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Asymmetric Hearing Loss in Chinese Workers Exposed to Complex Noise

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Abstract

Objectives—Evaluate audiometric asymmetry in Chinese industrial workers and investigate the effects of noise exposure, sex, and binaural average thresholds on audiometric asymmetry.

Design—Data collected from Chinese industrial workers during a cross-sectional study were re-analyzed. Of the 1388 workers, 266 met the inclusion criteria for this study. Each subject underwent a physical examination and an otologic examination and completed a health-related questionnaire. χ^2 and *t* tests were used to examine the differences between the asymmetric and symmetric hearing loss groups.

Results—One hundred thirty-one (49.2%) subjects had a binaural hearing threshold difference of 15 dB or more for at least one frequency, and there was no statistically significant difference between the left and right ears. The asymmetric hearing loss group was not exposed to higher cumulative noise levels ($t = 0.522$, $p = 0.602$), and there was no dose-response relationship between asymmetry and cumulative noise levels ($\chi^2 = 6.502$, $p = 0.165$). Men were 1.849 times more likely to have asymmetry than women were [95% confidence interval (CI), 1.051–3.253]. Among the workers with higher high-frequency hearing thresholds (HFHTs), audiometric asymmetry was 1.024 times more prevalent than that among those with lower HFHTs (95% CI, 1.004–1.044).

Conclusions—The results indicated that occupational noise exposure contributed minimally to asymmetry, while sex and binaural average thresholds significantly affected audiometric asymmetry. There was no evidence that the left ears were worse than the right ears.

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Introduction

Occupational noise-induced hearing loss (NIHL) has generally been thought to be symmetrical. However, studies over the last few decades have shown that audiometric asymmetry is common among individuals filing compensation claims for NIHL. Additionally, Alberti et al. (1979) reported that 15% of an occupational noise-exposed population had an average hearing threshold (HT) difference of 15 dB between ears at 0.5, 1, 2, and 4 kHz, which was much higher than the 1% reported by Lutman and Coles (2009) for the non-noise-exposed population. These findings imply that audiometric asymmetry might be associated with occupational noise exposure. However, most studies did not provide specific personal information (e.g., medical history, occupational history, and personal life habits) for the subjects; consequently, it is not known whether the study subjects had a history of head injury or gun use, both of which can cause asymmetric hearing loss. In other words, previous studies failed to control for potential confounding factors. Furthermore, most previous studies did not provide detailed information about the subjects' noise exposure. It is well known that occupational noise-induced hearing loss is highly related to the duration and level of noise exposure (ISO 1999; Zhao et al. 2010); consequently, it is difficult to evaluate the relationship between occupational noise exposure and asymmetric hearing loss without specific personal data and noise exposure information.

In this study, 266 screened workers from Chinese industry were investigated for audiometric asymmetry. We excluded subjects who had a history of head injury, gun use, otologic surgery, and ototoxic drug use, which were potential confounding factors. In addition, we selected subjects who had worked the same job category and environment (noise exposure) for their entire career. We aimed to determine audiometric asymmetry in a population whose noise exposure duration (NED) and sound pressure level could be determined with some accuracy. Lastly, we investigated the effects of noise exposure, sex, and binaural average thresholds on audiometric asymmetry.

Materials and Methods

Overview

This study was a secondary analysis of data collected from a group of industrial workers during a cross-sectional study conducted by Tao et al. (2013). The sample for the present study consisted of 266 of the 1388 workers who participated in the original study. All of the subjects were asked to sign an informed consent form, and the research protocol was approved by the Ethics Committee.

Study Design and Subject Selection

We conducted a cross-sectional study at an automobile manufacturing company in Shiyan, Hubei Province, China. A total of 266 subjects (175 men and 91 women) were selected from 1388 workers. Workers were included in this study if they satisfied the following criteria: (1) at least one year of employment at the current task, (2) no history of head injury or otologic surgery, (3) no history of ototoxic drug use, (4) no history of ear pathology, (5) no history of occupational or recreational gun shooting, (6) no family history of hearing loss, and (7) a stable job status. Each subject underwent a physical examination and an otologic examination and completed a health-related information questionnaire, which was followed by a face-to-face interview for quality control (to clarify and confirm responses).

