Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Oral pain, but not number of natural teeth, is associated with anxiety symptoms in older Chinese adults: a cross-sectional study of two national survey waves

Hanbo Tao
King's College London
Haoxiong Sun
University College London
Yunting Xue
Hangzhou Medical College
Zaozao Zhu
Xingfeng Dental Clinic
Zhuoming Huang
Hangzhou Medical College
Ting Hu
Hangzhou Medical College
Shuwen Zheng
Hangzhou Medical College
Wenfei Hu
2006036013@hmc.edu.cn

Hangzhou Medical College

Research Article

Keywords: Oral pain, Toothache, Orofacial pain, Anxiety, Tooth loss, Older adults, Oldest-old, China, Chinese Longitudinal Healthy Longevity Survey

Posted Date: November 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11614912/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Anxiety symptoms are common but under-recognized in older adults. Most studies of oral health and mental health have used structural measures such as the number of natural teeth, which track age, frailty, and socioeconomic position. Oral pain is the symptomatic dimension of oral health, but few data exist for the oldest-old. We compared the associations of oral pain and number of natural teeth with anxiety symptoms, and examined pain intensity, edentulous adults, and change in pain status.

Methods

We analyzed the 2018 (n = 10,858) and 2021 (n = 6,793) waves of the Chinese Longitudinal Healthy Longevity Survey, which oversamples adults aged 80 years and older. Oral pain was defined as toothache when eating or cheek or jaw pain in the preceding 6 months; toothache intensity was rated 1 to 10. Anxiety symptoms were defined as a Generalized Anxiety Disorder-7 score of ≥ 5. Logistic regression models included both exposures and adjusted for sociodemographic, economic, lifestyle, health, and functional factors. Change in oral pain status was examined among 3,853 participants in both waves.

Results

Oral pain was reported by 18.7% of participants in 2018 and 24.3% in 2021. In fully adjusted models, oral pain was associated with anxiety symptoms (odds ratio [OR] 1.64, 95% confidence interval [CI] 1.42–1.90; OR 1.87, 95% CI 1.61–2.18), whereas having fewer than 20 natural teeth was not (OR 1.04, 95% CI 0.88–1.21; OR 1.16, 95% CI 0.98–1.37). The odds of anxiety symptoms increased with toothache intensity (P for trend < 0.001). Among edentulous participants, cheek or jaw pain was associated with anxiety symptoms (OR 1.81 and 2.49). Compared with participants never reporting oral pain, those with remitted pain had no excess odds of anxiety symptoms (OR 0.92), whereas those with incident (OR 1.93) or persistent pain (OR 1.83) did.

Conclusions

Oral pain, particularly when current and severe, is associated with anxiety symptoms in older Chinese adults, whereas the number of natural teeth is not after adjustment for health and function. Oral pain warrants attention in mental health assessments of older adults, and anxiety in their dental care.

Background

Anxiety symptoms are common in later life, and anxiety disorders affect about one in six community-dwelling older adults [1, 2], yet anxiety in this population has received far less research attention than

depression [1, 3]. Late-life anxiety is associated with sleep disturbance, functional decline, and increased health service use, and it frequently co-occurs with depression but is less often recognized or treated [2, 3]. Identifying modifiable factors associated with anxiety in older adults therefore has public health relevance.

Oral health is one such candidate. Poor oral health has been linked to depression, cognitive decline, and lower quality of life in older adults [4], but pooled evidence on anxiety is sparser and largely restricted to oral health-related quality of life rather than symptomatic measures [5]. Most studies of oral health and mental health in older adults, including those using the Chinese Longitudinal Healthy Longevity Survey (CLHLS), have relied on structural or behavioral measures such as the number of natural teeth, denture use, or toothbrushing [6, 7]. These measures are informative but difficult to interpret. Tooth loss accumulates over the life course and is closely related to age, frailty, and socioeconomic position [8, 9], so its associations with psychological outcomes are hard to separate from those of general health and earlier disadvantage.

Oral pain is the symptomatic dimension of oral health and may bear more directly on mental health. Pain can interfere with eating, sleep, and social interaction, and under biopsychosocial models of pain, persistent or severe pain is a recognized source of worry and emotional distress [10]. The relationship is likely bidirectional, because anxiety also heightens pain perception and reporting [11]. Unlike the number of natural teeth (hereafter tooth count), which can only decline, oral pain can both begin and remit, which allows the association to be examined in relation to its onset, persistence, and remission. Cheek or jaw pain can also occur in people without natural teeth, so pain captures a dimension of oral health that tooth count cannot.

Few data are available on oral pain among the oldest-old. Oral and facial pain is reported less often by older than by younger adults [12], which may reflect lower prevalence, under-reporting, or reduced clinical attention, and pain intensity has rarely been measured in population studies. China has the largest older population in the world [13], tooth loss is highly prevalent among older adults [14], and only about one in five older adults uses dental services in a given year [15]. The CLHLS oversamples adults aged 80 years and older and collects data on oral pain, pain intensity, dentition, and anxiety symptoms, so it can address these questions. To our knowledge, no study has compared symptomatic and structural measures of oral health in relation to anxiety symptoms, or examined whether changes in oral pain status are associated with anxiety.

We therefore used two national waves of the CLHLS to compare the associations of oral pain and the number of natural teeth with anxiety symptoms in adults aged 65 years and older. We also examined pain intensity, oral pain among edentulous participants, and changes in oral pain status between waves. We hypothesized that oral pain would be associated with anxiety symptoms independently of the number of natural teeth, with a dose–response relationship by intensity, and that current rather than past oral pain would be associated with anxiety.

Methods

Data source and study population

This study used data from the CLHLS, a community-based longitudinal survey of older adults in China. The survey began in 1998 in randomly selected counties and cities in 22 provinces, oversamples the oldest-old, and collects data through face-to-face interviews conducted in participants' homes by trained interviewers [16].

