

A Preliminary Study of Tinnitus Subgroups based on Self-reported Presbycusis and Noise Induced Hearing Loss

Abstract

Objective: To compare some characteristics of two subgroups of tinnitus, noise-induced tinnitus and age-related tinnitus.

Design: An online survey from the Iowa Tinnitus Website was reviewed. The participants were divided into two subgroups according to their reported cause of tinnitus—noise or aging. Their answers to the questions about loudness, qualities, worsening and reducing factors of tinnitus were analyzed.

Study sample: There were 16 patients of age-related tinnitus and 147 of noise-induced tinnitus.

Results: Two groups did not differ significantly in loudness ($U = 887.5, p > 0.05$), qualities ($X^2 = 1.164, p > 0.05$) or reducing factors ($X^2 = 1.984, p > 0.05$).

Ringling/whistling was the most common quality of both age-related (37.5%) and noise-induced tinnitus (51.7%). 42.9% participants of noise-induced tinnitus and 31.3% of age-related tinnitus felt that nothing made tinnitus better. The main worsening factors for noise-induced tinnitus included being in a noisy place (44.2%) and lack of sleep (42.9%) , which differed from age-related group ($X^2 = 6.169, p < 0.05$).

Conclusions: There was a great deal of overlap between two subgroups, with some differences in worsening factors, including noise environment and lack of sleep. This is an important ‘red flag’ in counseling, and should be considered by doctors when choosing therapy.

Keywords

Tinnitus; noise-induced tinnitus; age-related tinnitus; subgroup; treatment

Key points

1. It is important to subgroup tinnitus subjects and understand the difference in the characteristics of tinnitus between subgroups.
2. There is difference in worsening factors between age-related tinnitus and noise-induced tinnitus subgroup.
3. Age-related tinnitus is more likely to be worsen when being in a quiet place while people with noise-induced tinnitus have a much larger experience of noise and / or lack of sleep make their tinnitus worse.
4. No difference was found in loudness, quality or reducing factors between two subgroups.
5. Improving clinical treatment of tinnitus is possible based on the features of different subgroups.

Introduction

Tinnitus is a very common symptom which has a high impact on patients' physical and mental health and their quality of life¹. The prevalence of tinnitus in the United States is approximately 9.6% in adults². Tinnitus can be caused by a variety of reasons. The most common and widely accepted risk factors are noise and aging. These two causes, presumably with different physiological mechanisms responsible for their tinnitus, represent two subgroups that might respond to different treatment³. The clinical features of tinnitus may vary within categories. For example, some tinnitus sufferers feel better in quiet environment while others like noisy situation⁴.

This study made use of part of data collected from the Iowa Tinnitus Website and enrolled participants whose tinnitus was caused by aging or noise but not both. We have argued that there are different subgroups of tinnitus patients, and identifying

different subgroups and focusing on individual result is likely essential to finding cures³.

Methods

516 adults completed the survey on Iowa Tinnitus Website from April 2012 to November 2017. Participants were selected and grouped according to their answers to the question: “What do you think originally caused your tinnitus?” 147 participants who answered “Noise exposure” and 28 who answered “Aging” were studied here. We excluded 12 young adults (59 years and below) in age-related tinnitus group. We had two noise-induced tinnitus groups: one with age cutoff (excluded 33 older patients aged 60 years and above) and one without any age consideration. We used the data of both noise-induced tinnitus groups when testing the strength of relationship or magnitude of difference observed between age-related and noise-induced tinnitus. We also analyzed the differences between two noise-induced tinnitus subgroups to identify the influence of age factor on noise-induced tinnitus sample.

We focused on four questions: “Describe the loudness of your tinnitus using a scale from 0-100”, “Which one of these qualities best describes your tinnitus?” “When you have your tinnitus, which of the following makes it worse?” and “Which of the following reduces your tinnitus?”

For the loudness of tinnitus, ANOVA test was used to examine the difference between subgroups. For the qualities, worsening factors and reducing factors of tinnitus, percentage of each options were calculated and Chi Square test was used to analyze the difference. The level of statistical significance was defined as $p < 0.05$.

