSSO 58th round 2002), the hearing disability was the second topmost disability followed by locomotor disability, even when the hearing disability of only better ear was taken into consideration.[2] Apart from the cumulative trend of hearing loss, this can be contributed to childhood onset and/or progressive hearing loss if remains undetected and untreated.[3,4]

Conductive and mixed hearing loss (HL) can be caused during childhood due to various pathologies.[1,5] Mild to moderately-severe conductive or mixed HL does not cause inability to detect and discriminate normal conversational sounds but can cause attenuation of sound, distortion of essential components of acoustical temporal cues, inability to localize and discriminate sound specifically in noise, reduced speech perception, interference in some binaural processes. Hence disturb advance auditory processes which are imperative for apposite linguistic and cognitive development.[3,6,7,8] Research has shown that these symptoms exist even after restoration of hearing loss depending on factors like early detection and management of HL, duration of HL etc.[3,6]

As, school environment is not free from noise, hence early identification is crucial in schools that can be done effectively by school hearing screening programs. In school, our aim should be to identify even mild hearing loss. However, it is arduous to screen below 20 dB HL in schools, due to the presence of ambient noise. It is also valuable to obtain information regarding tympanic membrane, eustachian tube and other middle ear disorders. Hence there is a need to utilize sophisticated tools like audiometer, immittance, otoscopy etc.[3,4,9]

An attempt has been made with the main objective of conducting hearing screening and alleviate factors that interfere with sound conduction for primary school going children by using otoscope, audiometer and tympanometer, so as to appraise children at risk for HL thereby facilitating timely intervention.

METHOD:

The study protocol was reviewed and accepted by the Institution review board and was strictly adhered in the course of the study (Letter No. SGTU/FAHS/ASLP-RD-256/2023). A written permission was obtained to conduct hearing screening and communication about same was provided to every school.

Participants:

25 primary schools from Delhi-NCR region consisting of 1114 students in grade I – V were the sample included in the present study. Informed consent form and brief history proforma was made available to the parents of the participants through the school authorities prior to the screening program and was duly filled by them. Out of these children, screening was carried out for 956 participants as the remaining participants did not meet the inclusion criteria.

Inclusion criteria:

- Participants from primary school, studying in grade I – V. Both male and female subjects.
- Participants for whom written consent was obtained from parent/caregiver and able to give voluntary or conditioned responses to the pure tone stimuli.

Exclusion criteria:

- Participants below grade one and above grade five.
- Participants with medical conditions which contraindicate participation in the screening, such as conjunctivitis, chicken pox etc.
- Participants who were absent on the day of screening or whose parents did not give consent for screening.

Instrumentation:

Handheld otoscope Heine mini 3000 was used for otoscopic screening; pure tone screening was done using calibrated audiometer Interacoustics AD628with ANSI S 3.6 1996 specifications and calibrated Maico Touch-tymp MI 34 was used for tympanometric screening with a low probe tone frequency of 226 Hz.

Procedure:

Screening by otoscope was performed for every participant for both ears to examine the external auditory canal (EAC) and status of the tympanic membrane (TM) in order to rule-out any abnormality such as wax, tympanic membrane perforation and retraction. In this, three parameters i.e., no abnormality detected, soft wax and hard wax were observed. Following this, pure tone screening was done by a skilled audiologist at 1000, 2000 and 4000 Hz with a cut-off point set at 25 dB HL. This cut-off criterion for pass/refer was set after biological calibration with 25 young adults (50 ears) with hearing sensitivity within normal limits i.e., Air conduction (AC) thresholds of these subjects for 1000, 2000 and 4000 Hz were <25 dB HL.

After pure tone screening, tympanometric screening was performed as per American Speech and Hearing Association (ASHA, 1997) guidelines.[10] Tympanometric height, width and equivalent ear canal volume were the parameters used for screening. The tympanometricrefer was defined when static compliance is less than 0.3 ml, tympanometric width is greater than 200 daPa and/or ear canal volume is higher than 1.0 cm^3. If a participant did not pass on any one or more screening tools in either ear, rescreening was done within three months of initial screening. Rescreening was done using same screening tools and parameters.

Any participant who did not pass on rescreening were designated as at 'hight risk' for hearing loss and referred to tertiary care hospital for detailed evaluation and management.