We analyzed the 2018 (eighth) and 2021 (ninth) waves as two cross-sectional samples. Participants interviewed in both waves were linked by their unique identifier for a longitudinal sub-analysis. The 2018 wave covered 23 provinces. In 2021, the survey was extended to four provinces not previously sampled (Guizhou, Yunnan, Gansu, and Ningxia), and Hainan was not included.

The 2018 and 2021 waves included 15,874 and 9,720 participants, respectively. In 2018, we excluded 103 participants younger than 65 years; no participant in 2021 was younger than 65 years. We then excluded participants with missing data on oral pain (673 in 2018 and 261 in 2021), number of natural teeth (203 and 857), anxiety symptoms (1,254 and 1,560), or covariates (2,783 and 249; Table S5). The final analytic samples comprised 10,858 participants in 2018 and 6,793 in 2021 (Fig. 1).

The CLHLS was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-13074), and all participants or their legal representatives provided written informed consent. This analysis used de-identified data and is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline [17].

Assessment of oral pain and dentition

The oral health and anxiety items were identical in the 2018 and 2021 waves. Oral pain in the preceding 6 months was assessed with two yes/no questions: whether participants had experienced toothache when eating more than once, and whether they had experienced cheek or jaw pain more than once. Oral pain was defined as a positive response to either question. Participants who reported toothache rated the intensity of their most severe episode from 1 to 10, with higher scores indicating more severe pain. Participants without toothache were assigned a score of 0, and intensity was categorized as 0, 1–3, 4–6, and 7–10.

Participants reported the number of natural teeth they had, excluding dentures. Dentition was classified as fewer than 20 or at least 20 natural teeth, a threshold commonly used to define functional dentition [18], and participants with no natural teeth were classified as edentulous.

Assessment of anxiety symptoms

Anxiety symptoms were assessed with the Chinese version of the 7-item Generalized Anxiety Disorder scale (GAD-7) [19, 20]. Participants reported how often in the past 2 weeks they had been bothered by feeling nervous, being unable to stop worrying, worrying too much, having trouble relaxing, being restless, being irritable, and feeling afraid that something awful might happen. Each item is scored from 0 (not at all) to 3 (nearly every day), giving a total score of 0 to 21. A score of ≥ 5, the threshold for at least mild anxiety, was used to define anxiety symptoms [19], and a score of ≥ 10 was used in a sensitivity analysis. The questionnaire requires participants to answer this section themselves, without a proxy. No item asks about pain or physical illness.

Covariates

Covariates were selected a priori as factors related to both oral health and anxiety. Sociodemographic factors included age, sex, place of residence (city, town, or rural area), years of schooling (none, 1–6, or ≥ 7), marital status (married and living with a spouse, or not), and living arrangement (with household members, alone, or in an institution). Because years of schooling were not asked again of participants followed up from earlier waves, the most recent value recorded in a previous wave was used for these participants. Economic factors included whether financial support was sufficient for daily expenses and whether the participant received any pension, defined as a retirement pension or public old-age insurance. Lifestyle factors included current smoking and current drinking.

Health and functional factors included disability in activities of daily living (ADL), limitations in instrumental activities of daily living (IADL), self-rated health, and chronic conditions. ADL disability was defined as needing help with any of bathing, dressing, toileting, indoor transferring, continence, or feeding [21]. IADL limitations were counted across eight activities adapted from the Lawton scale [22]. Self-rated health was categorized as good, fair, or poor. The number of six self-reported chronic conditions (hypertension, diabetes, heart disease, stroke or cerebrovascular disease, chronic lung disease, and arthritis) was categorized as 0, 1, or ≥ 2 and treated as missing if fewer than four conditions were answered.

Statistical analysis

Participant characteristics were summarized by oral pain status within each wave as mean (standard deviation [SD]) or number (%) and compared using t tests and chi-square tests.

Logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for anxiety symptoms separately in each wave, and all models were fitted in the same analytic sample. Model 1 was adjusted for age, sex, place of residence, and education. Model 2 was further adjusted for marital status, living arrangement, smoking, drinking, financial sufficiency, pension, ADL disability, IADL limitations, self-rated health, and chronic conditions. Oral pain and number of natural teeth were entered in separate models in Models 1 and 2 and together in Model 3.

Toothache and cheek or jaw pain were modeled separately and then together. Toothache intensity was modeled as a categorical variable, with a score of 0 as the reference, and as a continuous variable per 1-point increase. P for trend was obtained by entering the intensity categories as an ordinal variable. We repeated the analysis of cheek or jaw pain among edentulous participants, who cannot report toothache, and the analysis of any oral pain among dentate participants (those with at least one natural tooth). Effect modification by age group (65–79, 80–89, and ≥ 90 years), sex, and place of residence was assessed using likelihood ratio tests.

To assess whether the association reflected a general tendency to report adverse experiences, we fitted the same model with four negative control exposures (three in 2021): a fall in the past year, self-reported hearing difficulty, serious illness in the past 2 years (2018 only), and interviewer-assessed visual impairment, defined as being unable to see or to distinguish the break in a circle shown by the interviewer. Each negative control exposure was entered alone and then together with oral pain.

The longitudinal sub-analysis included participants interviewed in both waves who had no anxiety symptoms in 2018 and complete data on oral pain in both waves, anxiety symptoms in 2021, and covariates in 2018. Following previous analyses of change in exposure status over time [23, 24], participants were classified by oral pain status as never (no pain in either wave), remitted (pain in 2018 only), incident (pain in 2021 only), or persistent (pain in both waves). ORs for anxiety symptoms in 2021 were estimated with the never group as the reference and adjusted for Model 2 covariates measured in 2018.

Five sensitivity analyses were performed: (1) anxiety symptoms were defined as a GAD-7 score of ≥ 10; (2) the GAD-7 total score was analyzed as a continuous outcome using linear regression; (3) participants in 2021 whose oral pain items were answered by a proxy were excluded; (4) missing covariates were handled by multiple imputation by chained equations, using predictive mean matching with 10 imputed datasets combined by Rubin's rules; and (5) survey sampling weights were applied. Included and excluded participants were compared to assess selection into the analytic sample. E-values were calculated to quantify the minimum strength of association that an unmeasured confounder would need to have with both oral pain and anxiety symptoms to explain away the main estimates [25]; because anxiety symptoms were common, ORs were converted to approximate risk ratios by taking their square root when the outcome prevalence exceeded 15% [25].

