**RESEARCH**
O&G Forum 2024; 34 – 3s: 1944-1953

# THE STUDY OF CONSEQUENTS NOISE ON HEARING THRESHOLD FOR TWO CATEGORIES OF PEOPLE, GENERATOR WORKERS AND MILITARY PERSONNEL

**Eman M. Al-zoubaidi[1, a], Essa, A.F.[2, b] and Hayder S. Musa[3, c]**

1Department of Physics, College of Science, University of Wasit, Iraq.
2 Department of physics, College of Science, University of wasit, Iraq.
3 Consultant E.N.T Surgeon, AL- Karama Teaching Hospital –Kut, Wasit, Iraq.
[a]ealzoubaidi@gmail.com, [b]afadhel@uowasit.edu.iq , [c]Hayderserhan1979hs@gmail.com

**Abstract.** In this study, noise levels issued by electrical generators were measured using a sound level meter device. The noise level of 11 generators was measured. The average noise level was about 101.6409091 decibels, which is greater than the noise level permitted for daily exposure. The study included two categories of people. Electric generator workers, numbering 55, and soldiers, numbering 36. All of them were brought in groups of 4 people weekly to the hearing unit at Al Karama Teaching Hospital. A hearing test was conducted to evaluate their level of hearing and determine the extent of the effect of noise on the hearing threshold, after they were examined by an ear, nose and throat consultant using an otoscope device. Seven generator workers were excluded from the study due to their infection with middle ear infection. Thus, the number of those who underwent the test was the hearing included 48 workers and 36 military personnel, and no military personnel were excluded because their selection was made in a non-random manner. After conducting statistics on the data, it was found that 44 workers and 36 soldiers were suffering from hearing loss in high frequencies (left ear). The latest findings of this study are that hearing loss caused by noise can develop many years before a person complains of hearing loss.
**Keywords:** Hearing loss, Generator noise, Hearing threshold, Hearing examination, Military noise.

## Introduction

Sound is the human sensation of pressure fluctuation in the air. Noise poses a danger to humans and affects daily activities. The US Environmental Protection Agency considers noise as unwanted sound [1]. Cumulative noise levels in humans lead to side effects such as permanent or temporary deafness of the hearing aid. [2]. There are many sources of noise, but this research focused on two types of noise sources: the noise of electrical generators and the noise resulting from military activities such as explosions, bombing, and gunfire. Electrical generators are considered a source of environmental pollution, especially noise pollution (known as electromagnetic noise resulting from electrical transformers). [7]. The intensity of sound and noise coming from the electrical generator varies from one location to another in terms of the size of the generator, its voltage capacity, and its location in terms of proximity and distance from neighborhoods. Residential areas [6]. It must be noted that electric generators that operate on kerosene fuel are noisier than those that operate on gasoline

fuel. When the generator is located within the residential neighborhood and between the houses, The intensity of the noise is very high and close to the site, but the intensity of the noise decreases a few meters away from the source, because houses act as barriers that block the sound and reduce the intensity of the noise coming from the generator. As for generators located in an open area, the intensity of the noise depends on the size and type of the generator, but the noise reaches long distances (250) meters, and the sound remains audible, but the intensity of the noise decreases with increasing distance. Because the sound goes down. As the distance increases, that is, as the distance between the sound source and the listener doubles, the sound pressure level decreases by 6 dB [5]. This applies to generator noise, but military noise is considered much more dangerous than other noise sources. Although hearing protection devices are

routinely provided to military personnel, they are often not used in active service due to the need to hear warning signals and instructions. Hence, unexpected danger among military personnel remains a serious problem [8]. people serving in the military will, at some point, be exposed to high intensity noise of various types. Some may develop hearing loss, especially for high-frequency sounds, or tinnitus ("ringing in the ears"), or both, many sources of potentially harmful noise have long existed in military environments such as weapons (pistols, shooter, gunnery, and Missiles), aircraft and ships. Military personnel are exposed to such noise during training, military operations, and combat. Although the noise generated by the fighting its onset and duration cannot be determined. However, they were already exposed to loud noise regardless of its duration and onset. This exposure results in two possibilities. Hearing loss develops, which is evident from high-frequency sounds and tinnitus. The results of these noise effects are either temporary or permanent [9].

