COMPARISON OF DIFFERENT SCHOOL SCREENING PROCEDURES

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MAY-1988

To

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CERTIFICATE

This is to certify that the Disservation entitled : COMPARISON OF DIFFERENT SCHOOL SCREENING PROCEDURES is the bonafide work in part fulfilment for the degree of Master of science (Speech end Heating) of the student with Register No.8613.

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DECLARATION

ThiS dissertation is the result of my own study under the guidance of Dr.(Miss) S.Nikam, Professor and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

The purpose of hearing screening it to identify the school children who have hearing impairments. Any significant loss in hearing sensitivity will influence the overall educational process of the involved child (Roeser and Northern, 1980). The identification of hearing impairment in school children is the initial stop in the development of hearing conservation program. School screening should results in referral for proper diagnosis, treatment, appropriate amplification and special educational intervention. Without the provision of these conservation programs, children with significant hearing loss will continue to be sensorially deprived and will not attain their maximum educational potentials.

In recent years, investigators (House, and Glorig, 1957; ASHA, 1975; Northern and Downs, 1978 etc.) in the field of hearing screening and hearing conservation have suggested procedure that will more quickly and effectively screen large number of subjects.

Since there is no standard or recommended school screening procedure in India, it is necessary to evaluate and compare some of the commonly used procedures to choose the procedure which are suited to Indian conditions.

The first aim of this study is to compare different pure tone and impedance school screening procedures.

Four pure tone screening procedures: Most commondly used four recommended pure tone screening procedures chosen for this study are those used by:

1. House, and Glorig, (1957).
2. State of Illinois-Department of Health (1974).
3. American Speech, Language and Hearing Association (ASHA, 1975). and
4. Northern and Downs (1978).

For Impedance Screeing: Most commondly used the impedance school screening procedure selected for this study are the ones recommended by ASHA (American Speech Language and Hearing Association, 1979) and Nashville guideline (1980). These two procedures are considered to be the most notable among the several sets of guidelines established for impedance screening (Roeser, 1980).

The second aim is to do comparative study on impedance and pure tone screening in order to indicate which one (Pure tone or impedance) or combination of the two (pure tone and impedance) is the beat for school screening.

Brooks (1972). He postulated that acoustic impedance might be store satisfactory than conventional pure tone screening audiometry in detecting aural disorders in young children.

The third aim is to evaluate each procedure (pure tone and impedance) for its pass/fail criteria. In this connection, the intention is to investigate whether all the selected procedures give the same results.

The fourth aim of this study is to evaluate each procedure (pure tone and impedance) in terms of its cost effectiveness, reliability and validity.

The fifth is to suggest guidelines for future screening procedure which are most suited to Indian conditions.

REVIEW Of LITERATURE

The goal of hearing screening testing in school children was to identify the children with actual hearing impairment of significance communication & health problems. And the choice of hearing school screening procedure was not a simple matter. Each advocate of the procedures felt that his procedure was the one of choice for the population in which he was interested. The signals used in the behavioural testing which would be correctly detected in order for the child to demonstrate hearing within normal limits would be representative of the frequency range considered to be important for these purposes and would be at a level at which was reasonable to expect their detection (Anderson, 1978). And the level should not be very high nor the frequency range so restricted, In general, the frequencies recommended had been in the 500-6000Hz range. The recommended intensity at which screening accurred had generally varied between 23-30 dB HL (ANSI, 1969).

McDermott and Vantarsell (1981) reported the frequency and hearing levels used in hearing screening by School districts in Minnesila. All the districts did not use an uniform procedure, some used single combination of levels and frequencies; some used two or more combination of levels and

frequencies; some used verbal auditory screening for children (Greffing, Simonton and Head of Ceock, 1967). The authors susggested that any screening standard should incorporate at least the following procedures:

1. The population to be screened should be clearly specified.
2. Pure tone air conduction procedures should be used.
3. Frequency and intensity of which screening was to be performed would be established and rigidly adhered to.
4. Re-screening procedures should be practiced consistently. Anderson (1978) suggested that immediate re-screening of children who failed the initial screening to be followed before threshold determination.
5. Referral criteria should be established which varied depending on the procedure.

At one time, it was believed that limiting the screening frequencies to one or two tones would significantly reduce the time consumed for the screener without affecting the overall test results.

House and Glorig (1957) suggested screening of 4000Hz at 25dB HL. This recommendation was made after careful examination of 5000 (five thousand) records.and observing that 98-99% of the subjects with hearing loss

lower frequencies had the same or greater loss at 4000Hz. It was felt suitable for school screening though the test was initially for industrial workers. The subject was considered pass/fail when he passed or failed to hear the signal at the given level in either ear. Thias was followed by re-screening and threshold test.

Limiting the test frequencies to one or two frequencies was criticised by Siegenthalen and Sommer (1959) by evaluating the audiometric test results of more than 19, 500 children and estimated 30% of these failing in the test did not demonstrate looses at 4000Hz. Similar results were observed by Steven aad Davidson (l957). They suggested that limiting the screening frequencies to one or two frequencies would significantly reduce the sensitivity of the test produce.

