Ke *et al. BMC Geriatrics* (2025) 25:111
https://doi.org/10.1186/s12877-025-05750-x

BMC Geriatrics

RESEARCH

Open Access

Does low body weight mediate the relationship between tooth loss and cognitive impairment? A longitudinal cohort study of an older Chinese population

Pan Ke[1], Zuxun Lu[2], Wenqing Ni[3], Yan Zhang[3], Hongmin Zhang[3], Yijin Zheng[3], Xueli Yuan[3], Jian Xu[3], Xiaoxv Yin[2*] and Zhiguang Zhao[1,4*]

Abstract

Objective Our study aimed to investigate the relationship between the number of teeth remaining and cognitive impairment among Chinese older adults, and to explore the role of low body weight in this association.

Methods Data were drawn from 2011 to 2014 surveys of the Chinese Longitudinal Healthy Longevity Survey (CLHLS), involving 4056 respondents who had no cognitive decline and aged ≥ 65 years at baseline. Cognitive function was measured by the Mini-Mental Status Examination (MMSE), and the cognitive impairment was classified according to the length of education. Number of natural teeth was self-reported (classified as ≥ 20, 10–19, 1–9, and 0). Low body weight was defined as having a body mass index (BMI) of less than 18.5 kg/m^2. Cox proportional hazards regression and mediation effect analyses were applied in the study.

Results Comparing with participants with ≥ 20 teeth, 10–19 teeth and 1–9 teeth, those with 0 teeth (*HR*:2.14, 95% *CI*: 1.51, 3.03) were significantly associated with higher cognitive impairment risk in the fully adjusted model. Compared with denture users, the fully adjusted *HR* (95% *CI*) for non-denture users was 1.33 (1.04, 1.70). no teeth with non-denture users had the highest cognitive impairment risk (*HR*:1.63, 95% *CI*: 1.10, 2.41). Low body weight mediated 6.74% (ranging from 3.49 to 11%) of the association between the number of teeth remaining and cognitive impairment.

Conclusion Tooth loss increases the risk of cognitive decline, and low body weight partially mediates this association.

Clinical trial number This is a retrospective cohort study targeting a population survey, which does not involve clinical trials and does not have clinical trial numbers.

Keywords Cognitive impairment, Tooth loss, Denture use, Low body weight, Older adults

*Correspondence:
Xiaoxv Yin
yxx@hust.edu.cn
Zhiguang Zhao
1498384005@qq.com
[1]Cardio-Cerebrovascular & Diabetes Prevention, and Control Dept., Shenzhen Center for Chronic Disease Control, Shenzhen, Guangdong 518020, P.R. China
[2]Department of Social Medicine and Health Management, Tongji Medical College, Huazhong University of Science and Technology, No. 13 Hangkong Road, Wuhan 430030, P.R. China
[3]Department of Elderly Health Management, Shenzhen Center for Chronic Disease Control, Shenzhen, Guangdong 518020, P.R. China
[4]Shenzhen Center for Chronic Disease Control, No. 2021 Buxin Road, Shenzhen, Guangdong 518020, P.R. China

Introduction

Aging is a major global public health challenge. In 2020, the population of Chinese adults over 60 years old and over 65 years old had reached 264.02 million and 190.64 million respectively, accounting for 18.5% and 13.50% of the total population [1]. Cognitive impairment is common in older adults and significantly impacts their quality of life [2]. A large national epidemiological survey showed that the prevalence of mild cognitive impairment (MCI) in China reached 6.0% [3]. China has become the country with the fastest growing population of older people and those with cognitive impairment in the world [4]. Therefore, exploring modifiable risk factors of cognitive impairment in the older adults is of great significance to promote the prevention and control of dementia.

Recently, some studies investigated the relationship between oral diseases and cognitive impairment among older adults [5, 6]. Tooth loss has been shown to result in a decline in quality of life and self-esteem, as well as having socioeconomic impacts and associated healthcare costs [7–9]. A dose-response Meta-analysis has proven that risk of diminished cognitive function increased with incremental numbers of teeth lost [10]. Conversely, some studies found no clear association between tooth loss or number of tooth contacts and cognitive decline [11, 12]. Given the variability in study quality and outcomes of previous studies, the relationship between tooth loss and risk of cognitive impairment in older adults is inconclusive. Low body weight is particularly common in old age and is strongly associated with the risk of all-cause death and adverse outcomes in older adults [13]. Only one study investigated the mediating role of BMI in the relationship between tooth loss and cognitive impairment [14]. However, the study included people aged 45 and older, rather than over 60 years of age. Furthermore, the study found that high BMI only mediated tooth loss and cognitive impairment in middle-aged and older men, rather than explore the role of low body weight in this association [14]. Given that low body weight is an important indicator of nutrition and physical condition in older adults, our study aimed to explore its role in tooth loss and cognitive impairment.

Methods

Study population

Our study is a prospective community-based cohort study involving participants from Chinese Longitudinal Healthy Longevity Survey (CLHLS) [15]. Detailed descriptions of the survey's sampling design and data quality are available elsewhere. Our study utilized data from the 2011 to 2014 waves of the CLHLS. The CLHLS 2011 baseline survey interviewed 9765 individuals aged 65 and older, and follow-up surveys were conducted every two to three years. The inclusion criteria in our study were: (1) aged ≥ 65 years; (2) self-reported no Parkinson or dementia at the baseline survey; (3) without cognitive impairment; (4) follow-up Mini-Mental State Examination (MMSE) assessments were conducted. At baseline, 1766 respondents with missing MMSE scores and 1404 respondents with cognitive decline were excluded. We also excluded 2539 respondents who either died or were lost to follow-up by the deadline of follow-up in 2014. As a result, 4056 respondents were included as the study population. Our research follows the STROBE Statement guidelines.