The average age was 36.4 years (SD: 4.8 years), and the average NED was 15.2 years (SD: 6.0 years). The subjects were exposed to complex noise environments consisting of high-level transients embedded in Gaussian noise. The workforce, processes, and machinery did not change for a number of years.

Questionnaire Survey

A face-to-face interview was conducted to collect the following information: general personal information (e.g., name, age, sex), occupational history (e.g., plant, workshop, type of work, job description, length of employment, duration of daily noise exposure, military service, history of hearing protector use), personal life habits (e.g., shooting, smoking, alcohol use), and overall health conditions (e.g., history of ear disease, use of ototoxic drugs).

Physical and Audiometric Evaluation

Each subject underwent a general physical and an otologic examination. Pure tone, air conduction hearing thresholds at 0.5, 1, 2, 3, 4, and 6 kHz were measured in each ear by an experienced audiologist. These tests were conducted in an isolated acoustic room with a calibrated pure-tone audiometer (MADSEN ITERA) according to ISO 8253 standards. Audiometry was performed at least 16 hours after the subject's last occupational noise exposure.

Definition of Hearing Status

Asymmetric hearing loss was defined as a binaural hearing threshold difference of 15 dB or more for at least one frequency. Asymmetric hearing loss in the lower frequencies was defined as a 15 dB asymmetry at 0.5, 1, or 2 kHz with symmetric auditory damage at 3, 4, and 6 kHz, while asymmetric hearing loss in the higher frequencies was defined as a 15 dB asymmetry at 3, 4, or 6 kHz with symmetric auditory damage at 0.5, 1, and 2 kHz.

The following indicators were used to categorize hearing status:

1. High-frequency hearing threshold (HFHT): The average hearing threshold at 3, 4, and 6 kHz in both ears.
2. Low-frequency hearing threshold (LFHT): The average hearing threshold at 0.5, 1, and 2 kHz in both ears.

Noise Exposure Measurement

We obtained the subjects' NEDs from their occupational noise histories. Personal noise dosimeters (Aihua, Model AWA5610B, Hangzhou, China) were used to determine noise exposure levels. The equivalent continuous A-weighted sound pressure level over 8 hours ($L_{\mathrm{Aeq,\ 8h}}$) was calculated for each measurement. The high stability of the subjects' job status and the associated noise exposure allowed us to obtain relatively accurate NED and $L_{\text{Aeq, 8h}}$ values.

Before any measurements were taken, each dosimeter was calibrated using a Model AWA6221A Sound Level Calibrator (Aihua Instruments, Hangzhou, China). The subjects were required to wear the dosimeter throughout an entire work shift. The microphone was covered with a windscreen and placed at the level of the subjects' collars. Over a full shift, 14,400 two-second A-weighted equivalent continuous sound levels ($L_{\text{Aeq, 2s}}$) were collected (the logging period was two seconds). The noise data collected in the dosimeter were fed to an IBM computer for subsequent analysis. The results revealed noise exposure levels varying from 79.8 to 105.1 dB (A) among the subjects.

The cumulative noise exposure (CNE), a composite noise exposure index, was used to quantify each subject's noise exposure. Because all of the subjects in this study had a stable job status, the CNE for the subjects in this study can be calculated as follows (Zhao et al. 2010):

$$\text{CNE}=L_{Aeq,8h}+10\log T$$

Where $L_{\text{Aeq, 8h}}$ is the equivalent continuous A-weighted noise exposure level normalized to an 8-hour work day, and T is the occupational history in years.

Statistical Analysis

Data were analyzed using the SPSS Release 20.0 statistical package. The continuous variables are expressed as mean (SD). The categorical variables are expressed as n (%). χ^2 and *t* tests were applied to examine the differences between groups for categorical parameters. A multivariable binary logistic regression analysis was used to assess the relationships among CNE, sex, binaural average thresholds, and asymmetry (using Backward Stepwise). All reported p values were two tailed, and $p < 0.05$ was established as the level of significance.

