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Link between fertility behavior and edentulous jaw in middle-aged Chinese women: a cross-sectional study from the CHARLS

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Abstract

Background Women's health is a critical topic in global public health. Female fertility, an important stage in a woman's life, is closely tied to overall health. Currently, there is a lack of research exploring the relationship between oral health and female fertility.

Method The data for this study came from 10,475 female participants in the 2018 China Health and Retirement Longitudinal Study (CHARLS). The dependent variable was the edentulous jaw. Logistic regression analysis, threshold effect analysis, and restricted cubic splines (RCS) were used to examine the relationship between reproductive history—including age at first childbirth and parity—and edentulous jaw in Chinese women.

Results A total of 19,816 people were available for analysis. After exclusion, 5662 women with fertility data and edentulous jaw data were included in the analysis. In the sample of this study, the average age is 61.9 ± 10.3 years old, 17.5% have dentition loss, and 33.3% were younger than 21 years old when they gave birth to their first child (21 is the early childbearing age set in consideration of the current fertility situation in China, which happens to be the first quartile of the age of first birth of our sample), with an average of 2.7 ± 1.5 children. Logistic regression showed that the high incidence of edentulous jaws was related to early childbearing (AOR: 1.386, 95% CI: 1.126–1.710), and it was also related to parity (AOR: 1.106, 95% CI: 1.036–1.181). The results of threshold effect analysis show that when the age of the first birth is below the threshold of 25.898 and the parity is below the threshold of 3.329, its influence on the dependent variables may change significantly.

Conclusion The prevalence of edentulous jaw height in these women in the middle age groups is related to early childbearing and parity, indicating that conscious control of childbearing age and parity could effectively reduce the probability of edentulous jaw in women's later years.

Keywords Edentulous jaw, Oral health, Life course, Female health, Aging, Birth history

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Introduction

According to statistics, oral diseases are some of the most common diseases in the world [1]. The toothless jaw refers to a condition where no natural teeth or roots remain in the entire dental arch, preventing oral functions such as chewing from being performed with natural teeth. The edentulous jaw is considered the 'final marker of disease burden for oral health' [2]. It is estimated that the global prevalence of edentulous jaws is 25% among people aged 60 or above [3]. Numerous studies worldwide have demonstrated that tooth loss is significantly associated with age [4]. And according to previous studies, edentulous jaws are related to depression [5], cognitive impairment [5, 6], temporomandibular joint disorder [7], and malnutrition [8]. Given the unprecedented population aging in China [9], toothless jaws are considered a significant health issue for people in middle and old age in China. However, China is not the only country facing the challenge of aging, as this is a global issue. According to a 2022 report by the World Health Organization (WHO) [10], the issue of population aging is already affecting both developed and developing countries. Another topic closely related to aging is fertility. In recent decades, it has become evident that the total fertility rate in many high-income countries is lower than the mortality rate. This trend will ultimately alter the age composition of these nations, resulting in a higher proportion of older individuals and the emergence of an aging population [11]. Low birth rates are the result of a combination of economic, social, policy, health, and environmental factors [12, 13]. Among these, the improvement of women's status and educational attainment, which fall under social factors, plays a significant and undeniable role. Thus, the topic of fertility has gained greater attention. When should women have children? How many children should they have? These questions should be addressed from a scientific perspective. Chronic systemic diseases and reproductive health have a complex relationship. For example, autoimmune diseases and metabolic disorders can negatively impact reproductive health [14–16], while pregnancy may lead to conditions such as preeclampsia [17], gestational diabetes mellitus (GDM) [18], and obesity [19]. Additionally, pregnancy complications are often caused by early childbearing, advanced maternal age, and multiple pregnancies. Previous studies have shown that early childbearing and multiple pregnancies are related to the increased incidence of various chronic diseases [20, 21], the probability of depression in women with early childbearing and multiple pregnancies is significantly higher than that in women with late first childbearing age and fewer births [22]. Women who have given birth multiple times and those with early childbearing experiences are more prone to poorer health and higher mortality rates later in life [23–25]. Research indicates that women capable of childbearing after the age of 35 are more likely to have a longer lifespan [26]. Previous studies have shown that high parity is associated with an increased risk of tooth loss [27, 28], while delayed childbearing is linked to a lower prevalence of dental caries [28]. The mechanisms may include: changes in estrogen and progesterone during pregnancy altering the microenvironment of the gingival tissue [29, 30]; changes in oral care compliance and dietary intake patterns due to pregnancy behaviors indirectly affecting oral health [31]; the negative impact of pregnancy-related depression on oral health [32]; and socioeconomic status factors indirectly influencing pregnant women's awareness and behaviors regarding oral health [33, 34]. However, the utilization of oral healthcare resources in developing countries like China is more complex compared to that in other nations. In 2003, China implemented a policy (Opinions on Establishing a New Rural Cooperative Medical System) include childbirth-related expenses in the medical insurance system. China's dental care reimbursement policy has undergone a phased evolution. In 1998, basic dental treatments (e.g., fillings, tooth extractions) for urban employees were incorporated into the national medical insurance coverage. Subsequently, in 2003, the New Rural Cooperative Medical Scheme (NCMS) extended equivalent basic dental care coverage to rural residents. Following the implementation of the Urban Resident Basic Medical Insurance (URBMI) in 2007, basic dental treatments were gradually included for non-working urban residents. Additionally, it was not until 2010 that China implemented a series of policies to significantly increase the coverage rate of private dental clinics [35]. And the relationship between Chinese female reproductive history and edentulous jaw remains unclear. This study focuses on women's health and examines the prevalence of edentulous jaws in relation to female fertility. Chinese representative data were used to evaluate the association between age at first birth, parity, and edentulous jaw prevalence among middle-aged and elderly women, with the hypothesis that age at first birth is inversely associated with prevalence, while parity is positively associated.

