Measurement of Hearing Ability of Persons of Different Age Groups

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ABSTRACT
The human ear is most sensitive. Hearing problems increases with age as well as sound pollution. In today’s life, due to noise pollution or some reasons, per year, many people undergo from the problem of tentative hearing loss. In this experiment, 16 patients of different ages were taken, ranging from 20 years to 55 years of both sexes and we studied hearing sensitivity and it was compared between the right and left ears of each patient, as well as the comparability of hearing for different ages taken in this research.

Keyword: Audiometer, Rinne’s test, Triveni, Weber’s test, Tympanometry Test

1. Introduction:
In this paper I have discussed the audibility of persons of different age groups through using “Triveni Tam-25 Audiometer”. It is computerized portable device. This is an acoustic instrument for measuring hearing ability in terms of loudness and pitch of sounds. Loss of hearing occurs due to disorders in ear. It sometimes can put a person in a state of incomprehension of the speaker and thus be construed as a lack of cleverness. Loss of hearing can be unfounded for signs of an inability to operate well in the workplace [1]. Our college conducted free health check-up for senior citizens of our nearby area. Around 40 persons have been examined through this free health check-up.

2. Sound
Sound signifies the sensation received by the ear. It is also referred to as physical cause which stimulates the auditory nerves to produce the sensation of hearing. Sound is produced by the vibrations of material bodies. These vibrations are transmitted in the surrounding medium & it carried by the medium to the ear. The eardrum is thrown into similar vibrations & produces sensation of hearing. Sound energy is mechanical energy of the vibrations medium developed from the mechanical energy of the vibrating source. The vibrations lie within a certain limit to make sound audible. It is known as “limits of audibility”. The lower being about 20 vibrations per second (20Hz) & upper limit being about 20,000 vibrations per second (20kHZ) [2]. The audible Sound is known as sonic sound and waves carrying this sound are called sonic waves. Sound required material medium for propagation which may be solid, liquid or gas.

3. Amplitude

The average pressure (P0) at sea level without sound is disturbing the air is 1 atm, this value equals to 760 mmHg or (1 X 106 dyne/cm²), superimposed Sound pressure waves on average pressure. Since sound waves are oscillatory, the immediate absolute pressure (P) periodically differs above and below the average pressure. The sound pressure amplitude p is equal to the difference between the average and absolute pressures the sound pressure amplitude is generally expressed as dynes per square centimetre. The threshold of human hearing for a 1000-Hz pure tone is 2 x 10⁻⁴ dyne/cm² [3].

4. Measuring Hearing Ability Methods

Part of an ear examination is a hearing test that judges a person's ability to hear by measuring the ability of sound to reach the brain. We hear sounds as vibrations of air, fluid, and solid materials about ours. The vibrations produce sound waves, which vibrate at a certain speed (frequency) and have certain amplitude (height from origin point) [4]. Hearing happens when these sound waves travel through the ear and are turned into nerve impulses. These nerve impulses are sent to the brain, which “hears” them. Basically, there are four methods which measure the hearing loss and detect the problem in ear.

- Test method of Rinne
- Test method of Weber
- Test method of Tympanometry
- Audiometry test method

4.1. Rinne test method

Foundation of the vibrating tuning fork is set on mastoid procedure, until the subject cannot feel the vibration and can't hear the sound. At the point when the subject doesn't hear the sound any more, the tuning fork is held in air before the ear of same side.

Typical individual hears vibration in air significantly after the bone conduction stops in light of the fact that, in ordinary condition air conduction through ossicles is superior to bone conduction. In any case, in conduction deafness, the vibrations in air are not heard after discontinuance of bone conduction. In this way in conduction deafness, the bone conduction is better than air conduction. In nerve deafness, both air conduction and bone conduction are reduced or lost [5].

4.2. Test method of Weber

The standard of the vibrating tuning tine is positioned over a vertex about the cranium and the brow middle. Hear the sound on a normal character equally over each side [6]. In unilateral conductance deafness (one ear is deaf), the sound is heard louder into the diseased ear. In unaffected ear, even is an overlaying impact of environmental noise. So the sound through skeleton transportation is no longer
heard as truly so about the affected side. On the affected side, the noise is louder fit in imitation of the penury regarding the covering impact on environmental noises.