**Devices and samples**

The data was collected from October 2023 to April 2024 through random sampling of generator workers and specific sampling of military personnel. Our study included 91 people exposed to noise. Noise levels (equivalent sound pressure level) were measured using a sound level meter device. The noise assessment we did was for 11 generators. Then, all of these 91 of these samples were brought in groups of 4 weekly to the Hearing Unit at Al Karama Teaching Hospital for examination.

**Interview**

All workers and soldiers were interviewed personally. The interview included filling out a pre-prepared questionnaire, which included a set of questions asked to the workers, including age, workplace, duration of exposure to noise, chronic diseases, and uses of personal noise protection devices (PPD). The workers' hearing level was assessed with a pure-tone test.

**Hearing examination**

After otoscopy was performed to examine the tympanic membrane for workers and soldiers, only 7 generator workers were excluded from the examination. As for the military personnel, none of them were excluded because their selection was made non-randomly. Therefore, the number of workers who were subjected to a hearing test was (n = 48 workers) And the soldiers (n=36). For generator workers, the test was performed before the start of their shift to avoid contamination of the temporary shift limit hearing level numbers due to recent noise exposure. The test was performed using a pure tone tester (model TSM500-1752-GNDK). Hearing tests were performed by trained nursing staff who performed audiometric evaluations.

**Results**

Evaluation of noise: Noise evaluation was performed on 11 generators. the average of noise levels was 101.6409091 dB (Table 1 and Fig.1).

Table 1. Measurements of noise level

| Measured Generators | noise level (dB) |
|---|---|
| G 1 | 102.65 |
| G 2 | 100.15 |
| G 3 | 100.7 |
| G 4 | 104.25 |
| G 5 | 101.2 |
| G 6 | 100.1 |
| G 7 | 103.65 |
| G 8 | 99.35 |
| G 9 | 100.25 |
| G 10 | 100.4 |
| G 11 | 105.35 |
| Mean | 101.6409091 |
| standard deviation | 2.000477216 |
| maximum | 105.35 |
| minimum | 99.35 |

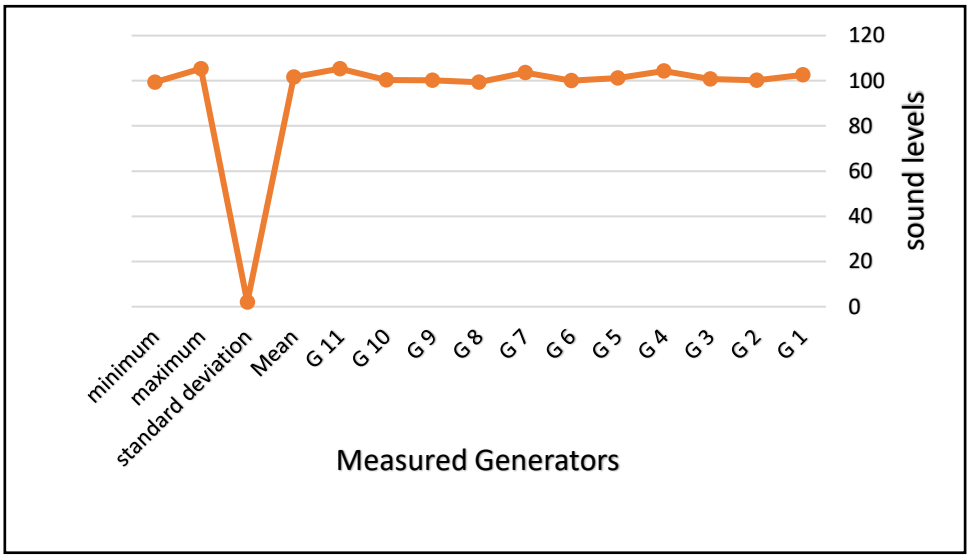


Fig.1. Distribution of noise levels of 11 Measured Generators.

**Audiometric assessment**

**The pure tone testing for generator workers:** which done to (n=48) workers shown as in Table 2 ( fig.2) and Table 3 (fig.3) for the right ear and left ear respectively, there were 44 hearing loss in L-ear/ high frequency which reflect the real clinical apparent hearing loss worker (because all worker with R-ear NIHL were bilaterally affected) and This value (n1=44) will be considered as a reference value in all calculations below to be compared with other values.