Method

Data and sample

In this study, the national baseline data of the China Health and Retirement Longitudinal Study (CHARLS) in 2018 was adopted. CHARLS is a large-scale interdisciplinary investigation project sponsored by the National Development Research Institute of Peking University in China and implemented by the China Social Science Investigation Center. The main goal of this project is to collect high-quality microdata representing the families and individuals of middle-aged and elderly people aged 45 and above in China, to analyze the problem of population aging in China, and to promote related interdisciplinary research. CHARLS data provides a scientific basis for formulating and perfecting relevant policies in China. CHARLS'national baseline survey began in 2011, covering 150 county-level units and 450 village-level units, involving 17,000 people in about 10,000 households. These samples are followed up every two to three years, and one year after the investigation, the data will be made public to the academic community for free. By November 2023, the research results published based on the data of CHARLS have reached 4,676, which shows its important value in academic research. The fourth wave of CHARLS includes 19,816 adults aged 45 and above. This study included 10,475 female individuals, of whom 225 samples were younger than 45 years old, 2 samples were older than 65 years old at the time of their first birth, and 4,229 respondents lacked the information of birth history, leaving 6,019 after excluding the aforementioned samples. After further excluding 22 participants with missing dentition data and 335 respondents with missing depression score data, this study included 5662 middle-aged and elderly women. The process of sample rejection in this study (Fig. 1).

Birth history and edentulous jaws

Birth history

The birth history is extracted from the data of part C (children's information) of the CHARLS questionnaire. Parity denotes the count of biological offspring (including deceased children) of the interviewee. By subtracting the year of the respondents from the year of birth of the respondents'children, the reproductive age of the

