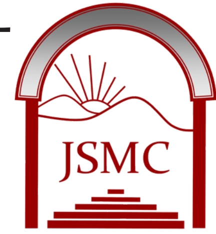
ACOUSTIC STAPEDIAL REFLEX THRESHOLD IN NORMAL HEARING PARTICIPANTS IN SULAIMANI CITY



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Submitted: 15/12/2020; Accepted: 25/5/2021; Published: 21/12/2021

ABSTRACT

Background

Acoustic stapedial reflex threshold (ASRT) is an objective, important test that can be included in a test battery along with behavioural pure tone audiometry and otoacoustic emissions to differentiate among middle ear, cochlear, and retro cochlear sites of the lesion. It can be used as a cross-check with a behavioural audiogram to increase confidence in the diagnosis. In most people with normal hearing thresholds and middle ear function, the acoustic stapedial reflex will be present at all frequencies and within an intensity range of 70-90 dB HL above the behavioural hearing threshold.

Objectives

To measure ASRT in participants with normal hearing thresholds in Sulaymaniyah city and to observe the effect of different parameters on the threshold.

Patients and Methods

The study was conducted on 200 participants (400 ears) who met inclusion criteria (110 males and 90 females); data were collected through visiting five different places with different age groups within three months duration. Participants were divided into three age groups (6-12 years), (13-18 years), (19 years and above). Only participants with normal otoscopic examination, normal pure tone audiometry, normal tympanogram, undergone through stapedial reflex threshold measurement, and the reflexes were elicited and recorded bilaterally by using tympanometer (Impedance meter) MAICO MI34 brand, single frequency 226 Hz of German-made model 2011.

Results

Mean ASRT measured in both ears was within the normal range of 70-90 dB HL above hearing threshold in both ipsilateral and contralateral pathways as Right ipsilateral (74.5 dB HL), right contralateral (76.9 dB HL), left ipsilateral (74.6 dB HL), and left contralateral (76.8 dB HL) above hearing thresholds. There was no significant difference between right and left ears according to ASRT (P-values > 0.05). There was no gender effect on ASRT (P-values > 0.05), while there was a significant effect of age on ASRT, especially in the adult population (P-values < 0.05).

Conclusion

A stapedial reflex threshold in normal hearing subjects was within normal range, different parameters as the side of ear and gender did not affect the threshold. In contrast, with advancing age amount of intensity needed to elicit the reflex increased.

Keywords: *Acoustic stapedial reflex threshold, Middle ear muscle reflex, and acoustic stapedial reflex, the effect of gender and age on ASRT.*

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https://doi.org/10.17656/jsmc.10330

INTRODUCTION

The acoustic reflex threshold is defined as the lowest possible intensity needed to elicit middle ear muscles contraction. Contraction of middle ear muscles evoked by intense sound results in a temporary increase in middle ear impedance[1].

The acoustic reflex threshold for pure tones in subjects with normal hearing and no pathology of the auditory system occurs at approximately 70-90 dB above the threshold of audibility for the tone. In cases of cochlear and eighth nerve (auditory nerve) disorders, ASRT may be elevated. Most of the available data sets on ASRT are based on acoustic immittance measures for a probe frequency of 226Hz [2].

When either ear is presented with a loud sound, the stapedius muscles on both sides contract, contraction of the stapedius muscle tilts the anterior stapes away from the oval window and stiffens the ossicular chain. The results in increased impedance measured as a slight decrease in compliance by an ear canal probe [3].

Historical background

Metz (1952) measured middle ear impedance and found that it increased when a loud sound was presented to the opposite ear. He hypothesized that the increased impedance was because of middle ear muscle reflexes (MEMR), which stiffened the middle ear system [4]. In the late 1960s and thereafter, interest and investigations in the diagnostic use of the middle ear muscle response overgrew. Consequently, the measurement of the middle ear muscle reflex has become a routine clinical procedure in nearly all comprehensive evaluations of hearing impairments [5].

Anatomy and physiology

The two middle ear muscles are the tensor tympani and the stapedius. The trigeminal nerve innervates the tensor tympani muscle. The tensor tympani may contract in response to tactile stimulation or startle response to loud unexpected sounds. However, the tensor tympani do not typically contribute to the MEMR measured clinically in humans [4].

