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ORIGINAL ARTICLE

Analysis of influential factors of self-reported hearing loss deviation in young adults

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Abstract

Background Hearing loss is becoming more and more common in young adults. Many researches have utilized self-reported hearing conditions only to obtain the morbidity of hearing loss. Therefore, we decided to explore factors contributing to self-reported hearing loss deviation in young Chinese adults and compare the loss with audiometric results.

Methods We examined the hearing condition of 2195 young adults aged 18–30 years in Zhejiang Province, China using a pure-tone audiometric test. We also collected information on self-reported hearing condition, demographic characteristics, ear problems, living behavior, and hearing health belief through a survey using a structured questionnaire.

Results We found that 31.6% of young adults showed inconsistencies between self-reported hearing loss and audiometric results. Age had a positive effect on underestimating hearing loss and a reverse effect on overestimating hearing loss. Being female, having a family history of hearing loss, and perceived severity of hearing health belief were associated with overestimation of hearing loss. Ear problems, such as tinnitus and otalgia, were associated with overestimating hearing loss. A higher frequency of using headphones was negatively associated with underestimating hearing loss [OR 0.491 (0.254–0.948)] and positively correlated with overestimating hearing loss [OR 2.702 (1.947–3.750)]. A higher probability of increasing the volume of headphones in a noisy environment drastically reduced the odds of underestimating hearing loss [OR 0.357 (0.148–0.860)] and made overestimating hearing loss [OR 1.523 (1.141–2.033)] more likely. Young adult smokers were more likely to underestimate hearing loss [OR 2.428 (1.140–5.170)].

Conclusions These data provide evidence that demographic characteristics, ear problems, living behavior, and hearing health belief contribute to the deviation of self-reported hearing loss in young adults.

Keywords Self-reported hearing loss · Demographic characteristics · Ear problems · Living behavior · Hearing health belief · Young adults

Background

Hearing loss results from impairment of the sound conduction pathway (Bagai et al. 2006). Globally, 3.6 million patients suffer from permanent hearing loss and about 1.1 billion young adults are at risk of hearing loss due to loud noise (Murphy et al. 2018). Hearing loss has a significant effect on social communications, negatively impacts the emotional state and working capacity of patients, and results in lower life quality and social status (Agrawal et al. 2008).

Accurate self-reported hearing loss is of paramount importance for early prevention and optimum utilization of medical resources. Self-reported measuring could conveniently supply an estimation of hearing status for clinicians and researchers when audiometric measurements are not available (Mccullagh

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et al. 2011; Kamil et al. 2015; Liljas et al. 2016). However, it is also important to ascertain the accuracy of such self-reported hearing losses, but they have, so far, only been explored in studies typically measuring sensitivity and specificity. Thus, our study investigates four different categories of factors that can potentially influence self-reported hearing loss in young adults, namely, demographic characteristics, ear problems, living behavior, and hearing health belief.

Research methods

Subject of research

Our target population was young adults aged 18–30 years living in Zhejiang Province, China. We convenience sampled Hangzhou Normal University and Hangzhou Hospital for the Prevention and Treatment of Occupational Diseases as research sites. A total of 1800 young adults were stratified sampled from Hangzhou Normal University and 792 young adults were randomly selected from the physical examination center of Hangzhou Hospital for the Prevention and Treatment of Occupational Diseases. All subjects were given a hearing-related questionnaire and underwent a pure-tone audiometric test. The sample elimination criteria were as follows: (1) currently have or have had otitis media in the past; (2) hereditary hearing loss; (3) occupational noise exposure; (4) missing data on age, gender, hearing loss family history, or other key variables; and (5) non-responsiveness or unreliable response during audiometric examinations. According to the above-mentioned criteria, 397 young adults were excluded and 2195 subjects finally enrolled in our study.