We followed the AMA reporting guidelines.

Results

Participant sample

There were 16 patients of age-related tinnitus including 5 men and 11 women, aged from 60 to 85 years. There were 114 patients of noise-induced tinnitus aged 59 years and below. There were 147 patients of noise-induced tinnitus without age cutoff, aged from 18 to 77 years. Table 1 shows the age, gender and location of tinnitus of the three subgroups.

Loudness of tinnitus

The mean loudness scale of tinnitus for age-related tinnitus, noise-induced tinnitus with and without age was 66.7 ($SD = 23.9$), 53.9 ($SD = 25.3$) and 55.9 ($SD = 24.5$), respectively. An oneway ANOVA test indicated three subgroups did not differ significantly in loudness of tinnitus ($F = 1.881$, $p = 0.154$). Comparative analysis was also conducted within every two subgroups using Mann-Whitney U test and t test and no difference was found ($p > 0.05$). Figure 1 shows the mean loudness of tinnitus.

Qualities of tinnitus

For the latter three questions, patients were provided a list of response options. For example, the options for the qualities of tinnitus included “Ringing, Whistling”, “Cricket-like”, “Roaring, Shhh, Rushing”, “Buzzing”, “Humming”, “Hissing” and “Other”.

Among patients of age-related tinnitus, noise-induced tinnitus with and without age cutoff, 6 (37.5%), 62 (54.4%) and 76 (51.7%) patients described their tinnitus as “ringing, whistling”, 3 (18.8%), 25 (21.9%) and 34 (23.1%) described it as “hissing”, 2 (12.5%), 8 (7.0%) and 11 (7.5%) described it as “roaring, Shhh, rushing”, 2 (12.5%), 9 (7.9%) and 14 (9.5%) reported it as “cricket-like”, 1(6.3%),

5 (4.4%) and 6 (4.1%) reported it as “buzzing” while 2 (12.5%), 2 (1.8%) and 6 (4.1%) chose the other options. Due to the small sample size of the aging group, we combine categories with the lowest frequency in a meaningful way. We analyzed “ringing/whistling” and “non-ringing/whistling” qualities within the three subgroups. The proportion of subjects who reported ringing/whistling did not differ between subgroups, $X^2 = 1.613$, $p = 0.455$. Comparative analysis was also conducted within every two subgroups and no difference was found ($p > 0.05$). Figure 2-1 and 2-2 show the occurrence of each quality of three subgroups.

Factors worsen the tinnitus

The options included “Being in a noisy place”, “Being in a quiet place”, “Physical activity”, “Caffeine (eg. coffee/tea/cola)”, “Being tired”, “Lack of sleep”, “Emotional or mental stress” and so on.

For age-related tinnitus, noise-induced tinnitus with and without age cutoff, 8 (50.0%), 48 (42.1%) and 59 (40.1%) patients felt it worsen by “being in a quiet place”, 5 (31.3%), 54 (47.4%) and 65 (44.2%) thought “emotional or mental stress” could make it worse, 5 (31.3%), 55 (48.3%) and 65 (44.2%) said that “being in a noisy place”, 4 (25.0%), 52 (45.6%) and 59(40.1%) said that “being tired” and 3 (18.8%), 57 (50.0%) and 63 (42.9%) answered that “lack of sleep” made their tinnitus worse. We analyzed “Being in a noisy place and/or lack of sleep” and “Neither being in a noisy place nor lack of sleep” in the three groups. The proportion of subjects who reported being in a noisy place / lack of sleep differed by cause of tinnitus, $X^2 = 8.860$, $p = 0.011$. Comparative analysis was conducted within every two subgroups. Age-related tinnitus showed significant difference in proportion of “Being in a noisy place” / “Lack of sleep” than noise-induce tinnitus with / without age cutoff ($X^2 = 8.884$, $p = 0.003$ / $X^2 = 6.169$, $p = 0.013$). There is

no difference between noise-induced tinnitus with and without age cutoff ($p > 0.05$). Figure 3-1 and 3-2 show the worsening factors in three subgroups.

