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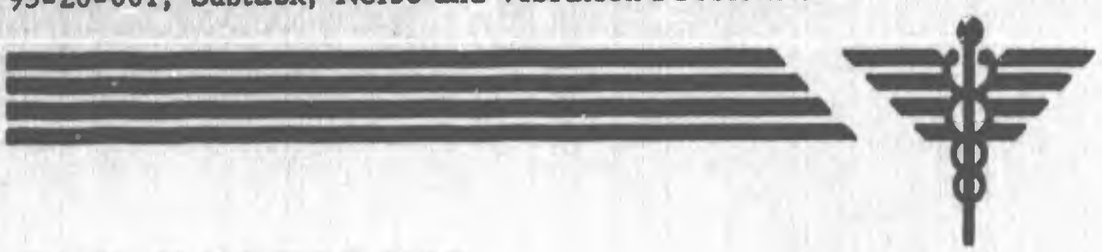
US ARMY MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

REPORT NO. 355
11 August 1958

HEARING LOSSES OF PERSONNEL EXPOSED TO IMPULSE AND STEADY STATE NOISE*

*Subtask under Psychophysiological Studies, USAMRL Project No. 6-95-20-001, Subtask, Noise and Vibration Problems.



RESEARCH AND DEVELOPMENT DIVISION
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

REPORT NO. 355

HEARING LOSSES OF PERSONNEL EXPOSED TO IMPULSE AND STEADY STATE NOISE*

by

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*Subtask under Psychophysiological Studies, USAMRL Project No. 6-95-20-001, Subtask, Noise and Vibration Problems.

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Report No. 355
Project No. 6-95-20-001
Subtask USAMRL S-3
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ABSTRACT

HEARING LOSSES OF PERSONNEL EXPOSED TO IMPULSE AND STEADY STATE NOISE

OBJECT

To study hearing loss differences between personnel working for varying lengths of time in impulse or steady state noise.

RESULTS

Hearing losses of personnel exposed to impulse and steady noise for 1 to 79 months are of the same magnitude and type. For those who are exposed over 80 months, steady noise exposure appeared to produce somewhat greater hearing losses than impulse noise. Apparent screening effects were noted in the 1-to-39- and 40-to-79-month exposure groups.

RECOMMENDATIONS

Results of this study should be taken as indicative of the general trend of losses from impulse and steady noise exposure over varying periods of time.

Further, more exhaustive research is indicated to establish the details necessary for successful hearing conservation, i. e., criteria for hazardous exposure, whether to rotate workers from their job and if so, when, and similar details.

Submitted 27 May 1958 by:
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HEARING LOSSES OF PERSONNEL EXPOSED TO IMPULSE AND STEADY STATE NOISE*

I. INTRODUCTION

Many persons in military service are normally exposed for varying lengths of time to both impulse and steady state noise (steady) at high intensities. The usual case is for the soldier to be exposed to steady noise from 90 to 129 decibels (db) (1) and to impulse noises ranging from 100 db to over 150 db (as measured by a peak reading indicator, all readings re .0002 microbar). The upper limit of impulse noise exceeds the maximum reading (150 db) possible with the instrument available, so cannot be specified. The steady noise is produced by the engines motivating the tanks, personnel carriers, and other combat vehicles manned by the subjects. Impulse noises result from firing on the ranges. This firing ranges from .22 sub-caliber to 155-mm guns.

However, cases can be found where the individual has been exposed primarily to only impulse or steady noise, but not both. For example, range operators control various aspects of range firing in the normal course of duty. This exposure, then, is to explosive-type impulse noise. On the other hand, tracked-vehicle mechanics and live (running)-engine instructors work in maintenance shops and are customarily exposed to the continuous sound of engines being run up and tested.

The question can now be raised, do the hearing losses of those exposed mostly to impulse noise for varying lengths of time differ from those exposed primarily to steady noise for similar time periods? If so, how do they differ and to what degree?