Questionnaire survey

A pilot questionnaire survey was carried out for adjustment and improvement before the self-designed questionnaire was finally adopted. Prior to the questionnaire survey, investigators received professional training to ensure data quality. The contents of the questionnaire included demographic characteristics, family history of hearing loss, tinnitus, otalgia, and aural fullness, frequency of using headphones, probability of increasing headphone volume under noisy conditions, smoking status, self-perceived hearing condition, and hearing health belief. Tinnitus was divided into three conditions: no tinnitus within the past year, occasional tinnitus (less than or equal to once a week), and frequent tinnitus (more than or equal to twice a week). Meanwhile, otalgia and aural fullness were similarly classified. Occasional and frequent morbid conditions were subsumed into a single group in the analysis below. The use of headphones was categorized into multiple groups depending on the frequency of usage: no headphone use, once or twice a day, three to five times a day, and more than five times a day. The probability categories of increasing headphone volume under noisy conditions included less than 30%, 30–50%, 51–70%, and more than 70%. Smoking status was divided into no smoking, occasional smoking (less than one cigarette a day), and frequent smoking (more than one cigarette a day for more than a year). The health belief model, abbreviated as HBM, was a psychological model that attempted to explain and predict health behaviors and included six scale dimensions, namely, perceived susceptibility, perceived severity, perceived benefits of correcting bad behavior related to hearing, perceived barriers against correcting bad behavior related to hearing, cues to action of correcting bad behavior related to hearing, and perceived self-efficacy of improving behavior related to hearing.

Self-reported hearing loss

Self-reported hearing loss was measured by asking participants the question: “How is your hearing?”. Response categories were classified into normal hearing, mild hearing loss, moderate heating loss, and severe hearing loss. We grouped the subjects with moderate and severe hearing loss together into the “moderate-severe hearing loss” group.

Audiometric measures

Devices utilized in this research were the Madsen Itera clinical diagnostic audiometer and TDH39 headphones developed by GN Otometrics of Denmark. The audiometer was calibrated and the audiometric test performed by trained technicians in a sound-proof chamber with noise levels below 30 dB. Subjects were advised to stay away from noisy conditions for more than 12 h prior to the hearing test in order to improve accuracy. Pure-tone air-conduction hearing threshold testing at frequencies between 0.125 and 8 kHz was performed on both ears. In the audiometric examination, participants who did not respond at least once were considered as non-responsive. In order to measure the reliability of the response in participants, the 1-kHz frequency was tested twice in each ear. If the results differed by more than 10 dB, it was considered to be an unreliable response.

The average hearing threshold in the ear that performed worse was determined at frequencies of 0.5, 1, 2, and 4 kHz, and defined in accordance with the World Health Organization (WHO). Hearing loss was defined as follows: ≤ 25 dB (normal hearing), 26–40 dB (mild hearing loss), and > 40 dB (moderate-severe hearing loss).

Grouping of the self-reported hearing loss deviation

In order to reveal the accuracy of self-reported hearing loss in young adults, self-reported hearing and measured audiometric results were compared and classified into consistency,

underestimate, and overestimate groups. The latter two categories constituted self-reported hearing loss deviation. For the consistency group, both the self-reported hearing condition and the actual measured audiometric result were consistent. For the underestimate group, self-reported hearing was normal, while the actual test results showed mild or moderate-severe hearing loss, or the self-reported hearing condition was described as a mild hearing loss, but the test results indicated moderate-severe hearing loss. As for the overestimate group, self-reported hearing was mild hearing loss, whereas the actual measured audiometric results revealed normal hearing, or the self-reported hearing condition was moderate-severe hearing loss, while the actual test results showed mild hearing loss or normal hearing.

Statistical approach

The Statistical Package for the Social Sciences (SPSS for Windows, version 20.0, SPSS Inc., Chicago, IL, USA) was used in our study. Sample descriptive data were summarized using percentage distributions, means, and standard deviations. Analysis of variance (ANOVA) and Chi-square tests were used to analyze differences between groups. The Kruskal–Wallis test was applied to examine the distribution patterns of frequency of headphone use, probability of increasing headphone volume under noisy conditions, and smoking status. Analysis of the influential factors of self-reported hearing loss deviation was done by performing multiple logistic regression based on the adjustment for confounding factors. The consistency group served as the reference group. Statistical significance was defined as $p < 0.05$. For the multiple logistic regression analysis, a 95% confidence interval (CI) was calculated.