Factors reducing the tinnitus

The options included “Being in a noisy place”, “Being in a quiet place”, “Physical activity”, “Food”, “Relaxation”, “Nothing makes it better” and so on.

Among patients of age-related tinnitus, noise-induced tinnitus with and without age cutoff, 5 (31.3%), 44 (38.6%) and 63 (42.9%) patients thought “nothing makes it better”, 2 (12.5%), 30 (26.3%) and 32 (21.8%) felt that “relaxation” made it better, 2 (12.5%), 22 (19.3%) and 25 (17.0%) said that “being in a noisy place”, 2 (12.5%), 19 (16.7%) and 20 (13.6%) said that “when you first wake up in the morning” and 2 (12.5%), 17 (14.9%) and 19 (12.9%) said that “physical activity” seemed to reduce their tinnitus. We analyzed “Nothing makes it better and/or relaxation” and “Neither nothing makes it better nor relaxation” in the three groups. The proportion of subjects who reported nothing makes it better and/or relaxation did not differ significantly by cause of tinnitus, $X^2 = 2.039$, $p = 0.377$. Comparative analysis was conducted within every two subgroups and no difference was found ($p > 0.05$). Figure 4-1 and 4-2 show the factors that reduced the tinnitus in three subgroups.

Discussion

Two of the most prominent causes for chronic tinnitus are noise-induced hearing loss (NIHL) and presbycusis^{5,6}. In this preliminary analysis, tinnitus patients were subgrouped based on the two causes. Due to the large age range of participants, we employed age cut-offs. Only participants aged 60 years and above were included in age-related tinnitus group since it's generally accepted that presbycusis begins around 60 years of age. Although NIHL could affect both young and old, the elder participants

self-reported as NIHL likely had some component of presbycusis in addition to a history of noise exposure. For this reason, we set an age cutoff of 60 years for noise-induced tinnitus while kept the total sample in order to suppress the interference of age factor. Statistics showed that the large age range in NIHL group did not affect the characteristics concerned in this study. Hence the following discussion was based on the comparison between age-related tinnitus subgroup and noise-induced tinnitus subgroup without age cutoff.

Age-related tinnitus

A complaint often accompanying presbycusis but even more troublesome is age-related tinnitus, termed presbytinnitus⁷. Presbytinnitus is supposed to reflect cochleovestibular dysfunction⁸. The otoacoustic emissions recordings are usually abnormal and speech recognition is decreased. This demonstrates that both degeneration of cochlea and retrocochlear structures give rise to presbytinnitus⁹. Many underlying diseases for the elderly such as hypertension and diabetes might contribute to tinnitus¹⁰. Medications can be used for these patients to control basic diseases. Fitting with hearing aids is an effective treatment for presbytinnitus¹¹. Since background noise is amplified, the tinnitus loudness can be reduced^{12,13}.

Noise-induced tinnitus

NIHL has been reported to be the most common cause of tinnitus, accounting for 37.8% of patients¹⁴. Unlike presbycusis, noise-induced degenerative part of the auditory pathway is most frequently within the cochlea¹⁵. Noise-induced tinnitus is also prevalent among young people. About 8.7% of high-school students and 14.8% of university students are bothered with noise-induced tinnitus^{16,17}. Due to the lack of knowledge, however, hearing protection is underused by young people when they

perceive tinnitus in the early period after noise exposure¹⁷. Therefore, a major role of the clinician is to prevent noise exposure⁶.

Differences of psychoacoustic characteristics of tinnitus in two subgroups

Quality of tinnitus is highly associated to the pitch. For instance, “ringing” or “whistling” describes high frequency sound. High-pitched tinnitus (above 4,000 Hz) is observed in both presbycusis and NIHL¹⁸. The average pitch of presbytinnitus was 3800-5800 Hz^{19,20}. In the present study, “ringing, whistling” and “hissing” are the top two qualities in both noise-induced (51.1%, 23.1%) and aged-related tinnitus (37.5%, 18.8%). 74.8% of noise-induced tinnitus and 56.3% of age-related tinnitus was reported to be either “ringing, whistling” or “hissing”. The difference in quality might originate from the difference in nerve fibers affected and spontaneous activity. The damage of noise exposure mainly starts in cochlear hair cells, often causing high-pitch “ringing, whistling” like sound. Since age-related degeneration can affect both cochlear and retrocochlear pathway, the qualities tend to be more divergent which lead to a relatively average distribution ratio of different sounds.