The stapedius muscle (length 7 mm, cross-section five mm^2) [6] is the minor skeletal muscle in the human body, and it is the main contributor to the MEMR measured clinically in humans. The body of the stapedius muscle is located in the pyramidal eminence, or small bony protrusion, on the posterior wall of the middle ear. The tendon stretches anteriorly from the body of the stapedius muscle to the posterior surface of the neck of stapes.

The stapedius muscle is innervated by the motor branch of cranial nerve VII (the facial nerve); when an intense sound is presented to the ear, it contracts and pulls the head of the stapes posteriorly toward the muscle body, which causes an increase in stiffness of the ossicular chain and the TM. Stiffening causes a decrease in admittance of sound into the middle ear that can be measured by a probe in the ear canal, and this is the basis of clinical ASRT measurements. ASRT is a bilateral response which means that when an activating stimulus is presented to one ear, the stapedius muscle contracts in both ears.

Therefore, the ASRT may be measured in the same ear where the activating stimulus is presented (ipsilateral conditions) or in the opposite ear (contralateral conditions) [4] . But the response is slightly more vital in the ipsilateral ear, and its threshold is lower [7].

There are four overlapping pathways of the reflex arc, including two ipsilateral and two contralateral pathways; one ipsilateral pathway is represented by the black arrows in (Figure 1); and includes the ipsilateral ear canal, middle ear, cochlea, VIIIth nerve, ventral cochlear nucleus (VCN), medial superior olivary complex (MSO), the motor nucleus of the facial nerve (MN VII), VIIth nerve, and stapedius muscle. The second ipsilateral pathway includes a connection between the VCN and the ipsilateral MN VII. One contralateral pathway represented by grey arrows in (figure 1) includes the middle ear, cochlea, VIIIth nerve, VCN, and MSO on the side of the activating stimulus, and the MN VII, VIIth nerve, and stapedius muscle on the contralateral side.

The second contralateral pathway includes a connection between the ipsilateral VCN and the contralateral MSO, which connects with the MN VII [4].

As the intensity of the eliciting stimulus increases, the amplitude of the ASR response increases (The strength of the muscle contraction increases gradually with increasing stimulus intensity). The contraction of the stapedius muscle occurs with a latency that decreases from approximately 100 MS for sounds near the threshold of the reflex to approximately 25 MS for high-intensity stimuli, which reflects the travel time of the signal from the cochlea through the pathway to the stapedius muscle [7].

Theories of functional significance

There are two main theories about the functional significance of the ASR:

First, it was thought that the ASR reduces the amount of sound pressure that reaches the cochlea, and therefore it has a protective effect from high-level sounds. The main problems with this theory are that the ASR:

It is not fast enough to protect the cochlea from high-level transient sounds. The ASR can fatigue, and thresholds may increase in the presence of high-level, long-duration sounds.

The second is that the ASR provides humans with an advantage for understanding speech in noise because lower frequencies are attenuated relative to higher frequencies when the stapedius muscle contracts. For example, Aiken et al. (2013) reported that listeners with stapedius tendons that were transected during stapedotomy had poorer speech discrimination scores in moderate levels of noise in comparison to listeners with intact ASR [(4)].

Relevance to Clinical Practice

ASR threshold tests can be included in a test battery, along with tympanometry, otoacoustic emissions (OAEs), and pure behavioural tone and speech tests, to differentiate among middle ear, cochlear, and retro cochlear sites of the lesion. ASRT also be used as a cross-check with the behavioural audiogram to increase confidence in the diagnosis of hearing loss in young children with whom behavioural results may be questionable and in older children and adults who may present with false or exaggerated hearing loss. ASRT is typically obtained with multiple pure tone activators and with ipsilateral and contralateral stimulation. The pattern of thresholds across conditions is examined and compared with pure tone behavioural thresholds and speech recognition scores [(4)].

Gender and age effects

There are no significant effects of gender (Gelfand et al.1990; Osterhammel and Osterhammel, 1979). However, there are two effects of age on ASRT:

First, ASRT in adults increases with age for BBN activators beginning around 44 years of age (Silverman et al., 1983) and increase with age above 50 years for pure tone activators above 2,000 Hz (Wilson and Margolis, 1999).

Second, higher probe tone frequencies must be used to increase the probability of observing an ASR in newborns and young infants [(4)].

Pharmacological effects

Elevated ASRT has been reported with alcohol (Borg and Moller, 1967), barbiturates and chlorpromazine (Simon and Pirsig, 1973) [(4)].