Exposure

Oral status was mainly assessed through the self-reported status of tooth loss and denture use at baseline [16]. The following 2 questions were used to define the oral status: "How many natural teeth do you still have (number)?"; "Do you have dentures (yes or no)?" (including any type of non-natural teeth, as partial or complete, removable or implant-retained fixed dentures). We grouped the participants as having 0 teeth, 1–9 teeth, 10–19 teeth, or having 20 or more teeth [16]. We chose 20 natural teeth as the threshold according to the WHO "8020" campaign. We also divided the sample into 7 groups based on combinations of teeth number and denture use as follows [16]: (1) 20 + teeth with or without dentures, (2) 10–19 teeth with dentures, (3) 1–9 teeth with dentures, (4) 0 teeth with dentures, (5) 10–19 teeth without dentures, (6) 1–9 teeth without dentures, and (7) 0 teeth without dentures. However, CLHLS was not specifically designed to study dental health, so no questions were asked about caries, periodontal disease, or dental examinations.

Measurement of low body weight

During the survey, the interviewers measured the participants' weight (in kilograms) and height (in centimeters) [17]. BMI (kg/m^2) = weight(kg)/height (m^2). BMI was divided into 3 groups according to the Chinese Individual guidelines, including low body weight (BMI < 18.5 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI < 24.0 kg/m^2), and overweight/obese (BMI ≥ 24.0 kg/m^2) [18].

Outcome

The CLHLS participants' cognitive function was measured using the Chinese version of the MMSE [19], which tests six aspects of cognitive function: orientation, registration, attention, language, memory, and visual construction skills, and scores range from 0 to 30, with a lower score indicating poorer cognition. The MMSE test is strongly associated with education level. A reliable decline in MMSE scores should be at least 2–3 points. Furthermore, cognitive impairment was defined as a combination of the following MMSE scores during follow-up surveys: illiterate: < 18; those with level of primary school: < 21; and those with level of middle school or above: < 25. We defined the time from baseline to first occurrence of cognitive impairment as the length of time for the survival analysis. For participants who were without cognitive impairment at the end of observation, the censoring point for the survival analysis was the time from the baseline to the last cognitive assessment.

Covariates

According to the prior studies [16, 20], we adjusted for socio-demographic variables, lifestyle behaviors, and health characteristics. Socio-demographic variables included sex (men/women), age (65–79 years old, ≥80 years old), marital status (married, unmarried/spread/widowed), residence (urban, rural), years of education (0, 1–6 years, or ≥7 years), household annual income (¥, <10,000, 10,000–29,999, ≥30,000), and BMI. Lifestyle behaviors include smoking (yes/no), drinking (yes/no), and regular exercise (yes/no) at present. Health characteristics including basic activities of daily living (BADL), depression, hypertension, diabetes, heart disease and cancer. Hypertension was defined as a systolic blood pressure (SBP) of 140 mmHg or higher and/or a diastolic blood pressure (DBP) of 90 mmHg or higher. Diabetes, heart disease, and cancer were self-reported conditions by the interviewees. Depressive symptoms were measured with two assessment questions: (1) Have you felt fearful or anxious? (2) Have you felt lonely and isolated? Respondents who had answered "always" or "often" to both questions were defined as having depressive symptoms.

Statistical analyses

Continuous variables are presented as means ± standard deviation (SD) and were analyzed with one-way ANOVA. Categorical variables are presented as percentages (%) and were analyzed with the chi-square test. Cox proportional hazards models were applied to generate hazard ratios (*HR*) and 95% confidence intervals (95% *CI*) for the association between the number of teeth and cognitive impairment. Two models were applied for analyzing the outcome: the basic model (crude model) and model 2 (adjusted for socio-demographic variables, lifestyle behaviors, and health characteristics). Additionally, denture use status and numbers of tooth loss were combined into predefined 7 groups to explore the combined effects of these 2 factors on incident cognitive impairment. Kaplan–Meier curves were generated for the number of teeth, and log-rank tests were used to examine the differences between groups. To estimate the linear dose-response relationship between tooth number and cognitive impairment, the restricted cubic spline regression model with three knots (5th, 50th and 95th percentiles) was employed. Subgroup analyses and their interactions were tested to explore whether sex, age, residence, and BMI would confound the association the number of teeth and cognitive impairment. The 'mediation' package was used for mediation effects analysis where we calculated mean causal mediation effects (ACME), mean direct effects (ADE), and the proportion of mediation with corresponding 95% *CI*. A two-tailed p-value < 0.05 was considered statistically significant in all analyses. Statistical analyses were conducted by IBM SPSS Statistics Version 24.0 and R software Version 4.4.0 (http://www.R-project.org).

Results

Baseline characteristics

Table 1 shows the baseline characteristics of the study participants ($n = 4056$). Among the 4056 participants (median age 79 years), 50.4% were men, and 52.7% were married. A total of 1260, 786, 1004, and 1006 participants were classified into group of having 20 or more teeth, 10–19 teeth,1–9 teeth, and 0 teeth, respectively.

Number of natural teeth, denture use and cognitive impairment

During follow-up 3 years (median: 2.77 years), 356 participants developed cognitive impairment. 20 or more teeth, 10–19 teeth, and 1–9 teeth, 0 teeth corresponded to 59, 53, 111, and 133 individuals with cognitive impairment, respectively (Table 1). The Table 2 showed that compared with participants with 20 or more teeth, the risk of cognitive impairment was significantly higher among individuals with 0 teeth (*HR*:2.14, 95% *CI*: 1.51–3.03), after adjusted all covariates. Compared with denture users, the fully adjusted *HR* (95% *CI*) for non-denture users was 1.33 (1.04, 1.70). Kaplan–Meier curves showed that 0 teeth was significantly related to the risk of developing cognitive impairment (Figs. 1 and 2, log-rank test: $p < 0.001$). In the dose-response analysis, the shape of the association of natural teeth with the risk of cognitive impairment was approximately *L*-shaped (non-linear, $p < 0.05$) (Fig. 3).