Results

The original study included 1388 subjects who were employed by an auto manufacturer in Shiyan, Hubei Province, located in central China. Only 266 subjects met the requirements for this study. Most of the subjects were exposed to high noise exposure levels ($L_{\text{Aeq, 8h}} \geq$ 85 dB; CNE averaged 101.9 dB). A linear regression analysis indicated that CNE was significantly associated with HFHT (B = 0.642, $p = 0.001$). The noise in the work environment was complex and consisted of unsteady continuous and impact noise. The field investigation and personal questionnaires indicated that the workforce, processes, and machinery had not changed for years.

All of the subjects worked 8-hour day shifts for five consecutive days per week. The subjects were limited to a certain workspace, and the noise exposure levels fluctuated with time. The workers were required to wear earplugs to reduce occupational noise exposure while working; however, some workers did not follow the rule for several reasons (e.g., communication, lack of awareness of safety concerns). Of the 266 subjects, only 87 reported wearing earplugs for the entirety of their shift.

The subjects' ages ranged from 22 to 53 years, while the NED varied from 1.2 to 30.8 years. The majority of the subjects (65.8%) were men. Of the 266 subjects, 131 (49.2%) had a binaural hearing threshold difference of 15 dB or more for at least one frequency. Twelve (4.5%) had asymmetry in the lower frequencies, and 106 (39.8%) had asymmetry in the higher frequencies. Of the 131 subjects who had asymmetric hearing loss, 69 (52.7%) had predominantly left-side hearing loss; however, the asymmetry rate of the left ear was not significantly higher than that of the right ear (u = 0.69, $p > 0.4$).

The general characteristics of the 266 study subjects are presented in Table 1. The average age of the asymmetric NIHL group was relatively similar to that of the symmetric NIHL group ($t = 0.006$, $p = 0.995$). Similar NED patterns emerged between the groups ($t = -0.037$, $p = 0.970$). The use of hearing protection devices had no effect on audiometric asymmetry ($\chi^2 = 2.198$, $p = 0.333$). Regarding noise exposure, the asymmetric NIHL group was exposed to slightly higher mean daily noise levels ($t = 0.548$, $p = 0.584$) and cumulative noise levels ($t = 0.522$, $p = 0.602$), but the differences between the groups were not statistically significant.

As Table 1 shows, 56% of the men and 36.3% of the women had asymmetry, and the difference was statistically significant ($\chi^2 = 9.330$, $p = 0.002$). This finding indicated that men were more likely to have asymmetric hearing loss. Regarding the binaural average thresholds, the asymmetrical hearing loss group had higher HFHTs ($t = 4.394$, $p < 0.001$) and LFHTs ($t = 3.206$, $p = 0.002$) than the symmetric hearing loss group.

CNE was classified into five groups: below 95 dB, 95-99 dB, 100-104 dB, 105-110 dB, and above 110 dB. As the CNE increased, the audiometric asymmetry rates were 60%, 43.3%, 51.4%, 41.2%, and 70.6%, respectively. The change in the asymmetry rate was not significant ($\chi^2 = 6.502$, $p = 0.165$).

The rates of asymmetry with increasing LFHT are shown in Figure 1. The asymmetry rates increased linearly with increasing LFHT ($\chi^2 = 10.599$, $p = 0.001$).The rates of asymmetry with increasing HFHT are shown in Figure 2. As the HFHT increased, a corresponding linear increase in the asymmetry rates was observed ($\chi^2 = 23.674$, $p < 0.001$).

The association between CNE and asymmetry was examined using a multivariable binary logistic regression. The dependent variable was audiometric asymmetry, and sex, CNE, and binaural average thresholds were the independent variables (CNE, HFHT, and LFHT were continuous variables). The adjusted odds ratio (OR) and 95% confidence intervals (CI) are summarized in Table 2. No statistically significant correlations between CNE and asymmetric hearing loss were found. However, sex and HFHT were correlated with asymmetry ($p < 0.05$). The men were 1.849 times more likely to have asymmetrical NIHL than the women (95%CI, 1.051–3.253). Among the workers with a higher HFHT, audiometric asymmetry was 1.024 times more prevalent compared with the workers with a lower HFHT (95%CI, 1.004–1.044). Additionally, CNE had no effect on asymmetry in either the lower frequencies (see Table 3) or the higher frequencies (see Table 4).