ASRT measurement

ASRT measurements should be completed using equipment that is calibrated to the ANSI S3.39 (2012) Specifications forInstruments to Measure Aural Acoustic Impedance and Admittance. The equipment is the same as used for tympanometry (Figure 2) and consists of a probe assembly that is coupled to the ear with a small ear tip to create a hermetic seal [(4)].

The ear with the immittance probe in it is called the probed ear, while the ear receiving the stimulus is called the stimulus ear. For ipsilateral testing, the probe ear and the stimulus ear are the same (stimulus and measurement occur in the same ear). For contralateral testing, the probe ear and the stimulus ear are different (stimulus presented to one ear, while measurement occurs in the opposite ear). Generally, a 226 Hz probe tone is used unless neonates are being tested. In this case, a high-frequency probe tone is used (1000 Hz) [(3)].

An acoustic reflex will most likely be elicited if all of the following conditions are met:

Normal hearing level, normal middle ear function, loud enough stimulus to elicit the response, no abnormal adaptation to a stimulus [(3)].

The immittance instrument detects an acoustic reflex by measuring changes in the reflected energy occurring from the tympanic membrane stiffening during stapedial contraction. A repeatable change in the amount of reflected energy is an indication of an acoustic reflex. The acoustic reflex provides clinicians with one of the most potent differential diagnostic audiological procedures because of the ease of administration and amount of information obtained [(8)].

The signal used to produce the acoustic reflex is called the (reflex-activating stimulus RAS), which can be any sound from a pure tone to a noise band. Typically, pure tones sampling the frequency range from 500 to 4000 Hz are used. A pure tone of the desired frequency should be introduced at 70 dB HL. If no compliance change is

seen on the meter, the level raises automatically to 80 dB, 90 dB, and so on until a response is seen or the limit of the equipment is reached. The total duration should be about one second, and measurements should be taken that sample the frequency range, for example, 500, 1000, 2000, and 4000 Hz; however, for no explainable reason, many normal hearing individuals show no acoustic reflex at 4000 Hz. (Gelfand 1984) [9].

Measuring acoustic reflexes for differential diagnosis purposes is helpful in:

Confirming middle ear disease, confirming threshold of hearing, acoustic reflex testing also is helpful in differentiating otosclerosis from superior semicircular canal dehiscence (SSCD) syndrome as it should be present in SSCD and abnormal in otosclerosis [10].

There are some limitations with acoustic reflex measures:

Care must be taken that the patient is capable of sitting quietly. Any jaw movements during coughing, crying, talking, swallowing, or jaw clenching will result in artefacts and provide fallacious results. Collapsed canals due to the placement of circum-aural headphones on the pinna of the contralateral ear may also result in fallacious findings [11].

Table 1. Goodman classification of hearing degrees[12]

-10 to 25 dB HL	Normal
26 to 40 dB HL	Mild
41 to 55 dB HL	Moderate
56 to 70 dB HL	Moderately severe
71 to 90 dB HL	Severe
≥ 91 dB HL	Profound

Aims of the study

To measure ASRT in participants with normal hearing thresholds in Sulaymaniyah city and to observe the effect of different parameters on the threshold.

SUBJECTS AND METHODS

A cross-sectional survey was used to measure the average hearing threshold and acoustic stapedial reflex threshold for each reflex frequency.

Five different places were selected to perform data collection, which was (one primary school, two secondary schools, Cihan University and Sulaimaniyah International Airport), data collection was conducted within three months, isolated rooms in schools, universities and airports were used to perform the tests but without a sound-treated booth.

The sample of the study was selected from the above-mentioned places and included students and employees of different age groups that divided into three age groups (6-12 years), (13-18 years), (19 years and above), prior consent taken from all participants or their teachers in charge, and then they assessed for age, gender and side of the ear according to the (test form) mentioned in the appendix.

Two hundred participants (400 ears) met inclusion criteria and undergone thorough study; 110 had all reflexes present, while 90 without 4 kHz reflex bilaterally.

No participants had taken sedatives or tranquillizers within 48 hours preceding the test session, they had a normal otoscopic examination, and normal facial nerve examination, normal hearing thresholds by pure tone audiometry (PTA) and normal middle ear function by tympanometry were included in the study.