Similarly, the State of Illinoise, Department of Health (1974) recommended the frequencies of 500, 1000, 2000 and 4000Hz0 at 25/35dB HL. The subject was considered to have failed when he did not respond to one tone at 35dB in either ear or to any two tones at 25dB HL.

The initial screening was followed by immediate res-screening. The subject was referred for threshold test when he failed in re-screening test. From this point, it was apparent that screening should be done at

least three or four frequencies (Roser, Roser, Northern, 1980).

Anderson (1978) suggested that screening be performed at 20dBHL (ANSI- 1969) at 1000, 2000 end 4000Hz. McDermott, and Vantersell (1981) suggested that the use of 500Hz in order to identify more children with possible middle ear disorders.

However, a review of the data of Eagles, Wishick and Doerfler (1967) and Roberts (1972) did not support the hypothosis that children with middle ear disorders would be identified with the inclusion of 500Hz. Children often failed to hear the frequencies below 1000Hz on the basis of interference from noise in the testing environment (National Conference on Identification Audiometry, 1961).

The ASHA (American Speech Language and Hearing Association) Committee on audiological evaluation (1975) recommended the frequencies of 1000, 2000 at 20dB HL and 4000Hz at 25dB HL. The subject was considered failed if he did not respond to any frequency in eitherear.

The ASHA guidelines suggested immediate re-screening When the subject failed in the first screening and referral for threshold test when he failed in rescreening. It

appeared to be generally accepted that one could use at least the frequencies 1000Hz,2000Hz and 4000Hz at levels not higher than 25dBHL (ABSI-1969) in the criteria for the referral (Anderson, 1978). Though ASHA procedure could make it possible to detect those children with educationally significant hearing loss but could not detect minimum hearing loss which was conductive and associated with middle ear disorders (Roser, 1980).

A store precise procedure (especially for identifying hearing impairment of medical significance) might be used to use tones of 500 and 6000Hz, in addition to 1000, 2000 and 4000Hz (Glorig, 1965). Northern and Downs (1978) employing the frequencies of 1000, 2000 and 3000, 4000 and 6000Hz at 25dBHL. The subject was considered to have failed whan he failed to respond to one tone at 1000 and 2000Hz and at any two tones at 3000 or 4000 and 6000Hz. The rescreening was followed by referral for threshold that when the subject failed to respond during re-screening. Since many children had hearing threshold levels at 4000 and 6000Hz at 30dB HL (ANSI-1969) or greater and did not have problem of medical significance. Newby (1964) recommended that priorities for medical referral be given to the children identified according those criteria.

The most notable finding was unanimous documentation that pure tone screening test were not sensitive to middle

ear disorders. Several sets of guidelines had been established for impedance screening. The two most notable were Nashville (1980) and ASHA (1979).

The Nashville guidelines recommended the use of 1000Hz pure tone at 105dB HL for screening reflexes and provided tympanometric criteria for both rounded (flat Type 'B') and negative pressure (Type 'C') curves. First, the Nashville guidelines recommended retest in 2-6 weeks of all those falling in the first screening before referral was made. This procedure assumed that some of those screened might recover spontaneously from their abnormal middle ear condition. According to Roeser and Northern (1980) Nashville guidelines were more conservative.

The ASHA guidelines (1979) suggested that a 1000Hz contralateral tone to be presented at 105dBHL and ipsilateral 1000Hz HL for the reflex and the tympanometric criteria be based on peak pressure only. Basing tympanometric findings solely on peak pressure was confusing, as it did not take into account rounded flat (Type-B) tyapanogram. However, it was assumed that such tympanogram would be considered abnormal by ASHA guidelines (Roeser and Northern,1980). The ASHA guidelines suggested direct referral on the first screening for one group i.e. (Category III). Those who

favoured the ASHA recommendation felt that the effects of otitis media were too severe to delay any possible treatment.

Roeser and Northern (1980) suggested that pure tone screening should be used with impedance measures, since pure tone screening could not detect minimum hearing loss like conductive hearing loss associated with middle ear disorders.

Brooks (1972) did a comparative study of an impedance method and pure tone screening. He postulated that acoustic impedance might be more satisfactory than conventional pure tone screening audiometry in detecting aural disorders in young school children. Be tested 543 children and found 443 (81.5%) agreement (pass/fail) between pure tone and impedance.

She major cause of disagreement were (1) fluid in the middle ear undetected by the hearing test but obvious by tympanometry and (2) failure to respond to low frequency tones on the hearing test while indicating normal function by impedance testing.

Catherine (1974) postulated that the use of acoustic impedance measurements and a single frequency at 25dB HL

screening would be a more efficient, more simple and less time consuming means of screening for hearing loss in schools than the conventional pure tone sweep test. And it was postulated that screening for each ear showing middle ear pressure between +20 and -175mm/H_20 were deemed to be normal. The reflex was measured 2000Hz at 95dB HL of less and it was considered normal if the reflex was present. The pure tone screening for single frequency i.e. 2000Hz was used at 25dB. Fletcher (1929) suggested that responses at this frequency also had more bearing on speech discrimination than responses to 4000Hz tone would have had.

The conventional pure tone sweep audiometry was carried out, frequencies were varied from 250Hz, 500, 1000, 2000 and 4000Hz at different levels 15, 20, 25 and 30dB HL.