II. METHOD AND SUBJECTS

Audiograms (using the Maico H-1 audiometer) and hearing-data sheets were collected on a large number of servicemen and civilian employees at Fort Knox, Kentucky over a period of about six months. The audiograms were made in the USAMRL mobile sound laboratory.

*The writer wishes to give grateful acknowledgement of the contributions to this paper of the Armed Forces National Research Council Committee on Hearing and Bio-Acoustics Working Group 32. The efforts of Pfc Henry M. Benedict, Pvt Irving Franke, and Pvt E. L. Lunt in the collection and analysis of the data are also gratefully acknowledged.

Ambient noise level in the testing area averaged 34 db. Analysis of the noise indicates that no masking need be expected at any of the frequencies tested.

Figure 1 shows the hearing data sheet that was filled out for each subject tested. This record was carefully examined to assure that those exposed to impulse noise would have as little steady exposure as possible and, similarly, that those steady cases be as free as possible of impulse noise exposure. Records of 177 range operators from the Weapons Department, US Army Armor School, Fort Knox, Kentucky were examined. From those records, 105 subjects were selected as having been exposed primarily to impulse noise. Those sixty persons primarily exposed to steady noise were selected from some 215 subjects from Post Ordnance and Automotive Department, US Army Armor School, Fort Knox, Kentucky. All subjects had been away from loud noise at least sixty hours prior to testing. Those exposed to the two types of noise were separated on the basis of time on job into three categories: 1 to 39 months, 40 to 79 months, and over 80 months. It should be noted that no attempt was made to equate the total energy in the exposure the subjects had, only the amount of time on the job. Previous work (1) has analyzed the exposure of persons working in tracked-vehicle maintenance shops. To date, no comprehensive data are available analyzing range noises, although studies are underway attempting to do so. But, at any rate, the comparison made is of persons exposed to impulse noise with those exposed to steady noise, disregarding the intensity and total energy of such exposure.

Median hearing-loss totals for the frequencies of 250, 500, 1000, 2000, 4000, and 8000 cycles per sec (cps) were then obtained from the audiograms of the subjects exposed to the impulse or steady noise at each of the three lengths of time on the job. These records of hearing loss for type and duration of noise exposure constitute the data of the study.

III. RESULTS

The age distributions of those exposed to impulse and steady noise are presented in Figure 2. The median age of the subjects exposed to steady noise was 38, that for those exposed to impulse noise was 35.

Tabulations were made of the hearing-loss data of those exposed to the two types of noise for the three different lengths of time. These results are shown in Figures 3, 4, and 5. Examination of these figures reveals that hearing losses for the two types of noise exposure are

essentially identical for durations of exposure of 1 to 39 and 40 to 79 months. However, losses for those exposed to steady noise on the job 80 months or longer tend to be larger than those for subjects exposed to impulse noise on the job the same length of time. The differences in mean hearing loss were tested for statistical significance by means of the t test. All differences were significant beyond the one per cent level of confidence. Some of the difference in hearing loss between these types of exposure might be due to age differences in personnel in the two groups. Figure 2 shows that there are more persons over forty in the steady-noise group. But age differences alone would not give an adequate answer for the significant differences that were found for low frequencies.

Figures 3 and 4 show an interesting phenomenon. Losses for persons in both noise-exposure groups were greater with 1-to-39-months noise exposure than with 40-to-79-months exposure. The difference in hearing loss of those exposed 1 to 39 months and 40 to 79 months were tested for significance by a chi-square test. The test was made by establishing the over-all median hearing loss, then determining how many cases in each group were above the median, assuming that the expected distribution should be a 50-50 split. Table 1 presents the results of the test of significance. Table 1 shows that those exposed 1 to 39 months had losses significantly greater than those exposed 40 to 79 months at 2000, 4000, 8000 cps. The difference is greatest at 4000 cps.

