

Postprint of Association Study on Tooth Loss and Hearing Impairment in Chinese Elderly Aged ≥ 65 Years

Authors: Ruijie Wang, Li Hongyu, Shi Hong, Li Hongyu

Date: 2023-09-01T00:00:00+00:00

Abstract

Background Hearing impairment and tooth loss are relatively common among older adults and seriously compromise their physical and mental health. However, population-based studies investigating the relationship between tooth loss, denture use, and hearing impairment in the elderly population remain limited. **Objective** To investigate the association between tooth loss and hearing impairment among older adults aged ≥ 65 years in China. **Methods** In January 2023, 15,161 older adults aged ≥ 65 years who met the inclusion criteria were selected from the 2018 follow-up data of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). Hearing impairment status was used as the outcome variable, number of teeth as the explanatory variable, and sociodemographic, lifestyle, and health status information as covariates. Multivariate Logistic regression analysis was employed to examine the effect of tooth number on hearing loss, with further stratified analyses conducted by age, sex, activities of daily living, and denture use status. **Results** Among the 15,161 participants, the numbers of older adults with ≥ 20 , 10–19, 1–9, and 0 teeth were 3,655 (24.11%), 2,355 (15.53%), 4,008 (26.44%), and 5,143 (33.92%), respectively. There were 6,148 individuals (40.55%) with hearing impairment. Multivariate Logistic regression results showed that after adjusting for relevant confounding factors, compared with those having ≥ 20 teeth, individuals with 10–19, 1–9, and 0 teeth had an increased risk of hearing impairment, with ORs (95% CIs) of 1.31 (1.08–1.58), 1.57 (1.32–1.86), and 1.97 (1.65–2.36), respectively. Stratified analysis results indicated that the association between tooth number and hearing impairment was more pronounced among older adults aged ≥ 80 years and those not using dentures ($P < 0.05$). **Conclusion** Tooth loss in older adults may increase the risk of hearing impairment, with the risk being higher among the oldest-old and those not using dentures.

Full Text

Association of Tooth Loss with Hearing Impairment in Chinese Older Adults Aged 65 Years and Above

WANG Ruijie^{1, 2}, LI Hongyu^{2*}, SHI Hong³

¹First Clinical Division, Peking University School and Hospital of Stomatology/National Center for Stomatology/National Clinical Research Center for Oral Diseases/National Engineering Research Center of Oral Biomaterials and Digital Medical Devices, Beijing 100081, China

²Office of National Clinical Research Center for Geriatric Diseases/Beijing Hospital/National Center of Gerontology/Institute of Geriatric Medicine of Chinese Academy of Medical Sciences, Beijing 100730, China

³Department of Geriatrics, Beijing Hospital/National Center of Gerontology/Institute of Geriatric Medicine of Chinese Academy of Medical Sciences, Beijing 100730, China

*Corresponding author: LI Hongyu, Research assistant fellow; E-mail: hylee1030@126.com

Funding: National Key R&D Program of China “International Cooperation in Science and Technology Innovation” Key Special Project (2021YFE0111800)

Citation: WANG R J, LI H Y, SHI H. Association of tooth loss with hearing impairment in Chinese older adults aged 65 years and above[J]. Chinese General Practice, 2024. [Epub ahead of print] DOI: 10.12114/j.issn.1007-9572.2023.0383.

Abstract

Background: Hearing impairment and tooth loss are common conditions among older adults that seriously endanger their physical and mental health. However, population-based studies examining the relationship between tooth loss, denture use, and hearing impairment in the elderly remain limited.

Objective: To explore the association between tooth loss and hearing impairment among Chinese older adults aged 65 years and above.

Methods: In January 2023, we selected 15,161 eligible older adults aged ≥ 65 years from the 2018 follow-up data of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). Using hearing impairment as the outcome variable, number of natural teeth as the explanatory variable, and sociodemographic, lifestyle, and health status information as covariates, we conducted multivariate logistic regression analysis to examine the effect of tooth loss on hearing impairment. Subgroup analyses were further performed by age, gender, activities of daily living (ADL) abilities, and denture use.