The findings indicated poor agreement between the results. In view of the effect of even small hearing losses on educational progress,the use of conventional pure tone audiometry testing for defective hearing among school children was felt to be the more appropriate test.

METHODOLOGY

Selection of Schools: The selection of schools was done on the zonal basis. Each zone i.e. West, East, North, South and Central in Mysore City was represented. From each zone sixty (60) students were selected. In this study there were hundred and fifty male and hundred and fifty female subjects.

Selection of students: Three hundred (300) students were systematically selected between six to fifteen years of age. The subjects were divided into ten(10) age groups from six to fifteen separated by one year interval. The number of students for each group was made up of thirty students in which half of them were male and half of were female. The subjects provided a pool of six hundred ears.

Case History: Background information was taken for each child those who had a history of eardischarge and hearing problem in the school etc. were noted. The format of the case history is given in the Appendix.

Instrumentation:

The screening was conducted with portable pure tone and impedance audiometrs. The audiometers used for pure tone screening were two Rexton Damplex AS51 DX 5250 derse Telefon (OS) 171735 equiped with TPH-39 earphones. The

two impedance audiometers used in the screening were Rexton Dataplex tymp DK 82. The pure tone audiometers had the following frequencies 250, 500, 1000, 2000, 4000, 6000 and 8000Hz with different intensity levels from -10 to 70dB HL. The impedance audiometers had the following frequencies 500, 1000, 2000 and 4000Hz for reflex at different intensity levels from 80, 85, 90, 95, 100dB HL with a probe tone of 220Hz. The tympanometer had pressure range from Omm/H_2o to $\pm$600 mm/H_2o.

Test condition:

The pure tone sad impedance screening was done in the school premises in a room meeting the following conditions:

1. Low ambient noise, away from the traffic noise.
2. Well lighted.
3. Adequate in size to accommodate the tester and equipment.
4. Away from the music room, shop areas and heating units - mechanical equipment, and
5. Well ventilated.

Calibration of Instrument:

Objective calibration - The calibration of instrument was done according to ANSI (1969) standard.

The instrument used in calibration ware (1) condenser microphone (B&K 4144) (2) Artificial ear (B&K 4152) (3) Sound level meters (B&K 2209) (4) Pistonphone (B&K 4220) with octave filter set (B&K 1613). Audiometers were Rexton Damplex (OK 5250) and type) (DK 82).

Subjective calibration: Prior to testing, subjective calibration was done by testing the screener himself to check whether the instruments were working within the expectation. It was done before and after each screening.

Procedure:

Firstly, the instrument was connected and checked.

Instruction:

Each subject was asked to sit in a chair in such a way that his/her elbow could be placed on the armest of the chair. The instruction was given as follows: "You are going to hear some tones. You have to raise your finger as soon as you hear the tone and drop when you do not hear the tone".

After giving instructional the earphones were placed over the ears of the subject and a practice was given at a level above the test tone at 40dB HL in order to acquaint the child with the type of signal to be heard.

All the stimuli were first presented to the right ear and to the other ear. No attempt had been made to change the attenuator dial to determine the threshold level when he she failed to respond any of the given frequencies at particular intensity level. Reinstruction was given in some cases who did not hear one ore more tones in each ear in order to minimise the false negative. The pure tone screening was conducted the frequencies from 500 to 6000Hz at different intensity levels 20 to 35dB HL. The audiogram is given in the appendix. And the criteria of fail/pass for different procedures are given below.

Source	Test frequencies	Intensity level ANSI 1969	Fail/pass criteria
House and Glorig (1957)	4000Hz	at 25dB	Fail to respond in either of the
State of Illinois Department of Public Health(1974)	500,1000, 2000 tad 4000Hz.	25 or 35dB	Fail to respond to 1 tone at 55dB in either ear or respond to any 2. tones at 25dB in the same ear.
American Speech Language and Hearing Association(1975)	1000,3000 and 4000Hz	20dB at 1000 and 2000Hz 25dB at 4000Hz.	Fail to respond at any frequency in either ear.
Northern and Downs(1978)	1000,2000, 3000 and/or 4000 and 6000Hz.	25 dB	Fail to respond to 1 tone at 1000 or 2000 Hz or Fail to respond to 2 out of 3 tones at 3000, 4000, and 6000Hz

Rescreening:

The rescreening of pure tone was done after 2-3 hours of screening on the same day for those who failed in any procedures in the first screening.

Referral for threshold test:

The subject was referral for threshold test if he/she failed in rescreening.

Procedure for threshold test:

The modified Hughson and Westlake procedure was used for threshold test (Carhart and Jerger, 1959). Before the test wasa begun, the subject was taken to sound treated room andinstructed like screening test. The transducers were placed appropriately after instructing the subject.

The following procedure was employed to determine the thresholds:

1. The better ear was tested first.
2. The test was begun by setting the frequency selector to l000Hz and the out put selector to right-or-left as required. This was because the ear is sensitive to mid—frequencies and test retest reliability is good.
3. The attenuator was set to 30dBHL if the subject did not complain of hearing loss or to 70dB HL if he did.