Table 2. The testing assessment of the right ear

| **Testing assessment** | **Speech frequencies** | **High frequencies** | **Percentage%** |
|---|---|---|---|
| normal | 4 | 4 | 8 % |
| slight | 18 | 8 | 16 % |
| mild | 14 | 24 | 50 % |
| moderate | 4 | 2 | 4 % |
| moderately sever | 4 | 6 | 13 % |
| sever | 0 | 4 | 8 % |
| Profound | 0 | 0 | 0 % |
| Total hearing loss | 40 | 44 | |

Table 3. The testing assessment of the left ear

| **Testing assessment** | **Speech frequency** | **High frequency** | **Percentage%** |
|---|---|---|---|
| normal | 8 | 4 | 8 % |
| slight | 28 | 12 | 25 % |
| mild | 0 | 16 | 33 % |
| moderate | 4 | 6 | 13 % |
| moderately sever | 2 | 2 | 4 % |
| sever | 2 | 6 | 13 % |
| Profound | 0 | 2 | 4 % |
| Total hearing loss | 36 | 44 | |

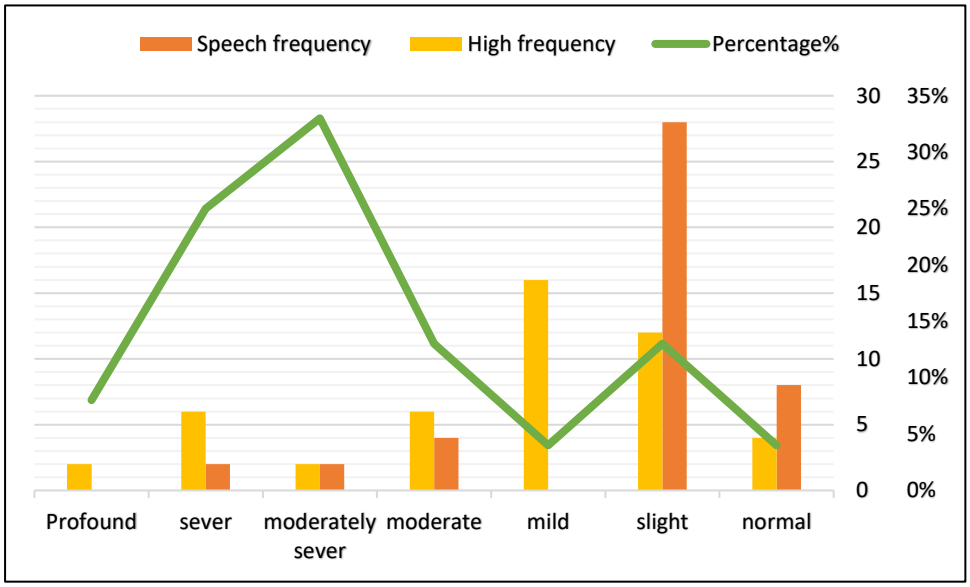


Fig.2. Right ear hearing loss at the average of hearing sensitivity at Speech and High frequencies.