All analyses were performed using R version 4.5.0. A two-sided $P < 0.05$ was considered statistically significant.

Results

Characteristics of participants

The analytic samples included 10,858 participants in 2018 (mean age 84.1 years [SD 11.3]; 54.0% women) and 6,793 participants in 2021 (mean age 82.3 years [SD 9.9]; 51.5% women) (Fig. 1). Oral pain

was reported by 18.7% of participants in 2018 and 24.3% in 2021. Toothache when eating was reported by 16.9% and 22.2% of participants, and cheek or jaw pain by 8.1% and 10.0%, respectively. Among participants with toothache, the mean pain intensity was 4.5 (SD 2.2) in 2018 and 4.8 (SD 2.5) in 2021, and 21.4% and 25.5% rated their pain as 7 or higher. The prevalence of anxiety symptoms was 11.4% in 2018 and 16.4% in 2021.

Table 1 shows participant characteristics by oral pain status. In both waves, participants with oral pain were younger, more likely to be married and living with a spouse, and had more years of schooling than those without oral pain. They were also less likely to have ADL disability, had fewer IADL limitations, and were less likely to have fewer than 20 natural teeth or to be edentulous. However, they more often reported poor self-rated health, two or more chronic conditions, and insufficient financial support. Anxiety symptoms were more common among participants with oral pain than among those without (18.1% vs. 9.9% in 2018; 25.9% vs. 13.4% in 2021).

Table 1
Characteristics of participants by oral pain status in the 2018 and 2021 waves

Characteristic	2018			2021		
	No oral pain (n = 8,832)	Oral pain (n = 2,026)	P	No oral pain (n = 5,140)	Oral pain (n = 1,653)	P
Age, years, mean (SD)	85.0 (11.3)	79.9 (10.2)	< 0.001	83.2 (10.1)	79.7 (8.9)	< 0.001
Aged ≥ 90 years, %	38.5	19.3	< 0.001	26.6	13.6	< 0.001
Women, %	53.9	54.3	0.76	50.8	53.5	0.06
Place of residence, %			< 0.001			0.001
City	22.6	25.3		24.9	26.9	
Town	32.2	34.9		43.6	46.3	
Rural	45.3	39.8		31.6	26.8	
Years of schooling, %			< 0.001			0.02
None	47.5	38.6		44.3	40.3	
1–6	33.3	37.2		34.5	36.8	
≥ 7	19.2	24.2		21.2	22.9	
Married and living with spouse, %	41.0	53.1	< 0.001	46.8	55.2	< 0.001
Living arrangement, %			0.17			0.03
With household members	80.5	79.9		79.4	80.8	
Alone	16.3	17.5		18.7	18.2	
In an institution	3.2	2.6		1.9	1.0	
Current smoking, %	15.7	17.0	0.16	20.0	17.0	0.009
Current drinking, %	15.3	16.4	0.19	15.6	14.3	0.23
ADL disability, %	22.0	15.6	< 0.001	18.8	16.3	0.03

P values from t tests for continuous variables and chi-square tests for categorical variables.

ADL, activities of daily living; GAD-7, 7-item Generalized Anxiety Disorder scale; IADL, instrumental activities of daily living; SD, standard deviation.

Characteristic	2018			2021		
	No oral pain (n = 8,832)	Oral pain (n = 2,026)	P	No oral pain (n = 5,140)	Oral pain (n = 1,653)	P
IADL limitations, mean (SD)	3.1 (3.2)	2.4 (2.8)	< 0.001	2.7 (2.9)	2.4 (2.7)	< 0.001
Self-rated health, %			< 0.001			< 0.001
Good	50.0	39.8		53.5	37.9	
Fair	37.5	39.7		34.5	39.5	
Poor	12.5	20.4		12.0	22.6	
Financial support sufficient, %	88.2	81.3	< 0.001	89.8	82.0	< 0.001
Any pension, %	52.5	60.1	< 0.001	74.9	77.4	0.04
Chronic conditions, %			< 0.001			< 0.001
0	42.2	29.4		38.3	23.4	
1	33.2	33.8		34.5	31.5	
≥ 2	24.6	36.8		27.2	45.1	
Fewer than 20 natural teeth, %	75.2	63.7	< 0.001	72.2	66.0	< 0.001
Edentulous, %	34.5	13.4	< 0.001	29.6	12.9	< 0.001
Denture use, %	39.7	41.0	0.30	43.9	45.4	0.31
GAD-7 score, mean (SD)	1.2 (2.5)	2.1 (3.3)	< 0.001	1.5 (2.9)	2.7 (3.9)	< 0.001
Anxiety symptoms (GAD-7 ≥ 5), %	9.9	18.1	< 0.001	13.4	25.9	< 0.001
P values from t tests for continuous variables and chi-square tests for categorical variables.						
ADL, activities of daily living; GAD-7, 7-item Generalized Anxiety Disorder scale; IADL, instrumental activities of daily living; SD, standard deviation.						

Compared with included participants, those excluded because of missing covariate data were older, more often women, more likely to have fewer than 20 natural teeth, and more likely to have anxiety symptoms (Table S1).

Oral pain, number of natural teeth, and anxiety symptoms

Table 2 shows the associations of oral pain and number of natural teeth with anxiety symptoms. In the fully adjusted model including both exposures (Model 3), oral pain was associated with higher odds of anxiety symptoms in 2018 (OR = 1.64, 95% CI: 1.42–1.90) and 2021 (OR = 1.87, 95% CI: 1.61–2.18). In the same model, having fewer than 20 natural teeth was not associated with anxiety symptoms in 2018 (OR = 1.04, 95% CI: 0.88–1.21) or 2021 (OR = 1.16, 95% CI: 0.98–1.37).