Combined effects of tooth loss and denture use on cognitive impairment

Table 3 showed that among non-denture users, adjusted *HR* (95% *CI*) were 1.63 (1.10, 2.41), 1.48 (0.89, 2.67), and 1.35 (0.72, 2.55) corresponding to 0, 1–9 and 10–19 teeth, respectively. However, the risk was not significant among denture users with 1–9 teeth, while a protective factor of denture users with 0 teeth and 10–19 teeth, (*HR*: 0.62, 95%*CI* (0.42, 0.91)), *HR*:0.21, 95%*CI* (0.08, 0.60), respectively.

Table 1 Baseline characteristics of the included participants

Variables	Number of Natural Teeth					*p*-value
	Overall(*n* = 4056)	≥ 20 (*n* = 1260)	10–19 (*n* = 786)	1–9 (*n* = 1004)	0(1006)	
Men (*n*, %)	2044(49.6)	742 (36.3)	386(18.9)	463(22.7)	453(22.2)	< 0.001
Age, years (mean ± SD)	79.76 ± 9.49	74.65 ± 7.31	78.66 ± 8.71	82.82 ± 9.32	83.95 ± 9.47	< 0.001
Years of schooling (mean ± SD)	2.91 ± 4.63	4.01 ± 5.31	2.84 ± 3.66	2.16 ± 3.34	2.35 ± 3.31	< 0.001
Married (*n*, %)	2138(52.7)	863 (40.4)	445 (20.8)	412(19.3)	418(19.6)	< 0.001
Household income < 10,000 (¥, annual) (*n*, %)	1669(41.4)	464 (27.8)	335 (20.1)	429 (25.7)	441(26.4)	0.005
Residence in rural (*n*, %)	2149 (53.0)	639 (29.7)	434 (20.2)	494 (25.9)	440(23.1)	0.110
Current smoking (*n*, %)	906(22.4)	318 (35.1)	149 (16.4)	220(24.3)	219(24.2)	0.008
Current drinking (*n*, %)	819(20.4)	291(35.5)	142(17.3)	187 (22.8)	199(24.3)	0.006
Current exercise (*n*, %)	1671(41.7)	551(33.0)	324 (19.4)	413 (24.7)	383(22.9)	0.044
BMI, kg/m^2 (mean ± SD)	22.81 ± 31.02	24.93 ± 52.89	22.54 ± 9.98	21.55 ± 9.19	21.62 ± 14.39	0.028
SBP, mmHg (mean ± SD)	137.84 ± 30.22	136.27 ± 19.89	137.62 ± 19.88	138.17 ± 34.13	139.63 ± 41.31	0.073
DBP, mmHg (mean ± SD)	81.77 ± 27.10	82.03 ± 14.28	82.01 ± 11.50	80.87 ± 31.47	82.15 ± 40.12	0.691
BADL ability (*n*, %)	333(8.2)	171(5.9)	82(11.1)	38(16.4)	42(23.3)	< 0.001
Sleep duration, hours (mean ± SD)	7.58 ± 3.51	7.50 ± 2.94	7.32 ± 2.03	7.65 ± 4.19	7.83 ± 4.24	0.017
Having depression symptom (*n*, %)	562(13.9)	164(29.2)	110(19.6)	154(27.4)	134(23.8)	0.416
Cognitive function						< 0.001
Normal (*n*, %)	1766(91.2)	1201(32.5)	733(19.8)	893 (24.1)	873(23.6)	
Impairment (*n*, %)	356(8.8)	59(16.6)	53(14.9)	111 (31.2)	133(37.4)	
Comorbidity chronic diseases						
Hypertension (*n*, %)	1288(32.7)	418(32.5)	271(21.0)	311(24.1)	288(22.4)	0.051
Diabetes (*n*, %)	192(4.9)	64(33.3)	53(27.6)	38(19.8)	37(19.3)	0.009
Heart disease (*n*, %)	523(13.4)	174(33.3)	103(19.7)	121(23.1)	125(23.9)	0.685
Cancer (*n*, %)	22(0.6)	6(27.3)	4(18.2)	9(40.9)	3(13.6)	0.299
Denture use						< 0.001
Yes (*n*, %)	1605(39.6)	252(15.7)	269(16.8)	382(23.8)	702(43.7)	
No (*n*, %)	2451(60.4)	1008(41.1)	517(21.1)	622(25.4)	304(12.4)	

Abbreviation: BMI, Body Mass Index; BADL, Basic Activities of Daily Living; DBP, Diastolic Blood Pressure; SBP, Systolic Blood Pressure;

Table 2 Multivariate cox regression model of the number of natural teeth, denture use and the risk of cognitive impairment

Models	Variables	Groups	HR (95% CI)	*p*-value
Model 1	Number of Natural Teeth	≥ 20	1(Ref.)	
		10–19	1.36(0.94, 1.98)	0.102
		1–9	2.52(1.64, 3.08)	< 0.001
		0	2.80(2.06, 3.80)	< 0.001
Model 2	Number of Natural Teeth	≥ 20	1(Ref.)	
		10–19	1.24(0.82, 1.80)	0.311
		1–9	1.78(1.25, 2.56)	< 0.001
		0	2.14(1.51, 3.03)	< 0.001
Model 1	Denture use	Yes	1(Ref.)	
		No	1.59(1.27, 1.99)	< 0.001
Model 2	Denture use	Yes	1(Ref.)	
		No	1.33(1.04, 1.70)	0.024