Results

Comparison between self-reported hearing loss and measured hearing loss

Among the 2195 research subjects, 69.4% deemed their hearing as normal, 30.3% self-reported mild hearing loss, and 0.3% self-reported moderate-severe hearing loss (Table 1). The measured audiometric results showed that participants with normal hearing, mild, and moderate-severe hearing loss accounted for 97.0, 2.4, and 0.6%, respectively. By comparing self-reported hearing loss and measured audiometric results, 68.4% (1501) of the total subjects were found to belong to the consistency group and 29.5% (647) in the overestimate group, of whom 643 subjects had normal hearing but self-reported mild hearing loss, with the other four subjects having normal hearing but self-reporting moderate-severe hearing loss. Young adults fell into the underestimate group in 2.1% of cases (47), including 42 young adults with self-reported normal hearing and five with self-reported mild hearing loss. Among the 42 young adults who self-reported normal hearing, 36 actually had mild hearing loss and six moderate-severe hearing loss. The five adults who self-reported mild hearing loss were, in reality, suffering from moderate-severe hearing loss.

General demographic characteristics

The average ages of subjects in the consistency, underestimate, and overestimate groups were 21.4 ± 2.5, 23.0 ± 3.2, and 20.5 ± 1.3 years, respectively, which showed a statistically significant difference (Table 2). Furthermore, we found a difference in gender distribution within the three groups. There were more male subjects (62.7%) in the underestimate group, while female subjects were greater in number in the overestimate and consistency groups, with proportions of 71.1 and 56.0%, respectively. There was also a significant difference in family history of hearing loss, with 65.6% of young adults in the overestimate group having a family history of hearing loss, but only 39.0% in the underestimate group.

Multiple logistic regression analysis showed that age, gender, and family history influenced the accuracy of self-reported hearing loss. Age was associated with underestimating hearing loss [OR 1.210 (1.100–1.331)] and, with increasing age, we found that it was also more difficult to overestimate hearing loss [OR 0.829 (0.788–0.872)]. Being female was associated with overestimating hearing loss compared to the male group [OR 1.566 (1.282–1.912)], with a probability of 56.6%. People with a family history of hearing loss showed a 59.6% probability of overestimating their hearing loss, which was significantly higher compared to the group without a family history of hearing loss [OR 1.596 (1.317–1.933)].

Analysis of factors that influence self-reported hearing loss

Our statistical analysis of the data was adjusted for age, gender, and family history of hearing loss. Compared to those who did not use headphones, people who used them once or twice a day were less likely to underestimate hearing loss [OR 0.491 (0.254–0.948)] (Table 3). Respondents who had a probability of 50–70% of increasing the volume of headphones in a noisy environment were less likely to underestimate hearing loss compared to those who had a less than 30% probability of turning up the volume [OR 0.357 (0.148–0.860)]. Occasional smokers underestimated hearing loss more compared to non-smokers [OR 2.428 (1.140–5.170)].

Tinnitus was a risk factor for overestimating hearing loss [OR 1.253 (1.036–1.516)] and the probability of overestimating in the aural fullness group was higher

Table 1 Comparison between self-reported hearing loss and measured hearing loss

Self-reported hearing	Measured hearing loss			Total (%)[a]
	Normal hearing (%)[a]	Mild hearing loss (%)[a]	Moderate-severe hearing loss (%)[a]	
Normal hearing	1482 (67.5)[b]	36 (1.6)[c]	6 (0.3)[c]	1524 (69.4)
Mild loss	643 (29.3)[d]	17 (0.8)[b]	5 (0.2)[c]	665 (30.3)
Moderate-severe loss	4 (0.2)[d]	0[d]	2 (0.1)[b]	6 (0.3)
Total	2129 (97.0)	53 (2.4)	13 (0.6)	2195 (100.0)