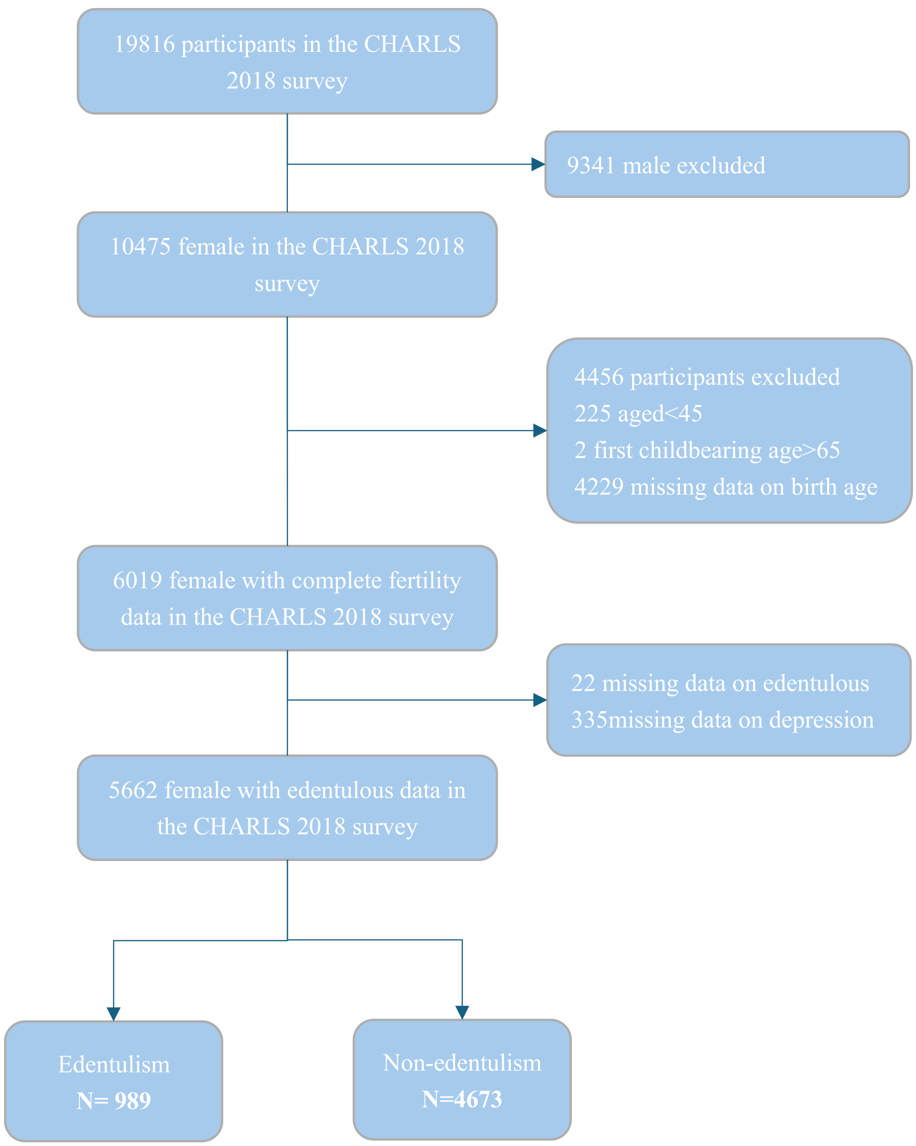

Fig. 1 Flowchart of participation

interviewee can be obtained. If the parity of the interviewee is greater than 1, the smallest reproductive age is selected as the age of the first childbirth. Some studies have shown that a woman's age at first childbirth being less than 21 or 22 years old can have negative impacts on the body [25, 36]. In this study, after analyzing the fertility status of Chinese women [37] and the distribution of the sample's age at first childbirth, the age for early childbearing was set at less than 21 years old.

Edentulous jaws

Part D of the CHARLS questionnaire asks questions about the health and functional status of the respondents, including the question"Have you lost all of your teeth?". If the respondents answered yes, they were considered edentulous patients.

Covariance

This study also considered covariables such as region, hukou, per capita monthly household expenditure, whether to wear dentures, whether there is difficulty in chewing, status of health insurance enrollment, gender, age, academic level, marital conditions, smoking conditions, drinking conditions, depressive conditions, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, and chronic pain, which may have an impact on the relationship between birth history and edentulous jaws. This investigation incorporated the use of denture utilization and self-reported chewing impediments as variables to mitigate potential biases in the assessment of oral functionality and general well-being. Due to the lack of data on oral health awareness and dental care-seeking behavior in the database, we used health insurance enrollment status as a proxy for respondents'health awareness. This approach is supported by prior studies demonstrating that:

Individuals enrolled in health insurance are more likely to utilize preventive healthcare services [38]. Demographic information (hukou, gender, age, education level, marital status) comes from Part B. Information about denture, chewing discomfort, smoking, drinking, depression, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, and chronic pain can be obtained from Part D. And the consumption and insurance enrollment information were obtained from Part E and Part G, respectively. The status of health insurance enrollment was measured by calculating the number of health insurance plans enrolled by respondents, serving as an indicator of their health awareness. Education level is divided into two categories, namely, education below high school and education above high school; marital status is divided into two categories: married and unmarried; drinking status can be divided into three categories: regular drinking, little drinking, and never drinking; the depression status is calculated according to the depression rating questionnaire, and in our study, the respondents'depression was evaluated using the Center for Epidemiologic Studies Depression Scale (CES-D-10) [39, 40], with a total score ranging from 0 to 30. A total score of 10 or above was deemed indicative of depression [41, 42]. Considering the regional differences in dental medical resources, this study included the participants'locations, dividing them into three groups based on the east, central, and west regions. The other information above is obtained by directly collecting the respondents'answers—yes or no.

Statistical analysis

All statistical analyses in this research were conducted using R (version 4.4.1). Continuous variables are presented as mean ± standard deviation (SD), and categorical variables are presented as percentages. Univariate and multivariate logistic regression analyses were used to evaluate the relationship between female reproductive history (including early childbearing and parity) and edentulous jaws. The conclusions of logistic regression analysis are expressed by the odds ratio (OR) and 95% confidence interval (95% CI), and the significance is determined by using the truncated value of $P < 0.05$. Model 1 is not adjusted. Model 2 is adjusted according to age, academic levels, marriage conditions, smoking conditions, and drinking conditions. Model 3 adds covariates such as region, hukou, expenditure, denture, chewing discomfort, insurance, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, depression, and chronic pain based on model 2. Subsequently, a multicollinearity analysis was conducted to assess whether there was high linear correlation among the independent variables in the regression model. Restricted Cubic Splines (RCS) were used to evaluate the nonlinear relationship between female reproductive history (including age at first birth and parity) and edentulous jaws. To better fit the model, the number of RCS nodes was set to 4. The RCS model was adjusted for region, hukou, expenditure, denture, chewing discomfort, insurance, age, educational level, marital status, smoking status, drinking status, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, and chronic pain. Subgroup analyses were conducted to further explore the heterogeneity, robustness, and applicability of our study findings, thereby providing more precise guidance. This study was conducted and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Result

Descriptive characteristics of study participants

Table 1 describes the baseline characteristics of the study participants according to their edentulous jaws. The eastern region had the lowest proportion of edentulous individuals, whereas the western region had the highest