The reported tinnitus loudness is a combination of sound intensity and patients’ reaction to it. Tinnitus loudness in previous studies was 32-48dB^{19,20}. In this study, we evaluated the subjective tinnitus loudness using a scale ranging from 0-100 rather than 0-10 as reported in literature¹¹. The mean loudness scales for noise-induced and age-related tinnitus were 62.4 and 53.9. There was no statistical difference between subgroups. It means that patients’ subjective feelings about tinnitus intensity are pretty much the same no matter what causes their tinnitus.

Differences of worsening and reducing factors in two subgroups

In a study in 2015, the most common factors that made tinnitus worse were quiet, stress, noise and lack of sleep; and the things that made tinnitus better were nothing, noise and relaxation²¹. According to another study, the symptoms of presbytnitis patients were aggravated in silent surroundings²². That is coincident with our results. In this study, the top factor worsening age-related tinnitus was quiet environment (50.0%) , while the other two popular answers were stress (31.3%) and noisy environment (31.3%). For noise-induced tinnitus, the main worsening factors were noise (44.2%), stress (44.2%) and lack of sleep (42.9%). 63.3% of noise-induced tinnitus was reported to be worsen by either noise or lack of sleep or both, showing a statistical difference from age-related tinnitus (31.3%). Two subgroups were both easily aggravated by environment and emotional / mental stress.

There was also difference - although not statistically significant - in things that make tinnitus better between two subgroups. The most common reducing factor was “nothing” for both noise-induced (42.9%) and age-related tinnitus (31.3%). The second common factors reducing the noise-induced tinnitus was relaxation (21.8%). For age-related tinnitus, the other options such as relaxation and noisy environment proportioned equally (12.5%). 61.9% of noise-induced and 43.8% of age-related tinnitus was reduced by either “nothing” or relaxation.

The results show that most noise-induced tinnitus is likely to be worsened by noise, stress and sleep deprivation; relaxation may reduce part of the symptom even though nothing makes it better for many patients. Age-related tinnitus tends to be worsened by quiet environment, stress and noise; there is some possibility although not much that relaxation, noise, physical activity make it better.

Tinnitus treatment suggestions according to the above characteristics

Tinnitus treatment might be more effective if it is based on the features of different subgroups. Patients of age-related tinnitus should avoid quiet as suggested by Stouffer and Tyler²³. Keeping away from stress can also be helpful. Relaxation and moderate physical exercises are good to both their tinnitus and general health. Sound therapy²⁴ in which tinnitus is masked totally or partially with noise²⁵ may be effective. Fitting with hearing aid is also recommended for them. Patients of noise-induced tinnitus should be suggested to stay away from noise, get enough sleep and release the stress. Those patients whose tinnitus is aggravated in noisy place may not consider sound therapy, or should begin masker therapy with low levels of partial masking²¹.

Conclusions

We attempted to determine if there were differences between tinnitus attributed to noise exposure compared to aging. Generally, there was a great deal of overlap. There was no large difference between two subgroups in loudness, qualities and reducing factors of tinnitus. The average tinnitus loudness was about 60/100 in both subgroups.