Discussion

In the present study, 49.2% of the subjects had a binaural hearing threshold difference of 15 dB or more for at least one frequency. However, previous studies (Barrs et al. 1994; Fernandes, and Fernandes 2010) reported that 20% and 22.6% had a binaural difference of 15 dB or more for at least one frequency. These previous studies calculated the asymmetry rate for a group of subjects who filed claims for NIHL compensation. The compensation cases were preselected based on the worker's belief that he or she had hearing loss; thus, they were not a representative sample of the general occupational noise-exposed population.

The results of the present study showed that the subjects with asymmetric hearing loss were not exposed to significantly higher cumulative noise levels compared with the subjects with symmetric hearing loss. No overall increased risk of asymmetry was observed for the subjects who were exposed to higher cumulative noise levels, and there was no dose-response relationship between asymmetry and cumulative noise levels in the present study.

There was, however, an effect of sex on asymmetry. Men were more likely to have asymmetric hearing loss, which is in accord with previous publications (Pirilä et al. 1991). This finding suggests a difference between men and women in genetic susceptibility to hearing damage. By contrast, Segal et al. (2007) argued that there was no such sex difference; however, their study failed to test differences between men and women. This issue warrants further study and research.

Additionally, binaural average thresholds had an effect on audiometric asymmetry. The asymmetry rate grew linearly with increasing binaural average thresholds, a finding that is in line with studies by Dobie (2014). Because lower LFHTs were observed in both the present study (the LFHT averaged 16.6 dB) and in Dobie's study (the LFHT averaged 18.9 dB), it is possible that the asymmetry rates increased with increasing binaural average thresholds when the subjects suffered mild hearing damage. Additionally, Barrs et al. (1994) reported higher LFHTs (mean: 34 dB) and a lower risk of asymmetry (20% vs 49.2% in the present study). These findings imply that the stagnant phase or the decline stage began when the subjects had moderate hearing loss. This assumption warrants further study and research.

This study found no evidence that the left ear is more likely to have hearing loss. However, some previous studies (Prosser et al. 1988; Cox and Ford 1995; Job et al. 1998; Stewart et al. 2001; Nageris et al. 2007; Berg et al. 2014) have suggested that the left ear was weaker and reported left ear hearing thresholds were significantly higher than right ear thresholds. These controversial results could arise from the heterogeneity of the subjects included in the analyses. Many researchers included study subjects with a history of military service and those who were recreational target shooters and hunters (Cox and Ford 1995; Nageris et al. 2007; Berg et al. 2014). Gun users are special cases because the characteristics of gun-related noise exposure are unique: the physical conditions of shooting a gun lead to unequal noise exposure between ears (Job et al. 1998). However, these characteristics do not apply to other occupational populations. Prosser et al. (1988) and Stewart et al. (2001) confirmed that shooters had more severe asymmetry than non-shooters. Thus, the inferiority of the left ear in such studies failed to support the existence of a weaker left ear in the general occupational noise-exposed population.

In addition to the heterogeneity of the study subjects, previous studies placed too much emphasis on statistical significance. Some researchers (Stewart et al. 2001; Segal et al. 2007; Dobie 2014) concluded that the left ear was weaker than the right ear merely because the hearing threshold of the left ear was significantly higher than that of the right ear. Dobie and Stewart et al. reported that left-ear hearing thresholds were 2.0 to 2.2 dB worse than right-ear hearing thresholds. Despite the statistically significant difference, the hearing threshold differences between the left and the right ears were small. Lutman et al. (1989) indicated that a threshold shift measured with an audiometer using 5 dB steps must be at least 15 dB to be treated as abnormal. Thus, the small asymmetries reported previously were most likely caused by measurement variability.

Presuming that small asymmetries were a testing variability, Barrs et al. (1994) and Fernandes et al. (2010) defined audiometric asymmetry as a binaural difference of 15 dB or more at any frequency. A more rigorous criterion - a 15 dB mean average asymmetry at 0.5, 1, 2, and 4 kHz - was suggested by Alberti et al. (1979) and Lutman et al. (2009). Because the objective of this study was to explore the phenomenon of audiometric asymmetry rather than to establish a criterion for the clinical diagnosis of asymmetry, the former criterion was more suitable to this study. If protecting workers' hearing is the objective, then it makes sense to loosen the criteria used to identify audiometric asymmetry at an early stage. However, the use of loose criterion could explain why we obtained a high asymmetry rate in this study. Moreover, people with worse hearing may have more difficulty when taking a hearing test, making it relatively easy for them to achieve a 15 dB difference between the two ears. Testing error could be another reason for the high asymmetry rate despite the great efforts made to avoid this type of error. It would be necessary to replicate this study using data acquired from a large number of people working under well-documented and diverse working conditions (including non-noise exposure, steady-state noise or complex noise exposures) to further explore audiometric asymmetry among workers.