[a] Constituent ratio

[b] Consistency group

[c] Underestimate group

[d] Overestimate group

compared to people with no aural fullness [OR 1.344 (1.079–1.675)]. Compared to participants who never used headphones, those who wore headphones once or twice a day were more likely to overestimate their hearing loss [OR 2.702 (1.947–3.750)]. Interviewees who use them three to five times a day had a high probability of overestimating their hearing loss [OR 3.443 (2.360–5.023)]. The association between using headphones more than five times a day and overestimating hearing loss was even higher [OR 3.943 (2.510–6.195)]. Compared to subjects having a less than 30% probability of increasing headphone volume under noisy conditions, those who were 30–50%, 51–70%, and over 70% more likely to do so all overestimated their hearing loss with higher probabilities. Compared to non-smokers, occasional smokers were less likely to overestimate their hearing loss [OR 0.259 (0.136–0.495)] and frequent smokers were even less likely to do so [OR 0.156 (0.056–0.435)]. Moreover, those who scored higher on perceived hearing loss severity were more likely to overestimate their hearing loss [OR 1.024 (1.006–1.043)].

Discussion

Conclusions

This study showed that the consistency rate between self-reported hearing loss and the actual audiometric test was 68.4%. Smoking had a drastically positive effect on underestimating hearing loss. Age, the frequency of using headphones, and the probability of increasing the volume of headphones in a noisy environment affected underestimating hearing loss reversely. In addition, being female, having a family history of hearing loss, tinnitus, otalgia, frequent use of headphones, the probability of increasing the headphone volume in a noisy environment, and perceived severity of hearing loss showed a positive effect on overestimating

Table 2 General demographic characteristics

Characteristic	Consistency group	Underestimate group			Overestimate group		
	Mean (%)[a]	Mean (%)[a]	OR	95% CI	Mean (%)[a]	OR	95% CI
Age (years)	21.4 ± 2.5[b]	23.0 ± 3.2[b]	1.210	1.100–1.331[c]	20.5 ± 1.3[b]	0.829	0.788–0.872[d]
Gender							
Male (reference)	44.0[b]	62.7[b]	1.000		28.9[b]	1.000	
Female	56.0[b]	37.3[b]	0.622	0.355–1.091	71.1[b]	1.566	1.282–1.912[d]
Family history of hearing loss							
No (reference)	49.8[b]	61.0[b]	1.000		34.4[b]	1.000	
Yes	50.2[b]	39.0[b]	0.872	0.499–1.526	65.6[b]	1.596	1.317–1.933[d]

[a] Constituent ratio

[b] $p < 0.05$ (ANOVA test for quantitative variables and Chi-square test for categorical variables between the three groups)

[c] $p < 0.05$ (comparison between underestimate group and consistency group, multiple logistic regression analysis)

[d] $p < 0.05$ (comparison between overestimate group and consistency group, multiple logistic regression analysis)

Table 3 Analysis of factors influencing self-reported hearing loss

Characteristic	Underestimate group			Overestimate group		
	Mean (%)[a]	OR	95% CI	Mean (%)[a]	OR	95% CI
Tinnitus						
No (reference)	22.00	1.000		46.30	1.000	
Yes	78.00	0.770	0.395–1.497	53.70	1.253	1.036–1.516[c]
Otalgia						
No (reference)	22.00	1.000		26.80	1.000	
Yes	78.00	1.878	0.967–3.646	73.20	1.344	1.079–1.675[c]
Frequency of using headphones						
No headphones (reference)	50.80	1.000		7.20	1.000	
Once/twice a day	33.90	0.491	0.254–0.948[b]	63.30	2.702	1.947–3.750[c]
3–5 times a day	10.20	0.646	0.246–1.694	20.20	3.443	2.360–5.023[c]
More than 5 times a day	5.10	0.767	0.217–2.727	9.30	3.943	2.510–6.195[c]
Probability of increasing headphone volume in noisy conditions						
Less than 30% (reference)	44.80	1.000		26.80	1.000	
30–50%	27.60	0.960	0.493–1.872	32.40	1.523	1.141–2.033[c]
51–70%	12.10	0.357	0.148–0.860[b]	25.20	1.337	1.014–1.763[c]
More than 70%	15.50	0.778	0.340–1.777	15.60	1.683	1.257–2.254[c]
Smoking						
Non-smoker (reference)	62.70	1.000		97.90	1.000	
Occasional smoker	23.70	2.428	1.140–5.170[b]	1.50	0.259	0.136–0.495[c]
Frequent smoker	13.60	1.962	0.802–4.802	0.60	0.156	0.056–0.435[c]
Perceived severity	35.34	0.987	0.952–1.023	38.08	1.024	1.006–1.043[c]

[a] Constituent ratio

[b] $p < 0.05$ (comparison between underestimate group and consistency group, multiple logistic regression analysis)

[c] $p < 0.05$ (comparison between overestimate group and consistency group, multiple logistic regression analysis)

hearing loss, while age and smoking had a reverse effect on overestimating hearing loss.