Ringings/whistling and hissing were the most common percepts in both subgroups. One important difference was that people with noise-induced tinnitus had a much larger experience of noise and / or lack of sleep make their tinnitus worse. This is an important ‘red flag’ in counseling. Furthermore, those with age-related tinnitus can be counseled about avoiding quiet. They also might be more likely to benefit from sound therapy.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

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Table 1. Gender, age and location of tinnitus of tinnitus subgroups with/without age cutoff

	Age related tinnitus (aged 60 years and above)	Noise induced tinnitus aged 59 years and below	Noise induced tinnitus without age cutoff
Number	16	114	147
Gender			
Male (N/%)	5 (28.57%)	83 (76.19%)	112 (76.19%)
Female (N/%)	11 (71.43%)	31 (23.81%)	35 (23.81%)
Age			
Mean Age (years)	70.73±7.36	41.38±12.39	46.85±15.09
Side			
Left (N/%)	2 (14.29%)	12 (10.88%)	16 (10.88%)
Right (N/%)	1 (7.14%)	8 (6.12%)	9 (6.12%)
Both (N/%)	10 (64.29%)	76 (68.71%)	101 (68.71%)
Head (N/%)	3 (14.29%)	18 (14.29%)	21 (14.29%)

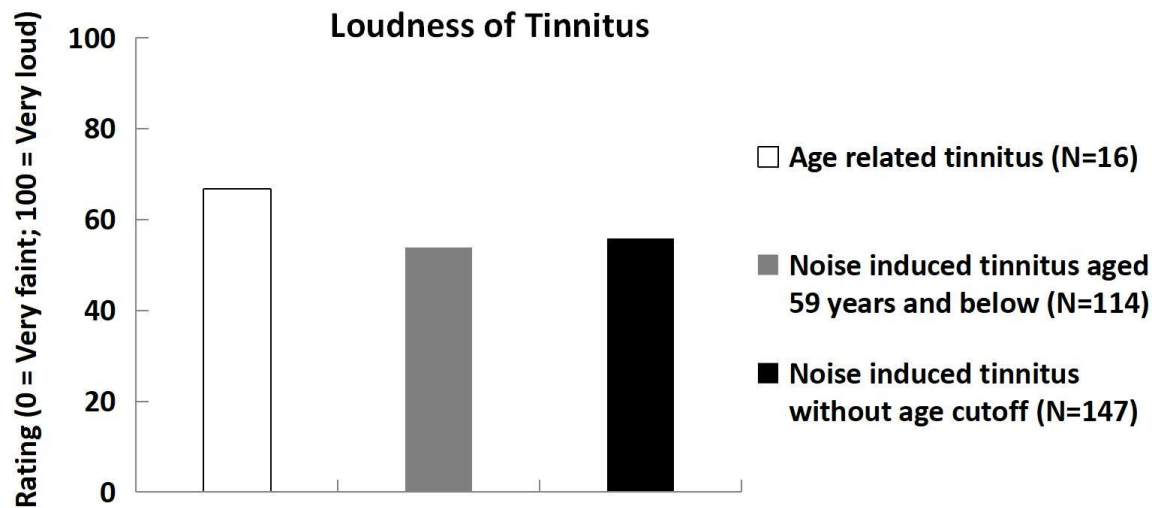


Figure 1. Mean loudness rating of tinnitus of different subgroups.