Abbreviation: *CI*, Confidence Intervals; *HR*, Hazard Ratio; Ref, Reference;

Model 1 was a crude model without adjustment for covariates

Model 2 was adjusted for sex, age(continuous), years of schooling(continuous), household income, marital status, residence, BMI, smoking, drinking, exercise, sleep duration, SBP, DBP, BADL ability, depression, hypertension, diabetes, heart disease, and cancer

Subgroup analyses

Subgroup analyses showed that the results were generally similar across different predefined strata (Supp Table 1). 0 teeth positively associated with the risk of cognitive impairment tended to be more evident among those with over 80 years of age (*HR*: 2.29, 95% *CI*: (1.35,3.90)) at greater risk of cognitive decline. We found that the number of teeth and age had interactive effects on cognitive impairment ($p_{-\text{interaction}}$=0.004).

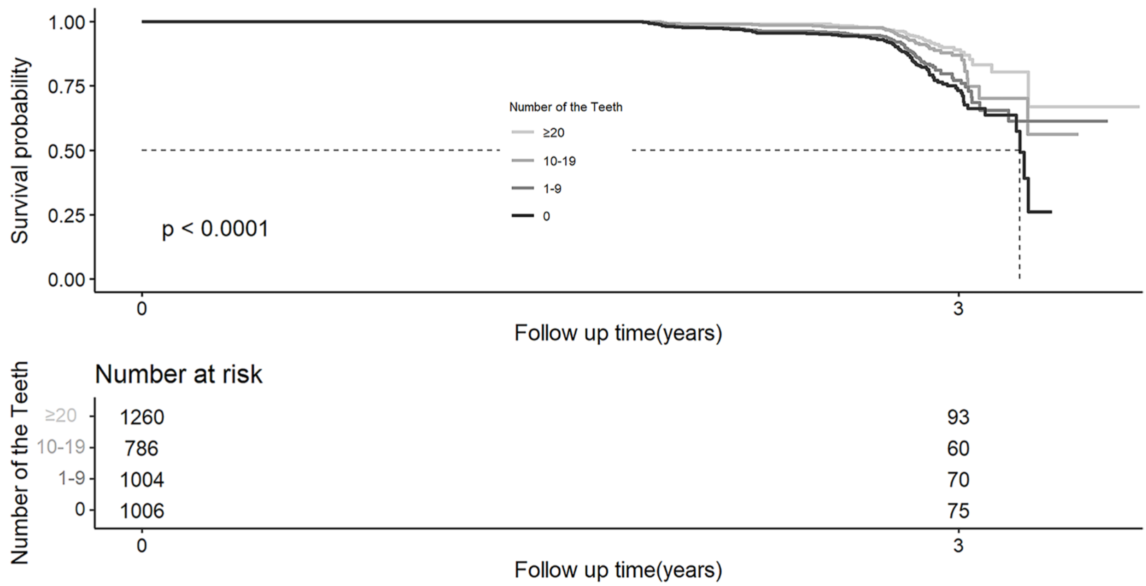

Fig. 1 K-M survival curve of the number of teeth and cognitive impairment

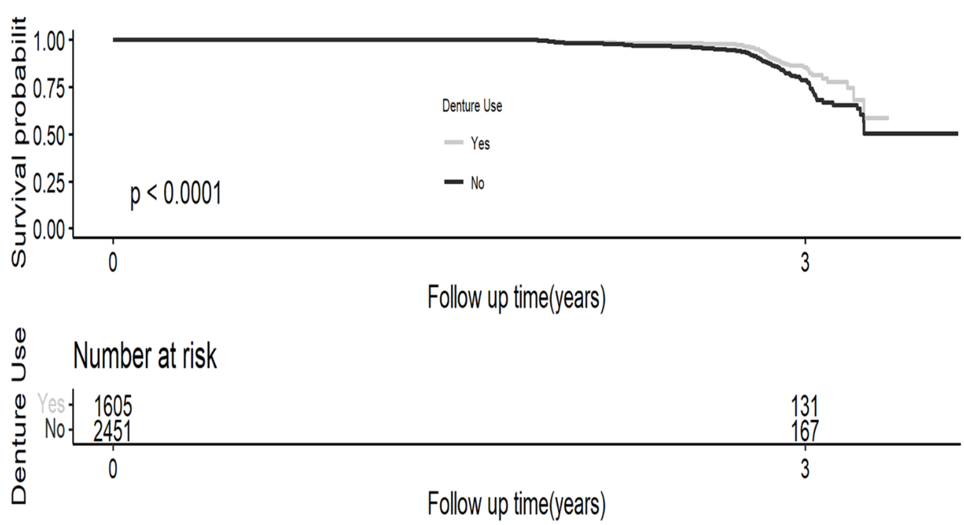

Fig. 2 K-M survival curve of denture use and cognitive impairment

Mediation effect analyses

Supp Fig. 1 shows that low body weight mediated 6.74% (95% *CI*: 3.49%, 11%) of tooth loss in relation to the risk of cognitive impairment.

Discussion

In our study, participants with increased tooth loss or without dentures had a higher risk of developing cognitive impairment. We also found that participants with 0 teeth and no dentures had a significantly increased risk of cognitive impairment compared with those with more than 20 teeth, regardless of whether they wore dentures. In stratified analyses, we observed that the association between tooth loss and cognitive impairment was modified by age. Low body weight partially mediates the association between tooth loss and cognitive impairment. Additionally, the use of dentures was associated with a reduced risk of cognitive impairment in participants with partial tooth loss. Our findings suggest that paying attention to and actively treating dental ill health, as well as addressing low body weight in older adults, have important implications for preventing and delaying cognitive decline.