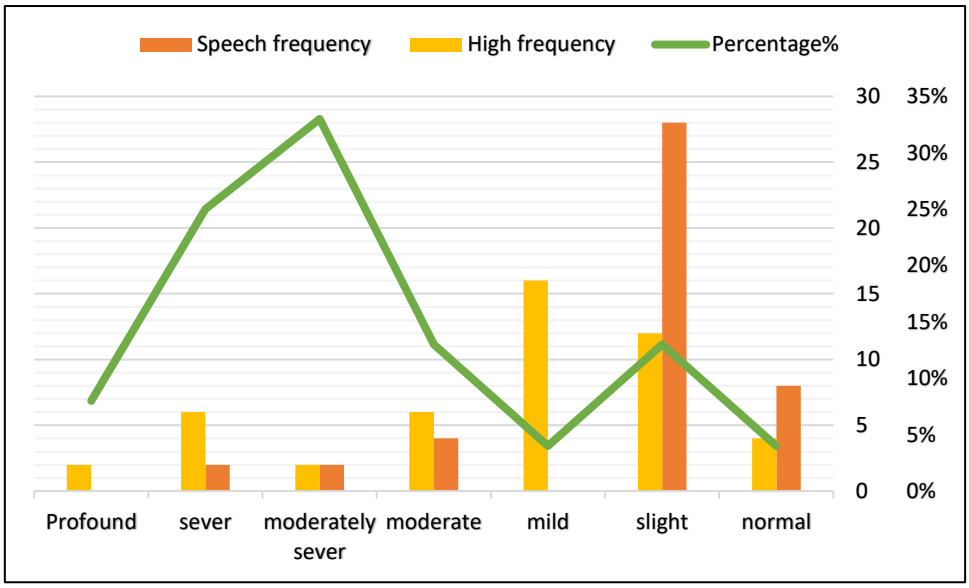


Fig.3. Left ear hearing loss at the average of hearing sensitivity at Speech and High frequencies**.**

relationship between NIHL, age and period of noise exposure.

The distribution of NIHL in High frequencies (n1=44) in Table 4 and Fig.4 explains the direct

Table 4. Distribution of the NIHL in high frequencies (n1=44)

| **Age** | **Average period of noise exposure** | **Number of workers in age Categories** | **Number of workers with NIHL** | **Percentage%** |
|---|---|---|---|---|
| 20 - 30 year | 8 years | 18 | 16 | 89 % |
| 31 - 40 year | 9 years | 15 | 14 | 93 % |
| 41 - 50 year | 14 years | 9 | 8 | 89 % |
| 51– 60 year | 14 years | 6 | 6 | 100% |

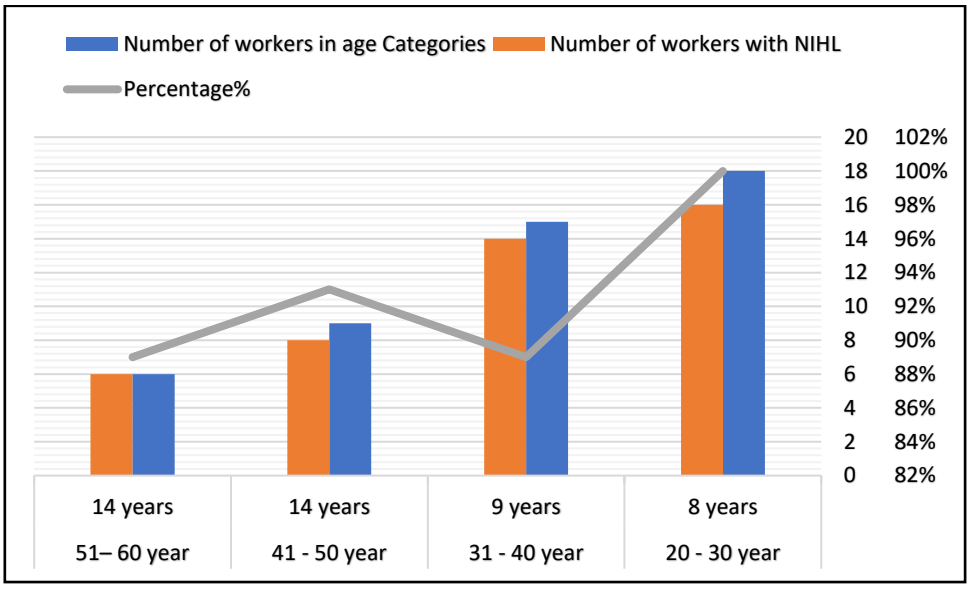


Fig.4. Distribution of the NIHL by age groups.

The study also included the distribution of workers who have hearing loss according to their main complaint, as shown in Table 5(Fig 5).