Table 1 Baseline participant characteristics

	Characteristics	Edentulism		*p*-value
		No (*N* = 4673)	Yes (*N* = 989)	
Region (%)	Central	1827 (39.1%)	326 (33.0%)	< 0.001
	East	1594 (34.1%)	321 (32.5%)	
	West	1252 (26.8%)	342 (34.6%)	
Hukou (%)	Rural	3606 (77.2%)	845 (85.4%)	< 0.001
	Non-rural	1067 (22.8%)	144 (14.6%)	
Expenditure (mean (SD))		914.06 (999.00)	844.05 (1364.94)	0.062
Denture (%)	Wearing	1477 (31.6%)	686 (69.4%)	< 0.001
	Not wearing	3196 (68.4%)	303 (30.6%)	
Chewing discomfort (%)	Yes	1868 (40.0%)	539 (54.5%)	< 0.001
	No	2805 (60.0%)	450 (45.5%)	
Insurance (mean (SD))		1.55 (0.48)	1.56 (0.42)	0.502
Education (%)	Below high school	4161 (89.0%)	961 (97.2%)	< 0.001
	High school or above	512 (11.0%)	28 (2.8%)	
Marriage (%)	Yes	3515 (75.2%)	492 (49.7%)	< 0.001
	No	1158 (24.8%)	497 (50.3%)	
Age (mean (SD))		60.12 (9.59)	70.15 (9.34)	< 0.001
Hypertension (%)	Yes	1743 (37.3%)	463 (46.8%)	< 0.001
	No	2930 (62.7%)	526 (53.2%)	
Dyslipidemia (%)	Yes	1149 (24.6%)	226 (22.9%)	0.264
	No	3524 (75.4%)	763 (77.1%)	
Chronic lung disease (%)	Yes	557 (11.9%)	195 (19.7%)	< 0.001
	No	4116 (88.1%)	794 (80.3%)	
Diabetes (%)	Yes	672 (14.4%)	154 (15.6%)	0.361
	No	4001 (85.6%)	835 (84.4%)	
Heart disease (%)	Yes	1108 (23.7%)	288 (29.1%)	< 0.001
	No	3565 (76.3%)	701 (70.9%)	
Stroke (%)	Yes	267 (5.7%)	94 (9.5%)	< 0.001
	No	4406 (94.3%)	895 (90.5%)	
Menopause (%)	Yes	3793 (81.2%)	952 (96.3%)	< 0.001
	No	880 (18.8%)	37 (3.7%)	
Smoke (%)	Yes	349 (7.5%)	112 (11.3%)	< 0.001
	No	4324 (92.5%)	877 (88.7%)	
Drink (%)	Usually	3992 (85.4%)	841 (85.0%)	0.204
	Seldom	434 (9.3%)	83 (8.4%)	
	Never	247 (5.3%)	65 (6.6%)	
Depression (%)	Yes	2238 (47.9%)	618 (62.5%)	< 0.001
	No	2435 (52.1%)	371 (37.5%)	
Chronic pain (%)	Yes	3248 (69.5%)	725 (73.3%)	0.02
	No	1425 (30.5%)	264 (26.7%)	
Parity (mean (SD))		2.51 (1.32)	3.67 (1.68)	< 0.001
First birth age (mean (SD))		23.14 (3.27)	22.38 (3.73)	< 0.001

Categorical variables are displayed as counts (percentage); continuous data are represented as mean (standard deviation)

SD: Standard deviation

Note: The last two rows represent the independent variables First birth age and Parity. All p-values are less than 0.001

proportion. In contradistinction to their non-edentulous counterparts, the majority of participants with edentulous jaws hailed from rural backgrounds, were more predisposed to utilizing dentures, and encountered a greater number of challenges with mastication. And among the edentulous respondents, the average age is higher, education levels are significantly lower, and the proportion of individuals with chronic lung disease, heart disease, stroke, and chronic pain is higher. Moreover, the prevalence of smoking, menopause, and depression is also higher. In addition, the mean number of children among the edentulous participants was notably elevated, and the incidence of individuals bearing their initial offspring at the age of 21 or below was markedly augmented. There were significant differences between edentulous women and non-edentulous women in terms of parity, primiparous age, hukou, denture wearing status, chewing difficulty status, psychological depression status, marital status, education level, smoking, chronic diseases (including hypertension, chronic lung disease, heart disease, and stroke), chronic pain, and menopause ($P < 0.05$, Table 1).

The relationship between female reproductive history and edentulous jaws

The results of the multivariate logistic regression analysis between female reproductive history and edentulous jaws are shown in Table 2. Due to the presence of extreme values in the age at first birth, this study divided it into quartiles to ensure the accuracy of the data [43]. The cutoff ages for the quartiles were determined by dividing the age variable into four equal-frequency groups (quartiles). The specific cutoff values are as follows: Q1 represents the age at first birth < 21, Q2 represents the age at first birth between 21 and 23, Q3 represents the age at first birth between 23 and 25, and Q4 represents the age at first birth > 25. The results indicated that age at first birth and parity were associated with edentulous jaws. Specifically, age at first birth < 21 (adjusted OR of 1.386, 95% CI: 1.126–1.710) and higher parity (adjusted OR of 1.106, 95% CI: 1.036–1.181) were associated with a higher prevalence of edentulous jaws. In other words, women with early childbearing and higher parity are more prone to developing edentulous jaws (Table 2). Given that the data of this study originated from a multi-stage and multi-level sampling design [44], to correct for sampling bias and non-response bias, weighted logistic regression analysis was further conducted on the above-mentioned model. The results indicated that the correlation between women's reproductive history and edentulism remained statistically significant ($p < 0.05$) (see Table S1 in the Appendix). To verify the robustness of the weighted and unweighted models, an overlap analysis of confidence intervals was also performed. The results showed that the confidence intervals of the key variables (the first birth age Q1 group and parity) in the weighted and unweighted models significantly overlapped, suggesting that the results were insensitive to the weight adjustment (see Table S2 in the Appendix).