What is already known on this topic?

Studies do exist which use self-reported hearing condition instead of objectively measured audiometric hearing condition (Ranganathan et al. 2011; Liljas et al. 2016). A study by Nondahl et al. (1998) found that the consistency rate between self-reported and audiometric test results was 71% among elderly people. In contrast, this rate was as low as 31.9% among factory workers (Kerr et al. 2003). Kamil et al. (2015) showed that deviations in self-reported hearing loss in the elderly were associated with age, gender, race, and education. With regard to gender, males and females tended to participate in gender-specific activities, and have divergent life expectancies and exposures; thus, there were always differences in their hearing ability (Wang et al. 2018). Additionally, the gender norms or cultural notions of masculinity influence male attitudes toward health and health service use, which probably make women overestimate hearing loss (Kim et al. 2017). Previous researches have also shown associations between occupation, stress, anxiety, tinnitus, hearing aid use, and self-reported hearing loss deviation. Tinnitus and aural fullness correlate with anxiety (Moon et al. 2018; Levo et al. 2014), a symptom of general psychological pressure which makes people vulnerable to hearing problems.

What this study adds

The study findings add to the current literature on self-reported hearing loss in several ways. We first compared self-reported hearing loss with audiometric tests in young adults and evaluated the factors that influence self-reported hearing loss deviation. In addition, our study divided participants into three hearing loss groups (normal, mild, and moderate-severe) because some studies point out that, compared to the results of the dichotomy of self-reported hearing loss, grade classification is more rigorous (Ferrite et al. 2011). The hearing threshold in our study was determined by the ear that performed worse, which may have led to more accurate identification of people who underestimate hearing loss. Moreover, beside demographics and ear problems, we also investigated a range of factors on hearing, including living behavior and hearing health belief, which only a few studies have examined to date. We found that smoking, frequency of

using headphones, probability of increasing headphone volume in a noisy environment, and perceived severity of hearing health belief were the most influential factors of self-reported hearing loss deviation, for example. Nicotine may have damaging effects on the auditory system (Nomura et al. 2005) and it may influence the nervous system to some extent (Durazzo et al. 2017), which might, in turn, reduce the sensitivity of hearing loss within a short time in young adult smokers. Short-time exposure to entertainment noise is likely to cause a temporary increase of the hearing threshold, also known as auditory fatigue, which leads to an overestimation of hearing loss in young adults (Cone et al. 2010). The model of hearing health belief can be applied in testing the possibility of changing behavior of subjects related to hearing health, as well as predicting the future of hearing conditions (Pronk et al. 2017). Saunders et al. (2016) pointed out that people with better hearing have higher perceived levels of sensitivity, severity, and benefits that are important for hearing loss prevention.

Limitations of this study

There are many influential factors obtained through self-reporting which could potentially contain measurement errors. Even though there are no studies at all to date that correlate patterns of living behavior with self-reported hearing loss, we only explored a small fraction of patterns of living behavior, a complex which needs to be investigated in more detail in future studies. Self-reported hearing loss belongs to subjective personal recognition and may be related to psychological conditions. However, this article did not study the relationship between psychological pressure, anxiety, and self-reported hearing loss, another topic which needs to be addressed in future studies.

Conclusion and implications of findings

We examined the difference between self-reported and objectively measured hearing loss by audiometric testing and identified factors contributing to self-reported hearing loss deviation in young Chinese adults. Understanding the influential factors of self-reported hearing loss deviation can provide effective information allowing clinicians to analyze the patient's self-reported hearing condition. It could also provide a preliminary basis for researchers to investigate the validity of using self-reported hearing conditions to obtain the morbidity of hearing loss, which would present insightful new data for the prevention of hearing loss in young adults.

