

# EFFECTS OF HEARING SUSCEPTIBILITY FOR NOISE INDUCED HYPERTENSION IN FERTILIZER MANUFACTURE WORKERS

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**Introduction** Long-term noise exposure can induce hearing loss and hypertension. If the noise induced hearing loss cases are easy to be hypertension? The paper based on a large scale of noise exposure population to explore relationship between hearing susceptibility and noise induced hypertension.

**Methods** The investigation includes seven large scale of chemical fertilizer factories in China with 1168 male and 425 female workers, aged  $30.2 \pm 7.7$  (18.1~58.1) years, working years  $9.5 \pm 6.7$  (1~35) years. Sound pressure level (SPL) of noise was measured in working position at ear level of workers. Working schedule of each worker was investigated to estimate real noise exposure duration in every working day. According with equal energy rule, cumulative noise exposure (CNE) was calculated by lower function:

$$CNE = 10 \times \log \left[ \sum_{i=1}^n 10^{0.1 \times SPL_i} \times \text{noise working years}_i \times \text{noise exposure minutes per day}_i \div 480 \right]$$

Questionnaire table includes general information, occupational history, hypertension history, ear disease history and personal living habits. Auditory thresholds from 500Hz to 6kHz for each ear were measured after leaving noise environment more than 16 hours. Hearing thresholds was adjusted by age and gender with ISO 1999:1990 appendix A. The averaged high frequency hearing threshold (AHFHT) for each worker was calculated by lower function:

$$AHFHT = \frac{\text{left ear hearing thresholds (3kHz + 4kHz + 6kHz)} + \text{right ear hearing thresholds (3kHz + 4kHz + 6kHz)}}{6}$$

Hypertension was defined as systolic pressure great than or equal to 140 mmHg, or diastolic pressure great than or equal to 90 mmHg, or both. The subjects were also classified as hypertension if they had hypertension history and currently using anti-hypertension drugs. All data were sent into computer with double input and checklist method. SPSS software was used for data analysis.

**Results** The hypertension prevalence was found 12.1% (193/1593) in the noise exposure population with typical dose-response relationship between CNE and prevalence of hypertension (see table 1). Hearing susceptibility for noise exposure was defined with modeling method<sup>[1]</sup>. The distribution of hearing susceptibility showed in Figure 1 with light left shift and one peak curve. Table 2 showed a significant dose-response relationship between hearing susceptibility and prevalence of hypertension. It suggests hearing susceptibility might be a risk factor for noise induced hypertension. Table 3 is a typical logistic regression model for noise exposure and hypertension, adding hearing susceptibility. The odds ratio of CNE, age, gender and hearing susceptibility was more than one with significant. It suggested that hearing susceptibility, noise exposure, age and gender were independent risk factors for hypertension. By backward method with logistic model, the difference of  $-2\log$  likelihood was age (34.416) > gender (14.276) > CNE (7.375) > hearing susceptibility (4.390) for hypertension. It means that the contribution of hearing susceptibility was about 60% of noise exposure.

Table 1. Relationship between cumulative noise exposure (CNE) and prevalence of hypertension in fertilizer manufacture workers

CNE(dB(A))	Hypertension	Total	Prevalence (%)
105~109	1	9	11.1
100~	10	37	27.0
95~	48	214	22.4
90~	47	301	15.6
85~	34	336	10.1
80~	33	305	10.8
75~	11	192	5.7
<75	9	199	4.5
Total	193	1593	12.1

$$\chi^2_{\text{trend}}=44.724 \square P<0.01$$

Table 2. Relationship between susceptibility for noise induced hearing loss and prevalence of hypertension in fertilizer manufacture workers

Susceptibility (percentage)	Hypertension	Total	Prevalence(%)
75~100	73	396	18.4
50~	53	399	13.3
25~	36	396	9.0
0~	31	396	7.8
Total	193	1593	12.1

$$\chi^2_{\text{trend}}=24.023 \square P<0.01$$

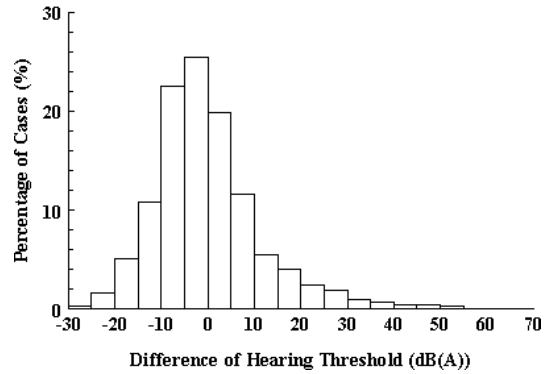


Figure 1. Distribution of hearing susceptibility for difference of averaged high frequency hearing threshold and hearing threshold predicted by linear regression model in fertilizer manufacture workers

Table 3. Logistic regression model for risk factors on hypertension in fertilizer manufacture workers

Parameter	Coefficient	SE	P value	OR
Constant	-7.617	0.907	——	——
CNE (dB(A))	0.030	0.011	0.007	1.031
Age	0.066	0.011	<0.001	1.069
Male	0.816	0.234	<0.001	2.261
Susceptibility $\geq 50\%$	0.374	0.177	0.035	1.454

**Discussion** Johsson<sup>[2]</sup> reported that blood-pressure was significantly higher in 44 male industrial workers with noise-induced hearing loss than in 74 males of the same age with normal hearing. Hirai<sup>[3]</sup> investigated 2124 male laborers working in a noisy factory and found no significant relationship between hearing loss and hypertension. Different papers showed different results for hearing loss and hypertension in noise exposure population. This paper explored the relationship by another method. First, a modeling method was applied to define hearing susceptibility to each worker. Second, a logistic regression model was used to adjust potential confounding effects and to explore contribution of noise exposure and hearing susceptibility for hypertension. By this way, there were no positive relationship between hearing susceptibility and CNE. Why hearing susceptibility associated with noise induced hypertension? Are there same pathological pathway in noise induced hearing loss and hypertension? Blood vessel response hypothesis might be a reasonable explanation. Noise exposure can induce blood vessel constriction and cause blood pressure increase. At same time, vessel constriction causes blood supply of inner ear to be declined and to induce hair cells damage. The vessel response stronger person has more chance to get hearing loss and hypertension. In future, molecular mechanism will be explored to explain why hearing susceptibility associates with noise induced hypertension.

**Keywords:** hearing, human, hypertension, industrial noise, hearing susceptibility, logistic regression model

## References

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