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Xiaoxiao Wang analyzed data and wrote the paper; Nan Li and Liyuan Tao designed and performed the original study; Lin Zeng provided interpretive analysis; Yiming Zhao commented on the manuscript and provided critical revision; Qiuling Yang and Liangliang Zhu collected data during the original study; Wei Qiu discussed the results and implications and provided critical revision.

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References

Alberti PW, Symons F, Hyde ML. Occupational hearing loss. The significance of asymmetrical hearing thresholds. Acta Otolaryngol. 1979; 87:255–263. [PubMed: 443006]

Barrs DM, Althoff LK, Krueger WW, et al. Work-related, noise-induced hearing loss: evaluation including evoked potential audiometry. Otolaryngol Head Neck Surg. 1994; 110:177–184. [PubMed: 8108153]

Berg RL, Pickett W, Linneman JG, et al. Asymmetry in noise-induced hearing loss: evaluation of two competing theories. Noise Health. 2014; 16:102–107. [PubMed: 24804714]

Cox HJ, Ford GR. Hearing loss associated with weapons noise exposure: when to investigate an asymmetrical loss. J Laryngol Otol. 1995; 109:291–295. [PubMed: 7782682]

Dobie RA. Does occupational noise cause asymmetric hearing loss? Ear Hear. 2014; 35:577–579. [PubMed: 24879031]

Fernandes SV, Fernandes CM. Medicolegal significance of asymmetrical hearing loss in cases of industrial noise exposure. J Laryngol Otol. 2010; 124:1051–1055. [PubMed: 20519041]

ISO (International Standard) 1999. ISO/TC43-Acoustics. Geneva, Switzerland: International Organization for Standardization; 1990. ISO 1999: Acoustics-Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment.

Job A, Grateau P, Picard J. Intrinsic differences in hearing performances between ears revealed by the asymmetrical shooting posture in the army. Hear Res. 1998; 122:119–124. [PubMed: 9714580]

Lutman ME, Cane MA, Smith PA, et al. Comparison of manual and computer-controlled self-recorded audiometric methods for serial monitoring of hearing. Br J Audiol. 1989; 23:305–315. [PubMed: 2605383]

Lutman ME, Coles RR. Asymmetric sensorineural hearing thresholds in the non-noise-exposed UK population: a retrospective analysis. Clin Otolaryngol. 2009; 34:316–321. [PubMed: 19673978]

Nageris BI, Raveh E, Zilberberg M, et al. Asymmetry in noise-induced hearing loss: relevance of acoustic reflex and left or right handedness. Otol Neurotol. 2007; 28:434–437. [PubMed: 17435523]

Pirilä T, Sorri M, Jounio-Ervasti K, et al. Hearing asymmetry among occupationally noise-exposed men and women under 60 years of age. Scand Audiol. 1991; 20:217–222. [PubMed: 1842293]

Prosser S, Tartari MC, Arslan E. Hearing loss in sports hunters exposed to occupational noise. Br J Audiol. 1988; 22:85–91. [PubMed: 3390636]

Segal N, Shkolnik M, Kochba A, et al. Asymmetric hearing loss in a random population of patients with mild to moderate sensorineural hearing loss. Ann Otol Rhinol Laryngol. 2007; 116:7–10. [PubMed: 17305271]

Stewart M, Konkle DF, Simpson TH. The effect of recreational gunfire noise on hearing in workers exposed to occupational noise. Ear Nose Throat J. 2001; 80:32–34. [PubMed: 11209517]

Tao L, Davis R, Heyer N, et al. Effect of cigarette smoking on noise-induced hearing loss in workers exposed to occupational noise in China. Noise Health. 2013; 15:67–72. [PubMed: 23412581]