Table 2
Associations of oral pain and number of natural teeth with anxiety symptoms

Exposure	2018			2021		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Oral pain	2.00 (1.75–2.29)	1.64 (1.42–1.90)	1.64 (1.42–1.90)	2.24 (1.95–2.58)	1.87 (1.61–2.17)	1.87 (1.61–2.18)
Fewer than 20 natural teeth	1.15 (0.99–1.33)	1.02 (0.87–1.19)	1.04 (0.88–1.21)	1.30 (1.11–1.53)	1.14 (0.96–1.34)	1.16 (0.98–1.37)

Odds ratios (95% confidence intervals [CIs]) from logistic regression models fitted in the same analytic sample within each wave (n = 10,858 in 2018 and 6,793 in 2021). Model 1: age, sex, place of residence and education. Model 2: Model 1 plus marital status, living arrangement, smoking, drinking, financial sufficiency, pension, ADL disability, IADL limitations, self-rated health and chronic conditions. Models 1 and 2 were fitted separately for each exposure. Model 3: Model 2 with both exposures entered together. References: no oral pain; 20 or more natural teeth.

ADL, activities of daily living; CI, confidence interval; IADL, instrumental activities of daily living; OR, odds ratio.

Both associations were attenuated after adjustment for health and functional covariates. From Model 1 to Model 2, the OR for oral pain decreased from 2.00 to 1.64 in 2018 and from 2.24 to 1.87 in 2021. The OR for fewer than 20 natural teeth decreased from 1.15 (95% CI: 0.99–1.33) to 1.02 in 2018 and from 1.30 (95% CI: 1.11–1.53) to 1.14 in 2021. Adding the other exposure in Model 3 did not materially change either estimate.

Dimensions and intensity of oral pain

Toothache and cheek or jaw pain were each associated with anxiety symptoms, and both associations persisted after mutual adjustment (Table 3). The odds of anxiety symptoms increased with toothache intensity. Compared with participants without toothache, the ORs for intensity scores of 1–3, 4–6, and 7–10 were 1.50, 1.64, and 2.21 in 2018 and 1.53, 1.92, and 2.11 in 2021 (P for trend < 0.001 in both waves). Each 1-point increase in intensity was associated with an OR of 1.10 (95% CI: 1.07–1.13) in both waves.

Table 3
Dimensions and intensity of oral pain and anxiety symptoms

Exposure	2018 OR (95% CI)	2021 OR (95% CI)
Separate models		
Toothache when eating	1.68 (1.45–1.96)	1.77 (1.51–2.06)
Cheek or jaw pain	1.91 (1.59–2.30)	1.96 (1.62–2.38)
Mutually adjusted		
Toothache	1.44 (1.21–1.71)	1.51 (1.26–1.80)
Cheek or jaw pain	1.52 (1.23–1.89)	1.55 (1.25–1.93)
Toothache intensity		
0 (reference)	1.00 (reference)	1.00 (reference)
1–3	1.50 (1.20–1.89)	1.53 (1.21–1.94)
4–6	1.64 (1.31–2.05)	1.92 (1.52–2.42)
7–10	2.21 (1.69–2.88)	2.11 (1.62–2.74)
P for trend	< 0.001	< 0.001
Per 1-point increase	1.10 (1.07–1.13)	1.10 (1.07–1.13)
Subgroups		
Edentulous participants: cheek or jaw pain	1.81 (1.18–2.78)	2.49 (1.61–3.84)
Dentate participants: any oral pain	1.63 (1.39–1.92)	1.89 (1.59–2.23)

Odds ratios (95% CIs) from logistic regression. Toothache and cheek or jaw pain were entered separately ("Separate models") and then together ("Mutually adjusted"). All estimates were adjusted for Model 2 covariates and number of natural teeth. The edentulous and dentate subgroup analyses were adjusted for Model 2 covariates (n = 3,314 and 7,540 in 2018; 1,737 and 5,056 in 2021).

CI, confidence interval; OR, odds ratio.

Among edentulous participants, cheek or jaw pain was associated with anxiety symptoms in 2018 (OR = 1.81, 95% CI: 1.18–2.78; n = 3,314) and 2021 (OR = 2.49, 95% CI: 1.61–3.84; n = 1,737). Among dentate participants, the ORs for any oral pain were 1.63 (95% CI: 1.39–1.92) in 2018 and 1.89 (95% CI: 1.59–2.23) in 2021.

Change in oral pain status and anxiety symptoms

Of the 7,199 participants interviewed in both waves, 3,853 were included in the longitudinal sub-analysis (Fig. 1; Table 4). In 2021, anxiety symptoms were present in 11.8% of participants without oral pain in either wave, 11.9% of those with remitted pain, 20.3% of those with incident pain, and 21.3% of those

with persistent pain. Compared with the never group, the adjusted ORs were 0.92 (95% CI: 0.68–1.24) for remitted pain, 1.93 (95% CI: 1.51–2.46) for incident pain, and 1.83 (95% CI: 1.34–2.48) for persistent pain.

Table 4
Change in oral pain status between 2018 and 2021 and anxiety symptoms in 2021

Oral pain status	n	Anxiety symptoms in 2021, n (%)	Adjusted OR (95% CI)
Never (no oral pain in either wave)	2,377	280 (11.8)	1.00 (reference)
Remitted (oral pain in 2018 only)	538	64 (11.9)	0.92 (0.68–1.24)
Incident (oral pain in 2021 only)	610	124 (20.3)	1.93 (1.51–2.46)
Persistent (oral pain in both waves)	328	70 (21.3)	1.83 (1.34–2.48)
Participants interviewed in both waves without anxiety symptoms in 2018 and with complete data on oral pain in both waves, anxiety symptoms in 2021 and covariates in 2018 (n = 3,853). Adjusted for Model 2 covariates measured in 2018.			
CI, confidence interval; OR, odds ratio.			