Table 5. Partition of employees according to their main protest

| **Main protest** | **Number of workers** | **Percentage%** |
|---|---|---|
| Difficulty **h**earing | 9 | 19 % |
| Ear pain with tinnitus | 18 | 38 % |
| Loss of concentration and difficulty communicating with others | 26 | 54 % |

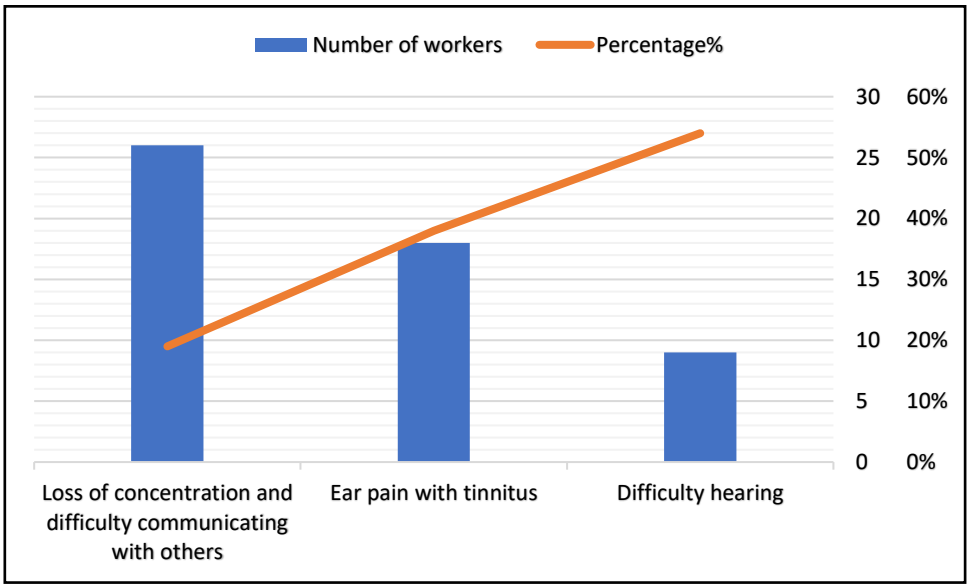


Fig.5. Partition of workers depending on their main protest.

According to Table 5 and Fig.5, which shows the distribution of workers according to their main complaint, it was found that 9, 18, and 26 workers complained of difficulty hearing, ear pain, tinnitus, loss of concentration, and difficulty communicating with others, respectively. In addition, the questionnaire

paper included many questions that were asked to the workers, including the use of noise protection devices. The results we reached on this subject were that the workers did not resort to using any type of protective devices. One of the most prominent things included in the questionnaire sheet was the presence of diseases that affect hearing, as shown in Table 6 (Fig 6).

Table 6. Distribution of workers according to the presence of diseases affecting hearing

| **Affecting illnesses** | **No. of worker** | **No. of NIHL worker** | **Percentage%** |
|---|---|---|---|
| hypertension | **12** | **12** | **100 %** |
| Diabetes | **10** | **10** | **100 %** |
| Allergic rhinitis and asthma | **4** | **4** | **100 %** |
| Congenital ear problems | **6** | **6** | **100 %** |
| thrombosis | **0** | **0** | **0 %** |