TABLE 1

RESULTS OF THE CHI-SQUARE TEST OF SIGNIFICANCE

Frequency	Chi-Square Value	DF	p*
250	0.9944	1	Not Significant
500	0.2357	1	Not Significant
1,000	3.2679	1	Not Significant
2,000	7.1153	1	.01
4,000	11.1662	1	.01
8,000	5.7569	1	.05

*With 1 DF, 3.841 is required for .05% of significance, 6.635 for 1% level of significance.

One possible explanation of the results in Table 1, based on personal observation, is that included among those on the job 1 to 39 months are many who will later transfer into other jobs because they cannot tolerate the noise. Many persons newly assigned to very noisy jobs complain of aural pain or tinnitus and transfer after only a few months on the job. But in the few months on the job they can very easily have suffered noticeable losses. The next group, 40 to 79 months on the job, has then been screened of many of the "susceptibles" (here defined as those who tend to lose their hearing when exposed to loud noise) who were on the

job earlier and had already suffered losses, and, therefore, has less overall loss in spite of longer exposure to the noise.

As seen in Figure 5, those subjects with over 80 months experience on the job, regardless of group, begin to experience greater hearing losses in the region from 4000 to 8000 cps. It is reasonable to assume that, in spite of the almost continual screening process that has been occurring, and even though those remaining have "tough" ears (here defined as those who do not tend to show early hearing loss when exposed to loud noise), the cumulative effects of both age and continued high-intensity noise exposure begin to take their toll. At first glance, one might assume that the very high-peak amplitudes encountered in firing noises would result in greater hearing losses than the more moderate amplitudes produced by engine noises. But, it is evident from our data that such is not the case. Probably the rest between rounds during firing permits recovery, whereas the constant stimulation of engine noise does not allow recovery and eventually results in greater hearing loss.

IV. SUMMARY

Findings of this study suggest that hearing losses of personnel exposed to impulse and to steady noise are of the same magnitude and type (perceptive loss with similar slopes from 2000 to 8000 cps) if exposed from 1 to 79 months. For those who are exposed longer than 80 months, steady noise exposure appeared to produce somewhat greater hearing losses than impulse noise. Apparent screening effects upon hearing losses were noted in the 1-to-39- and 40-to-79-month exposure groups.

V. RECOMMENDATIONS

Results of this study should be taken as indicative of the general trend of losses from impulse- and steady-noise exposure over varying periods of time.

More exhaustive research is indicated to establish the details necessary for successful hearing conservation, i. e., criteria for hazardous exposure, whether to rotate workers from their job, and, if so, when, and similar details.

VI. REFERENCES

1. Fletcher, J. L. and L. N. Solomon. A survey of hearing losses among armor personnel. USAMRL Report No. 282, Ft. Knox, Ky., 1957.

AGE _____

Total Active Svc ___ Mos.

NAME: _____ SN: _____ UNIT: _____

CURRENT NOISE EXPOSURE:

JOB: _____ LENGTH OF TIME: _____

PROTECTION?

1. ALWAYS 2. FREQ. 3. SELDOM 4. NEVER

TYPE OF PROTECTION:

1. DRY COTTON
2. WAXED COTTON
3. EAR PLUGS
4. EAR MUFFS
5. HELMET
6. OTHER?

PREVIOUS NOISE EXPOSURE:

A. MILITARY

	JOBS	TIME ON JOB
1.		
2.		
3.		
4.		
5.		

COMBAT EXPOSURE:

HEAVY ARMS	YES	NO	HOW LONG?
LIGHT ARMS	YES	NO	HOW LONG?
BASIC TRNG	YES	NO	TYPE

EVALUATION OF NOISE EXPOSURE:

_____

_____

B. CIVILIAN

	JOBS	TIME ON JOB
1.		
2.		
3.		
4.		
5.		

EVALUATION OF NOISE EXPOSURE:

_____

_____

MED. HISTORY:

1.	AURAL PAIN _____	R - L
2.	DRAINAGE _____	R - L
3.	EAR INJURY MECH. _____	R - L
4.	SURGERY (EAR OR MASTOID) _____	R - L
5.	TINNITUS PRIOR TO FIRST EXP. _____	R - L
6.	TINNITUS FOLLOWING FIRST EXP. _____	R - L

REMARKS:

AUDIOGRAMS EVER HAD BEFORE? _____ Yes _____ No _____

Fig. 1. Hearing data sheet.