Multicollinearity analysis

To assess the potential issue of multicollinearity among the independent variables, we calculated the variance inflation factor (VIF) for each variable. The analysis revealed that all VIF values were below the threshold of 5, with the highest value being 2.19. These results indicate

Table 2 The association between Fertility behavior and edentulism

Association between female childbearing history and edentulism in cross-sectional study						
	Model 1		**Model 2**		**Model 3**	
Exposure	**OR(95%CI)**	***p*-value**	**AOR(95%CI)**	***p*-value**	**AOR(95%CI)**	***p*-value**
First birth age Quartiles						
Q1 (*N* = 1886) (11–21)	1.783(1.496–2.140)	< 0.001	1.397 (1.148–1.704)	< 0.001	1.386 (1.126- 1.710)	0.002
Q2 (*N* = 1455) (21–23)	1(Reference)	—	1(Reference)	—	1(Reference)	—
Q3 (*N* = 1270) (23–25]	1.037(0.838–1.282)	0.477	1.059 (0.841–1.332)	0.617	1.072 (0.842–1.366)	0.572
Q4 (*N* = 1051) (25–43]	0.982(0.782–1.230)	0.995	0.938 (0.732–1.196)	0.607	0.934 (0.720–1.210)	0.607
Parity	1.615(1.543–1.691)	< 0.001	1.132 (1.068–1.120)	< 0.001	1.106 (1.036–1.181)	0.003

Model 1: unadjusted;

Model 2: adjustment of age, education, marriage, smoking and drinking;

Model 3: Adjust according to region, hukou, expenditure, denture, chewing discomfort, insurance, age, education, marriage, smoking, drinking, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, depression and chronic pain

OR: Odd ratio

AOR: Adjusted Odds Ratio

95%CI: 95%confidence interval

that multicollinearity is not a significant concern in our model, as VIF values below 5 are generally considered acceptable and do not substantially affect the stability or interpretability of the regression coefficients (Fig. 2).

Threshold effect analysis

In this study, we focus on whether there is a threshold effect. A threshold effect refers to the point at which changes in independent variables have a significant impact on the dependent variables. The threshold effect analysis of model 3 in correlation analysis shows that the inflection point of the first birth age is 25.898, and the inflection point of parity is 3.329. Specifically, when the first childbearing age is below 25.898, it has a significant impact on edentulous jaws in later years ($p < 0.05$). However, once the age of first birth exceeds this threshold, we observe that the age of first birth has no significant effect on edentulous jaws in later years. This discovery shows that the influence of the first childbearing age on edentulous jaws is not linear, but the risk of edentulous jaws decreases with the increase of the first childbearing age before reaching the threshold. Similar results were observed in the analysis of the threshold effect of parity, that is, before reaching the threshold of 3.329 ($p < 0.05$), with the increase of parity, the probability of edentulous jaws increased.

Restricted cubic splines

To further verify this threshold effect, we conducted restricted cubic spline analysis (RCS) and found that the results supported our preliminary findings. Significant nonlinear correlation was found between the female reproduction history and incidence of edentulous jaws (first birth age: $P < 0.001$ and P-nonlinear $= 0.038$; Parity: $P < 0.001$ and P-nonlinear $= 0.010$). The results indicated that the incidence of edentulous jaws decreased with the rise of the first childbearing age before the age of 26, and reached the lowest in the range of 25 to 26. However, the incidence of edentulous jaw increases with the increase of parity and reaches a peak in the range of 3 to 4. The existence of this threshold effect is very important for understanding the relationship between female reproductive history and edentulous jaws (Fig. 3).

Interactive analysis

Although this study analyzed two independent variables separately in logistic regression models, examining the interaction between these variables was essential. We conducted an interaction analysis between age at first birth and parity, revealing a significant negative correlation between the two variables (Spearman's $\rho = -0.378$, $p < 0.001$). Specifically, younger age at first birth was associated with a higher number of births. Finally, a scatter plot (Fig. 4) was generated to visually