4.3. **Tymanometry Test**

Tymanometry testing is used to assess the condition of the ear drum and middle ear. It is the measure of energy transmissions through the middle ear. The test should not be used to access the sensitivity of hearing and the results of this test should always be viewed in conjunction with pure tone audiometry [1]. The tymanometry test detects the problems such as fluid/wax build-up perforated eardrum; ossicles bone damage, or tumors in the middle ear this test differs from Audiometric Test.

Tymanometry is an objective test of middle-ear function. It is performed by inserting a Tymanometry into the ear canal. Tymanometry provides information regarding the nature of the hearing loss, particularly the difference between a sensor neural and a conductive hearing loss. During this test, a soft Plugin placed on a person’s ear. This plug changes pressure to make loud noise and tracks, a person’s responses to the sound and various pressures movement of the eardrum is measured as well as the reflexes of the tiny muscles attached to the ossicles. Tymanometry is a measurement of admittance in the ear canal as the air pressure within the canal is varied. These measurements provide useful information regarding the middle ear and Eustachian tube function, which are of great interest when investigating conductive hearing disorders.

The graphic displays of such measurements are called Tympanograms and are obtained using a probe inserted in the ear canal. Tympanograms can be very useful for some applications but vary with individual ear canal characteristics, such as shape and volume [2]. The tymanometry looks likely an echoscope. However, it delivers sound waves, while a vacuum creates both positive and negative pressures within the ear canal. The returned energy creates a waveform that a physician can use to evaluate for disorders of the middle ear[4]. This waveform is called a Tympanograms. Possible disorders of the middle ear that can be evaluated by tymanometry include:

- Acute otitis media
- Tymanosclerosis
- Tumor in the middle ear
- Typanic membrane scarring
- perforated tympanic membrane
- otosclerosis
- cholesteatoma

![Figure1. Tympanometry](image)

4.4. **Audiometry test**

An Audiometry evaluation is painless, non-invasive hearing test that measures person’s ability to hear different sounds, pitches or frequencies. Audiometry test possible detect
whether you have sensory neural hearing loss occurs due to damage to the nerve or cochlea, or conductive hearing loss occurs due to damage to the ear drum or tiny ossicles bones. Audiometry tests to be done with the help of audiometers [1].

Audiometer means audio + matron (to measure). An audiometer is a special instrument that is used to measure the acuity of hearing or hearing level. Bekesy`s automatic audiometer with which the client makes his own audiogram by pushing and releasing a button to indicate whether or not he hears pure tones at changing intensity levels [5]. An automatic audiometer is instrument which utilizes client control principle to test hearing, an operator being needed only to start the machine.

5. **TRIVENI**
An audiometer that was built for field or clinical use by field based and clinical based Audioligists from around the world who has shared their ideas on the perfect low-cost audiometer.

![Figure 2. Block diagram of Basic audiometer](image)

![Figure 3. TRIVENI TAM-25](image)
5.1. New in the TAM 25;
- Narrow & Speech band masking now available along with wide band masking. A separate toggle switch for left and right channels.
- A separate toggle switch for masking select.
- The TAM-25 is able to accept both 10 and 8 ohms headphones to accommodate the standard TDH 39, 49, 50 and DR 49, and HD01 (that maybe included as standard).
- Quicker calibration using the protocol found at the end of this manual. Additionally calibration for masking is also available.
- The instrument’s distortion is under 3%.
- The revised P.C software has 2 way communications allowing the audiometer to be operated by both the P.C. and the TAM-25 keys.
- The P.C software has a new installer which should allow seamless installation on all windows operating platforms [7].

5.2. Packing list
- TAM-25 Audiometers.
- S.M.P.S Power supply with battery backup (Optional).
- HD-01 Headphones (Optional).
- Radio Ear B71 Bone conductor.
- 9 pin serial cable for computer connection.
- External microphone with lapel clip.
- CD containing TAM - Control software.
- Patient Response Switch
- Operating Manual.