Zhao YM, Qiu W, Zeng L, et al. Application of the kurtosis statistic to the evaluation of the risk of hearing loss in workers exposed to high-level complex noise. Ear Hear. 2010; 31:527–532. [PubMed: 20588120]

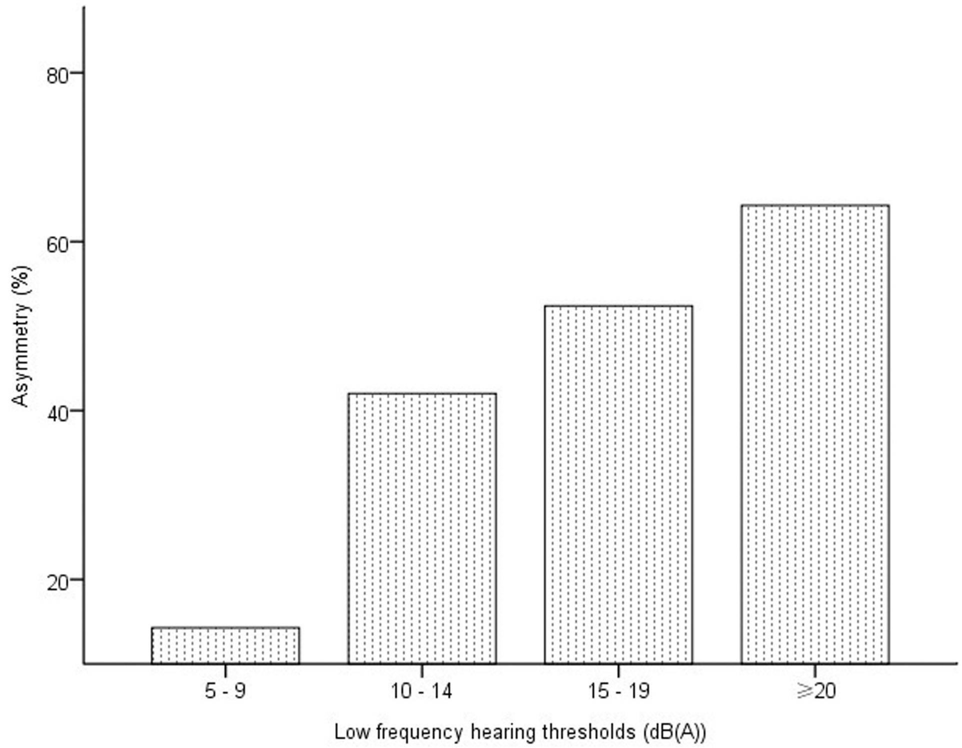

Figure 1. The rate of asymmetry as a function of low frequency hearing thresholds