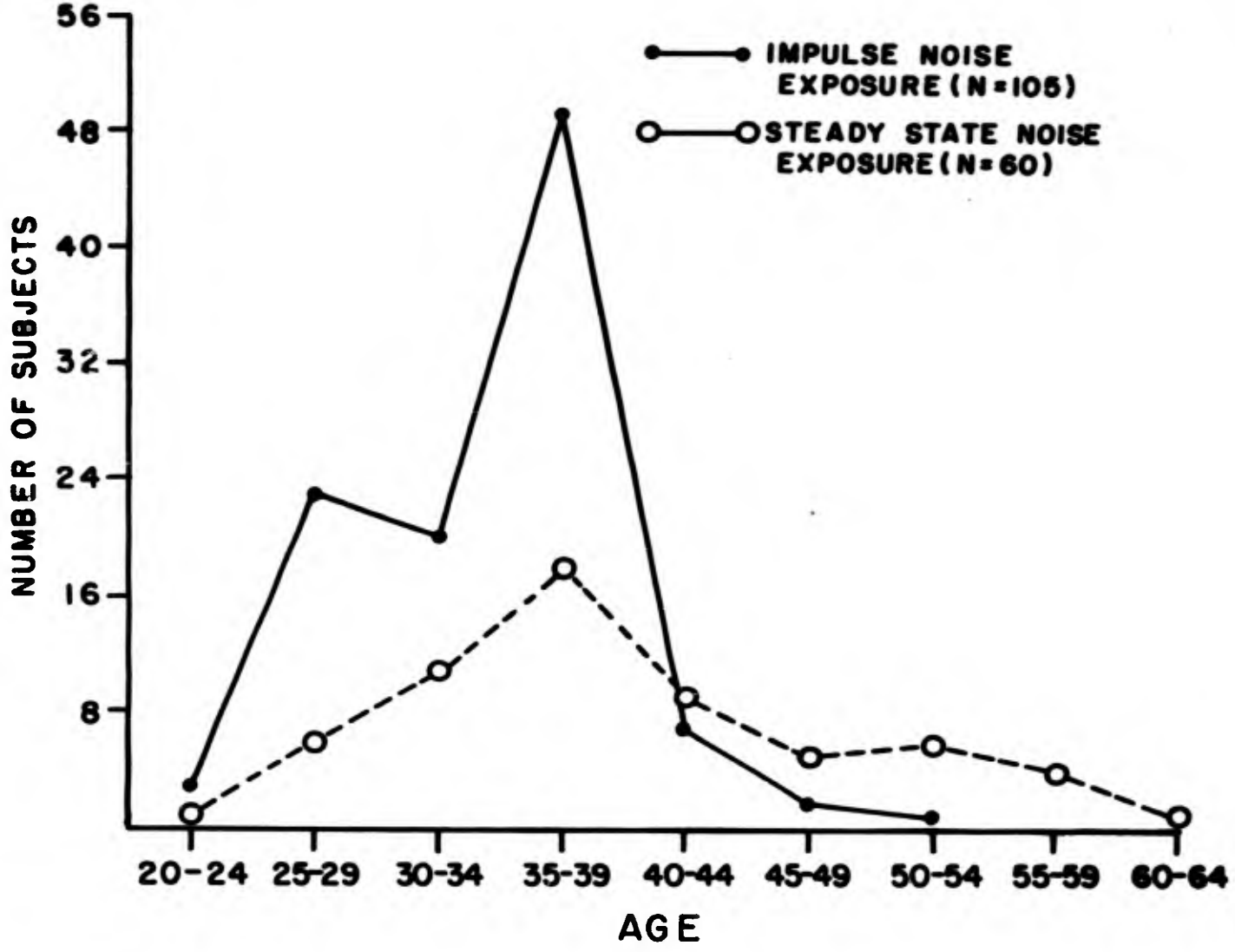

Fig. 2. Age distribution of impulse and steady state noise exposed subjects.