4. The tone was presented for one or two seconds by pressing the interrupt switch.
5. If the subject did not hear or respond, the presentation level was increased in 5dB steps till a response was obtained.
6. On obtaining a response, the level in step of 10dB was decreased until he failed to respond.
7. Thus the threshold was obtained by finding the minimum level at which a subject responded at least two out of three times.
8. Next the threshold for 2000Hz, 4000Hz, 6000Hz and 8000Hz was determined. And the recheck at 1000Hz was done. Then the threshold at 250Hz and 50Hz was determined.
9. The procedure was repeated for other ear.
10. The subject who had hearing level between -10dB to +25dB for all frequencies 250 to 8000Hz was considered to be normal in the threshold test.

Impedance:

Prior to testing,the instrument was first connected and checked .

Instruction:

The subject was instructed individually not to respond to any signal given to him nor do the followings:

1. Chewing
2. Talking
3. Making noise and
4. Moving during testing

Then a suitable ear tip was selected and fitted to the probe (220Hz) of the instruments, and was inserted winto ear canal. The recording of the results (tyapanogran) was done automatically. For reflex, a 1000Hz was presented at 30, 85, 90, 95, 100dBHL. The recorded tyapenogram are given in the appendix.

Pass/fail criteria for the two procedures are given below:

ASHA(1979)

Classification.	Initial screen		Disposition
I. Pass	Tympanogram Acoustic Reflex.	Normal+ or mildly positive negative.+ Present + +	Clear: no return
II At Risk	Tympanogram: and Acoustic Reflex (or) Tympanogram: (or) Acoustic Reflex	Abnormal• Present + + Normal* Mildly positive negative+ Absent.	Retest after 2-3 hours. a) If results fall into Class-I, pass b)If reaults into Class II, fail and referred.
III Fail	Tympanogram Acoustic Reflex.	Abnormal• Absent.	Referred

* Peak at - 50 mm/H_2O

+ +50 to +100 mm/H_2O or -60 to -200 mm/H_2O

++ Contralateral tone l000Hz at 100dB HL or ipsilateral tone at 100dBHL.

• Pressure peak more than +100mm/H_2O or more negative than -200mm/H_2O.

ASHA (1979) they had classified pass or fail criteria into 3 categories i.e.

I. Pass

II. At Risk

III. Fail.

In Type-I, the subject was considered pass if peak pressure was between $\pm$ 50mm/H_2O or mild positive or negative i.e. (+50 to 100 mm H_2O) or (-60 to 200 mm/H_2O) with the presence of reflex i.e. contralateral tone 1000Hz at 100dB or ipsilateral 100dB.

In type-II, the subject was considered at risk since either tympanogram or reflex was abnormal.

In type-III, the subject failed in both raflexometry and tympanometry test was referred for further evaluation.

For type-II, rescreening was done after 2-3 hours of Ist screening.

a) If the results fell into Class-I after rescreening than the subject was considered as passed.

b) If results fell in II or III then referral.

NASHVILLE (1980)

Classification	Initial screen	Retest (after 2-3 hours)	Subject outcome
1.	Tympanogram: Normal* and Acoustic reflex present+	Not required	cleared
2.	Tyapanogram: abnormal++ and/or acoustic Reflex: Absent +	Tympanogram: abnormal + and/or + acoustic reflex absent.	Referred
3.	Tympanogram: Abnormal+ and/or acoustic + reflex absent.	Tympanogram: Abnormal* and Acoustic reflex: present+	At risk recheck,

* Clear peak between -50 and -200 mm / H_20

+ Contralateral or ipsilateral tone 1000Hz at 1056B HL.

+ Flat or rounded, or negative pressure equivalent beyond -200 mm / H_2o.

They had three type of classification for pass/fail criteria:

Type-I: The subject was considered passed since the results of tympanogram and reflex were normal.

Type-II: In Type-II, both the results tympanogram and reflex were abnormal. The subject was considered failed if he failed in rescreening and referred for threshold test.

Type-III: Both of the results were abnormal. Abnormal tympanogram and acoustic reflex present on the rescreening was considered at risk and rechecked.

In type-III the subject was considered fail if he failed in the rescreening.*

Diagnostic Test for Impedance:

The test and recording of the results for impedance audiometer was done automatically. The reflex was measured from 500Hz to 4000Hz at 70dB to 125dBHL. The recording of tympanogram was done from Omm/H_2o to $\pm$ 4000 mm/H_2O. The subject was considered normal when there was clear preasure peak within 0 to $\pm$ .5mm/H_2O i.e. A type tympanogram with the presence of ipsilateral and contra-lateral reflex.

RESULTS

57 ears provided in sufficient data for analysis. This was due to eardischarge in some ears and wax. The pure tone screening results of 300 subjects or 600 ears were analysed after excluding those ears who had discharge and wax.

Table-I: Comparison of four pure tone screening procedures.