5.3. Speech-Tone section
- Oscillator: Analog with digital control.
- Pure Tone Attenuator: in Steps of 5dB.
- Attenuator Range: -20dB to 120dB.
- Attenuator Linearity: Maximum Error at Any One.
- Attenuator Setting is: ±1B.
- Tone Interruption: Less than 100ms for rise & Decay of Tone.
- Frequency Range:
  - For Air Conduction: 250/s, 500/s, 750/s, 1K/s, 1.5K/s, 2K/s, 3K/s, 4K/s, 6K/s, 8K/s
  - For Bone Conduction: 250/s, 500/s, 1K/s, 1.5K/s, 2K/s, 3K/s, 4K/s, 6K/s
- Frequency Accuracy: within 3%.
- Hearing Level Accuracy: within 2dB.
- Maximum dB settings: shown in table1
Table 1. Maximum dB settings

| Frequency kHz | Intensity (dB) | Frequency kHz | Intensity (dB) |
|---------------|---------------|---------------|---------------|
| 0.25          | 90            | 0.25          | 50            |
| 0.50          | 120           | 0.50          | 70            |
| 0.75          | 120           | 0.75          | 70            |
| 1.0           | 12            | 1.0           | 70            |
| 1.5           | 120           | 1.5           | 70            |
| 2.0           | 120           | 2.0           | 70            |
| 3.0           | 120           | 3.0           | 70            |
| 4.0           | 120           | 4.0           | 70            |
| 6.0           | 100           | 6.0           | 70            |
| 8.0           | 100           | 8.0           | 70            |
| Speech        | 100           | Speech        | 70            |

5.4. Triveni TAM-25 audiometer software features

- Using the Traven Audiometer software the audiometer can be turned into a complete P.C based audiometer.
- Patient records can be easily maintained on P.C thus eliminating paper work.
- Old records can be reviewed and updated later.
- The intuitive user interface allows you to work much faster and efficiently.

![Figure 4. TRIVENI TAM-25 Audiometer software features](image-url)
6. Results
In this experiment has taken 16 Patients with different ages and we got on the results which show in the following tables

**Table 2.** Observation data of Patient-1- his age 55 years & Sex: male

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     | RE  | 30  | 20  | 15  | 15   | 30  | 25  | 15  | 25  | 35  | 40  |
|               | LE  | 20  | 25  | 15  | 15   | 20  | 30  | 35  | 45  | 60  | 50  |

![Graph showing sensitivity](image)

**Figure 5.** A graph of table2 show left ear is less sensitive than Right ear than Right ear within the range 2K to 8K.

**Table 3.** Observation data of Patient-2- his age 38 years & Sex: male

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     | RE  | 35  | 35  | 35  | 35   | 35  | 35  | 20  | 30  | 30  |
|               | LE  | 35  | 35  | 30  | 30   | 40  | 25  | 15  | 20  | 65  | 55  |

![Graph showing sensitivity](image)

**Figure 6.** A graph of table3 show left ear is less sensitive than right ear within range 6 to 8K.
Table 4. Observation data of Patient-3- his age 20 years & Sex: male

| frequency (Hz) | 250  | 500  | 750  | 1K   | 1.5K | 2K   | 3K   | 4K   | 6K   | 8K   |
|---------------|------|------|------|------|------|------|------|------|------|------|
| Intensity     | RE   | 20   | 30   | 15   | 20   | 25   | 15   | 15   | 5    | 15   |
|               | LE   | 25   | 30   | 25   | 20   | 20   | 15   | 15   | 10   | 10   |

Figure 8. A graph of table 4 show both ears are equally sensitive.