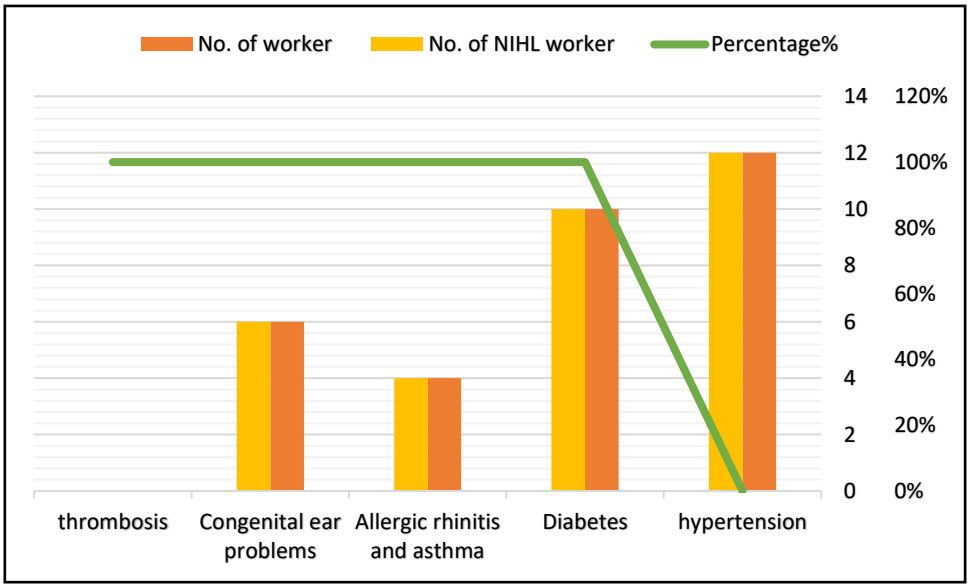


Fig.6. Distribution of workers according to the presence of diseases affecting hearing.

**The pure tone testing for the military:** which done to (n=36) soldiers. 12 soldiers who suffered from slight to mild hearing loss were excluded. Their hearing loss was the result of factors other than noise, such as age and diseases affecting hearing, so they were excluded from the study. Thus, the study included 24 soldiers who were classified according to the type of noise, as shown in Table 7.

Table 7. Classification of military personnel according to the type of noise

| **Noise type** | **Number of soldiers exposed to noise** | **Number of soldiers with hearing loss** | **Percentage%** |
|---|---|---|---|
| Explosion | 8 | 8 | 100 % |
| Bombing | 10 | 10 | 100 % |
| gunshot | 6 | 6 | 100 % |

Then the military personnel were distributed according to the degree of hearing loss, as shown in Table 8(Fig 7) and Table 9(Fig 8) For the right and left ear, respectively.

Table 8. The testing assessment of the right ear

| degree of hearing loss | Speech frequencies | High frequencies | Percentage% |
|---|---|---|---|
| normal | 0 | 0 | 0 % |
| slight | 10 | 4 | 17 % |
| mild | 4 | 0 | 0 % |
| moderate | 6 | 10 | 42 % |
| moderately sever | 4 | 2 | 8 % |
| sever | 0 | 8 | 33 % |
| Profound | 0 | 0 | 0 % |
| Total hearing loss | 24 | 24 | |

Table 9. The testing assessment of the left ear

| degree of hearing loss | Speech frequencies | High frequencies | Percentage% |
|---|---|---|---|
| normal | 0 | 0 | 0 % |
| slight | 10 | 2 | 8 % |
| mild | 6 | 2 | 8 % |
| moderate | 4 | 8 | 33 % |
| moderately sever | 4 | 4 | 17 % |
| sever | 0 | 8 | 33 % |
| Profound | 0 | 0 | 0 % |
| Total hearing loss | 24 | 24 | |

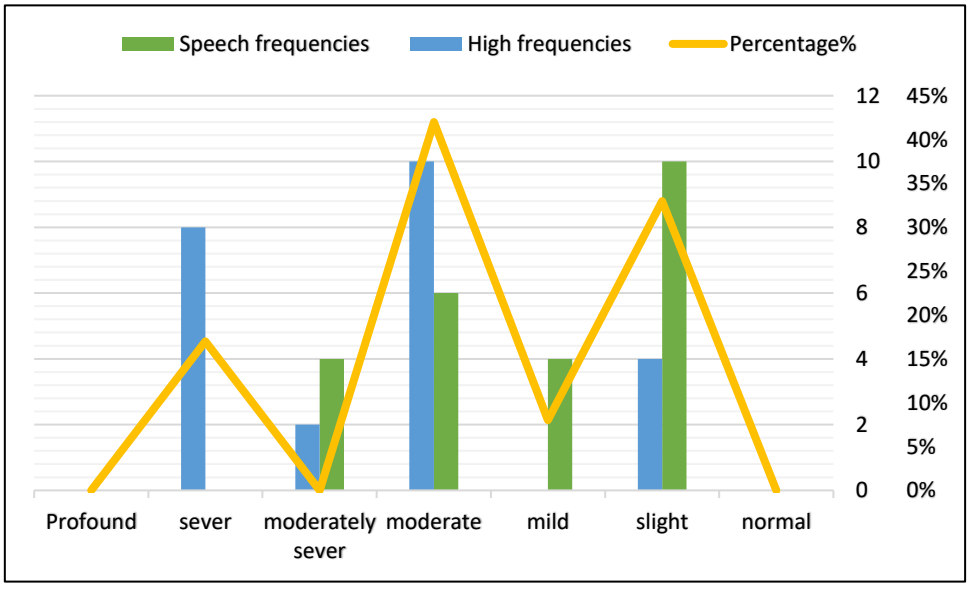


Fig 7. Right ear hearing loss at the average of hearing sensitivity at Speech and High frequencies

