Occupational Noise-Induced Tinnitus：Knowledge, Attitude and Practice (KAP)

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Research article

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Abstract

Background: Occupational noise is the most common hazards in the workplaces. Noise exposure may induce tinnitus (ringing in the ears), which seriously affects workers' normal life, even impair their work performance. To investigate associations between if respondents are awareness of tinnitus induced by occupational noise (Knowledge), what the viewpoint they have (Attitude) and how they cope with it (Practice).

Methods: A questionnaire based cross-sectional study was conducted. 519 noise-exposed workers in railway transportation mechanical manufacturers were recruited as the exposed group. 515 non noise-exposed workers as the control group. To investigate the effects of noise exposure level, the exposed group was classified into 4 subgroups according to sound level measurements reported by industrial hygienists., while the exposed group was categorized into 3 subgroups according to usage of personal hearing protection device (PHPD). Questionnaire was focused on medical history, occupational history, life habits and tinnitus for all participants. Qualified audiologists assessed hearing threshold by using standardized audio-metric procedures assuring at least 48 h of noise avoidance.

Results: The prevalence of tinnitus were 36.6% and 18.8% in the exposed group and in the control group, respectively. The difference was statistically significant (c^2=40.725, P<0.05). The prevalence of tinnitus were 36.2%, 20.5% and 41.7% in 3 using PHPD subgroups of the exposed group. The difference was statistically significant (c^2=6.072, P<0.05). The prevalence of tinnitus were 34.7%□8.3%□63.6% and 54.0% in 4 sound level subgroups. The difference was statistically significant (c^2_{trend}=30.491, P < 0.05). The percentage of clinic visit for tinnitus was 15.8% in the exposed group. 93.2% workers claimed tinnitus symptoms were unimproved since they still heard buzzing or ringing in ears. 81.05% of them gave up treatment. The percentage of clinic visit for tinnitus was 7.2% in the control group and 99.0% workers claimed tinnitus symptoms were unimproved.

Conclusions: Only when workers have awareness of tinnitus and tinnitus treatment can they have positive attitude and better practice. Noise-exposed workers should periodically attend educational courses on "taking care of your ears" and should be under the supervision.

Background

Noise is the most pervasive hazard in workplaces [1, 2]. Approximately 600 million workers are exposed to occupational noise all over the world [3]. Noise induced hearing loss (NIHL) and awareness have been raised worldwide. Although workers are often told that noise exposure may cause deafness, little is mentioned about tinnitus.

Tinnitus, the perception of ringing or buzzing in the ears or head without external sound source, is a common complaint that may have disabling consequences [4]. Tinnitus mainly results in emotional disability rather than physical disability [5]. Tinnitus is more likely to affect patients' mental and

emotional health. Workers with tinnitus often complain that it interferes with life, rest and job badly [6]. Workers with severe tinnitus even try to commit suicide [7]. Tinnitus has become a burden to the health care system, which is in the necessity of efficient clinical care and health service plans [8, 9].

Individual susceptibility to tinnitus varies a lot [10]. And the reason is unknown. The risk of noise induced tinnitus would be increased with higher sound level, longer exposure duration or without PHPD [11]. Through regular treatment and positive cooperation , it does improve quality of life and reduce symptoms of tinnitus [1].

The main object of this cross-sectional study is to investigate KAP about tinnitus in noise-exposed workers. Then, we can help them correct wrong KAP and improve occupational health .

Methods

Subjects:

This cross-sectional study was conducted in railway transportation mechanical manufacturers situated in Beijing, 2015. Noisy workplaces were selected based on industrial hygienists' reports on sound level measurements. These measurements were performed annually and saved as "noise monitoring records". In this study, the last 3 records were used. 13 parts of the factory were selected as noisy workplaces where sound level was equal to or greater than 80 dB in 8 hours per day or 40 hours per week [12]. There were no other known occupational hazards affecting hearing acuity but noise in recruited workplaces.