Table 5. Observation data of Patient-4- his age 20 years & Sex: male

| frequency (Hz) | 250  | 500  | 750  | 1K   | 1.5K | 2K   | 3K   | 4K   | 6K   | 8K   |
|---------------|------|------|------|------|------|------|------|------|------|------|
| Intensity     | RE   | 40   | 40   | 20   | 30   | 30   | 25   | 20   | 20   | 25   |
|               | LE   | 25   | 30   | 30   | 35   | 30   | 25   | 15   | 30   | 25   |

Figure 8. A graph of table 5 show both ears are equally sensitive.
Table 6. Observation data of Patient-5 - his age 20 years & Sex: male

| frequency (Hz) | 250 | 500 | 750 | 1K | 1.5K | 2K | 3K | 4K | 6K | 8K |
|----------------|-----|-----|-----|----|------|----|----|----|----|----|
| Intensity      |     |     |     |    |      |    |    |    |    |    |
| RE             | 30  | 30  | 25  | 30 | 35   | 20 | 20 | 15 | 15 | 15 |
| LE             | 30  | 30  | 35  | 30 | 25   | 20 | 15 | 15 | 15 | 25 |

Figure 9. A graph of table 6 show both ears are equally sensitive.

Table 7. Observation data of Patient-6 - his age 32 years & Sex: female

| frequency (Hz) | 250 | 500 | 750 | 1K | 1.5K | 2K | 3K | 4K | 6K | 8K |
|----------------|-----|-----|-----|----|------|----|----|----|----|----|
| Intensity      |     |     |     |    |      |    |    |    |    |    |
| RE             | 45  | 40  | 30  | 30 | 25   | 5  | 10 | 20 | 20 | 5  |
| LE             | 10  | 30  | -10 | -10| -10  | -20| -20| -5 | -5 | -15|

Figure 10. A graph of table 7 show right ear is less sensitive than Left ear within the range 250Hz to 6K.
**Table 8.** Observation data of Patient-7 - his age 39 years & Sex: male

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     | RE  | 35  | 30  | 25  | 25   | 35  | 35  | 30  | 45  | 35  |
|               | LE  | 35  | 30  | 20  | 25   | 20  | 20  | 15  | 20  | 15  |

**Figure 11.** A graph of table 8 show right ear is less sensitive than left ear within the range 1.5K to 8K.

**Table 9.** Observation data of Patient-8 - his age 40 years & Sex: female

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     | RE  | 25  | 20  | 15  | 30   | 30  | 25  | 20  | 35  | 35  |
|               | LE  | 35  | 20  | 30  | 35   | 40  | 30  | 25  | 30  | 20  |

**Figure 12.** A graph of table 9 show left ear is less sensitive than Right ear within range 750Hz to 3K.
Table 10. Observation data of Patient-9- his age 21 years & Sex: male

| Frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     |     |     |     |     |      |     |     |     |     |     |
| RE            | 20  | 15  | 20  | 15  | 25   | 15  | 25  | 20  | 10  | -5  |
| LE            | 25  | -10 | 15  | 15  | 15   | 10  | 15  | 15  | 15  | 0   |

Figure 13. A graph of table 10 show right ear is less sensitive than Left ear within the range 1.5K to 4K.

Table 11. Observation data of Patient-10- his age 48 years & Sex: female

| Frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     |     |     |     |     |      |     |     |     |     |     |
| RE            | 40  | 30  | 35  | 20  | 35   | 25  | 25  | 20  | 50  | 30  |
| LE            | 40  | 35  | 40  | 30  | 20   | 20  | 25  | 25  | 70  | 60  |

Figure 14. A graph of table 11 show left ear is less sensitive than Right ear within range 4K to 8K.
Table 12. Observation data of Patient-11- his age 31 years & Sex: female

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|----------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity RE   | 20  | 25  | 20  | 25  | 35   | 30  | 35  | 25  | 50  | 35  |
| Intensity LE   | 35  | 35  | 25  | 25  | 35   | 30  | 35  | 30  | 40  | 45  |

Figure 15. A graph of table 12 show right ear is sensitive than left ear within range 250Hz to 750Hz.

Table 13. Observation data of Patient-12- his age 47 years & Sex: female

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|----------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity RE   | 35  | 30  | 30  | 35  | 40   | 30  | 20  | 30  | 20  | 15  |
| Intensity LE   | 40  | 40  | 35  | 35  | 40   | 35  | 30  | 20  | 30  | 20  |

Figure 16. A graph of table 13 show right ear is more sensitive than left ear within the range 250 Hz to 750 Hz & 2K to 3K.