Previous studies have examined the association between tooth loss, denture use, and the risk of cognitive impairment [21–23]. Hui Min Chen [24] et al. found through NHANES data analysis that moderate to severe tooth loss in older adults increases the risk of cognitive impairment, and high-density lipoprotein partially mediates the association (mediation percentage of 2.11%).

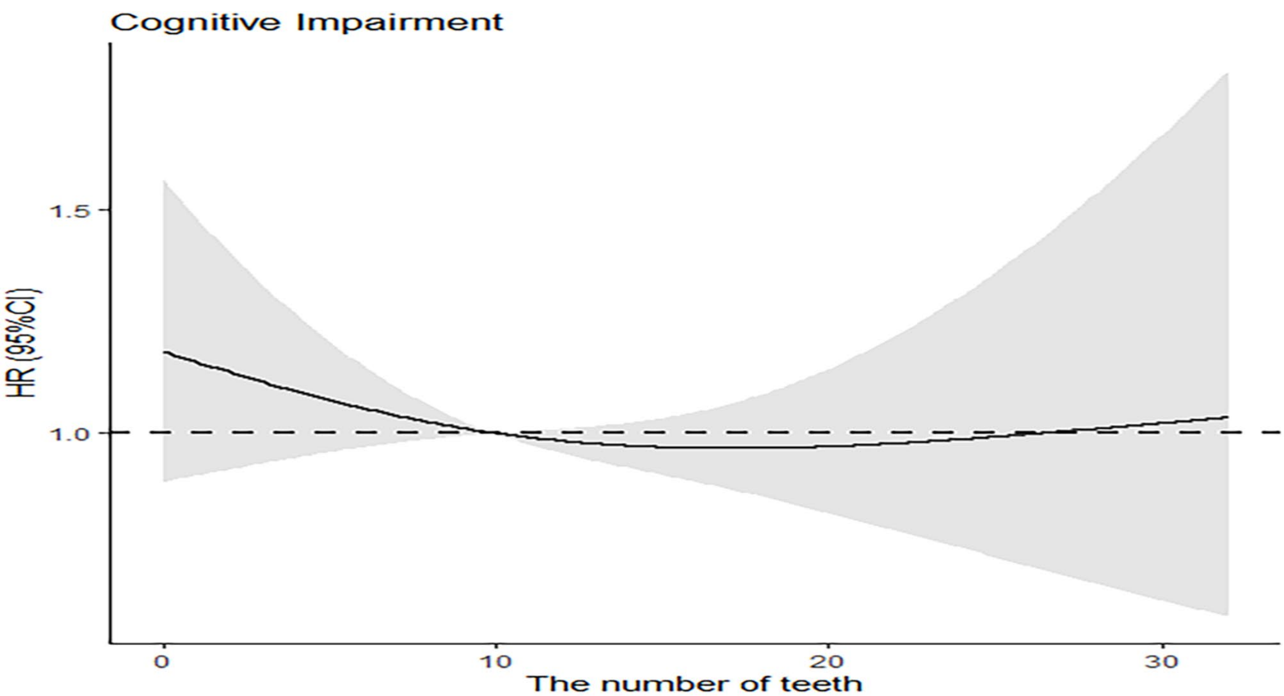

Fig. 3 RCS curve of the number of teeth and cognitive impairment

Table 3 The combined effects of tooth loss and denture use on incident cognitive impairment

Variables	Groups	HR (95% CI)	*p*-value
Number of Natural Teeth and Denture Use Status	≥ 20	1(Ref.)	
	10–19, with dentures	0.21(0.08, 0.60)	0.004
	10–19, without dentures	1.35(0.72, 2.55)	0.347
	1–9 with dentures	0.68(0.41, 1.12)	0.131
	1–9, without dentures	1.48(0.89, 2.67)	0.131
	0, with dentures	0.62(0.42, 0.91)	0.013
	0, without dentures	1.63(1.10, 2.41)	0.015

Abbreviation: *CI*, Confidence Intervals; *HR*, Hazard Ratio; Ref, Reference;

The Model has adjusted for sex, age(continuous), years of schooling(continuous), household income, marital status, residence, BMI, smoking, drinking, exercise, sleep duration, SBP, DBP, BADL ability, depression, hypertension, diabetes, heart disease, and cancer

Another study simulated the scenario where tooth loss in older adults emerges as a risk factor for severe cognitive impairment [25]. Our findings show an association between tooth loss, denture use, and cognitive impairment is consistent with previous research [26], supporting the validity of our results.

The mechanisms by which tooth loss, denture use is associated with cognitive impairment remain unknown. However, this association has been explored in animal experiments and human epidemiology [27, 28]. First, the role of oral inflammation and pathogenic oral bacteria such as porphyromonas gingivalis in neuroinflammatory processes and β-amyloid production has received increasing attention as a possible mechanism [29]. Periodontitis, a causative factor in tooth loss, also stimulates the release of inflammatory cytokines associated with the activation of molecules that contribute to the progression of dementia, such as C-reactive protein, tumor necrosis factor-alpha, immunoglobulin G, interleukin-1beta, and Interleukin-6 [30]. After dissemination into the blood, periodontitis pathogens and associated molecules may induce low-grade systemic inflammation by upregulating the release of cytokines and inflammatory mediators, thereby triggering neuroinflammation and causing neuronal degeneration [31, 32]. Second, tooth loss indicates nutrient deficiencies, which in turn result in the loss of nutrients critical to brain health [33]. Third, tooth loss may lead to decreased chewing function [34]. Chewing plays a key role in sending sensory information to the brain and maintaining learning and memory functions in the hippocampus [35]. Chewing dysfunction is thought to be associated with hippocampal morphological abnormalities and cognitive decline in older adults [36]. Although the use of dentures may not fully compensate for chewing function, it can mitigate the nutritional impact of reduced chewing by favoring food choice and nutrient intake. Results from animal model studies suggest that mastication-induced sensory stimuli decrease, and there are volume decreases in cortical brain regions involved in somatosensory, motor, cognitive, and emotional functions [27]. This leads to neurodegeneration, reduced neurogenesis, and ultimately cognitive decline in aged mice and rats. Taken together, these evidences suggest that tooth loss may be a risk factor for cognitive decline due to loss of sensory stimulation in cognition-related brain regions.