		Pass in		Fail in	
	Total no.of ears.	Number	Percent-age.	Number	Percent-age.
House and Glorig, 1957	600	562	93.66	38	6.34
State Illinos Department of Public and Health (1974)	600	476	79.33	124	30.64
ASHA(1975)	600	498	83	102	17
Northern and Downs 1978.	600	498	83	102	17

The results obtained from the four procedures, three of them were significantly difference from each other, The results of ASHA 1975, and Norther and Downs 1978 were same. House and Glorig, 1957 - Of 600 ears 362 passed and 30 ears failed the screening. The percentage of passed was 93.66% and failed was 6.34% respectively.

State Illinoise - Department of Public and Health 1974 - From the results obtained 476 (99.33%) ears passed and 124 (20.64%) failed the screening.

ASHA 1975; Northern and Down- 1978 - The results obtained from the two procedures were same. Of 600 ears 498 (83%) passed and 102 (17%) failed the screening. According to statistical analysis the results obtained from these procedures were significantly difference as given below:

Comparison of four pure tone school screening procedures. (Statistical Analysis)

Table-II(a)

Observed frequency table.

AB		PASS A_1	FAIL A_2	Total
House and Glorig 1957	B_1	562	38	600
Stats Illinoise, Department of Public & Health. 1974.	B_2	476	124	600
ASHA, 1975	B_3	498	108	600
Northern and Downs, 1978	B_4	498	102	600
Total		2034	366	2400

$$A_1B_1 = \frac{(A_1B_1)}{N} = \frac{2034 \times 600}{2400} = 508.5$$

$$A_1B_2 = \frac{(A_1B_2)}{N} = \frac{2034 \times 600}{2400} = 508.5$$

$$A_1B_3 = \frac{(A_1)\ (B_2)}{N} = \frac{2034 \times 600}{2400} = 508.5$$

$$A_1B_4 = \frac{(A_1)\ (B_4)}{N} = \frac{2034 \times 600}{2400} = 508.5$$

$$A_2B_1 = \frac{(A_2)\ (B_1)}{N} = \frac{366 \times 600}{2400} 91.5$$

$$A_2B_2 = \frac{(A_2)\ (B_2)}{N} = \frac{366 \times 600}{2400} = 91.5$$

$$A_2B_3 = \frac{(A_2)(B_3)}{N} = \frac{366 \times 600}{2400} = 91.5$$

$$A_2B_4 = \frac{(A_2)\ (B_4)}{N} = \frac{366 \times 600}{2400} = 91.5$$

Table-II(b) Expected Frequency Table.

		Pass A_1	Fail A_2	Total
House and Glorig 1957	B_1	508.5	91.5	600
State Illinois Dept.of Public Health, 1974.	B_2	508.5	91.5	600
ASHA, 1975-	B_3	508.5	91.5	600
Northern and Downs, 1978	B_4	508.5	91.5	600
Total		2034	366	2400

Table-II(c) Calculation of Chi Square.

Observed	Expected	(Observed- expected)	$(\text{Observed}_2 - \text{expected})^2$	$\frac{(\text{observed}_2 - \text{expected})^2}{\text{expected}}$.
562	508.5	53.5	2862.25	5.628
476	508.5	-32.5	1056.25	2.077
498	508.5	-10.5	110.25	0.216
498	508.5	-10.5	110.25	0.216
38	91.5	-53.5	2862.25	31.28
124	91.5	32.5	1056.25	11.54
102	91.5	10.5	110.25	1.204
102	91.5	10.5	110.25	1.204

$$x^2(\text{Chi square}) = \sum \frac{(O-E)^2}{E} = 54.36$$

df (Degree of freedom) = (C-1) (r-1) where C = columns and r = rows.

= (2-1) (4-1)

= 1 x 3

df = 3.

Since the calculated value was greater than the given table 7.82 at .05 level of significance, therefore the results obtained from these procedures were significantly difference.

Impedance: Only 340 ears were collected for data analysis since some ears had discharge and wax. The remaining 340 ears were possible to collect for data analysis.

Table-3: Comparison of two impedance screening procedure ASHA-1979 and Nashville, 1980.

	Statistical analysis				
	Total No.of ears.	Pass in		Fail in	
		Number	percentage	Number	percentage
ASHA, 1979	340	260	76.47	80	23.53
Nashville. 1980	340	257	75.59	83	24.41

ASHA-1979 of 340 ears 260 (76.47%) passed and 80 (23.53%) failed the screening.

Nashville - 1980)- Of 340 ears 257 (75.59) passed and 83 (24.41) failed the impedance screening.

The results obtained from the two procedures were found to be same. And according to statistical analysis the results obtained were not significantly difference as shown in Table-4(a) (b) and (c).

Table-4(a) Observed frequency table.

AB	Pass A_1	Fail A_2	Total
ASHA, 1979 B_1	260	80	340
Nashville, 1980 B_2	257	83	340
Total	517	163	680

(b) Expected frequency table.