After filling in the questionnaire, workers meet one of the following conditions were excluded: history of noise exposure in previous jobs, exposure to non-occupational noise (such as amplified music, participation in war, hunting, etc.), any kind of hearing loss with a known etiology except occupational noise exposure, history of head trauma, severe or frequent ear infection, perforated tympani membrane, ear surgery, congenital or acquired ear malformation, ototoxic drug use, diabetes mellitus.

519 workers who worked in noisy workplaces and participated in periodic medical examination became the exposed group. 515 non noise-exposed workers became the control group. There were 442 men and 77 women in the exposed group. Their mean age was (37.82±10.27) years (range 19-58 years), and mean working age was (15.53±10.18) years (range 1-38 years). There were 448 men and 67 women in the control group. Their mean age was (28.64±10.62) years (range 16-60 years), and mean working age was (19.22±9.35) years (range 1-40 years).

All the subjects participated voluntarily in this study and an inform consent was filled in by each.

Instrumentation:

Questionnaire

Questionnaire was designed and covered followed areas [13]:

- General information, such as age, sex, height, weight, etc.
- Occupational history and occupational health knowledge, such as noise-exposure duration, using PHPD, periodic medical examination, hazard of noise exposure, taking care of your ears, etc.
- Personal life habits, such as smoking, drinking, using earphone, etc.
- Medical history, such as clinic visit for tinnitus.

Questionnaire Investigation

Investigation was carried on by trained qualified specialists, in the way of face-to-face with workers.

Pure tone audiometry (PTA) and Tinnitus:

The responding workers were evaluated by periodic medical examination. Under the law of occupation diseases prevention and control in China [14], auditory examinations were performed as a screening program included in periodic medical examination.

Hearing thresholds were determined by audiometry in an isolated acoustic room meeting the ISO 8253-1 standards with a diagnostic audiometer. The audiometer was calibrated every year according to ISO standards. Qualified audiologists assessed hearing thresholds using standardized audio-metric procedures assuring at least 48 hours of noise avoidance. The pure-tone hearing thresholds at 500, 1000, 2000, 3000, 4000, and 6000 Hz were measured for air and bone conduction, in both ears. Hearing thresholds were adjusted by age and sex in accordance with ISO7029:2000.

Abnormal hearing was defined as an adjusted hearing threshold for either ear at 500, 1000, or 2000 Hz above 25 dB. Others were classified as normal hearing.

Tinnitus was defined from the study participants' questionnaire responds, and they were considered suffering from tinnitus if they have the symptoms of ringing, or sounds in the ears, or tinnitus at least once every week.

Statistical methods and analysis:

Epidata 3.0 was used to set up database. Data were analyzed using SPSS version 21.0.

The following statistical tests were applied in analysis of the data presented in this article. Association of tinnitus with risk factors was examined by binary logistic regression. Some variables were quantitative such as age and sound level. The other variables were categorical such as history of infectious diseases and using PHPD. All variables were included in a logistic regression model.

Chi-square test was applied for testing quantitative parameters differences.

All tests applied were two-tailed. A P value of 0.05 was considered statistically significant.

Results

Association of tinnitus with risk factors was examined by binary logistic regression. The confounders adjusted in model was age as quantitative variable. According to age, the exposed group was divided into 3 subgroups of 50~58 years、40~49 years、30~39 years. The associations of tinnitus with age、history of infectious diseases、sound level were significant in the logistic regression, as shown in Table 1.