While hearing threshold more than 20 dB HL, abnormal external auditory canal, abnormal middle ear function, abnormal facial nerve examination, age below six years were excluded from the study.

Pure tone audiogram (SIEMENS Screening Audiometer SD 21) was used with a standard supra-aural TDH-39 headphone to perform the PTA. The audiogram device was manufactured in 2002 by SIEMENS Company –

Denmark; Serial Number is 157323, with specifications

arranged according to American National Standards Institute for measurements (ANSI s3.6 1996).

Tympanometer (Impedance meter) of MAICO MI34

brand, single frequency 226 Hz of German-made model 2011 (Serial Number: 9915752) with the following technical specifications:

- ❖ **Tympanometry mode**
- ✓ **Probe frequency, intensity**: 226 Hz, 85dBSPL into 2 cm^3
- ✓ **Pressure range:** + 200 to - 400 daPa
- ✓ **Volume range:** 0,1 to 6,0 ml
- ✓ **Test time:** < 3 seconds
- ❖ **Reflex Mode 226 Hz**
- ✓ **Test frequencies:** 500, 1000, 2000, 4000 Hz
- ✓ **Test method:** ipsilateral, contralateral
- ✓ **Intensities ipsilateral:** 70 ... 105 dB HL
- ✓ **Intensities contralateral:** 70 ... 120 dBHL
- ✓ **Test time:** 13 sec., 10 sec. auto tone present

During PTA taking four frequencies (500, 1000, 2000, and 4000 Hz) were used to test participants who had undergone the study program. Pure tone audiometric sweep conducted using an ANSI calibrated portable audiometer with TDH-39 supra - aural earphones. Pure tone signals are presented across different frequencies, starting at 1 kHz, giving 50 dB HL, decreasing the intensity by 10 dB HL to the level of 20 dB HL. Then continue examination regularly 2 kHz, 4 kHz, and 500 Hz accordingly. The responses to the signals typically include a hand raise or a conditioned response. The test was made only by air Conduction.

Then probe of the immittance meter (MAICO MI34) with the appropriate ear tip is positioned in the opening of the ear canal; the supra-aural headphone is positioned on the contralateral ear.When a tight seal is obtained between the probe tip and the ear, the ASRT is measured after the measurement of the tympanogram.

A pure tone of the desired frequency (500, 1000, 2000 and 4000 Hz) with a tonal duration of about one second will automatically be introduced to the ear through the reflex activator loudspeaker at 70 dB HL, in the ipsilateral ear through probe tone generator, and contralateral ear through the supra-aural headphone.

The probe pickup microphone measures the amount of sound reflected from the eardrum during the tonal presentation.

If no change in the reflected sound is obtained at 70 dB, the level will be raised automatically to 80 dB, 90 dB, and so on until a change occurs or the upper limit of the device is reached (105 dB HL) for ipsilateral measurement and (120 dB HL) for contralateral measurement.

The change in the reflected sound is due to stiffening of the middle ear (decrease in acoustic admittance due to increase in acoustic impedance) as a response to the increased signal intensity, which leads to contraction of the stapedius muscle and reflex occurrence.

When we got an odd result that didn't look correct or didn't match audiogram findings, we repeated the test.

Statistical analysis

Each (test form) paper was given an identity number (ID) prior to data entry and analysis, the different categories of the form sheet were coded. Data were entered into a Microsoft Excel Spreadsheet; after data cleaning, the data was transported into SPSS (Statistical Package for the Social Sciences-version 21) package software program for statistical analysis. Means and standard deviations were calculated for continuous variables like age and gender and categorical variables. Descriptive statistics were calculated for all variables; as well as analytical statistics was done to find the relations between variables using the T-test and Chi-square test.

RESULTS

Of the 200 participants, 110 (55%) were males, and 90 (45%) were females. The age ranges of participants were (children 6-12 years old), (adolescents 13-18 years old), (adults 19 years old and above). Average intensity needed to elicit ASRT:

Means, standard deviations for ipsilateral and contralateral ASRT measured in dB SL from both ears according to each reflex frequency and all together are displayed in Tables 2 & 3. The reflex threshold data for the 4 kHz activator are based on (110) persons within the total participants of (200). Relation between right and left ears:

Applying T-test by using Excel 2013, there is no significant difference of ASRT between right and left ears (P- values> 0.05), as shown in Table 3. Gender effects on ASRT:

By applying the Chi-square test there is no significant association between gender and ipsilateral, contralateral ASRT of both ears (P-values> 0.05) as shown in Table 4.