Table 14. Observation data of Patient-13- his age 21 years & Sex: female

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|----------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity RE   | 25  | 25  | 30  | 15  | 15   | 10  | 10  | 5   | 20  | 10  |
| Intensity LE   |     |     |     |     |      |     |     |     |     |     |
Table 15. Observation data of Patient-14—his age 23 years & Sex: male

| frequency (Hz) | 250 | 500 | 750 | 1K  | 1.5K | 2K  | 3K  | 4K  | 6K  | 8K  |
|---------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|
| Intensity     | RE  | 35  | 35  | 25  | 25   | 30  | 15  | 15  | 0   | 15  | 5   |
|               | LE  | 35  | 30  | 25  | 25   | 25  | 15  | 20  | 0   | 15  | 5   |

Figure 17. A graph of Table 14 shows both ears are equally sensitive.

Figure 18. A graph of Table 15 shows both ears are equally sensitive within the range 750Hz to 1K & 4K to 8K.
Table 16. Observation data of Patient-15- his age 36 years & Sex: female

| Frequency (Hz) | 250 | 500 | 750 | 1K | 1.5K | 2K | 3K | 4K | 6K | 8K |
|----------------|-----|-----|-----|----|------|----|----|----|----|----|
| **Intensity**  |     |     |     |    |      |    |    |    |    |    |
| RE             | 25  | 25  | 30  | 25 | 30   | 20 | 15 | 20 | 25 | 25 |
| LE             | 35  | 30  | 30  | 30 | 35   | 20 | 15 | 20 | 25 | 25 |

Figure 19. A graph of table 16 show both ears are equally sensitive within the range 2K to 6K.

Table 17. Observation data of Patient-16- his age 25 years & Sex: female

| Frequency (Hz) | 250 | 500 | 750 | 1K | 1.5K | 2K | 3K | 4K | 6K | 8K |
|----------------|-----|-----|-----|----|------|----|----|----|----|----|
| **Intensity**  |     |     |     |    |      |    |    |    |    |    |
| RE             | 20  | 25  | 15  | 25 | 25   | 15 | 15 | 15 | 30 | 25 |
| LE             | 25  | 15  | 15  | 15 | 10   | 15 | 15 | 15 | 15 | 20 |

Figure 20. A graph of table 17 show Left ear is sensitive than right ear within the range 1K to 1.5K & 6K to 8K.
Table 18. Statistical results

| Sr. No. | Description                        | Result                  |
|---------|------------------------------------|-------------------------|
|         |                                    | Right ear | Left ear |
| 1       | Total no. of patients checked       | 16         | 16       |
| 2       | Normal patients                     | 4.54%      | 13.63%   |
| 3       | Patients having Minimal loss        | 54.54%     | 45.45%   |
| 4       | Patients having Miid loss           | 40.92%     | 38.63%   |
| 5       | Patients having Moderate loss       | ___        | 2.29%    |
| 6       | Patients having Moderately severe loss | ___     | ___      |
| 7       | Patients having severe loss         | ___        | ___      |
| 8       | Patients having profound loss       | ___        | ___      |

7. Conclusions
I have measured hearing ability of 16 persons of different age groups it is observed that, Threshold of hearing changes from person to person and it depends upon one’s sensitivity of ear. Because of this sensitivity of ear to respond at various frequencies is different for different person.

From the above data, it is also observed that left ear is less sensitive than right ear. Most of the patients have hearing loss at high frequencies i.e. sensitivity of ear to respond to higher frequency is minimum as compared to respond to low frequency.

From this observation I conclude that, sensitivity of ear to respond to high frequency decreases with increasing age of the person. Because of this, they are unable to hear conversational speech especially if there is background noise such as television or radio. Among them, 2.29% patients have Moderate loss. Therefore under the guidance we advised them to consult their results to ENT specialist.

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