Notably, the percentage of low body weight mediated in tooth loss and cognitive impairment was 6.74%. The underlying mechanism is that tooth loss leads to chewing difficulties and subsequently poor nutrient intake in older adults [37]. People who are underweight may have inadequate intake and absorption of essential amino acids and vitamins [38]; this lead to a decrease in the hormone leptin, which may be accompanied by an increase in tau protein deposition, resulting in poor cognitive outcomes [39]. For instance, underweight participants were reported to chew more asymmetrically and more slowly than normal-weight or obese participants [40]. Previous research have also shown that low body weight increases the risk of cognitive impairment [41–43]. BMI is an important objective index that estimates the nutritional status of the older adults. Low body weight reflects adverse outcomes such as sarcopenia and decreased body fat mass, particularly in the older adults [44]. Another explanation is that low-weight individuals have more mobility difficulty [45], and this, in turn, increases the risk of cognitive impairment.

Subgroup analyses showed that association between number of natural teeth and cognitive impairment risk in older adults was modified by age. The impact of tooth loss on cognitive impairment was more pronounced in those aged 80 and older than in those aged 65–79. This may be due to structural degeneration of the brain from other causes and declining cognitive function with increased age.

The most important finding of this study is that the risk of cognitive decline due to tooth loss tends to be more pronounced in older adults who do not wear dentures. This is similar to the results of a 4-year prospective cohort study of 4425 Japanese adults [46]. The study showed that older adults with fewer teeth but no dentures had a higher risk of dementia compared with those with more than 20 teeth; the association was not significant among denture users with fewer teeth. We found that participants with 0 teeth but no dentures had a higher risk of cognitive impairment. In this regard, the possible explanation is that in the state of tooth loss and no denture protection, they have insufficient chewing efficiency and fundamental changes in their eating habits [47].

Strengths and limitations

The strength of our study is that the data are from a longitudinal cohort, providing stronger evidence than a cross-sectional design. Second, we explored the combined effect of tooth number and denture use on cognitive impairment in older adults. Third, we found that high-risk groups, particularly those who are 80 years of age and older and denture-free, had a more significant association between tooth loss and cognitive impairment risk. Finally, low body weight partially mediates the association between tooth loss and cognitive impairment. Of course, our study also has certain limitations. Our follow-up period was only 3 years, which may have limited our ability to fully capture long-term associations. Due to limitations in the original data, CLHLS did not assess the oral conditions of the older adults, such as periodontal disease. Meanwhile, the MMSE could only roughly screen cognitive function and did not include a formal measurement of functionality in the questionnaire. Finally, while there are many risk factors for cognitive impairment in older adults, our study focused solely on tooth loss and denture use, suggesting that future research should explore additional factors. The mediation effect of low body weight on this association is only 6.74%, indicating that the potential mechanism of cognitive impairment has not yet been fully explored. Moreover, the measure of cognitive function used (MMSE) and the adjustment of cut-offs based on educational status may not fully reflect actual changes in cognition over the study period.

Conclusion

Both tooth loss and no denture use are associated with an increased risk of developing cognitive impairment in Chinese older adults. Low body weight partially mediates the association between tooth loss and cognitive impairment. The use of dentures and enhanced nutritional support in the older people could reduce the risk of cognitive impairment caused by tooth loss.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-025-05750-x.

Supplementary Material 1

Acknowledgements

We thank the staff and the participants of the CLHLS study.

Author contributions

Z.G.Z and X.X.Y designed the study. contributed data. K. P performed the statistical analysis and wrote the manuscript. Z.X.L., N.WQ., Y.Z, Z.H.N, Y.J.Z, X.L.Y, J.X, participated in topics selection, research design, literature review, data analysis, etc. Z.G.Z and X.X.Y are P.K.'s postdoctoral co-supervisors and co-corresponding authors of the study. They play a decisive role in the selection of the topic and the final revision of the study, and are responsible for the authenticity of this article. All authors reviewed and edited the manuscript and approved of its submission is the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Funding
This study was supported by the National Natural Science Foundation of China (No. 82273631), Shenzhen Medical Research Fund (No.C2406002), Sanming Project of Medicine in Shenzhen (No. SZSM202311019), the Science and Technology Planning Project of Shenzhen City, Guangdong Province, China (No. KCXFZ20201221173600001), the Science and Technology Planning Project of Shenzhen City, Guangdong Province, China (No. JCYJ20220531094410024), and the Shenzhen Medical Key Discipline Construction Fund, Guangdong Province, China (No. SZXK065). The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Data availability
The CLHLS questionnaires and database are available at https://opendata.pku.edu.cn/dataverse/CHADS. The full datasets used in our analysis are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The CLHLS study was approved by The Biomedical Ethics Committee of Peking University (IRB00001052-13074), and written consent was obtained from all participants during the face-to-face interview.

Declaration of generative AI in scientific writing
Nothing to disclose.

Author statements
The material presented in our manuscript is original and has not been submitted for publication elsewhere.

Competing interests
The authors declare no competing interests.