Results: Among the 15,161 participants, 3,655 (24.11%), 2,355 (15.53%), 4,008 (26.44%), and 5,143 (33.92%) had \$ \$20, 10-19, 1-9, and 0 teeth, respectively. A total of 6,148 individuals (40.55%) had hearing impairment. After adjusting for confounding factors, multivariate logistic regression showed that compared to those with \$ \$20 teeth, older adults with 10-19, 1-9, and 0 teeth had higher risks of hearing impairment, with ORs (95% CIs) of 1.31 (1.08-1.58), 1.57 (1.32-1.86), and 1.97 (1.65-2.36), respectively. Stratified analysis revealed that the association between tooth loss and hearing impairment was more pronounced among adults aged \$ \$80 years and those not using dentures ($P < 0.05$).

Conclusion: Tooth loss is associated with increased risk of hearing impairment in Chinese older adults, with higher risks observed among those who are older and do not use dentures.

Keywords: Hearing loss; Tooth loss; Aged; Denture use; Cross-sectional studies; Logistic models

Introduction

Hearing impairment is a common sensory dysfunction among older adults. Studies show that the prevalence of hearing impairment among Chinese adults aged \$ \$60 years is approximately 58.9% [1]. Multiple factors, including age, gender, genetics, and chronic diseases, are risk factors for hearing impairment [2]. Hearing impairment is associated with numerous adverse health outcomes, including social isolation, frailty, depression, dementia, cognitive decline, and physical functional decline [3-7]. As China's population aging accelerates, the proportion of adults aged \$ \$65 years among all older adults continues to increase [8-9]. Identifying modifiable risk factors for hearing impairment is therefore crucial for preventing and delaying its onset and promoting healthy aging.

Tooth loss can be used to evaluate oral health status [10]. Surveys indicate that the prevalence of tooth loss among Chinese adults aged 65-74 years is as high as 81.7%, with 36.8% of these individuals not receiving prosthetic treatment [11]. Tooth loss not only affects chewing function and normal pronunciation but is also associated with cardiovascular disease and cognitive decline, seriously endangering the physical and mental health of older adults [12-13].

Currently, research on the relationship between tooth loss and hearing impairment remains limited, and the association between these conditions is unclear [14-17]. Some studies have found that tooth loss is associated with increased risk of hearing impairment in middle-aged and older adults [14-16], while others have found no association [17]. Most existing research has focused on developed countries, and population-based studies examining the effects of tooth loss on hearing impairment among Chinese older adults across different age groups and denture use statuses remain scarce. Using data from the 2018 follow-up survey of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), this study

explores the relationship between tooth loss, denture use, and hearing impairment among Chinese adults aged ≥ 65 years to understand the epidemiological association between tooth loss and hearing function in older adults.

Methods

Data Source The CLHLS (<https://doi.org/10.18170/DVN/WBO7LK>) is a longitudinal survey of older adults conducted by Peking University and the China Research Center on Aging. The survey covers 23 provinces (autonomous regions, municipalities) across China, with participants including adults aged ≥ 65 years and their adult children aged 35-64 years. Survey content encompasses basic information about older adults and their families, socioeconomic background, family structure, personal health status, and lifestyle factors.

The 2018 CLHLS follow-up data included 15,874 adults aged ≥ 65 years. The study was approved by the Peking University Biomedical Ethics Committee (approval number: IRB00001052-13074), and all participants provided informed consent. In January 2023, researchers applied for and obtained approval to use the 2018 CLHLS data through the Peking University Open Research Data Platform. After excluding 713 individuals aged < 65 years, those with missing information on tooth count or hearing impairment, and those with sudden-onset hearing impairment, 15,161 participants were included in the final analysis.