For ipsilateral right pathway, as shown in Table (4) from (110) male participants, 56.8% needed 65-74 dBSL, 58.5% needed 75-84 dBSL and 56.1% needed 85-95 dBSL to elicit Artform 90 female participants, 43.2% needed 65-74 dBSL, 41.5% needed 75-84 dBSL, and 48.4% needed 85-95 dBSL to elicit ASRT.

For ipsilateral left pathway, as shown in Table (4) from (110) male participants, 53.2% needed 65-74 dBSL, 54.2% needed 75-84 dBSL and 56.4% needed 85-95 dBSL to elicit ASRT. From 90 female participants, 46.8% needed 65-74 dBSL, 45.8% needed 75-84 dBSL, and 43.6% needed 85-95 dBSL to elicit ASRT.

For contralateral right pathway, as shown in Table (4) from (110) male participants, 58.7% needed 65-74 dBSL, 51.7% needed 75-84 dBSL and 60.2% needed 85-94, and 32% needed 95-100 dBSL to elicit ASRT. From 90 female participants, 41.3% needed 65-74 dBSL, 48.3% needed 75-84 dBSL, 39.8% needed 85-94 dBSL and 68% needed 95-100 dBSL to elicit ASRT.

For contralateral left pathway, as shown in Table (4) from (110) male participants, 59% needed 65-74 dBSL, 50% needed 75-84 dBSL, 57.9% needed 85-94 dBSL, and 31.3% needed 95-100 dBSL to elicit ASRT. From 90 female participants, 41% needed 65-74 dBSL, 50% needed 75-84 dBSL, 42.1% needed 85-94 dBSL and 68.7% needed 95-100 dBSL to elicit ASRT.

Age effect on ASRT

By applying the Chi-square test, there is a significant association between age and ipsilateral, contralateral ASRT of both ears (P-values<0.05), especially age group (19 years & above), as shown in Tables (5):

For ipsilateral right pathway; from 50 participants of age group (6-12 years) 0% needed 65-74 dBSL, 23.1% needed 75-84 dBSL and 38.5% 85-95 dBSL to elicit ASRT. From 40 participants of age group (13-18 years) 29.5% needed 65-74 dBSL, 27.7% needed 75-84 dBSL and 9.9% 85-95 dBSL to elicit ASRT. From 110 participants of age group (19 years and above) 70.5% needed 65-74 dBSL, 49.2% needed 75-84 dBSL and 50.1% 85-95 dBSL to elicit ASRT.

For ipsilateral left pathway; from 50 participants of age group (6-12 years) 6.4% needed 65-74 dBSL, 20.3% needed 75-84 dBSL and 37.2% 85-95 dBSL to elicit ASRT. From 40 participants of age group (13-18 years) 31.9% needed 65-74 dBSL, 22.1% needed 75-84 dBSL and 12.8% 85-95 dBSL to elicit ASRT. From 110 participants of age group (19 years and above) 61.7% needed 65-74 dBSL, 57.6% needed 75-84 dBSL and 50% 85-95 dBSL to elicit ASRT.

For contralateral right pathway; from 50 participants of age group (6-12 years) 6.3% needed 65-74 dBSL, 3.4% needed 75-84 dBSL, 39.8% needed 85-94 and 48% needed 95-100 dBSL to elicit ASRT. From 40 participants of age group (13-18 years) 28.6% needed 65-74 dBSL, 27.6% needed 75-84 dBSL, 15.6% needed 85-94 and 4% needed 95-100 dBSL to elicit ASRT. From 110 participants of age group (19 years and above) 65.1% needed 65-74 dBSL, 69% needed 75-84 dBSL, 44.6% needed 85-94 and 48% needed 95-100 dBSL to elicit ASRT.

For contralateral left pathway; from 50 participants of age group (6-12 years) 3.3% needed 65-74 dBSL, 7.1% needed 75-84 dBSL, 42.1% needed 85-94 and 37.5% needed 95-100 dBSL to elicit ASRT. From 40 participants of age group (13-18 years) 32.8% needed 65-74 dBSL, 17.9% needed 75-84 dBSL 13.7% needed 85-94 and 12.5% needed 95-100 dBSL to elicit ASRT. From 110 participants of age group (19 years and above) 63.9% needed 65-74 dBSL, 75% needed 75-84 dBSL 44.2% needed 85-94 and 50% needed 95-100 dBSL to elicit ASRT.