Table 1 Binary logistic Regression of Tinnitus

Factors	B	S.E	Wals	P	Exp(B)
Sub-variable of age			30.550	0.000	
age [a]	1.573	0.305	26.628	0.000	14.823
age [b]	0.756	0.313	5.841	0.016	2.129
age [c]	0.525	0.284	3.407	0.035	1.690
infectious diseases	0.726	0.247	8.603	0.003	2.066
sound level	0.028	0.013	4.768	0.029	1.028
constant	-4.945	1.622	9.297	0.002	0.007

According to using PHPD, the exposed group was categorized into 3 subgroups: 1. always using PHPD, 2. not always using earplug, 3. not using PHPD at all. According to sound level, the exposed group was classified into 4 subgroups: 1. Equivalent Sound Level in 8h[dB(A)]<85, 2. 85~<90, 3. 90~<95, 4. ≥95. The difference of tinnitus prevalence was compared between the exposed group and the control group by chi-square. We also analyze the difference of tinnitus prevalence in 3 using PHPD subgroups and in 4 sound level subgroups. As shown in Table 2, the prevalence of tinnitus were 36.6% and 18.8% in the exposed group and in the control group, respectively (c^2=40.725, P < 0.05). The prevalence of tinnitus in 3 using PHPD subgroups were 36.2%、20.5% and 41.7% (c^2=6.072, P < 0.05). The prevalence of tinnitus in the 4 sound level subgroups were 34.7%、8.3%、63.6% and 54.0% (c^2_{trend}=30.491, P < 0.05). As shown in Table 3, the prevalence of tinnitus were 44.0% and 22.6% in the abnormal hearing group and the normal hearing group, respectively、c^2=18.29、P<0.05、.

Table 2 Tinnitus in Exposed Group and Control Group with Different Characteristic

Characteristic	Tinnitus	Non-tinnitus	n
group			
exposed group	190(36.6)	329(63.4)	519
control group	97(18.8)	418(81.2)	515
Using PHPD			
always using PPE	119(36.2)	210(63.8)	329
not always using PPE	8(20.5)	31(79.5)	39
not using PPE	63(41.7)	88(58.3)	151
Sound Level 8h[dB(A)]			
□85	125(34.7)	235(65.3)	360
85~□90	4(8.3)	44(91.7)	48
90~□95	7(63.6)	4(36.4)	11
≥95	54(54.0)	46(46.0)	100

notes□number in parenthesis is percentage□%□

Hypothesis-testing for exposed group and control group: c^2=40.725□P□0.05

Hypothesis-testing for using PHPD: c^2=6.072□P□0.05

Hypothesis-testing for sound level:c^2_{trend}=30.491□P□0.05

Table 3 Tinnitus and Hearing Abnormal in Exposed Group

Group	Abnormal hearing	Normal hearing	Missing	Total
Tinnitus	129(67.9)	31(16.3)	30	190
Non-tinnitus	164(49.8)	106(32.2)	59	329
Total	293	137	89	519

notes□number in parenthesis is percentage□%□

Hypothesis-testing for hearing and tinnitus: c^2=18.29□P□0.05

According to questionnaire data, the percentage of clinic visit for tinnitus was 15.8% in the exposed group. 93.2% workers claimed tinnitus symptoms were unimproved since they still heard buzzing or ringing in ears. 81.05% of them stopped treatment. Similarly, the percentage of clinic visit for tinnitus was 7.2% in the control group and 99.0% workers stated tinnitus symptoms were unimproved.

Table 4 Clinic Visit for Tinnitus in Exposed Group and Control Group

Group	No clinic visit	Clinic visit	recovery(%)	improved(%)	Unimproved(%)	n
Exposed group	160(84.2%)	30(15.8)	3(1.6%)	10(5.3%)	177(93.2%)	190
Control group	90(92.8%)	7(7.2%)	0(0.0%)	1(1.0%)	96(99.0%)	97
n	250	37	3	11	273	287

Discussion

There is no single agreed-upon definition of tinnitus [15]. The definition of tinnitus in this study was less strict than those used by, for instance Axelsson and Ringdahl and Coles [4,16]. Such definition may have biased our findings.

In this study, the tinnitus prevalence in the exposed group was higher than that in the control group [17]. The difference was statistically significant. The tinnitus prevalence in 4 sound level subgroups were different. The difference was also statistically significant. The results demonstrated that occupational noise exposure is main reason of tinnitus. And the risk of tinnitus would be increased with higher sound level [18-20].