Variable Definitions **Independent Variable: Oral Status Assessment.** Information on the number of natural teeth was obtained through the questionnaire item “How many natural teeth do you have (excluding dentures)?” This variable was categorized into four groups: 0, 1-9, 10-19, and ≥ 20 teeth.

Outcome Variable: Hearing Impairment Assessment. Hearing impairment information was obtained through the questionnaire item “Do you have hearing difficulties?” Participants were classified into either a normal hearing group or a hearing impairment group based on their responses.

Covariates: (1) Sociodemographic information including age, gender, ethnicity, living arrangement, residence, marital status, adequate daily income (determined by the questionnaire item “Is your income sufficient for daily living”), and education level; (2) Lifestyle factors including smoking, alcohol consumption, exercise, and intake of fruits, vegetables, meat, and nuts; (3) Health status including activities of daily living (ADL, assessed by six items: bathing, dressing, indoor activities, toileting, eating, and continence; participants who could independently perform all six activities were classified as having normal ADL, otherwise as ADL impaired), self-rated health status, hypertension (defined as systolic blood pressure > 140 mmHg or diastolic blood pressure > 90 mmHg, or self-reported hypertension with current medication use [18]), diabetes (as the survey did not include blood glucose measurements, participants who self-reported a diabetes diagnosis and current medication use were classified as having diabetes), depression (assessed using the 10-item Center for Epidemiologi-

cal Studies Depression Scale [CES-D10], with scores ≥ 10 indicating depressive symptoms [19]), cognitive impairment (assessed using the Chinese version of the Mini-Mental State Examination [MMSE], with scores < 24 indicating cognitive impairment [20]), body mass index (BMI, categorized as < 18.5 , $18.5-23.9$, $24.0-27.9$, and $\geq 28.0 \text{ kg/m}^2$ [21]), and denture use. All covariate information was collected through standardized, structured questionnaires [22].

Statistical Analysis Statistical analysis was performed using SAS 9.4 software. Categorical data were presented as frequencies and percentages. Chi-square tests were used to compare differences in basic characteristics between the normal hearing and hearing impairment groups, as well as differences in tooth count among older adults with different ages, genders, ADL statuses, and denture use. Multivariate logistic regression analysis was used to examine the relationship between tooth count and hearing loss. Three models were constructed: Model 1 adjusted for age and gender only; Model 2 additionally adjusted for other sociodemographic and lifestyle factors including ethnicity, living arrangement, residence, marital status, adequate daily income, education level, smoking, alcohol consumption, exercise, and intake of fruits, vegetables, meat, and nuts; Model 3 further adjusted for health status information including ADL, self-rated health status, hypertension, diabetes, BMI, and denture use.

Stratified analyses were conducted by age, gender, ADL, and denture use. Interaction terms were added to Model 3 to test for interactions. Sensitivity analysis was also performed by further adjusting for depression and cognitive impairment. Statistical significance was set at $P < 0.05$.

Results

Basic Characteristics Among the 15,161 older adults, 5,149 (33.96%) were aged 65-79 years and 10,012 (66.04%) were aged ≥ 80 years; 8,551 (56.40%) were female and 6,610 (43.60%) were male. A total of 9,013 individuals (59.45%) had normal hearing, while 6,148 (40.55%) had hearing impairment. There was no statistically significant difference in residence distribution between the normal hearing and hearing impairment groups ($P > 0.05$), but significant differences were observed in other sociodemographic, lifestyle, and health status variables ($P < 0.05$).

Comparison of Tooth Count Among Older Adults with Different Characteristics Significant differences in tooth count were observed among older adults with different ages, genders, ADL statuses, and denture use ($P < 0.05$).

Multivariate Logistic Regression Analysis of Tooth Loss and Hearing Impairment Using tooth count as the independent variable and hearing impairment status (normal hearing=0, hearing impairment=1) as the dependent variable, multivariate logistic regression analysis showed that in Model 3, after

adjusting for confounding factors, older adults with 10-19, 1-9, and 0 teeth had significantly higher risks of hearing impairment compared to those with ≥ 20 teeth, with ORs (95% CIs) of 1.31 (1.08-1.58), 1.57 (1.32-1.86), and 1.97 (1.65-2.36), respectively. After additional adjustment for depression and cognitive impairment, the associations remained consistent.