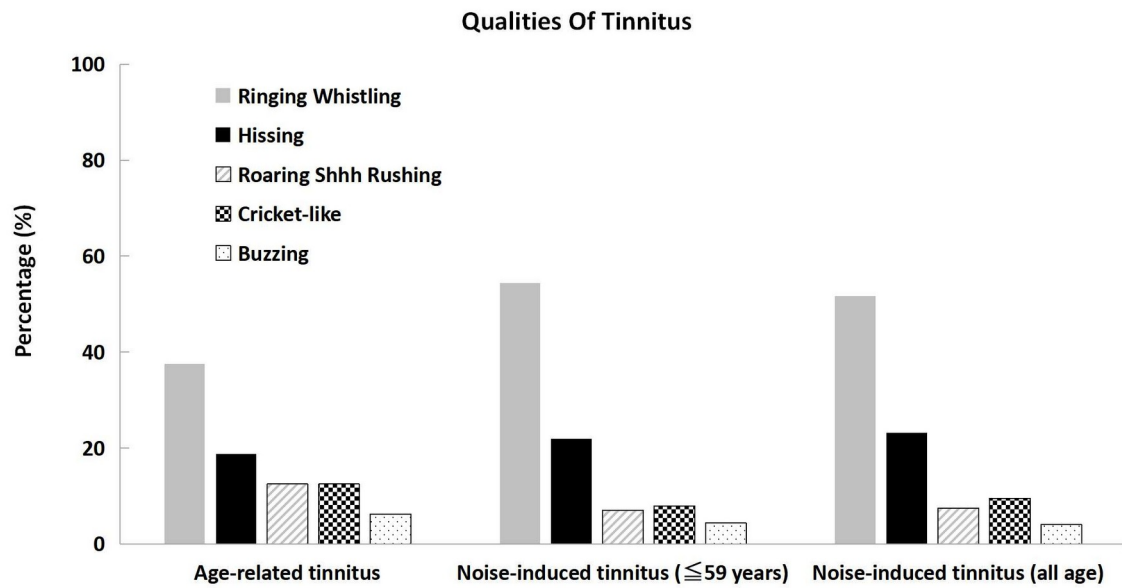


Figure 2-1. Qualities of tinnitus of three subgroups.

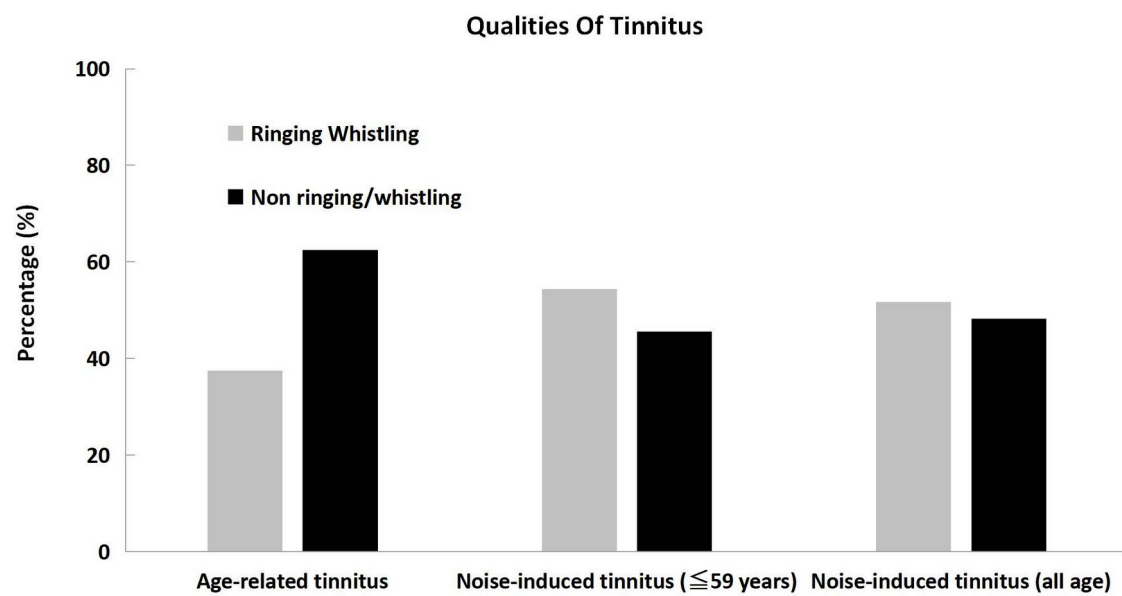


Figure 2-2. Proportion of “ringing/whistling” and “non-ringing/whistling” qualities of three subgroups.