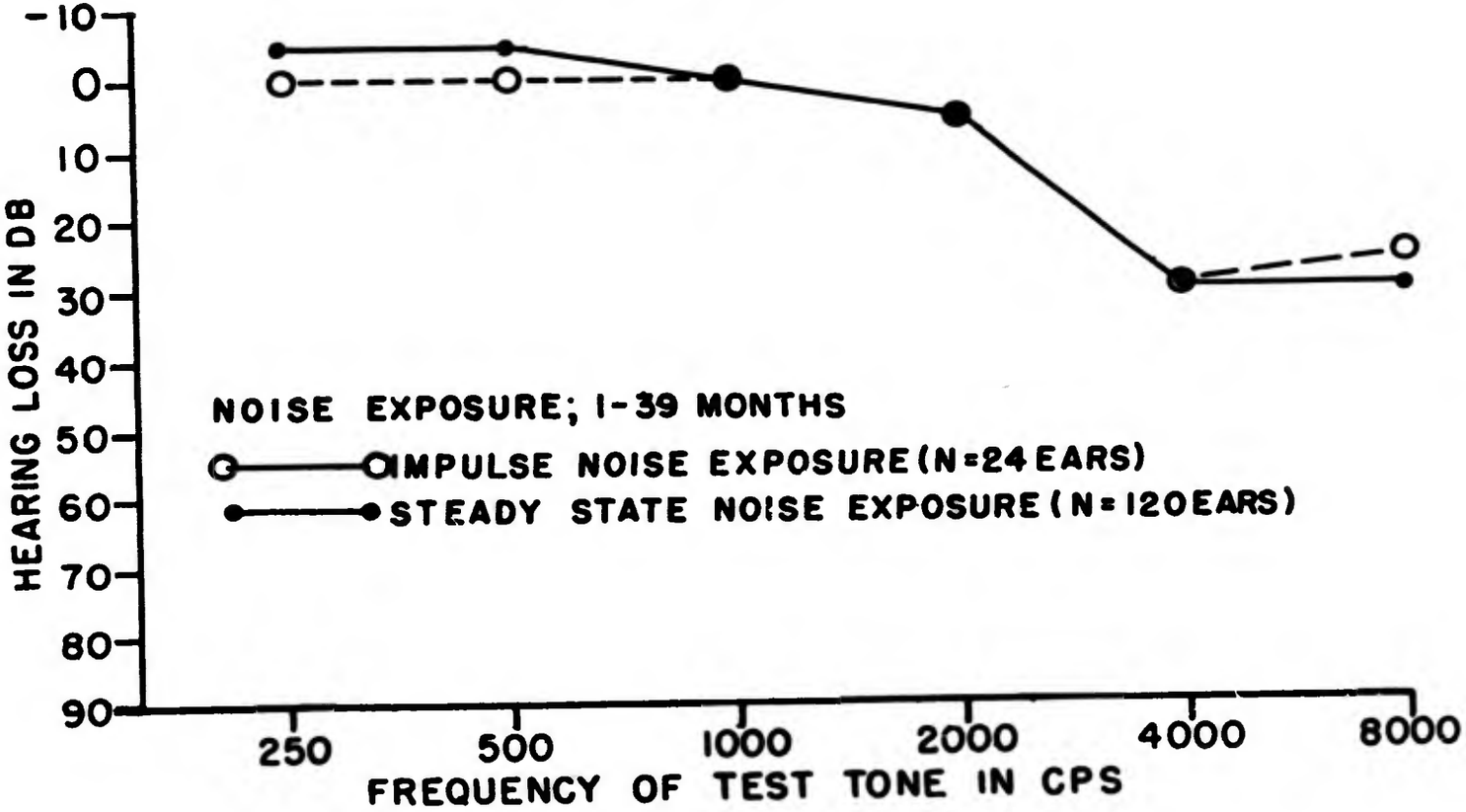

Fig. 3. Hearing loss and noise exposure.