Stratified Analysis of Tooth Loss and Hearing Impairment by Characteristics Further subgroup analysis revealed that compared to adults aged 65-79 years, those aged ≥ 80 years showed stronger associations between tooth counts of 10-19 [OR (95% CI) = 1.50 (1.17-1.93)], 1-9 [OR (95% CI) = 1.97 (1.58-2.46)], and 0 [OR (95% CI) = 2.47 (1.98-3.09)] and hearing impairment (P-interaction <0.05). Compared to denture users, non-denture users showed stronger associations between tooth counts of 10-19 [OR (95% CI) = 1.47 (1.18-1.83)], 1-9 [OR (95% CI) = 2.02 (1.62-2.49)], and 0 [OR (95% CI) = 2.63 (2.09-3.31)] and hearing impairment (P-interaction <0.05).

Discussion

This study examined the relationship between tooth loss and hearing impairment in Chinese older adults. The results showed that among Chinese adults aged ≥ 65 years, having 0 teeth (complete edentulism) and having 1 – 9 teeth were both associated with increased risk of hearing impairment. The association between tooth loss and hearing impairment was stronger among older adults (≥ 80 years) and those not using dentures compared to younger adults (65-79 years) and denture users. The risk of hearing impairment increased with decreasing tooth count, with the highest risk observed among those with 0 teeth.

These findings are consistent with previous population-based studies [14-16]. A cross-sectional survey of 1,004 Japanese adults aged 36-84 years found that individuals with <22 teeth had a higher risk of hearing impairment compared to those with ≥ 28 teeth [OR (95% CI) = 1.96 (1.18-3.30)] [14]. A 20-year prospective follow-up study of 1,156 U.S. veterans found that compared to those with no change in tooth status, participants whose tooth count decreased from ≥ 17 to <17 had a 1.60-fold increased risk of hearing impairment [95% CI (1.24-2.17)]. Furthermore, after adjusting for baseline and time-varying covariates, each tooth lost since baseline was associated with a 1.04-fold increased risk of hearing decline [95% CI (1.02-1.06)] [15]. Similarly, a Belgian cross-sectional study of 48 adults with a mean age of 64.7 years found that patients with <17 teeth had significantly higher hearing impairment risk compared to those with ≥ 17 teeth [16].

Stratified analysis by age and denture use revealed that the effect of tooth loss on hearing impairment was primarily observed among adults aged ≥ 80 years and those not using dentures. In younger adults (65-79 years) and denture users, no statistically significant association was found between tooth count and hearing impairment risk. Additionally, stratification by gender showed that the effect of tooth count on hearing impairment was mainly concentrated in men. These

findings suggest that denture use may effectively reduce the adverse effects of tooth loss on hearing impairment.

The potential biological mechanisms underlying the association between tooth loss and hearing impairment remain unclear, though several hypotheses have been proposed. Dental deafferentation (DD) is defined as the reduction or elimination of peripheral afferent nerve signals related to the oral cavity and masticatory organs. Tooth loss, periodontal disease, or improper prosthetic treatment may lead to DD, causing reorganization of the brain's sensory and motor cortices and affecting multisensory neural centers, ultimately resulting in or exacerbating neurodegenerative changes. Hearing impairment is a neurodegenerative disease, and DD may impair hearing function through these mechanisms, leading to memory and cognitive deficits. Tooth loss and masticatory dysfunction are modifiable and preventable risk factors; therefore, preserving more healthy teeth and maintaining good oral health may effectively reduce DD and decrease the incidence of neurodegenerative diseases [23].