Subgroup, negative control, and sensitivity analyses

The association between oral pain and anxiety symptoms did not differ by age group (P for interaction = 0.89 in 2018 and 0.53 in 2021) or sex (P for interaction = 0.32 and 0.71) (Table S2). Place of residence did not modify the association in 2018 (P for interaction = 0.11) but did in 2021 (P for interaction = 0.01), with ORs of 1.40 in cities, 2.19 in towns, and 1.75 in rural areas. In both waves, the ORs were above 1 in every stratum.

In the negative control analysis (Table S3), falls, hearing difficulty, serious illness, and visual impairment were each examined in the same model. In 2018, falls (OR = 1.59), hearing difficulty (OR = 1.35), visual impairment (OR = 1.24, 95% CI: 1.05–1.46), and serious illness (OR = 1.18) were each associated with anxiety symptoms. When all exposures were entered together, the ORs were 1.47 (95% CI: 1.26–1.71) for oral pain and 1.49 (95% CI: 1.29–1.72) for falls. In 2021, falls were associated with anxiety symptoms (OR = 1.42), whereas hearing difficulty (OR = 1.07) and visual impairment (OR = 1.05) were not. When all exposures were entered together, the ORs were 1.83 (95% CI: 1.57–2.13) for oral pain and 1.35 (95% CI: 1.15–1.58) for falls.

The results for oral pain were consistent across sensitivity analyses (Table S4). With a GAD-7 cutoff of ≥ 10, the ORs were 1.63 (95% CI: 1.20–2.21) in 2018 and 1.85 (95% CI: 1.38–2.47) in 2021. For the continuous GAD-7 score, the β coefficients were 0.60 (95% CI: 0.47–0.72) and 0.80 (95% CI: 0.63–0.97). The estimates were similar after exclusion of proxy respondents in 2021 (OR = 1.92, 95% CI: 1.64–2.24),

with multiple imputation (OR = 1.80, 95% CI: 1.58–2.04 in 2018; OR = 1.89, 95% CI: 1.63–2.19 in 2021), and with sampling weights (OR = 1.79, 95% CI: 1.46–2.20 in 2018; OR = 1.96, 95% CI: 1.34–2.87 in 2021).

For number of natural teeth, no sensitivity analysis showed a statistically significant association in 2018, and the multiple imputation estimates were not statistically significant in either wave (OR = 1.11 and 1.17). In 2021, having fewer than 20 natural teeth was associated with a GAD-7 score of ≥ 10 (OR = 1.75, 95% CI: 1.22–2.52) and a higher continuous GAD-7 score (β = 0.23, 95% CI: 0.06–0.40), whereas the weighted OR was 0.81 (95% CI: 0.56–1.19).

The E-values for the association between oral pain and anxiety symptoms were 2.67 (2.20 for the lower confidence limit) in 2018 and 2.08 (1.85 for the lower confidence limit) in 2021.

Discussion

In two national samples of Chinese adults aged 65 years and older, oral pain was associated with anxiety symptoms after adjustment for sociodemographic, health, and functional factors. The odds of anxiety symptoms increased with pain intensity, and the association was also observed for cheek or jaw pain among edentulous participants. The number of natural teeth was not associated with anxiety symptoms after adjustment for health and functional factors. Participants whose oral pain had remitted between waves did not have higher odds of anxiety symptoms, whereas those with incident or persistent pain did.

Our findings help reconcile previous reports from the CLHLS. Using the 2018 wave, Sun et al. found that having 20 or more natural teeth was associated with lower odds of anxiety symptoms (OR = 0.84, 95% CI: 0.72–0.98) after adjustment for sociodemographic and lifestyle factors and hypertension [6], which corresponds to an OR of 1.19 for fewer than 20 teeth and is close to our Model 1 estimate (OR = 1.15, 95% CI: 0.99–1.33). Wang and Sun reported that only moderate tooth loss (9–19 missing teeth) was associated with anxiety symptoms, whereas severe tooth loss and edentulism were not, in a model that included ADL disability and the number of chronic conditions [7]. Neither study adjusted for IADL limitations or self-rated health, and neither examined oral pain.

In our data, the association for tooth count was attenuated and no longer statistically significant once these factors were taken into account, which suggests that earlier associations between tooth loss and anxiety symptoms at least partly reflected the poorer functional status of participants with fewer teeth. In contrast, toothache in the CLHLS has been associated with depressive symptoms (OR = 1.49) [26], and a small Japanese cohort found that intra-oral pain predicted depressive symptoms 3 years later [27]. Our results extend these findings to anxiety symptoms and are consistent with studies of orofacial pain in younger and middle-aged adults, in which temporomandibular and other orofacial pain have been associated with anxiety and psychological distress [28, 29].

The attenuation of the association for tooth count after adjustment is consistent with evidence that tooth loss is closely associated with frailty [8] and accumulates over the life course in relation to earlier disadvantage [9, 30]. Oral pain showed a different pattern. Compared with participants without oral pain,

those with oral pain were younger and less often had ADL disability, yet they more often reported anxiety symptoms. This pattern makes confounding by frailty an unlikely explanation for the association with oral pain, although it remains a plausible explanation for the unadjusted association with tooth count.

Several mechanisms may explain the association between oral pain and anxiety symptoms. Oral pain interferes with eating, sleep, and conversation, and older adults may avoid social meals because of it, which can lead to worry and withdrawal [31]. Pain and anxiety also share neural and neuroendocrine pathways, and persistent pain leads to anticipatory worry about further episodes [10, 32]. In older adults, oral pain may also signal untreated dental disease and limited access to dental care, which are themselves sources of concern. Conversely, anxiety lowers pain thresholds and increases attention to bodily symptoms [11, 33], so part of the association may reflect greater reporting of pain among anxious participants. The cross-sectional design cannot separate these pathways, and the relationship is probably bidirectional.