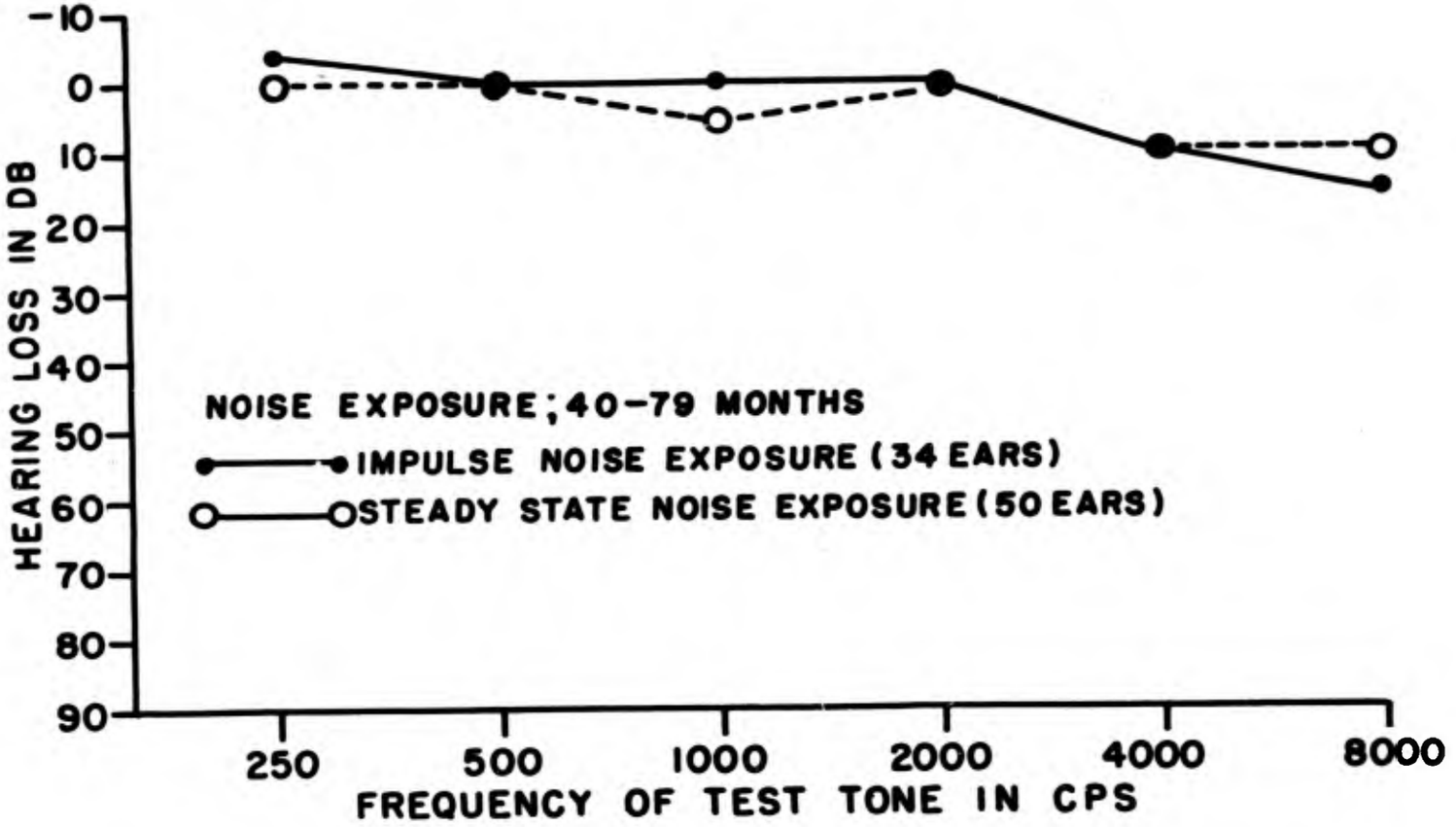

Fig. 4. Hearing loss and noise exposure.