AB	Pass A_1	Fail A_2	Total
ASHA, 1979 B_1	258.5	81.5	340
Nashville, 1980 B_2	258.5	81.5	340
Total	517	163	680

$$A_1B_1 = \frac{(A_1)\ (B_1)}{N} = \frac{517 \times 340}{680} = 258.5$$

$$A_2B_1 = \frac{(A_2)\ (B_1)}{N} = 81.5$$

$$B_2A_1 = \frac{B_2\ A_1}{N} = \frac{340 \times 517}{680} = 258.5.$$

$$B_2A_2 = \frac{(A_2)\ (B_2)}{N} = \frac{163 \times 340}{680} = 81.5$$

(c)

Calculation of X^2 (Chi Square)

Observed Frequency (O)	Expected frequency (E)	(O - E)	$(o - E)^2$	$\frac{(o - E)2}{E}$
260	258.5	1.5	2.25	.008
257	258.5	-1.5	2.25	.008
80	81.5	-1.5	2.25	.027
83	81.5	1.5	2.25	.027

X^2(Chi square) $= \sum \frac{(O-E)^2}{E} = .07$,

df = (C-1+ (r-1) where c column and r = row.

df = (2-1) (2-1) = 1

Since calculated value was less than the given table value 3.84 of .05 significant level, there was no significant difference between the two procedures.

Comparison between pure tone and impedance screening (ASHA-(pure tone and Impedance 1975 and 1979)

Tablo-5: C (ASHA-puretone 1975; and Impedance 1979)

Total No. of ears)	Totalno. of/ears passed in PT-IMP.		No.of ears passed in PT but failed in Impedance.		No.of ears passed imp. but filed in PT.		No.of ears failed in both Imp and PT.	
340	234	68.82%	47	13.82%	29	8.53%	30	8.83%

PT — Pure tone; Imp: Impedance.

Data on 340 ears were collected and analysed for both pure tone and impedance screening. Of 340, 234 (60%) were classified as normal by both procedures. They responded to 20dB HL at 1000Hz and 2000Hz and 25dB HL at 4000Hz in the presence of normal tympanogram and ipsilateral or contralateral stimulation at 1000Hz on both ears.

Thirty ears (8.83%) were classified as abnormal by both procedures. Forty seven (13.82%) ears passed pure tone test but failed in impedance screening since minimum hearing loss associated with a middle ear disorder (fluid etc) could not be detected by pure tons screening.

Twentynine ears (8.53%) passed in impedance screening but failed in pure-tone screening.

The agreement between the two tests reached in 264 (77.65%) of the ears tested. Audiometric testing failed to identify definite middle ear pathology, wither SOM (Serous otitis media) or retraction of tympanic membrane, 29 eara (8.53%) identified as having totally normal middle ear function failed to pass the audiometric screening.

DISCUSSION

The students who failed in the screening tests were referred for threshold test. Since many of the subjects did net come for the diagnostic or threshold test, the calculation of sensitivity, false positive, specificity and false negative could not be done. However, sixteen subjects (32 ears) were taken for threshold test from each procedure who failed in the screening test. She results of the four different pure tone screening procedures are given below:

Results (Table-6) "After threshold test"

	Failed		Passed		Total(ears)
House and Glorig 1957)	4	12.5%	28	87.5%	32
State Illinoise Dept.of Public Health (1974)	4	12.5%	28	87.5%	32
ASHA(1975)	4	12.5%	28	87.5%	32
Northern end Downs (1978)	4	12.5%	33	87.5%	32

According to the results shown in Table-6, all the procedures could detect 12.5% of ears (i.e. 4 out of 32)

with hearing loss but failed to identify 87.5% of ears (i.e. 28 out of 32) with no hearing loss. The results obtained from the threshold test were same for all the procedures.

The answer of the test or most effective procedure for Indian condition cannot be given due to the following reasons:

1. Limitation of time for further investigation
2. The number of samples (subjects) in the threshold - or diagnostic test were very low.
3. The results obtained from Table-(6) for all the procedures were same.

Impedance (Diagnostic test):

Forty subjects or 80 ears who failed in the impedance screening were referred for diagnostic test. Of the 40 only 7 students (14 ears) came for diagnostic test. The results of the two procedures were given below:

Results: (Table-7) : "After diagnostic test"..

	Failed		Passed		Total
ASHA, 1979	1	7.14%	13	92.8%	14
Nashville, 1980	1	7.14%	13	92.8%	14

According to the results obtained from table-7 with both the procedures it was possible to correctly identify 7.14% of ears with hearing loss (i.e. 1 out of 14 ears) but the procedure failed to 92.8% of ears with no hearing loss (i.e 13 out of 14 ears). The results of both the procedures are presented in Table-7.

SUMMARY AND CONCLUSIONS

In recent years, investigators like House and Glorig 1957; ASHA, 1975, Northern and Downs, 1978 etc. in the field of hearing screening and hearing conservation have suggested procedure that will more quickly and efficiently screen large number of subjects. Since there is no standard or recommended school screening procedure in India it is necessary to evaluate and compare some of the commondly used procedures to choose the one that is suited to Indian conditions.

AIMS:

1. To compare four different pure tone and two impedance school screening procedures.
2. To do comperative study on impedance and pure tone screening in order to indicate which one (pure tone or impedance) or combination of the two is the best for school screening.
3. To evaluate each procedure for its pass/fail criteria and find whether the results obtained are same.
4. To evaluate each procedure in terms of its cost effectiveness, reliability and validity.
5. To suggest guidelines forfuture screening procedure which are most suited to Indian conditions.