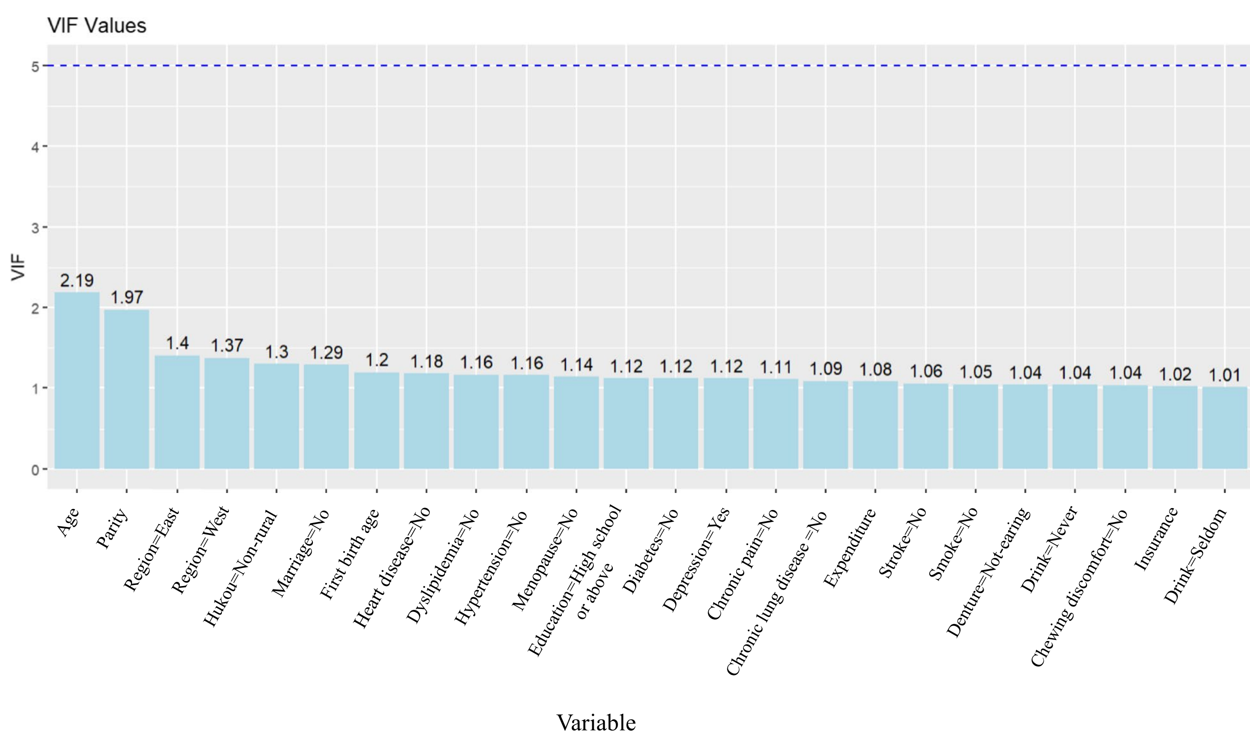

Fig. 2 VIF Analysis

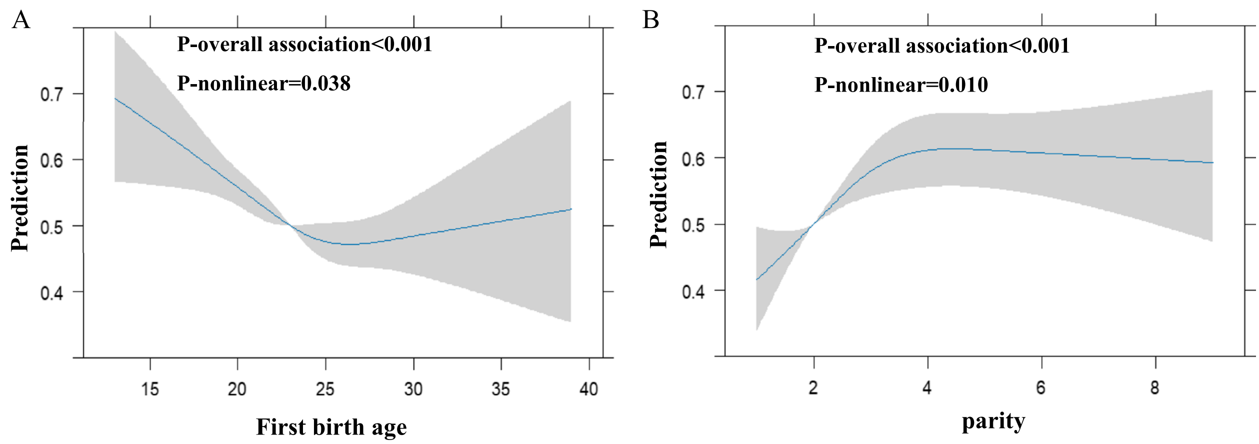

Fig. 3 Restricted Cubic Splines for Fertility behavior vs edentulism Restrictive cubic splines on the relationship between age of first birth, parity and edentulous jaws **A** RCS of the association between age of first birth and edentulous jaws **B** RCS of the association between parity and edentulous jaws