This study has several limitations. First, due to the observational nature of the study, causal inference between tooth count and hearing impairment cannot be established. Second, the dental health examination data lacked information on the cause, timing, and specific location of tooth loss, as well as the effectiveness and evaluation of prosthetic treatment, preventing further assessment of how missing tooth location affects outcomes. Third, both tooth count and hearing impairment were self-reported by participants, and hearing impairment due to organic diseases such as otitis media could not be excluded, potentially leading to information bias.

In conclusion, this study demonstrates that tooth loss is associated with increased risk of hearing impairment among Chinese older adults, with this association being more pronounced among those aged ≥ 80 years and those not using dentures. These findings suggest that maintaining an adequate number of teeth is important for preserving hearing function in older adults, and that prosthetic treatment may mitigate the adverse effects of tooth loss (particularly complete edentulism) on hearing function. Therefore, greater attention should be paid to oral health in older adults, with regular dental examinations and treatment, and timely prosthetic restoration for those with tooth loss. Future prospective cohort studies should further examine the effects of specific tooth loss locations and types of prosthetic restoration on hearing function.

Author Contributions: WANG Ruijie conceptualized the study, collected literature/data, and wrote the manuscript; WANG Ruijie and LI Hongyu collected and organized data, performed statistical analysis, and prepared tables; SHI Hong revised the manuscript and provided resources and supervision; LI Hongyu was responsible for quality control, overall manuscript review, and supervision.

Conflict of Interest: The authors declare no conflict of interest.

References

- [1] GONG R, HU X Y, GONG C, et al. Hearing loss prevalence and risk factors among older adults in China[J]. *Int J Audiol*, 2018, 57(5): 354-359. DOI: 10.1080/14992027.2017.1423404.
- [2] CUNNINGHAM L L, TUCCI D L. Hearing loss in adults[J]. *N Engl J Med*, 2017, 377(25): 2465-2473. DOI: 10.1056/NEJMra1616601.
- [3] MAHARANI A, PENDLETON N, LEROI I. Hearing impairment, loneliness, social isolation, and cognitive function: longitudinal analysis using English longitudinal study on ageing[J]. *Am J Geriatr Psychiatry*, 2019, 27(12): 1348-1356. DOI: 10.1016/j.jagp.2019.07.010.
- [4] LOUGHREY D G, KELLY M E, KELLEY G A, et al. Association of age-related hearing loss with cognitive function, cognitive impairment, and dementia: a systematic review and meta-analysis[J]. *JAMA Otolaryngol Head Neck Surg*, 2018, 144(2): 115-126. DOI: 10.1001/jamaoto.2017.2513.
- [5] YE X, ZHU D W, CHEN S Y, et al. The association of hearing impairment and its severity with physical and mental health among Chinese middle-aged and older adults[J]. *Health Qual Life Outcomes*, 2020, 18(1): 155. DOI: 10.1186/s12955-020-01417-w.
- [6] NING H T, ZHANG H, XIE Z H, et al. Relationship of hearing impairment, social participation and depressive symptoms to the incidence of frailty in a community cohort[J]. *J Am Geriatr Soc*, 2023, 71(4): 1167-1176. DOI: 10.1111/jgs.18164.
- [7] ROSENBERG K. Hearing impairment linked to poorer physical function in older adults[J]. *Am J Nurs*, 2021, 121(10): 51. DOI: 10.1097/01.NAJ.0000794256.43996.2f.
- [8] National Bureau of Statistics. Statistical communique of the People's Republic of China on national economic and social development in 2022[EB/OL]. (2023-02-28)[2023-03-06]. http://www.stats.gov.cn/sj/zxfb/202302/t20230228_1919011.html.
- [9] XIANG X, WANG Y. Current status, characteristics, causes, and countermeasures of population aging in China[J]. *Chinese Journal of Gerontology*, 2021, 41(18): 4149-4152. DOI: 10.3969/j.issn.1005-9202.2021.18.072.
- [10] KASSEBAUM N J, BERNABÉ E, DAHIYA M, et al. Global burden of severe tooth loss: a systematic review and meta-analysis[J]. *J Dent Res*, 2014, 93(suppl 7): s20-28. DOI: 10.1177/0022034514537828.
- [11] WANG X. Report of the Fourth National Oral Health Epidemiological Survey[M]. Beijing: People's Medical Publishing House, 2018: 33-34.
- [12] LEE H J, CHOI E K, PARK J B, et al. Tooth loss predicts myocardial infarction, heart failure, stroke, and death[J]. *J Dent Res*, 2019, 98(2): 164-170. DOI: 10.1177/0022034518814829.