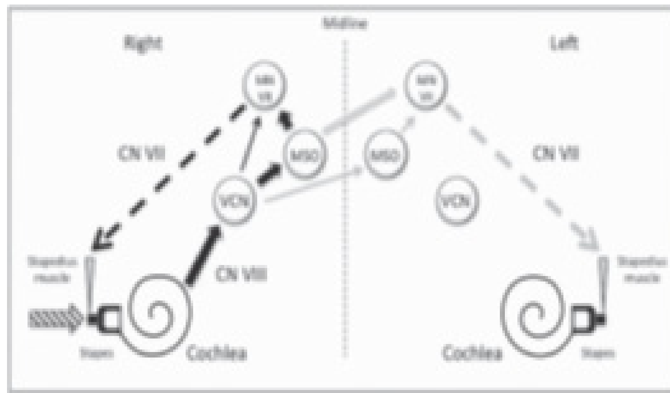

Figure 1. right ipsilateral and right contralateral ASR pathways.

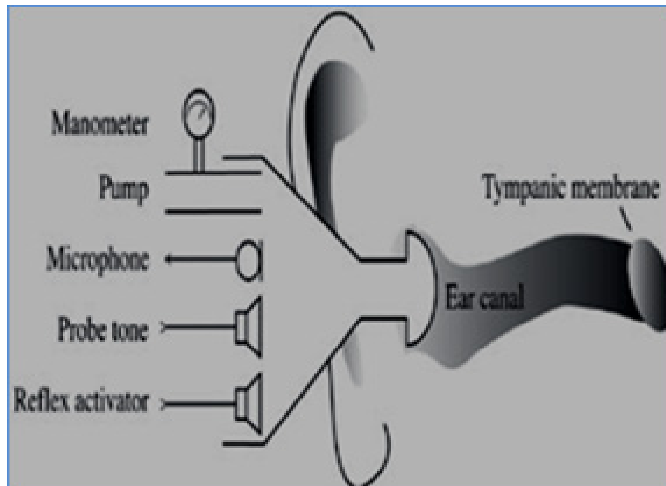

Figure 2. Components of a tympanometer probe assembly.

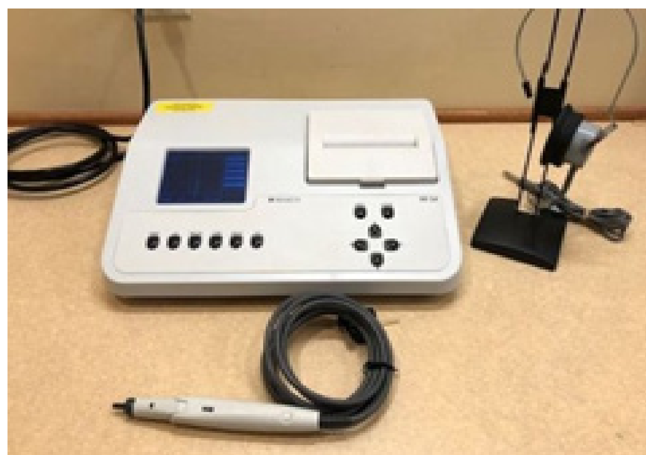

Figure 3. MAICO MI 34 Immittance meter.

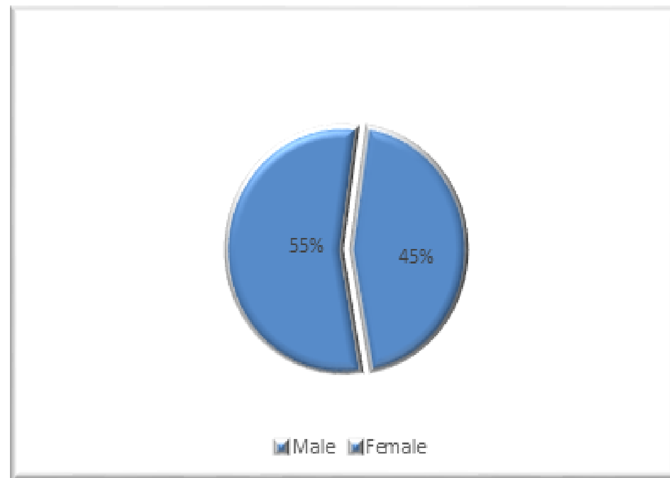

Figure 4. Gender distribution by percentage.