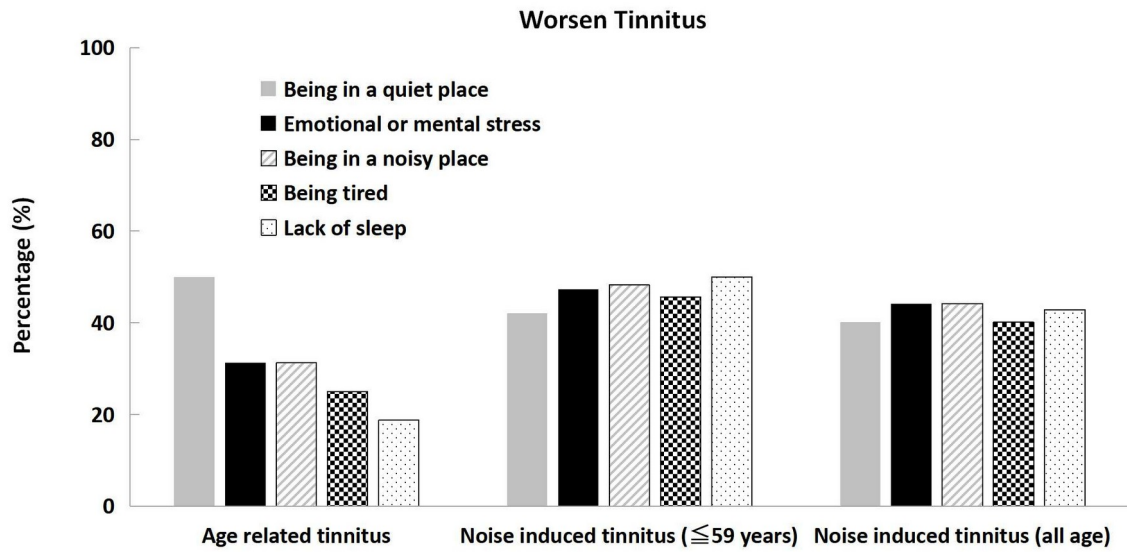


Figure 3-1. Factors that worsen the tinnitus in three subgroups.

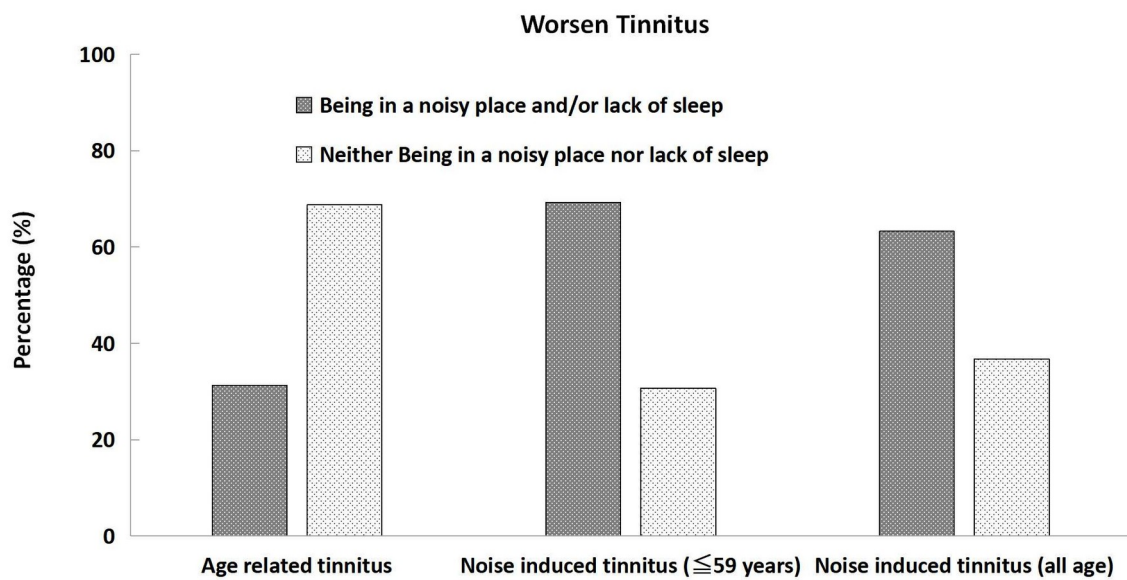


Figure 3-2. Proportion of two main worsening factors, “Being in a noisy place” / “Lack of sleep” of three subgroups.