Two findings suggest that the association reflects pain itself rather than the presence of diseased teeth. First, the odds of anxiety symptoms increased with toothache intensity in both waves, with ORs rising from 1.50 and 1.53 for mild pain (score 1–3) to 2.21 and 2.11 for severe pain (score 7–10) in 2018 and 2021, respectively. Second, cheek or jaw pain was associated with anxiety symptoms among edentulous participants, in whom toothache is not possible. Oral pain is common in edentulous older adults and has been linked to depressive symptoms in this group [34]. Cheek or jaw pain in edentulous people may arise from ill-fitting dentures, denture-related mucosal lesions, or temporomandibular disorders [35, 36], and these conditions are treatable. Together, these results suggest that oral pain is a marker of a current, symptomatic condition rather than of lifetime dental history.

Anxiety symptoms were associated with current rather than earlier oral pain. A similar pattern has been reported in UK and US cohorts of adults aged 50 years and older, in which decreasing chronic pain was not associated with incident depressive symptoms, whereas consistent, increasing, or fluctuating pain was [23]. If the association reflected a stable tendency to report symptoms, participants whose pain had remitted would be expected to have remained at higher risk.

The negative control analysis gave a mixed picture. Hearing difficulty and visual impairment were not associated with anxiety symptoms in 2021, and in 2018 hearing difficulty, visual impairment, and serious illness showed weaker associations (ORs of 1.35, 1.24, and 1.18) than oral pain, which argues against a strong general tendency to report adverse experiences. Falls, however, were associated with anxiety symptoms in both waves, with an OR similar to that for oral pain in 2018. A fall is not an ideal negative control because fear of falling is itself a recognized source of anxiety in older adults [37, 38]. The associations of oral pain and falls were independent of each other, so the oral pain estimate was not explained by falls. The stronger association in towns than in cities in 2021 may reflect differences in access to dental care, but this interaction was not observed in 2018 and may be due to chance. The higher prevalence of both oral pain and anxiety symptoms in 2021 may partly reflect differences in

sample composition between waves or reduced access to dental services during the COVID-19 pandemic, although the survey was not designed to assess this.

The E-values indicate that an unmeasured confounder would need to be associated with both oral pain and anxiety symptoms with a risk ratio of at least about 2 to fully explain the observed associations.

This study has several strengths, including two national waves (overlapping in 7,199 participants, so the replication is partial rather than fully independent), a large number of participants aged 90 years and older, a measure of pain intensity, negative control exposures, and a linked analysis of change in oral pain status. Several limitations should also be considered. First, the main analyses were cross-sectional, and anxiety may increase the reporting of pain. Second, both oral pain and anxiety symptoms were self-reported, and oral pain may have been under-reported by frail participants. Third, in 2018, falls were associated with anxiety symptoms to a similar degree as oral pain, so a broader contribution of adverse experiences cannot be excluded. Fourth, the results for tooth count were not entirely consistent. In 2021, having fewer than 20 natural teeth was associated with a GAD-7 score of ≥ 10 and a higher continuous GAD-7 score, so tooth loss may still be related to the severity of anxiety symptoms. Fifth, oral pain was based on self-report over the preceding 6 months, with no clinical examination, and no information was available on dental treatment or analgesic use. Sixth, pain intensity was recorded for toothache only. Seventh, the longitudinal sub-analysis included only participants who survived and were re-interviewed in 2021, and those lost to follow-up are likely to have been older and frailer, so the estimates for incident and persistent pain may be conservative if pain and anxiety were both more common among those not retained. Eighth, cognitive function was not included among the covariates, so residual confounding by cognitive status cannot be excluded. Finally, participants excluded because of missing covariates were older and more likely to have anxiety symptoms (Table S1), although multiple imputation gave similar results.

Unlike tooth loss, oral pain is potentially reversible with treatment, and its association with anxiety symptoms was strongest when pain was current and severe. Asking about oral pain during mental health assessments of older adults, and about anxiety during dental visits, would require little additional effort. Expanding access to dental care for the oldest-old, of whom only about one in five in China use dental services in a given year [15], may benefit mental as well as oral health.

Conclusions

Oral pain is common among older adults in China and is associated with anxiety symptoms, particularly when the pain is current and severe. Oral pain warrants attention in mental health assessments of older adults, and anxiety in their dental care. Longitudinal studies with repeated measurements of both oral pain and anxiety symptoms are needed to establish the direction of the association.

Declarations

Ethics approval and consent to participate

The Chinese Longitudinal Healthy Longevity Survey was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-13074), and all participants or their legal representatives provided written informed consent. The present study is a secondary analysis of de-identified data and did not require additional ethical approval. All methods were carried out in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The CLHLS datasets analyzed in this study are available from the Peking University Open Research Data Platform (https://opendata.pku.edu.cn) upon registration and approval. The analysis code is available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by the National Innovation Training Program for College Students (grant number 202613023045X). The funder had no role in the design of the study, the collection, analysis, or interpretation of data, or the writing of the manuscript.

Authors' contributions

HS and HT conceived and designed the study and contributed equally to this work. HS obtained access to the data, performed data management and statistical analysis, and prepared the tables and figures. HT reviewed the literature and drafted the manuscript. HS and HT interpreted the results and revised the manuscript. YX, ZZ, ZH, TH, and SZ critically reviewed the manuscript. WH was responsible for project administration, supervision, and funding acquisition, and critically reviewed and revised the manuscript. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

Acknowledgements

Data used in this study were provided by the Chinese Longitudinal Healthy Longevity Survey (CLHLS), which is managed by the Center for Healthy Aging and Development Studies, Peking University. The CLHLS has been supported by the National Natural Science Foundation of China (71233001, 71110107025), the U.S. National Institutes of Health (National Institute on Aging, R01AG023627), and the United Nations Population Fund.