In this study, 300 students in the age range of six to fifteen were screened using pure tone audiometers (two Rexton Damplex DK AS 51), 340 ears were screened using impadance audiometers, Rexton Damplex tymp (DK 82) and 340 ears were screened for both pure tone and impadance audiometers. The instruments were calibrated according to ANSI 1969 standard. The screening was conducted in a room meeting the following conditions:

1. Well lighted
2. Low ambient noise
3. Well ventilated.

Rescreening was done after 2-3 hours for those who failed in the 1st screening.

Referral for diagnostic test:

The student or subject was referred for diagnostic test when she/he failed in rescreening using the modified Hughson and Westlake procedure (Carhart and Jerger, 1959).

The following conclusions havabeen drawn from the results obtained:

1) The results of four different pure tone screening procedures were found to be different. The statistical analysis using chi-square test showed that there was significant difference among the results of the different procedures.

2) There was no significant difference between the two impedance screening.procedures.

3) A combination of pure tone and impedance screening is more effective in identifying children with hearing loss.

4) Since many of the subjects did not came for thrsh-old or diagnostic test and due to limitation of time for further investigation, it was difficult to calculate the effectiveness of each procedure in terms of their sensiti-vity, false positive, specificity and false negative. The question of suggesting the best school screening procedure for Indian condition would be adequately answered only with the help of further investigation.

As the number of subjects in the threshold or diagnostic test were very low, further investigations are suggested to verify the results obtained in the present study with largeer number of subjects.

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APPENDIX

CASE HISTORY

1. Name
2. Sex
3. Age
4. Education
5. Income of parent
6. History of previous hearing loss
   a. Nature of hearing loss
   b. Onset.
   i) Sudden (ii) gradual
   c. Progressive or non-progressive
7. Previous hearing evaluation -I type II degree.
8. Previous medical history
   a) medical
   b) surgical
9. Family history
10. Consanguinity
11. Sibling
12. Problem in the class due to hearing loss*

Hearing Screening Record

Name : J. S. Smitha. Age : 6yrs. Sex : M/F Date :

School : Class : Income :

	500			1000			2000			4000			6000		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Right Ear (A)	✓	✓	25dB	✓	✓	20dB	✓	✓	20dB	✓	✓	25dB	✓	✓	25dB
				X	X	X	X	X	X						
				X	X	X	X	X	X						
Left Ear (B)	✓	✓		✓	✓		✓	✓		✓	✓		✓	✓	
				X	X	X	X	X	X						
				X	X	X	X	X	X						

A : 500 Hz at 25 dB HL
1 KHz & 2 KHz at 20 dB HL
4 KHz & 6 KHz at 25 dB HL

☑ Normal

☐ Rescreen

☐ Refer for Hearing Aid

NORMAL AUDIOGRAM

Hearing Screening Record

Name : Savitri Age : 10 Sex : M/F Date : 12/

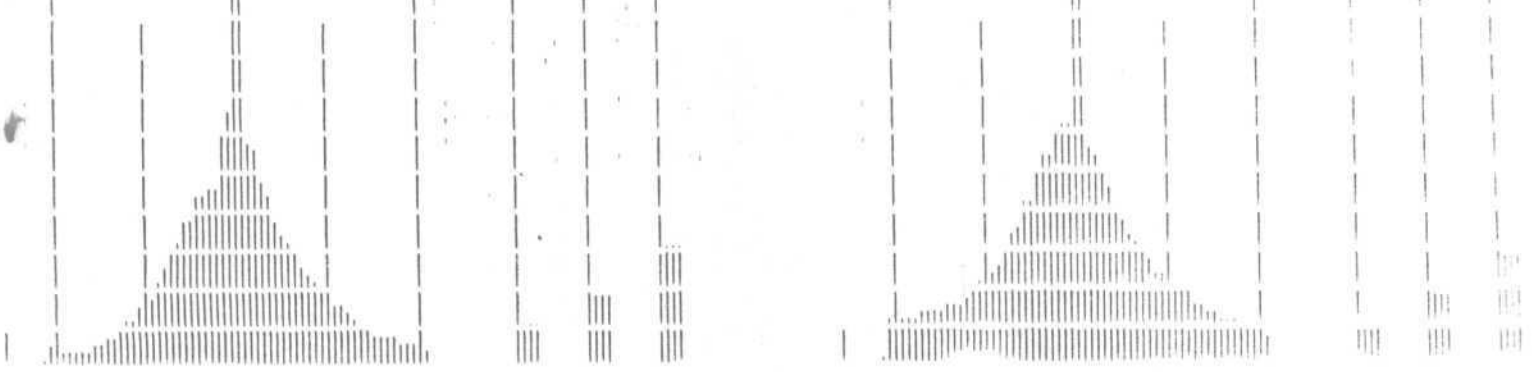
School : Savitri C Class : V Income :

		500			1000			2000			4000			6000		
		I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Right Ear	A	X	X	25	X	X	20	X	X	20	X	X	25	X	X	25
	B	X	X		X	X	X	X	X	X	X	X		X	X	
	C				X	X	X	X	X	X						
Left Ear	A	X	X	25	X	X	20	X	X	20	X	X	25	X	X	
	B	X	X		X	X	X	X	X		X	X		X	X	
	C	X	X		X	X	X	X	X	X	X	X		X	X	