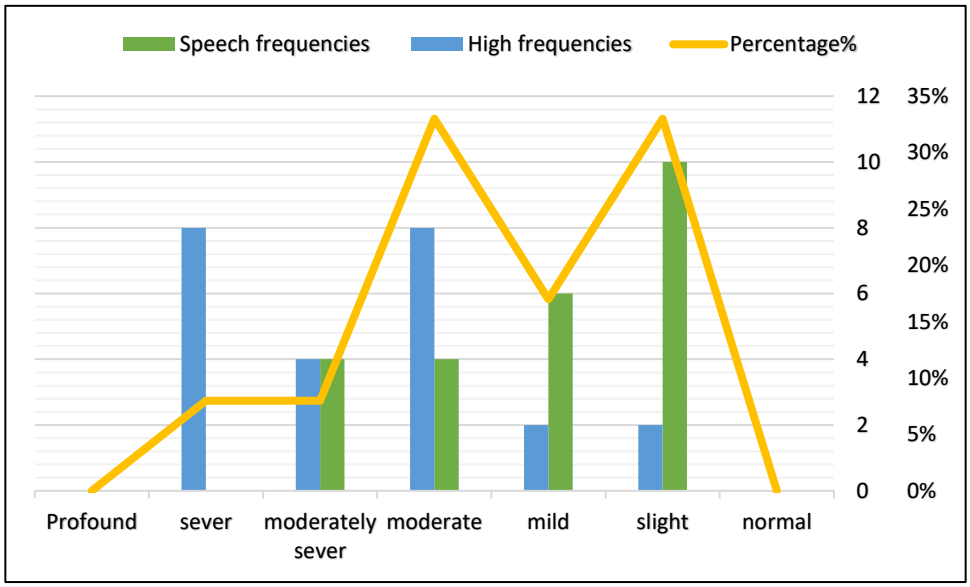


Fig.8. Left ear hearing loss at the average of hearing sensitivity at Speech and High frequencies**.**

From the data conducted, we have determined that military personnel are exposed to very loud temporary noise (noise at a specific time and place) such as the noise of explosions, shelling and gunfire, which is beyond the human ear's ability to tolerate, resulting in immediate and permanent hearing loss ranging from moderate to severe. At high frequencies (4000 - 8000) kilohertz, as a result of damage to the hairs or nerve cells in the cochlea, which are responsible for converting sound vibrations into electrical signals that are transmitted through the auditory nerve to the brain for translation. As a result of aging and diseases affecting hearing, the development of hearing loss. Previous studies have proven that age has a significant impact on hearing loss. Since hearing loss takes 5 years to develop, the louder the sound, the less exposure time is required for hearing loss to occur.

**Safe Sound Level**

According to National Institute for Occupational Safety and Health (NIOSH) guidelines [3].

Table 10. Duration of exposure to noise by NOISH

| **Sound Levels(dB)** | **Permissible exposure** |
|---|---|
| 85dB | 8hours |
| 88dB | 4hours |
| 91dB | 2hours |
| 94dB | 1hour |
| 97dB | 30minutes |

The results showed that workers working in generators are unsafe due to high noise levels, which averaged more than 90 decibels, which is the applied standard value. After conducting a hearing screening test for them, it was found that 44 workers were suffering from hearing loss in high frequencies, while only 19% of the workers complained of difficulty hearing, because hearing loss usually initially includes high frequencies, so we note that the worker suffers from hearing loss. And he doesn't complain about it. Only 38% complained of ear pain and tinnitus, while the largest percentage of their complaints was loss of concentration and difficulty communicating with others (54%). According to the World Health Organization, the degree of hearing loss is classified as shown in Table 11[4]. As for the results reached from the data of military personnel who were exposed to very loud temporary noise (noise at a specific time and place), such as the noise of explosions, bombing, and gunfire, which are sounds that exceed the ability of the human ear to bear, it was found that exposure to such high levels of noise led to immediate and permanent hearing loss, ranging from moderate to severe. At high frequencies (4000 - 8000) kilohertz, this is due to