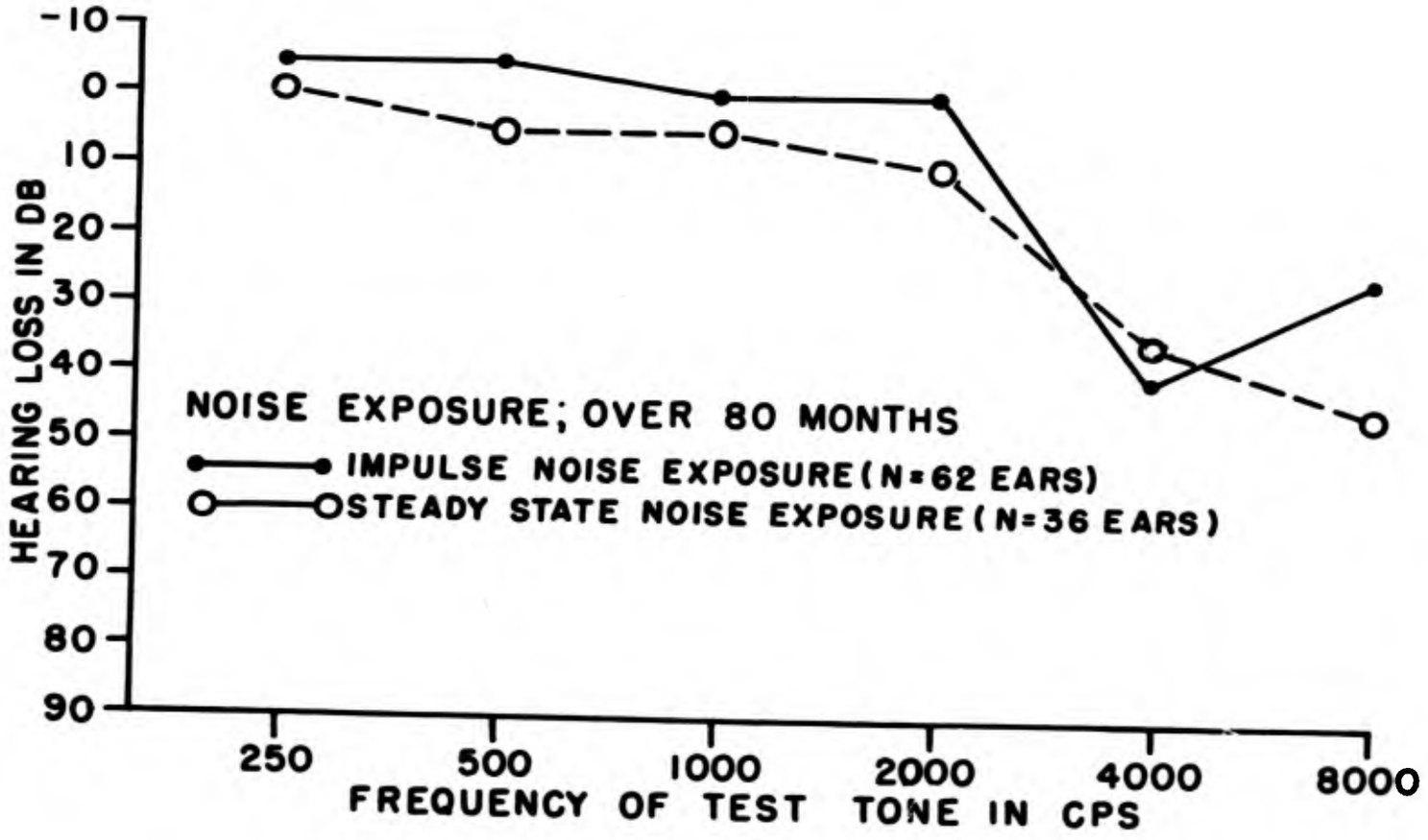

Fig. 5. Hearing loss and noise exposure.