A : 500 Hz at 25 dB HL
1 KHz & 2 KHz at 20 dB HL
4 KHz & 6 KHz at 25 dB HL

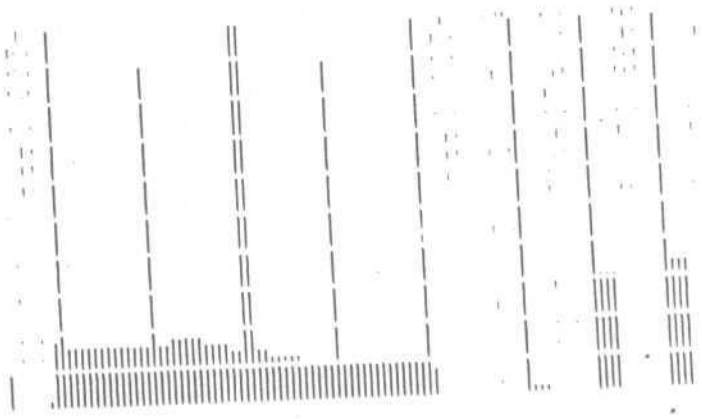
☐ Normal
☑ Rescreen
☐ Refer for th. Lab

ABNORMAL AUDIOGRAM



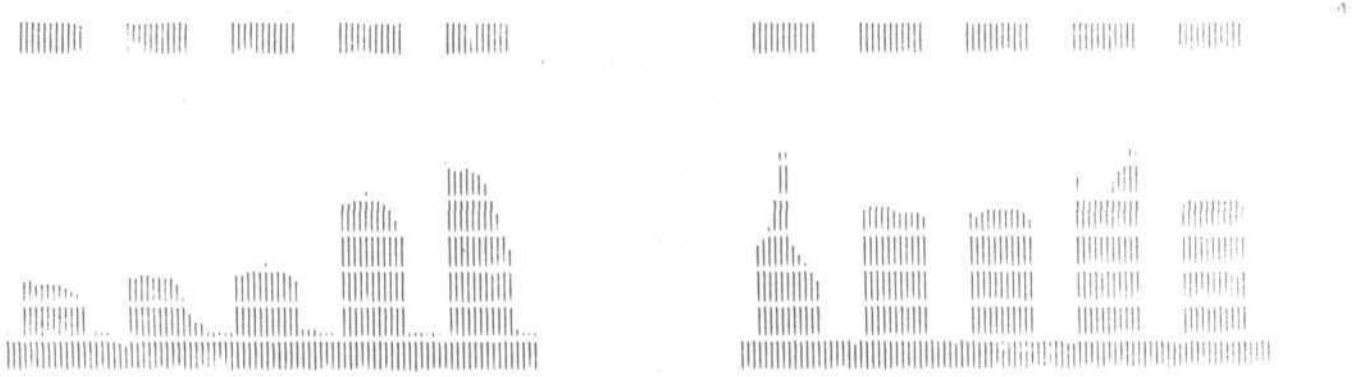
+200mm/H_2O -200mm/H_2O +200mm/H_2O -200mm/H_2O

NORMAL TYMPANOGRAM



+200mm/H_2O -200mm/H_2O

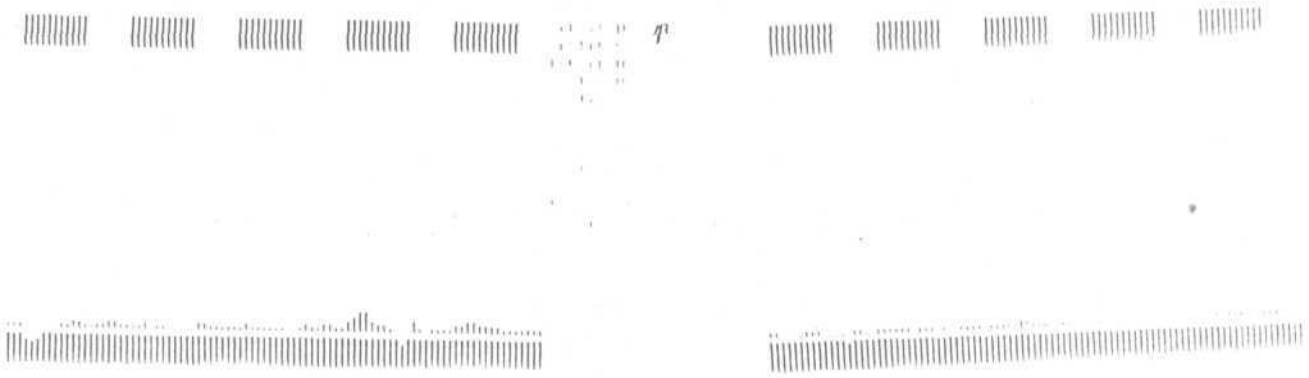
ABNORMAL TYMPANOGRAM



CONTRALATERAL REFLEX

IPSILATERAL REFLEX

NORMAL REFLEX



CONTRALATERAL REFLEX

IPSILATERAL REFLEX

ABNORMAL REFLEX