References

1. Bryant C, Jackson H, Ames D. The prevalence of anxiety in older adults: methodological issues and a review of the literature. J Affect Disord. 2008;109(3):233–50. https://doi.org/10.1016/j.jad.2007.11.008.
2. Canuto A, Weber K, Baertschi M, Andreas S, Volkert J, Dehoust MC, et al. Anxiety disorders in old age: psychiatric comorbidities, quality of life, and prevalence according to age, gender, and country. Am J Geriatr Psychiatry. 2018;26(2):174–85. https://doi.org/10.1016/j.jagp.2017.08.015.
3. Wolitzky-Taylor KB, Castriotta N, Lenze EJ, Stanley MA, Craske MG. Anxiety disorders in older adults: a comprehensive review. Depress Anxiety. 2010;27(2):190–211. https://doi.org/10.1002/da.20653.
4. Song S, Xie W, Huang S, He J, Chen L, Liu F. Examining the link between tooth loss and multiple health outcomes: a comprehensive synthesis of evidence from meta-analyses. Front Public Health. 2026;14:1857651. https://doi.org/10.3389/fpubh.2026.1857651.
5. Alimoradi Z, Jafari E, Roshandel Z, Potenza MN, Lin CY, Pakpour AH. Meta-analysis with systematic review to synthesize associations between oral health related quality of life and anxiety and depression. BDJ Open. 2024;10(1):9. https://doi.org/10.1038/s41405-024-00191-x.
6. Sun M, Wu Z, Ma X, Zhao H, Ai H, Huang C. The association of oral health with anxiety symptoms among older adults in China: a cross-sectional study. BMC Geriatr. 2026;26(1):937. https://doi.org/10.1186/s12877-026-07853-5.
7. Wang Y, Sun X. The effect of tooth loss on depression and anxiety among older adults in China: the mediating role of dietary diversity. Nutrients. 2026;18(6):893. https://doi.org/10.3390/nu18060893.
8. Zhang XM, Cao S, Teng L, Xie X, Wu X. The association between the number of teeth and frailty among older adults: a systematic review and meta-analysis. Aging Clin Exp Res. 2025;37(1):156. https://doi.org/10.1007/s40520-025-03053-0.
9. Tsakos G, Demakakos P, Breeze E, Watt RG. Social gradients in oral health in older adults: findings from the English longitudinal survey of aging. Am J Public Health. 2011;101(10):1892–9. https://doi.org/10.2105/AJPH.2011.300215.
10. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. Psychol Bull. 2007;133(4):581–624. https://doi.org/10.1037/0033-2909.133.4.581.
11. Asmundson GJ, Katz J. Understanding the co-occurrence of anxiety disorders and chronic pain: state-of-the-art. Depress Anxiety. 2009;26(10):888–901. https://doi.org/10.1002/da.20600.
12. Zieliński G, Ginszt M, Ginszt A, Wójcicki M, Litko-Rola M, Więckiewicz M. Meta-analysis of the global prevalence of oral and facial pain. Dent Med Probl. 2026;63(1):219–31. https://doi.org/10.17219/dmp/214956.
13. Chen X, Giles J, Yao Y, Yip W, Meng Q, Berkman L, et al. The path to healthy ageing in China: a Peking University–Lancet Commission. Lancet. 2022;400(10367):1967–2006. https://doi.org/10.1016/S0140-6736(22)01546-X.

14. Guo J, Ban JH, Li G, Wang X, Feng XP, Tai BJ, et al. Status of tooth loss and denture restoration in Chinese adult population: findings from the 4th National Oral Health Survey. Chin J Dent Res. 2018;21(4):249–57. https://doi.org/10.3290/j.cjdr.a41083.
15. Xu M, Cheng M, Gao X, Wu H, Ding M, Zhang C, et al. Factors associated with oral health service utilization among adults and older adults in China, 2015–2016. Community Dent Oral Epidemiol. 2020;48(1):32–41. https://doi.org/10.1111/cdoe.12497.
16. Zeng Y, Feng Q, Hesketh T, Christensen K, Vaupel JW. Survival, disabilities in activities of daily living, and physical and cognitive functioning among the oldest-old in China: a cohort study. Lancet. 2017;389(10079):1619–29. https://doi.org/10.1016/S0140-6736(17)30548-2.
17. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–7. https://doi.org/10.1016/S0140-6736(07)61602-X.
18. World Health Organization. Recent advances in oral health. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser. 1992;826:1–37.
19. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006;166(10):1092–7. https://doi.org/10.1001/archinte.166.10.1092.
20. He XY, Li CB, Qian J, Cui HS, Wu WY. Reliability and validity of a generalized anxiety disorder scale in general hospital outpatients [in Chinese]. Shanghai Arch Psychiatry. 2010;22(4):200–3.
21. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA. 1963;185:914–9. https://doi.org/10.1001/jama.1963.03060120024016.
22. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179–86. https://doi.org/10.1093/geront/9.3_Part_1.179.
23. Tu MQ, Yi TP, Tu JY. Association of chronic pain trajectories with incident depressive symptoms among older adults: evidence from national cohorts in the UK and the US. Int J Psychiatry Med. 2026;61(5):650–72. https://doi.org/10.1177/00912174261440653.
24. Zhang K, Zheng X, Ma T. Longitudinal changes of sarcopenia status and risks of cardiovascular disease and all-cause mortality. Exp Gerontol. 2026;213:112989. https://doi.org/10.1016/j.exger.2025.112989.
25. VanderWeele TJ, Ding P. Sensitivity analysis in observational research: introducing the E-value. Ann Intern Med. 2017;167(4):268–74. https://doi.org/10.7326/M16-2607.
26. Cui Y, Yang L, Du J, Duan Y, Qi Q, Liu H. Relationships among oral hygiene behavior, toothache, and depressive symptoms in Chinese older adults. Clin Oral Investig. 2023;27(10):6147–55. https://doi.org/10.1007/s00784-023-05231-8.
27. Hanindriyo L, Yoshihara A, Takiguchi T, Miyazaki H. Chronic intra oral pain and depressive symptoms in Japanese community-dwelling elderly: a longitudinal study. Community Dent Health.