Received: 27 October 2024 / Accepted: 3 February 2025
Published online: 18 February 2025

References
1. Ye P, Jin Y, Er Y, Duan L, Palagyi A, Fang L, Li B, Ivers R, Keay L, Tian M. A scoping review of National policies for healthy ageing in Mainland China from 2016 to 2020. Lancet Reg Health West Pac. 2021;12:100168.
2. Pérez Palmer N, Trejo Ortega B, Joshi P. Cognitive impairment in older adults: epidemiology, diagnosis, and treatment. Psychiatr Clin North Am. 2022;45(4):639–61.
3. Jia L, Du Y, Chu L, Zhang Z, Li F, Lyu D, Li Y, Li Y, Zhu M, Jiao H, et al. Prevalence, risk factors, and management of dementia and mild cognitive impairment in adults aged 60 years or older in China: a cross-sectional study. Lancet Public Health. 2020;5(12):e661–71.
4. Bradburn S, Murgatroyd C, Ray N. Neuroinflammation in mild cognitive impairment and Alzheimer's disease: a meta-analysis. Ageing Res Rev. 2019;50:1–8.
5. Jia L, Quan M, Fu Y, Zhao T, Li Y, Wei C, Tang Y, Qin Q, Wang F, Qiao Y, et al. Dementia in China: epidemiology, clinical management, and research advances. Lancet Neurol. 2020;19(1):81–92.
6. Nakamura T, Zou K, Shibuya Y, Michikawa M. Oral dysfunctions and cognitive impairment/dementia. J Neurosci Res. 2021;99(2):518–28.
7. Bitencourt FV, Corrêa HW, Toassi RFC. Tooth loss experiences in adult and elderly users of primary Health Care. Cien Saude Colet. 2019;24(1):169–80.
8. Qi L, Qian Y, Zhu F, Cao N, Lu H, Zhang L. Association between periodontal disease and tooth loss and mortality in an elderly Chinese population. Aging Clin Exp Res. 2020;32(11):2375–82.
9. Åstrøm AN, Mastrovito B, Sannevik J, Tsakos G. Role of behavioural and age-related factors in the long-term impact of tooth loss on oral health-related quality of life: a 25-year follow-up of Swedish older adults. Community Dent Oral Epidemiol. 2023;51(5):918–26.
10. Qi X, Zhu Z, Plassman BL, Wu B. Dose-response Meta-analysis on tooth loss with the risk of cognitive impairment and dementia. J Am Med Dir Assoc. 2021;22(10):2039–45.
11. Hansson P, Eriksson Sörman D, Bergdahl J, Bergdahl M, Nyberg L, Adolfsson R, Nilsson LG. Dental status is unrelated to risk of dementia: a 20-year prospective study. J Am Geriatr Soc. 2014;62(5):979–81.
12. Shimazaki Y, Soh I, Saito T, Yamashita Y, Koga T, Miyazaki H, Takehara T. Influence of dentition status on physical disability, mental impairment, and mortality in institutionalized elderly people. J Dent Res. 2001;80(1):340–5.
13. Winter JE, MacInnis RJ, Wattanapenpaiboon N, Nowson CA. BMI and all-cause mortality in older adults: a meta-analysis. Am J Clin Nutr. 2014;99(4):875–90.
14. Zhao D, Luo J, Li J, Gao T, Fu P, Wang Y, Zhou C. Tooth loss, body mass index and cognitive function among middle-aged and older adults in China: does gender matter? J Affect Disord. 2023;333:517–23.
15. Zhang J, Xu G, Xu L. Number of Teeth and Denture Use are Associated with Frailty among Chinese older adults: a Cohort Study based on the CLHLS from 2008 to 2018. J Nutr Health Aging. 2023;27(11):972–9.
16. Yang HL, Li FR, Chen PL, Cheng X, Mao C, Wu XB. Tooth loss, denture use, and cognitive impairment in Chinese older adults: A Community Cohort Study. J Gerontol Biol Sci Med Sci. 2022;77(1):180–7.
17. Lv Y, Zhang Y, Li X, Gao X, Ren Y, Deng L, Xu L, Zhou J, Wu B, Wei Y, et al. Body mass index, waist circumference, and mortality in subjects older than 80 years: a mendelian randomization study. Eur Heart J. 2024;45(24):2145–54.
18. Chen C, Lu FC. The guidelines for prevention and control of overweight and obesity in Chinese adults. Biomed Environ Sci. 2004;17 Suppl:1–36.
19. Jin X, He W, Zhang Y, Gong E, Niu Z, Ji J, Li Y, Zeng Y, Yan LL. Association of APOE ε4 genotype and lifestyle with cognitive function among Chinese adults aged 80 years and older: a cross-sectional study. PLoS Med. 2021;18(6):e1003597.
20. Xu S, Huang X, Gong Y, Sun J. Association between tooth loss rate and risk of mild cognitive impairment in older adults: a population-based longitudinal study. Aging. 2021;13(17):21599–609.
21. Saito S, Ohi T, Murakami T, Komiyama T, Miyoshi Y, Endo K, Satoh M, Asayama K, Inoue R, Kikuya M, et al. Association between tooth loss and cognitive impairment in community-dwelling older Japanese adults: a 4-year prospective cohort study from the Ohasama study. BMC Oral Health. 2018;18(1):142.
22. Taslima F, Jung CG, Zhou C, Abdelhamid M, Abdullah M, Goto T, Saito T, Saido TC, Michikawa M. Tooth loss induces memory impairment and Gliosis in App Knock-In mouse models of Alzheimer's Disease. J Alzheimers Dis. 2021;80(4):1687–704.
23. Suma S, Furuta M, Takeuchi K, Tomioka M, Iwasa Y, Yamashita Y. Number of teeth, denture wearing and cognitive function in relation to nutritional status in residents of nursing homes. Gerodontology. 2022;39(2):197–203.
24. Chen HM, Li KY, Li TL, Kwong E, Wong GHY, McGrath C, Chen H. The association between tooth loss and cognitive decline in the aged population: the mediating role of HDL-cholesterol. J Dent. 2023;135:104570.
25. Kiuchi S, Cooray U, Aida J, Osaka K, Chan A, Malhotra R, Peres MA. Effect of tooth loss on cognitive function among older adults in Singapore. J Dent Res. 2023;102(8):871–8.
26. Li J, Xu H, Pan W, Wu B. Association between tooth loss and cognitive decline: a 13-year longitudinal study of Chinese older adults. PLoS ONE. 2017;12(2):e0171404.
27. Luo B, Pang Q, Jiang Q. Tooth loss causes spatial cognitive impairment in rats through decreased cerebral blood flow and increased glutamate. Arch Oral Biol. 2019;102:225–30.
28. Peres MA, Bastos JL, Watt RG, Xavier AJ, Barbato PR, D'Orsi E. Tooth loss is associated with severe cognitive impairment among older people: findings from a population-based study in Brazil. Aging Ment Health. 2015;19(10):876–84.
29. Leira Y, Iglesias-Rey R, Gómez-Lado N, Aguiar P, Campos F, D'Aiuto F, Castillo J, Blanco J, Sobrino T. Porphyromonas gingivalis lipopolysaccharide-induced periodontitis and serum amyloid-beta peptides. Arch Oral Biol. 2019;99:120–5.
30. Gil Montoya JA, Barrios R, Sanchez-Lara I, Ramos P, Carnero C, Fornieles F, Montes J, Santana S, Luna JD, Gonzalez-Moles MA. Systemic inflammatory impact of periodontitis on cognitive impairment. Gerodontology. 2020;37(1):11–8.
31. Gil-Montoya JA, Sanchez-Lara I, Carnero-Pardo C, Fornieles F, Montes J, Vilchez R, Burgos JS, Gonzalez-Moles MA, Barrios R, Bravo M. Is periodontitis a risk factor for cognitive impairment and dementia? A case-control study. J Periodontol. 2015;86(2):244–53.