- [13] YANG H L, LI F R, CHEN P L, et al. Tooth loss, denture use, and cognitive impairment in Chinese older adults: a community cohort study[J]. *J Gerontol A Biol Sci Med Sci*, 2022, 77(1): 180-187. DOI: 10.1093/gerona/qlab056.
- [14] TANAKA K, OKADA M, KATO H, et al. Higher number of teeth is associated with decreased prevalence of hearing impairment in Japan[J]. *Arch Gerontol Geriatr*, 2021, 97: 104502. DOI: 10.1016/j.archger.2021.104502.
- [15] LAWRENCE H P, GARCIA R I, ESSICK G K, et al. A longitudinal study of the association between tooth loss and age-related hearing loss[J]. *Spec Care Dentist*, 2001, 21(4): 129-140. DOI: 10.1111/j.1754-4505.2001.tb00242.x.
- [16] PEETERS J, NAERT I, CARETTE E, et al. A potential link between oral status and hearing impairment: preliminary observations[J]. *J Oral Rehabil*, 2004, 31(4): 306-310. DOI: 10.1046/j.1365-2842.2003.01252.x.
- [17] WU Y L, PANG Z C, ZHANG D F, et al. A cross-sectional analysis of age and sex patterns in grip strength, tooth loss, near vision and hearing levels in Chinese aged 50-74 years[J]. *Arch Gerontol Geriatr*, 2012, 54(2): e213-e220. DOI: 10.1016/j.archger.2011.05.022.
- [18] LIU Y, CHEN X, YAN Z J. Depression in the house: the effects of household air pollution from solid fuel use among the middle-aged and older population in China[J]. *Sci Total Environ*, 2020, 703: 134706. DOI: 10.1016/j.scitotenv.2019.134706.
- [19] Ministry of Health Disease Control Division. Guidelines for Prevention and Control of Overweight and Obesity in Chinese Adults[M]. Beijing: People's Medical Publishing House, 2006.
- [20] REN Z, LI Y Y, LI X R, et al. Associations of body mass index, waist circumference and waist-to-height ratio with cognitive impairment among Chinese older adults: based on the CLHLS[J]. *J Affect Disord*, 2021, 295: 463-470. DOI: 10.1016/j.jad.2021.08.093.
- [21] Chinese Hypertension Prevention and Treatment Guidelines Revision Committee, Hypertension League (China), Chinese Society of Cardiology, Chinese Medical Doctor Association Hypertension Professional Committee, et al. Chinese hypertension prevention and treatment guidelines (2018 revised edition)[J]. *Chinese Journal of Cardiovascular Medicine*, 2019, 24(1): 24-56. DOI: 10.3969/j.issn.1007-5410.2019.01.002.
- [22] ZHANG W, TANG F Y, CHEN Y W, et al. Education, activity engagement, and cognitive function in US Chinese older adults[J]. *J Am Geriatr Soc*, 2019, 67(s3): s525-531. DOI: 10.1111/jgs.15560.
- [23] JOU Y T. Dental deafferentation and brain damage: a review and a hypothesis[J]. *Kaohsiung J Med Sci*, 2018, 34(4): 231-237. DOI: 10.1016/j.kjms.2018.01.013.

(Received: July 12, 2023; Revised: August 17, 2023)

(Editor: WANG Fengwei)

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.