Statistical Analysis:

The data was collected and basic statistical analysis (Descriptive statistics) were done. To check the effect of grades and gender, Pearson chi square test and Fisher's exact test were done. To see the agreement between tools, kappa test was performed.

RESULTS:

A two-stage hearing screening was attempted in primary schools' setup from first to fifth grade students by using three different tools. The first tool used was hand held otoscope.

Total 956 students from grade I – V [500 males (52%) and 456 females (48%)] were screened. Out of these participants (100%), 676 (71%) passed otoscopic screening whereas, 278 (29%) could not pass due to wax (either soft or hard) in EAC.

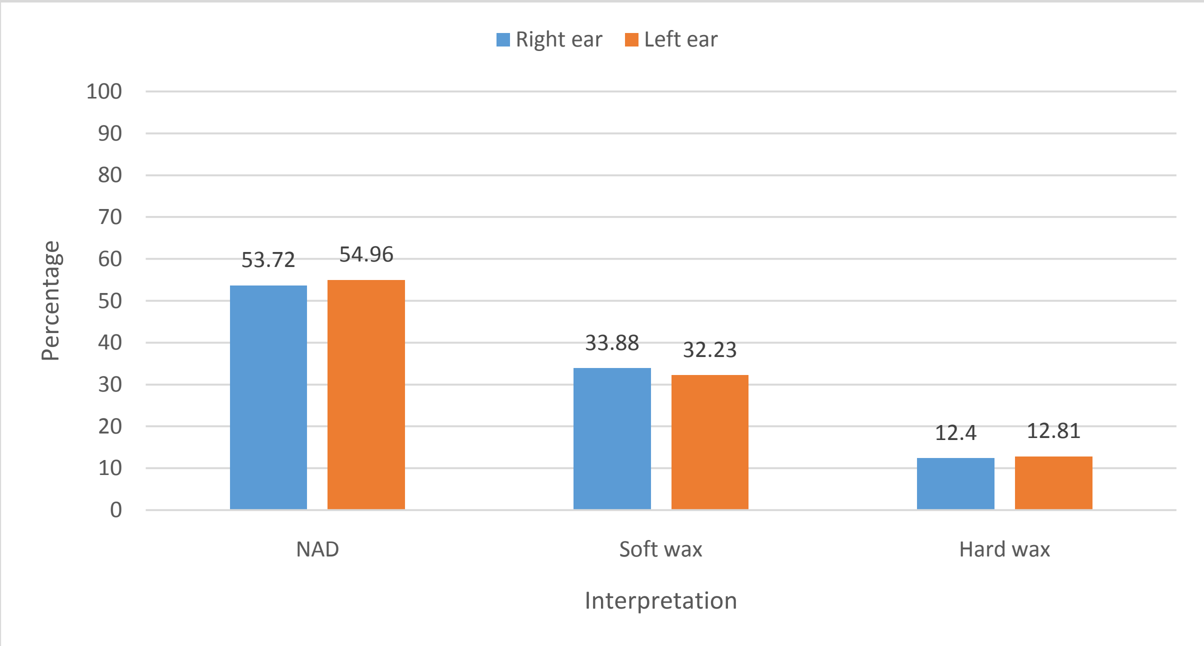
Of these 278 participants, 212 participants passed in rescreening but 66 participants still could not pass. Hence, overall, 7% participants failed in otoscopic two-stage screening. Table 1 depicts the overall otoscopy screening and rescreening results:

Table 1: Otoscopy screening result:

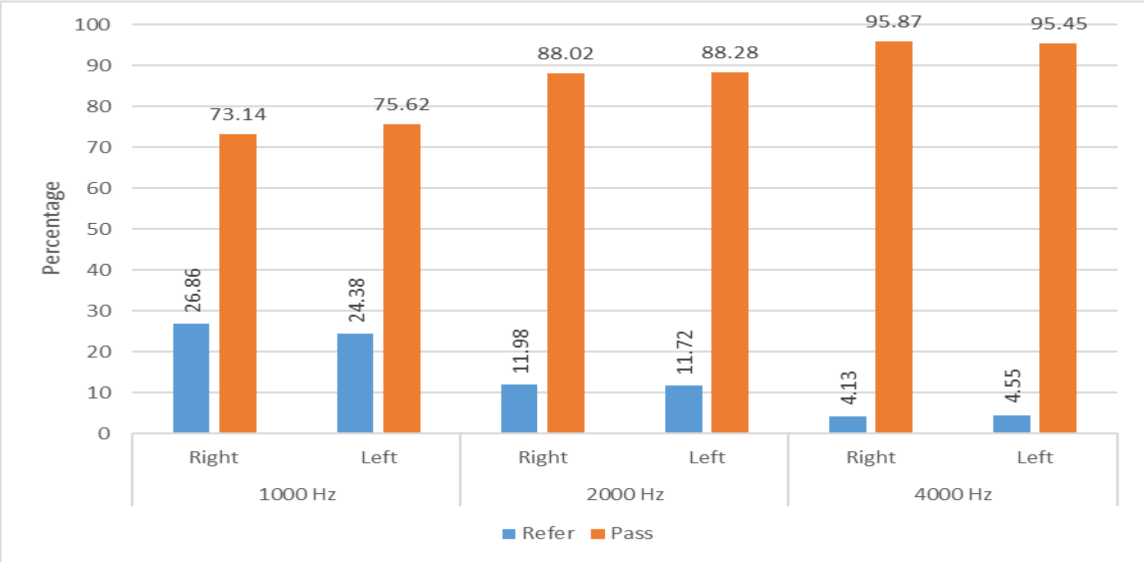
Result	Screening	Rescreening
Pass	678	212
Fail	278	66
Total	956	278

The overall percentage of hard wax was 12.40% in right ear and 12.81% in left ear. Graph 1 shows the ear wise otoscopy results:

Graph 1: Ear-wise otoscopy result:



The second tool was pure tone screening. The results on the same revealed that out of 956 participants, 287 participants were referred in screening while remaining 669 were passed. On rescreening, 201 participants passed, hence the residual remain were 86, the participants who refereed twice on pure tone screening. It is also to be noted (Graph 2) that most participants failed to respond at 1000 Hz and only around 75% participants passed screening at this frequency in either ear. Most of participants (>95%) were able to respond at



4000 Hz irrespective side of ear. Hence minimum referral rate was at 4000 Hz <5% in either ear, maximum at 1000 Hz approximately 25% and approximately 12% in either ear at 2000 Hz. **Graph 2 is depicting ear and frequency wise pure tone rescreening result:**

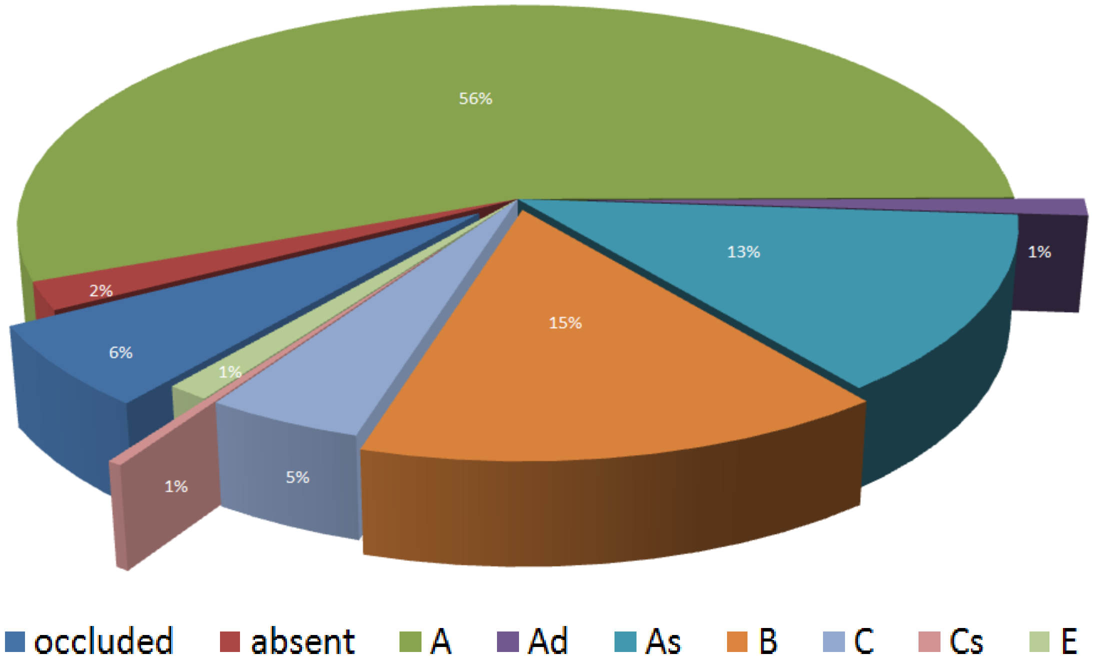
Graph 2: Ear and Frequency wise pure tone screening result.