damage to the hairs or nerve cells in the cochlea, which are responsible for converting sound vibrations into electrical signals that are transmitted through the auditory nerve to the brain for translation. As a result of aging and diseases that affect hearing, hearing loss develops. Previous studies have proven that age has a significant impact on hearing loss. Since hearing loss takes 5 years to develop, the louder the sound, the less exposure time is required for hearing loss to occur.

Table 11. Degrees of hearing loss

| Hearing Loss (dB) | Degree of Hearing Loss |
|---|---|
| **< 15** | **Normal** |
| **16-25** | **Slight** |
| **26-40** | **Mild** |
| **41-55** | **Moderate** |
| **56-70** | **Moderately severe** |
| **71-90** | **Severe** |
| **≥ 90** | **Profound** |

The largest percentage of hearing loss among generator workers was in the mild / high frequency classification. While the largest percentage of hearing loss among military personnel falls within the moderate to severe classification. Through our study, it was found that there is a significant impact of age and duration of exposure to noise on the level of hearing, as the percentage of hearing loss increased with increasing age, meaning that the relationship between them is direct. However, age accounts for a small amount of inter-individual variation in their propensity for hearing loss compared to exposure to a noisy environment. Among the effects that the study noted, which have a major role in increasing hearing loss, are chronic diseases. In our study of 12, 10, 4, and 6 workers with associated chronic diseases (hypertension, diabetes, allergic rhinitis, asthma, and congenital ear problems), respectively, all of them had hearing loss, indicating the presence of A strong relationship between chronic diseases and the chance of hearing loss.

## Conclusion

The noise rating of the generators was higher than the permissible noise. Noise-induced hearing loss develops in workers without them complaining of hearing loss. Their only complaint was tinnitus and ear discomfort.

## References

[1] Akpan, A. O., Onuu, M. U., Menkiti, A. I., &Asoquo, U. E. (2003). Measurements and Analysis of Industrial Noise and its Impact Workers in Akwa-Ibom State, South-Eastern Nigeria. Nig. Journal of Phys, 15 (2), 41-45.

[2] A. Babawuya, I. Bori, M. D. Bako, S. A. Yusuf, A. Jibrin, A.J. Elkanah, A. Mohammed. Effects of Generating Plant Noise on Humans and Environment. International Journal of Engineering Trends and Technology (IJETT) – Volume 35 Number 9 - May 2016.

[3] Hameed, H. M., A. H. Eleue, and F. M. Hussein. "Noise induced hearing loss (nihl) in wasit corporation textile industries." *Journal of Otolaryngology-ENT Research* 11.2 (2019): 108 114.

[4] Reham Ali Dakhel, Nematollah Rouhbakhsh, Ghasem Mohamadkhani." Assessment of Occupational Noise-Induced Hearing Loss in Baghdad Cotton mills, Iraq". Tehran University of Medical Sciences, 2022.

[5] Charles E. wilson,"Noise", in James R. pfaffin and Ed ward N. ZEncyclopedia of Environmental science and Engineering, vol.2(MZ),5th ed., CRC Press, NewYork,2006.

[6] Wartan, Sonia Arzrouni, and Abdullah, Yasmine Najm, Noise pollution in Basra Governorate (its sources - effects - treatment), Al-Ghari Journal of Economic and Administrative Sciences, University of Basra, Center for Basra and Arab Gulf Studies, ninth year, no. 26.

[7] Al-Hassan, Shukri Ibrahim, Environmental Pollution in the City of Basra, unpublished doctoral thesis, University of Basra, College of Arts, Department of Geography, 2011.

[8] Moore, Brian CJ. "Diagnosis and quantification of military noise-induced hearing loss." *The Journal of the Acoustical Society of America* 148.2 (2020): 884-894.

[9] Durch, Jane S., Lois M. Joellenbeck, and Larry E. Humes, eds. *Noise and military service: Implications for hearing loss and tinnitus*. National Academies Press, 2006.