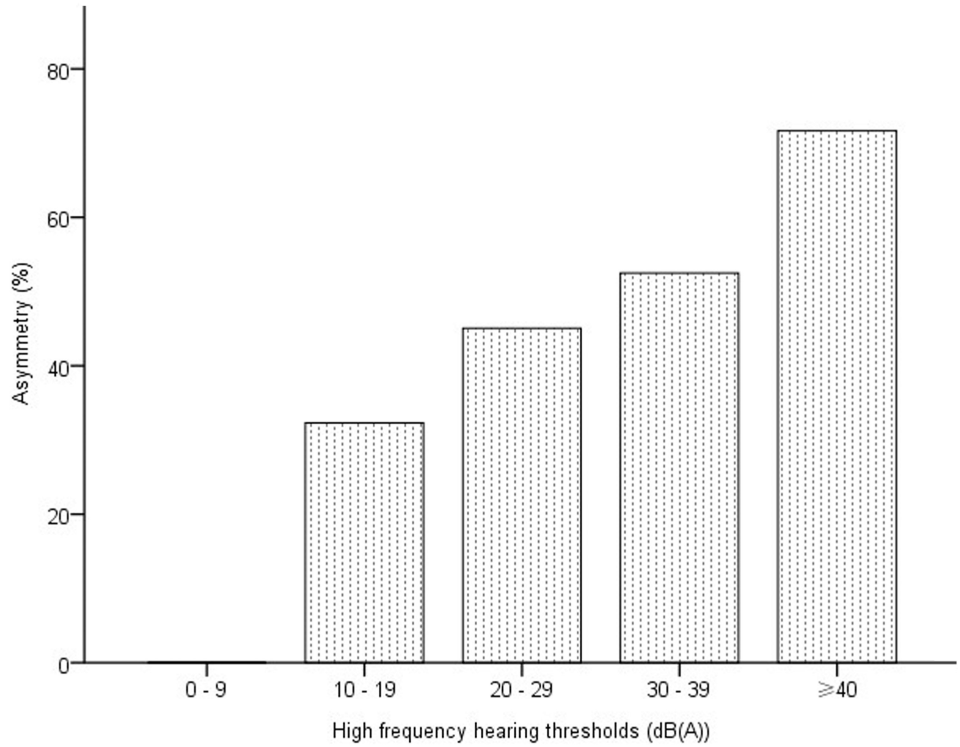

Figure 2. The rate of asymmetry as a function of high frequency hearing thresholds

Table 1

General Characteristics of Subjects in Asymmetric and Symmetric NIHL groups

	Total (N=266)	Asymmetric NIHL(n = 131)	Symmetric NIHL(n = 135)	*p*
Age*	36.4(4.8)	36.4(4.8)	36.4(4.9)	0.995
NED*	15.2(6.0)	15.2(5.9)	15.3(6.1)	0.970
Sex†				
Male	175(65.8)	98(74.8)	77(57)	0.002
Female	91(34.2)	33(25.2)	58(43)	
HPD application†				
Yes	87(32.7)	48(36.6)	39(28.9)	0.333
No	174(65.4)	80(61.1)	94(69.6)	
Missing	5(1.9)	3(2.3)	2(1.5)	
HFHT‡	30.7(15.7)	34.9(15.9)	26.7(14.5)	<0.001
LFHT‡	16.6(6.1)	17.8(7.1)	15.4(4.7)	0.002
$L_{Aeq,8h}$‡	90.6(4.5)	90.7(4.8)	90.4(4.2)	0.584
CNE‡	101.9(5.0)	102.1(5.1)	101.8(4.8)	0.602

*expressed as mean (SD), yrs.

†expressed as n (%).

‡expressed as mean (SD), dB (A).

CNE, cumulative noise exposure; HFHT, high frequency hearing thresholds; HPD, hearing protective devices; $L_{Aeq,8h}$, equivalent continuous A-weighted sound pressure level over 8 hrs; LFHT, low frequency hearing thresholds;NED, noise exposure duration; NIHL, noise-induced hearing loss.

Table 2

Adjusted Odds Ratio and 95% CI for Asymmetric NIHL

Variables	B	SE	*p*	OR	95%CI
Constant	-2.599	0.645	<0.001	0.074	
HFHT	0.023	0.010	0.020	1.024	1.004–1.044
LFHT	0.051	0.027	0.054	1.053	0.999–1.109
Sex					
Male	0.615	0.288	0.033	1.849	1.051–3.253

CI, confidence interval; HFHT, high frequency hearing thresholds; LFHT, low frequency hearing thresholds; NIHL, noise-induced hearing loss; OR, odds ratio; SE, standard error.

Table 3

Adjusted Odds Ratio and 95% CI for Asymmetric NIHL in the Lower Frequencies

Variables	B	SE	*p*	OR	95%CI
Constant	-4.604	0.732	<0.001	0.010	
LFHT	0.084	0.033	0.010	1.088	1.021–1.160

CI, confidence interval; LFHT, low frequency hearing thresholds; NIHL, noise-induced hearing loss; OR, odds ratio; SE, standard error.

Table 4

Adjusted Odds Ratio and 95% CI for Asymmetric NIHL in the Higher Frequencies

Variables	B	SE	*p*	OR	95%CI
Constant	-2.640	0.539	<0.001	0.071	
HFHT	0.020	0.009	0.021	1.020	1.003–1.038
Sex					
Male	0.949	0.304	0.002	2.583	1.424–4.684

CI, confidence interval; HFHT, high frequency hearing thresholds; NIHL, noise-induced hearing loss; OR, odds ratio; SE, standard error.