2018;35(2):102–8. https://doi.org/10.1922/cdh_4200hanindriyo07.

28. Dos Santos EA, Peinado BRR, Frazão DR, Né YGS, Fagundes NCF, Magno MB, et al. Association between temporomandibular disorders and anxiety: a systematic review. Front Psychiatry. 2022;13:990430. https://doi.org/10.3389/fpsyt.2022.990430.
29. Bäck K, Hakeberg M, Wide U, Hange D, Dahlström L. Orofacial pain and its relationship with oral health-related quality of life and psychological distress in middle-aged women. Acta Odontol Scand. 2020;78(1):74–80. https://doi.org/10.1080/00016357.2019.1661512.
30. Thomson WM, Barak Y. Tooth loss and dementia: a critical examination. J Dent Res. 2021;100(3):226–31. https://doi.org/10.1177/0022034520957233.
31. Shueb SS, Nixdorf DR, John MT, Alonso BF, Durham J. What is the impact of acute and chronic orofacial pain on quality of life? J Dent. 2015;43(10):1203–10. https://doi.org/10.1016/j.jdent.2015.06.001.
32. Bushnell MC, Čeko M, Low LA. Cognitive and emotional control of pain and its disruption in chronic pain. Nat Rev Neurosci. 2013;14(7):502–11. https://doi.org/10.1038/nrn3516.
33. LaRowe LR, Bakhshaie J, Vranceanu AM, Greenberg J. Anxiety, pain catastrophizing, and pain outcomes among older adults with chronic orofacial pain. J Behav Med. 2024;47(3):537–43. https://doi.org/10.1007/s10865-024-00473-7.
34. Chuinsiri N, Thinsathid N. Oral pain and comorbidities in an edentulous older population: a k-prototypes cluster analysis. PLoS ONE. 2025;20(3):e0319819. https://doi.org/10.1371/journal.pone.0319819.
35. Martori E, Ayuso-Montero R, Martinez-Gomis J, Viñas M, Peraire M. Risk factors for denture-related oral mucosal lesions in a geriatric population. J Prosthet Dent. 2014;111(4):273–9. https://doi.org/10.1016/j.prosdent.2013.07.015.
36. Dallanora AF, Grasel CE, Heine CP, Demarco FF, Pereira-Cenci T, Presta AA, et al. Prevalence of temporomandibular disorders in a population of complete denture wearers. Gerodontology. 2012;29(2):e865–9. https://doi.org/10.1111/j.1741-2358.2011.00574.x.
37. Scheffer AC, Schuurmans MJ, van Dijk N, van der Hooft T, de Rooij SE. Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. Age Ageing. 2008;37(1):19–24. https://doi.org/10.1093/ageing/afm169.
38. Whitmore C, Neil-Sztramko S, Grenier S, Gough A, Goodarzi Z, Weir E, et al. Factors associated with anxiety and fear of falling in older adults: a rapid systematic review of reviews. PLoS ONE. 2024;19(12):e0315185. https://doi.org/10.1371/journal.pone.0315185.

Figures

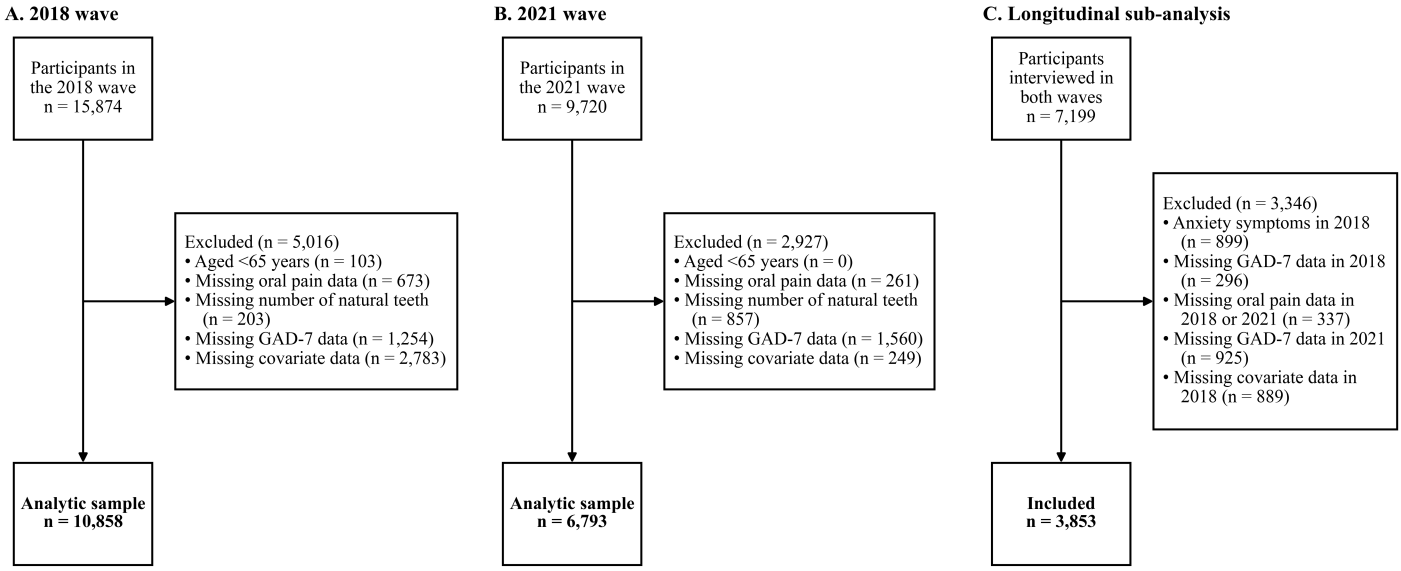


Figure 1

Flow chart of participant selection. (A) 2018 wave. (B) 2021 wave. (C) Longitudinal sub-analysis of participants interviewed in both waves.

GAD-7, 7-item Generalized Anxiety Disorder scale.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1Supplementarytables.docx
- Additionalfile2STROBEchecklist.docx