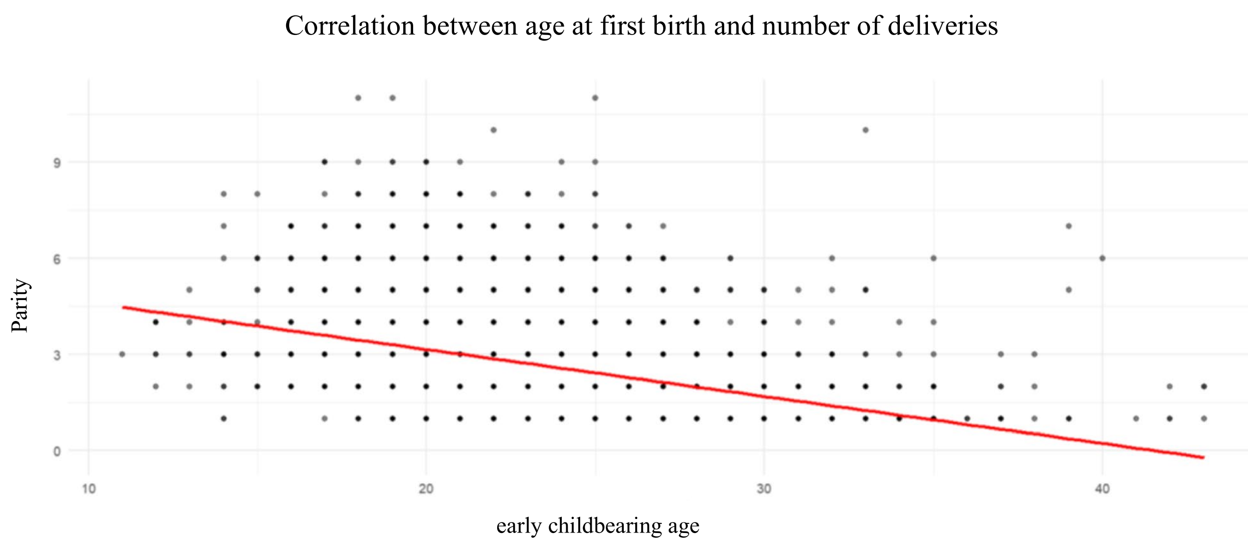

Fig. 4 Interactive analysis

demonstrate the relationship between these two independent variables.

Subgroup analysis

We conducted a sensitivity analysis of the variables in Model 3, and age was found to have the most significant influence on edentulous jaws. Therefore, we divided the respondents into two age groups and performed a subgroup analysis, as shown in Table 3. The results showed that, in the younger group (age <65 years), the logarithmic odds ratio of edentulism decreased by approximately 5.7% for each additional year of initial childbearing age, which was statistically significant ($P < 0.05$), suggesting that an earlier initial childbearing age is negatively correlated with the risk of edentulism. However, the results in the older group (age >65 years) were not statistically significant ($P > 0.05$), indicating that initial childbearing age has a lesser impact on edentulism in the older group. Generally speaking, the analysis results of the two subgroups show that the age of first birth is negatively correlated with the risk of edentulous jaws, but this correlation is more significant among people aged 45–65. Similarly, we also conducted a subgroup analysis by parity with respect to the respondent's age, and the results revealed that in the younger group, an increase in parity was associated with an approximately 27.9% increase in the logarithmic odds of edentulism, whereas in the older group, an increase in parity was associated with a 18.1%

Table 3 Subgroup analysis

variate	subgroup	coefficient	95% CI	*p*-value	significance
First birth age	Younger	−0.057	[−0.101, −0.014]	0.010	significant
	Older	−0.025	[−0.053, 0.002]	0.074	non-significant
	Low parity	−0.055	[−0.087, −0.024]	< 0.001	significant
	High parity	−0.010	[−0.050, 0.030]	0.621	non-significant
	Rural	−0.027	[−0.053, −0.002]	0.035	significant
	Non-rural	−0.059	[−0.117, −0.002]	0.044	significant
Parity	Younger	0.279	[0.155, 0.400]	< 0.001	significant
	Older	0.181	[0.113, 0.248]	< 0.001	significant
	Early childbearing	0.139	[0.047, 0.230]	0.003	significant
	Non-early childbearing	0.260	[0.176, 0.344]	< 0.001	significant
	Rural	0.165	[0.100, 0.231]	< 0.001	significant
	Non-rural	0.392	[0.234, 0.550]	< 0.001	significant

The non-rural subgroup: adjust according to age, denture status, education, drinking habits, metabolic score, and menopause

The remaining subgroups: adjust according to region, denture status, chewing discomfort, insurance, education, marital status, smoking, drinking, menopause, hypertension, diabetes, chronic lung disease, dyslipidemia, heart disease, stroke, depression, and chronic pain

95%CI: 95%confidence interval

increase in the logarithmic odds of edentulism. The correlation between parity and edentulous jaws was statistically significant in both subgroups ($P < 0.05$), but it was more significant in the young group. In addition, our data indicate a negative correlation between first birth age and parity, reflecting that women who start childbearing earlier tend to have more children. This overlap complicates disentangling their independent effects, but stratified analyses could clarify their roles. The study stratified the analysis into subgroups based on age at first birth and parity, the results are presented as follows: we observed a positive correlation between parity and edentulous prevalence in the non-early fertility subgroup, an increase in parity was associated with an approximately 26.0% increase in the logarithmic odds of edentulism; and in the early childbearing subgroup, an increase in parity was associated with a 13.9% increase in the logarithmic odds of edentulism; we categorized the parity based on the median parity, pregnancies with three or fewer births were classified into the low parity group, in the low-parity subgroup, age at first birth was inversely associated with edentulous prevalence, the logarithmic odds ratio of edentulism decreased by approximately 5.5% for each additional year of initial childbearing age, while in the high-parity subgroup, there was no significant association between age at first birth and edentulous jaw. We also performed a subgroup analysis based on household registration (hukou). The results indicated that the p-values of the logistic regression in both the rural and non-rural subgroups were less than 0.05 (see Table 3), additionally, due to the smaller sample size of non-rural participants (1,211), this study adjusted the covariates for the non-rural subgroup model. We further divided the non-rural subgroup (based on parity and whether early childbearing) and conducted subgroup analysis (see Table S3 in the Appendix). The results showed that in the non-rural subgroup with high parity (parity ≥ 3), there was no statistically significant association between the age at first childbirth and edentulism ($p > 0.05$). Due to the limited sample size, no accurate and reliable logistic regression analysis results could be obtained for the low-parity and early childbearing subgroups among the non-rural population. Therefore, we do not have sufficient evidence to prove that the age at first childbirth is associated with edentulism in the non-rural population.