The third tool used in the study was tympanometric screening. Results of the same revealed that about 60% participants showed A-type tympanogram (passed). Among the remaining participants (referred), B-type tympanogram was the most common for right ear followed by As and C-type; whereas As-type was most common for left ear followed by B and C-type tympanogram. Cs and Ad-type tympanograms were the least occurring type for either ear (Graph 3). It is also observed that not a single participant showed A+ type tympanogram in any ear.

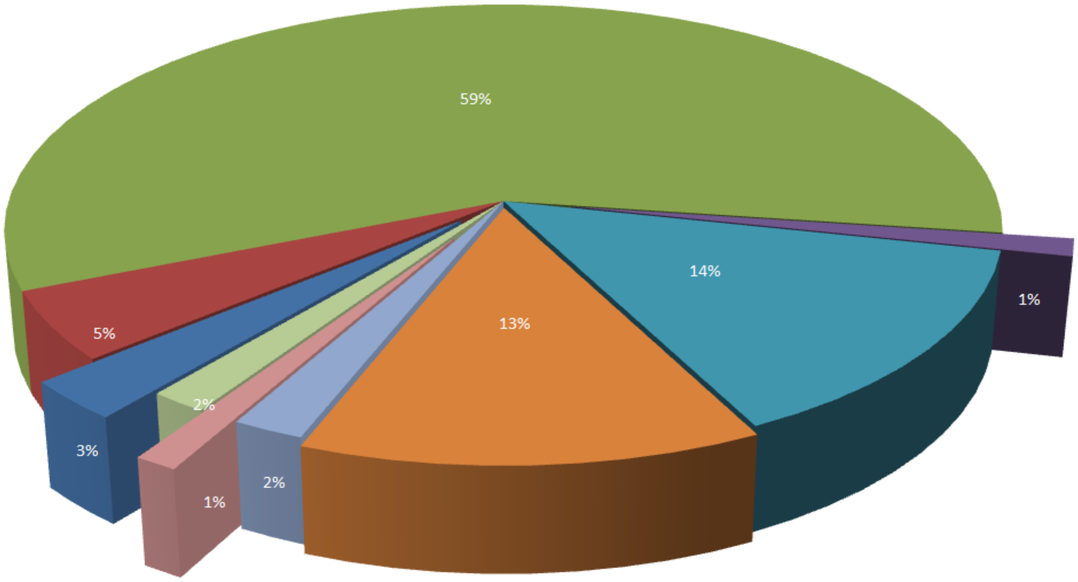
The various types of tympanograms obtained on tympanometric screening are shown by Graph 3:

Graph – 3: Different types of tympanograms obtained (ear specific):

Distribution of study group as per Rt ear tympanogram types



Distribution of study group as per Lt ear tympanogram types



In the present study participants were not distributed uniformly. Hence it was important to determine the effects of gender and grades on refer rate. To see the effect of grades, Pearson chi square test was performed and it showed that there was no significant effect of grades on referral rate. To see the effects of gender on referral rate, Pearson chi square test and Fisher's exact test was done. These tests showed that there was no significant difference in refer rates of male versus female participants.

Furthermore, the agreement between three tools was tested using kappa test of agreement. It was done for following: (A) otoscopy and pure tone screening, (B) otoscopy and immittance and (C) pure tone and immittance screening for right as well as for the left ear.

The results showed that there was fair agreement (either ear) for (A); good agreement (both ears) for (B); but poor agreement between pure tone and immittance screening (C) in either ear (Table 2). The following table shows the ear-wise kappa test values for A, B and C case.

Table 2: Agreement between tools:

Condition / Kappa		Value	Asymp. Std. Error (a)	Approx.(b)	P value
A	Right	0.301	0.058	4.985	0.000
	Left	0.386	0.056	6.461	0.000
B	Right	0.377	0.059	5.955	0.000
	Left	0.425	0.058	6.670	0.000
C	Right	0.195	0.064	3.079	0.002
	Left	0.104	0.063	1.672	0.094

**Refer text for A, B and C conditions*

DISCUSSION:

According toWHO and others (Ojha et al. 2016, Varshney, S. 2016, Kumar et al. 2019, Ansari 2021), on-going hearing screening is must in school going population especially in developing countries like India.[1,3,4,9,11,12,13] An attempt was made to conduct hearing screening by utilizing sophisticated tools among school age children.