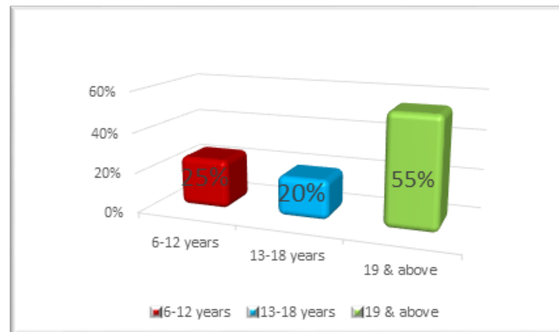

Figure 5. Age distribution by percentage.

Table 2. Ipsilateral and contralateral average ASRT with SD in both ears for each reflex frequency in dBSL.

Reflex frequency		500 Hz	1000 Hz	2000 Hz	4000 Hz	Mean	SD
Number of participants		**200**	**200**	**200**	**110 from 200**		
Right ipsi	Mean	76.325	73.6	74.95	73.318	74.548 dB SL	1.38214
	SD	5.92	5.68	6.02	5.05		
Right contra	Mean	77.15	76.3	76.325	78.09	76.966 dB SL	0.84689
	SD	5.9	5.64	5.46	5.95		
Left ipsi	Mean	77.175	72.925	74.8	73.68	74.645 dB SL	1.85423
	SD	6.05	5.414	6.18	5.12		
Left contra	Mean	78.3	75.675	76.1	77.36	76.858 dB SL	1.19797
	SD	5.75	5.23	6.06	6.698		

Table 3. Relation between right and left ears according to ASRT.

	P-value	
	ipsi R & L	**Contra R & L**
500 Hz	0.157	0.06
1000 Hz	0.26	0.27
2000 Hz	0.869	0.729
4000 Hz	0.552	0.336

Table 4. Effect of Gender on ASRT in the ipsilateral right ear, ipsilateral left ear, contralateral right ear and contralateral left ear.

Ipsilateral-right								
Gender	**65-74 dBSL**		**75-84 dBSL**		**85-95 dBSL**		**Total**	**P-value**
	No.	**%**	**No.**	**%**	**No.**	**%**		
Male	25	56.8	38	58.5	47	51.6	110	
Female	19	43.2	27	41.5	44	48.4	90	0.675
Total	44	100	65	100	91	100	200	

Ipsilateral-left								
	65-74 dBSL		**75-84 dBSL**		**85-95 dBSL**		**Total**	**P-value**
	No.	**%**	**No.**	**%**	**No.**	**%**		
Male	25	53.2	32	54.2	53	56.4	110	
Female	22	46.8	27	45.8	41	43.6	90	0.928
Total	47	100	59	100	94	100	200	

Contralateral-right										
	65-74 dBSL		**75-84 dBSL**		**85-94 dBSL**		**95-100 dBSL**		**Total**	**P-value**
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**		
Male	37	58.7	15	51.7	50	60.2	8	32	110	
Female	26	41.3	14	48.3	33	39.8	17	68	90	0.081
Total	63	100	29	100	83	100	25	100	200	

Contralateral-left										
	65-74 dBSL		**75-84 dBSL**		**85-94 dBSL**		**95-100 dBSL**		**Total**	**P-value**
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**		
Male	36	59	14	50	55	57.9	5	31.3	110	
Female	25	41	14	50	40	42.1	11	68.7	90	0.199
Total	61	100	28	100	95	100	16	100	200	

Table 5. Effect of Age on ASRT in the ipsilateral right ear, ipsilateral left ear, contralateral right ear and contralateral left ear.