The tinnitus prevalence in 3 using PHPD subgroups were different. The difference was statistically significant. The result demonstrated that PHPD could protect hearing. And the risk of tinnitus would be decreased by using PHPD.

In the exposed group, 190 workers had tinnitus, and they all claimed that tinnitus was caused by occupational noise exposure. 329 workers did not have tinnitus and 48.63% (160/329) of them were aware of the risk of developing tinnitus by exposed to occupational noise. However, only 6.74% (35 / 519) workers in the exposed group agreed that using PHPD could protect hearing. In noisy workplace, using PHPD is a simple, economical and effective measure. Using PHPD correctly and persistently is the key point. If workers have right KAP, the risk of tinnitus could be decreased greatly [21].

According to questionnaire data, although all workers worried about their hearing, only 15.8% workers in the exposed group and 7.2% workers in the control group had clinic visit for tinnitus. The unimproved rate were 93.2% and 99.0% in the exposed group and in the control group, respectively. In the exposed group, 12.11% workers with tinnitus have never asked a doctor for a treatment due to personal viewpoint about cure. 81.05% of them accepted tinnitus treatment, but they gave up since they still heard buzzing or ringing in ears. Only 6.84% of them felt tinnitus relief through regular treatment. [22]

Workers thought that tinnitus would disappear after treatment. It's wrong. Nowadays masking and retraining therapy are common as tinnitus treatments. Masking therapy is covering tinnitus with outside sound to relieve tinnitus. Retraining therapy is teaching patients to get used to tinnitus.

If workers have right knowledge, they will accept regular treatment. Their quality of life would be improved. What they need is right KAP.

Some scholars suggested that tinnitus may be caused by NIHL [23-25]. In this study, the tinnitus prevalence in the abnormal hearing group was higher than that in the normal hearing group. Our results also showed the similar conclusion. NIHL may cause tinnitus. Tinnitus could interfere with hearing [26]. It is a vicious circle.

Conclusions

The screened risk factors of tinnitus are age, infectious diseases history and sound level [15]. The risk of tinnitus would be increased with higher sound level or without PHPD. If workers have right knowledge, they will always have PHPD in noisy workplaces and the risk of tinnitus would be decreased.

Tinnitus treatment is teaching patients to get used to tinnitus and reduce tinnitus symptoms. If workers have right knowledge, they will follow doctors' advice, accept regular treatment and correct bad life habits. Workers will feel tinnitus relief after regular treatment and the quality of life will be improved [27].

Right KAP would be very helpful for workers. Workers should periodically attend educational health courses and should be under the strict supervision.

Abbreviations

KAP: knowledge, attitude, practice; NIHL:noise induced hearing loss; PTA: pure tone audimetry; PHPD: personal hearing protection device

Declarations

Ethics approval and consent to participate

Ethical review on the project was conducted by Beijing Preventive Medicine Research Center Ethics Board. This research study was considered as WITHOUT RISK, since it did not anticipate any intervention or modification of any physiological, psychological or social variable. So a letter of approval for the project was issued, classifying as risk-free.

Before the project investigation, explain the purpose, significance, implementation method to all workers. And promise to protect personal privacy. After knowing the details of the project, workers agree to participate in the investigation, and sign the informed consent form.

Consent for publication

Not applicable.

Availability of data and materials

The data sets used and / or analyzed in the current study come from our daily work. It is one of our daily work to carry out regular occupational health surveillance for workers exposed to occupational hazards. According to these data, we carry out occupational health education for workers and promote their occupational health.

Competing Interests

None declared.

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None declared.

Author Contributions

LB, JY, HD, ZS, HY conceived of this study, acquired data. LB drafted the paper. LB and JY approves this version of the manuscript and agrees to be accountable for all aspects of the work. All authors have read and approved the manuscript.

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