32. Li A, Du M, Chen Y, Marks LAM, Visser A, Xu S, Tjakkes GE. Periodontitis and cognitive impairment in older adults: the mediating role of mitochondrial dysfunction. J Periodontol 2022.
33. Kossioni AE. The Association of Poor Oral Health Parameters with malnutrition in older adults: a review considering the potential implications for cognitive impairment. Nutrients. 2018. 10(11).
34. Bortoluzzi MC, Traebert J, Lasta R, Da Rosa TN, Capella DL, Presta AA. Tooth loss, chewing ability and quality of life. Contemp Clin Dent. 2012;3(4):393–7.
35. Tramonti Fantozzi MP, De Cicco V, De Cicco D, d'Ascanio P, Cataldo E, Bruschini L, Faraguna U, Manzoni D. Chewing and cognitive improvement: the side matters. Front Syst Neurosci. 2021;15:749444.
36. Jockusch J, Hopfenmüller W, Nitschke I. Chewing function and related parameters as a function of the degree of dementia: is there a link between the brain and the mouth? J Oral Rehabil. 2021;48(10):1160–72.
37. Jung SH, Ryu JI, Jung DB. Association of total tooth loss with socio-behavioural health indicators in Korean elderly. J Oral Rehabil. 2011;38(7):517–24.
38. Ter Borg S, Luiking YC, van Helvoort A, Boirie Y, Schols J, de Groot C. Low levels of branched chain amino acids, eicosapentaenoic acid and micronutrients are Associated with low muscle Mass, strength and function in Community-Dwelling older adults. J Nutr Health Aging. 2019;23(1):27–34.
39. Gustafson DR. Adiposity and cognitive decline: underlying mechanisms. J Alzheimers Dis. 2012;30(Suppl 2):S97–112.
40. Flores-Orozco EI, Tiznado-Orozco GE, Osuna-González OD, Amaro-Navarrete CL, Rovira-Lastra B, Martinez-Gomis J. Lack of relationship between masticatory performance and nutritional status in adults with natural dentition. Arch Oral Biol. 2016;71:117–21.
41. Dong W, Kan L, Zhang X, Li M, Wang M, Cao Y. Association between body mass index and cognitive impairment in Chinese older adults. Front Public Health. 2023;11:1255101.
42. Lou Y, Jiang Q, Huang S, Xie Y, Wang H, Wang L, Wang S, Xu M, Lu Z, Cao S. Association of dietary diversity and weight change with cognitive impairment among Chinese elderly: a prospective national cohort study. J Affect Disord. 2024.
43. Ren Z, Li Y, Li X, Shi H, Zhao H, He M, Zha S, Qiao S, Pu Y, Liu H, 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 Affect Disord. 2021;295:463–70.
44. Schneider SM, Correia M. Epidemiology of weight loss, malnutrition and sarcopenia: a transatlantic view. Nutrition. 2020;69:110581.
45. Yang M, Hao Q, Luo L, Ding X, Wu H, Zhang Y, Dong B. Body mass index and disability in Chinese nonagenarians and centenarians. J Am Med Dir Assoc. 2014;15(4):e303301–306.
46. Yamamoto T, Kondo K, Hirai H, Nakade M, Aida J, Hirata Y. Association between self-reported dental health status and onset of dementia: a 4-year prospective cohort study of older Japanese adults from the Aichi Gerontological Evaluation Study (AGES) project. Psychosom Med. 2012;74(3):241–8.
47. Kossioni A, Bellou O. Eating habits in older people in Greece: the role of age, dental status and chewing difficulties. Arch Gerontol Geriatr. 2011;52(2):197–201.

Publisher's note