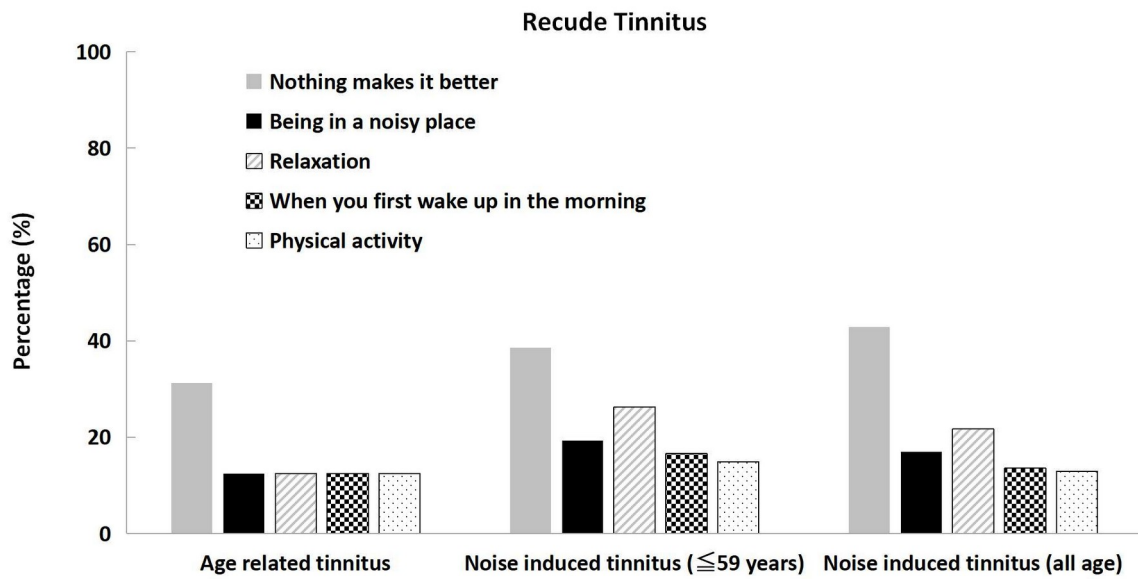


Figure 4-1 Factors that reduced the tinnitus in three subgroups

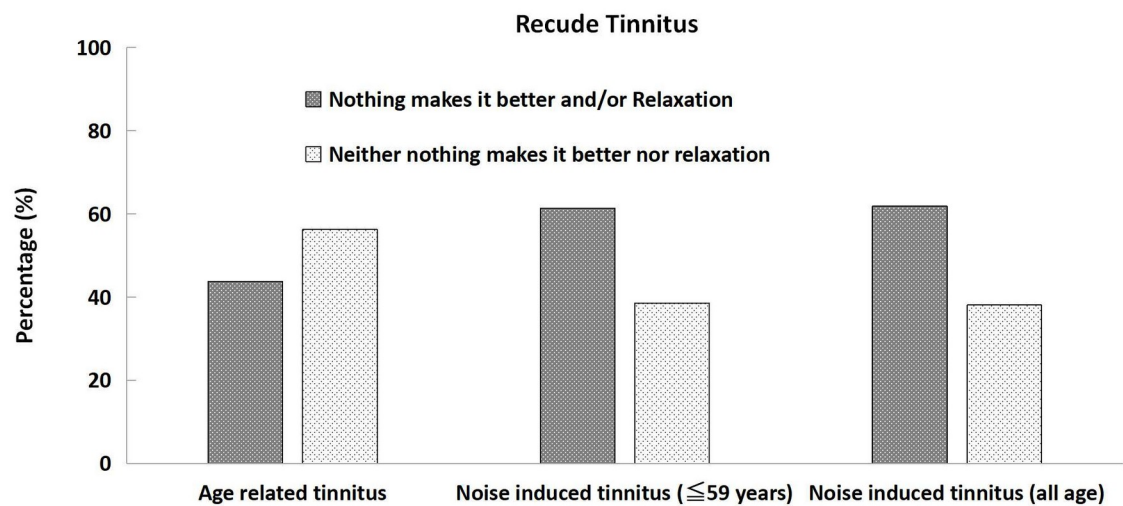


Figure 4-2 Proportion of two main reducing factors, “Nothing makes it better” / “Relaxation” of three subgroups