The first tool used was handheld otoscope in which three parameters i.e no abnormality detected (NAD), soft wax and hard wax were observed. The overall percentage of hard wax was above 12% for either ear (Graph 1) which is in accordance with Minja et al. 1996, Godinho et al. 2001, Czechowicz et al. 2010, Ojha et al. 2019 and WHO 2021).[1,9,14,15,16] It is also suggested that referral on otoscopy (e.g. presence of ear wax) is a crucial factor in determining the hearing impairment.[15,17] Furthermore, the otoscopic results showed highest pass rate (>50% in either ear), which is due to the fact of direct visualization of EAC but inability to test the hearing sensitivity.

On the other hand, the second tool i.e. pure tone screening showed the highest referral rate. Not only that, but this tool also depicted frequency specific results as, the referral rate decreased with the frequency increased (Graph 2). It is, however, to be noted that prior to the screening in each school, 25 normal hearing adults were tested and were found to have thresholds ≤25 dB HL at 1000, 2000 and 4000 Hz using the same audiometer and in the same environment. This indicates that ambient noise levels in low frequencies cannot completely be responsible for high referral rate. Rather, presence of middle ear pathology especially in low frequencies could be the reason for this high referral rate. The referral rate on pure tone screening is in agreement with Mcpherson et al. 2010, Taha et al. 2010 and Ojha et al. 2019.[9,18,19] This suggests that the actual prevalence of hearing impairment among school children might be comparable to WHO 2021 report on hearing but not to NSSO where the hearing disability was quantified by questionnaires.[1,2]

On the third screening tool, the percentage of occurrence of different types of tympanograms was not equal. In both the ears, type A tympanogram was seen in >50% of the population which was followed by B and As tympanograms (Graph 3). Hence, the present study suggests high occurrence of middle ear pathology especially middle ear effusion in children. The referral rate on immittance screening was 38.3% on initial screening which decreased to 22.57% and 21.31% in right and left ears respectively after rescreening which is in agreement with the referral rate reported by Allen et al. 2004 and Ojha et al. 2019.[9,20] Ad type was the least occurring type of tympanogram, Pilka et al. 2021 also could not find Ad tympanogram in their study in school going children.[21]

Effects of gender and grades on screening results were determined by Pearson chi square and Fisher’s exact tests. These tests revealed no effects of gender and grades on screening results.

ASHA’1997 recommends rescreening within 3 months of screening to improve screening efficiency as some spurious conductive pathology may resolve with time. Similar protocol was used in present study. The overall referral rate after rescreening decreased from 57.8% to 39.5% for detailed evaluation thus reiterating the importance of rescreening in any school hearing screening program.[3,10]

At last, to check the agreement between tools; kappa coefficient was determined between all three tools utilized in the present study (Table 2). It was found that there was good agreement for otoscopic and immittance screening results, fair agreement between otoscopic and pure tone screening results, but poor agreement between pure tone and immittance screening results.

The current article in-fact compares results from studies throughout the different regions of world as well as various areas (rural and urban) of India and found a resemblance in high percentage occurrence of children with cerumen, B-type tympanogram and at-risk for hearing loss in school age children. Hence, emphasizing the significance of utilizing sophisticated tools and standardized methodology in hearing screening that might show universal uniformity. Nevertheless, the sparsity among data is due to difference in targeted population, socio economic status, weather conditions, atmosphere, general awareness towards health and impairment etc. Thus, it is evident that by utilizing assorted and sophisticated tools would strengthen the process of screening.

SUMMARY AND CONCLUSION:

The present study underlies the need for utilizing sophisticated tools in hearing screening across schools in India. This study was an attempt to aid the process of early identification and intervention of hearing loss. The data obtained in this study can contribute to a greater extent in determining the incidence of hearing loss in primary school children. The data should also be utilized in creating awareness about need for regular hearing screening and testing at school level in order to promote early hearing detection and intervention, thus foster learning and development through good quality of life.

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DECLARATION:

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Conflict of interest: Declared none.

Ethical approval: The study was approved by the Institutional Ethics Committee of SGT University,Gurugram,Haryana

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