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Author contributions YZ Zhuang and DH Wang performed the statistical analysis for this study and wrote the manuscript. LW Xu and L Yang designed the study and revised the manuscript. YY Wu and HY Ma were responsible for the quality control of the project. YZ Zhuang, Y Peng, BD Zhang, H Xu, L Zhang, and S Lei were responsible for the data collection.

Compliance with ethical standards

Ethical approval was provided by the Ethics Committee of Hangzhou Normal University. All subjects signed an informed consent form for the hearing survey.

Conflict of interest The authors declare that they have no conflict of interest.

References

Agrawal Y, Platz EA, Niparko JK (2008) Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999–2004. Arch Intern Med 168:1522–1530

Bagai A, Thavendiranathan P, Detsky AS (2006) Does this patient have hearing impairment? JAMA 295:416–428

Cone BK, Wake M, Tobin S, Poulakis Z, Rickards FW (2010) Slight-mild sensorineural hearing loss in children: audiometric, clinical, and risk factor profiles. Ear Hear 31:202–212

Durazzo TC, Meyerhoff DJ, Yoder KK, Murray DE (2017) Cigarette smoking is associated with amplified age-related volume loss in subcortical brain regions. Drug Alcohol Depend 177:228–236

Ferrite S, Santana VS, Marshall SW (2011) Validity of self-reported hearing loss in adults: performance of three single questions. Rev Saude Publica 45:824–830

Kamil RJ, Genther DJ, Lin FR (2015) Factors associated with the accuracy of subjective assessments of hearing impairment. Ear Hear 36: 164–167

Kerr MJ, McCullagh M, Savik K, Dvorak LA (2003) Perceived and measured hearing ability in construction laborers and farmers. Am J Ind Med 44:431–437

Kim SY, Kim HJ, Kim MS, Park B, Kim JH, Choi HG (2017) Discrepancy between self-assessed hearing status and measured audiometric evaluation. PLoS One 12:e0182718

Levo H, Kentala E, Rasku J, Pyykkö I (2014) Aural fullness in Ménière's disease. Audiol Neurootol 19:395–399

Liljas AE, Wannamethee SG, Whincup PH, Papacosta O, Walters K, Iliffe S, Lennon LT, Carvalho LA, Ramsay SE (2016) Socio-demographic characteristics, lifestyle factors and burden of

morbidity associated with self-reported hearing and vision impairments in older British community-dwelling men: a cross-sectional study. J Public Health 38:e21–e28

Mccullagh MC, Raymond D, Kerr MJ, Lusk SL (2011) Prevalence of hearing loss and accuracy of self-report among factory workers. Noise Health 13:340–347

Moon KR, Park S, Jung Y, Lee A, Lee JH (2018) Effects of anxiety sensitivity and hearing loss on tinnitus symptom severity. Psychiatry Investig 15:34–40

Murphy WJ, Eichwald J, Meinke DK, Chadha S, Iskander J (2018) CDC grand rounds: promoting hearing health across the lifespan. MMWR Morb Mortal Wkly Rep 67:243–246

Nomura K, Nakao M, Morimoto T (2005) Effect of smoking on hearing loss: quality assessment and meta-analysis. Prev Med 40:138–144

Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein R, Klein BE (1998) Accuracy of self-reported hearing loss. Audiology 37:295–301

Pronk M, Deeg DJH, Versfeld NJ, Heymans MW, Naylor G, Kramer SE (2017) Predictors of entering a hearing aid evaluation period: a prospective study in older hearing-help seekers. Trends Hear 21: 2331216517744915

Ranganathan B, Counter P, Johnson I (2011) Validation of self-reported hearing loss using television volume. J Laryngol Otol 125:18–21

Saunders GH, Frederick MT, Silverman SC, Nielsen C, Laplante-Lévesque A (2016) Description of adults seeking hearing help for the first time according to two health behavior change approaches: transtheoretical model (stages of change) and health belief model. Ear Hear 37:324–333

Wang J, Qian X, Chen J, Yang Y, Gao X (2018) A cross-sectional study on the hearing threshold levels among people in Qinling, Qinghai, and Nanjing, China. Am J Audiol 27:147–155