Ipsilateral-right								
Age categories/year	65-74 dBSL		75-84 dBSL		85-95 dBSL			
	No.	%	No.	%	No.	%	Total	P-value
6-12 years	0	0	15	23.1	35	38.5	50	0.00
13-18 years	13	29.5	18	27.7	9	9.9	40	
19 years & above	31	70.5	32	49.2	47	50.1	110	
Total	44	100	65	100	91	100	200	

Ipsilateral-left								
	65-74 dBSL		75-84 dBSL		85-95 dBSL			
	No.	%	No.	%	No.	%	Total	P-value
6-12 years	3	6.4	12	20.3	35	37.2	50	0.01
13-18 years	15	31.9	13	22.1	12	12.8	40	
19 years & above	29	61.7	34	57.6	47	50	110	
Total	47	100	59	100	94	100	200	

Contralateral-right										
	65-74 dBSL		75-84 dBSL		85-94 dBSL		95-100 dBSL			
	No.	%	No.	%	No.	%	No.	%	Total	P-value
6-12 years	4	6.3	1	3.4	33	39.8	12	48	50	0.00
13-18 years	18	28.6	8	27.6	13	15.6	1	4	40	
19 years & above	41	65.1	20	69	37	44.6	12	48	110	
Total	63	100	29	100	83	100	25	100	200	

Contralateral-left										
	65-74 dBSL		75-84 dBSL		85-94 dBSL		95-100 dBSL			
	No.	%	No.	%	No.	%	No.	%	Total	P-value
6-12 years	2	3.3	2	7.1	40	42.1	6	37.5	50	0.00
13-18 years	20	32.8	5	17.9	13	13.7	2	12.5	40	
19 years & above	39	63.9	21	75	42	44.2	8	50	110	
Total	61	100	28	100	95	100	16	100	200	

DISCUSSION

The ASRT for all reflex frequencies in both sides and both pathways were within the normal range of 70-90 dB HL above hearing threshold (Tables 2, 3) but with lesser intensities than those reported by Wiley, Gelfand and Feeney[13-15, 23]; this is because the hearing threshold of our study was 20 dB HL, but previous studies were much less due to examining participants in sound-treated booths [14, 15], while we visited participants in their communities (schools, university, and airport).

The reflex threshold data for 4000 Hz activator were present only in 110 participants for no explainable reason [6]; this may be due to sensitivity and output limitation of the immittance instrument used in the study [15]. Also, 4000 Hz activators have less diagnostic value because it is often elevated or absent in ears with normal hearing, probably due to rapid adaptation of the VIIIth nerve to this activator frequency [14, 24].

Interaural differences were evaluated, indicating a significant difference between right and left ears in both ipsilateral and contralateral pathways by applying T-test as shown in (Table 3) with (P-values > 0.05), which agrees with the previous study of [16, 24].

Gender also has no significant relation to ASRT, as shown in Tables (4) with (P-values> 0.05), which agrees with the previous study of Gelfand, Osterhammel, and Da Costa [14, 16, 24].

There is a significant effect of age on ASRT (P-values < 0.05) in which, with increasing age, the ASRT increase, especially in those 19 years and above, as shown in Tables [5].

The results agree with the previous study of (Wilson and Margolis,Absalan and Di Giovani [13,17,25] ; this may be due to alterations in external, middle and inner ear structures with the ageing process [13,18,20,25] , also degeneration and metabolic changes of outer hair cells of the cochlea [19, 21, 25].

Age-related changes to ASR thresholds have been reported in earlier studies; some have reported that there are no changes in ASR thresholds with age [17], while others have found that they either decrease with age [16] or increase with age [17, 26], those that reportedly tested at 4000 Hz found an age-related increase in the ASR threshold at that frequency [16, 17, 26] noted, ASR results at 4000 Hz are atypical and often absent even in otherwise normal ears. Irrespective of age, ASR thresholds appear similar in men and women, although there have been few studies performed [23].

Wilson and Margolis [17] attribute apparent inconsistencies between studies of ASR thresholds to several factors, including the use of different measurement procedures, variations in participant selection criteria such as level of hearing loss and age groupings, and whether tonal or other stimuli were used to elicit the ASR. Absalon [13] found that ageing affects the reflex threshold for tonal but not broadband noise (BBN), but others have reported an increase in thresholds for BBN with age [14, 16, 21, 26].

Further comparisons between our outcomes and these studies are difficult to make because of differences in the sampling of participants and the lack of adjustment for hearing thresholds in the earlier reports. It is, however, possible to conclude that any statistically significant age-related increases in the mean ASR thresholds to tonal stimuli are small and unlikely to be clinically significant.

In conclusion , the stapedial reflex threshold in normal hearing subjects was within normal range, different parameters as the side of ear and gender did not affect the threshold. In contrast, with advancing age amount of intensity needed to elicit the reflex increased.

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