Discussion

Despite the high rate of sample exclusion (46%), the included group and the excluded group show a highly similar distribution in demographic characteristics, socioeconomic status, and health behaviors (see Fig. S1 in the Appendix). Nevertheless, future research should still pay attention to the potential residual confounding that may arise from missing data.

Few studies have been published on women's health, and even fewer have focused on the relationship between women's fertility and oral health. This study is the first to examine the relationship between reproductive history and oral health in middle-aged and elderly women in China. The results reveal that early childbearing and multiple births are both risk factors for edentulous jaws, with a significant impact. However, the association is influenced by the respondents'age. Among women over 65, early childbearing has no significant effect on edentulous jaws, while in the 45 to 65 age group, both early childbearing and multiple births promote the development of edentulous jaws. The potential reasons for these findings can be attributed to physiological and psychological factors. Previous studies have shown that early childbearing and multiple pregnancies can lead to malnutrition [45], frequent immunosuppression [46], and metabolic disorders [47, 48]. Changes in hormone levels during pregnancy will have an impact on the oral microenvironment, leading to gingivitis and even periodontitis [29, 30]. In addition, some studies have shown that during pregnancy, some caries-causing microorganisms [49], saliva pH and flow rate [50, 51], and calcium ion concentration in saliva [52] will change, these factors play an important role in the process of dental caries. Periodontitis and dental caries are both important promoting factors of edentulous jaws [53, 54]. Early pregnancy means that the risk of dental caries or periodontitis will increase earlier. As dental caries and periodontitis are chronic progressive diseases [55, 56], the longer the illness lasts, the greater the possibility of eventually leading to edentulous jaws. Additionally, women with multiple children may deprioritize self-care, delaying dental visits until tooth loss becomes inevitable [57]. Although hormone levels in pregnant women return to normal after pregnancy [58, 59], the loss of bone attachment levels in periodontitis and the hard tissue destruction of tooth decay are irreversible [56, 60], and even if the disease stops progressing after pregnancy, there is a higher risk of edentulous jaw in later life than others as the disease stops progressing after pregnancy or multiple pregnancies.

Pregnancy may also have an adverse impact on women's mental health [61, 62]. Accumulated physical and psychological stress may lead to postpartum depression [63], and the correlation between depression and edentulous jaws has been discussed by many researchers [64]. Early pregnancy or childbirth will cause greater pressure and psychological burden on the parturient, increase the risk of depression, and thus lead to the occurrence of edentulous jaws. The impact of postpartum depression on edentulism can be summarized into three aspects [65]: hormonal, behavioral, and social. The interference of depression and anxiety with the immune system is closely related to the onset and progression of periodontitis [32]; depression and anxiety significantly reduce individuals'adherence to oral health behaviors [31]; additionally, postpartum depression patients with economic challenges are less likely to seek medical care for oral health issues such as periodontitis and dental caries [33, 34].

Elderly individuals with osteoporosis, as well as those with heart disease, depression, or diabetes, who generally have poorer health status, are at a higher risk of developing periodontitis [65–67]. Research indicates that at least one-third of women over 65 years of age suffer from osteoporosis [68], which can lead to reduced bone density. This reduction in bone density exacerbates alveolar bone loss in patients with periodontitis [69]. Furthermore, periodontitis is a major cause of tooth extraction among the elderly, accounting for 66.17% of such cases [70]. Therefore, we can draw the following conclusions: the influence of reproductive behavior on the risk of edentulous jaws of respondents over 65 years old is not significant, which may be because osteoporosis [71, 72] (decreased bone metabolism level) and general health status [73–75] have more significant effects on alveolar bone absorption than reproductive behavior, thus covering up the influence of reproductive behavior on edentulous jaws. And in the subgroup analysis, we also observed that first birth age was not significantly associated with edentulism in the high parity subgroup. The result may be attributed to the dominant effect of multiple pregnancies, which could overshadow the influence of the independent variable on the dependent variable. In women with high parity, the cumulative burden of multiple pregnancies might be the primary driver of oral health deterioration, making the influence of first birth age less significant. However, our study has several limitations. The subgroup analyses were based on relatively small sample sizes, which may have reduced the statistical power to detect significant associations. Future studies with larger cohorts and more detailed assessments of reproductive history are needed to confirm these findings and explore the underlying mechanisms.

The results of this study are of great significance to promote the public health of oral health, reduce the prevalence of edentulous jaws, and promote the oral health and quality of life of middle-aged and elderly women. The results of this study show that women who give birth around the age of 26 are less likely to have edentulous jaws. The fewer the number of pregnancies, the less the chance of suffering from edentulous jaws. It shows that the vision of oral preventive medicine should also be broadened to the field of women's fertility, encouraging women to give birth at the most suitable age, advocating prenatal and postnatal care, and abandoning the old concept of having more children and more happiness. On the other hand, for those young women who have given birth many times, we should strengthen oral hygiene education and psychological counseling, to reduce the risk of edentulous jaws.

There are some limitations in this study. First of all, the design of this study is cross-sectional, which means that the order of its correlation is unknown. Secondly, the data on birth history are collected by the interviewees'memories, which is easy to cause memory deviation. Third, the article explores the impact of osteoporosis on edentulism, but it was unable to obtain relevant information on osteoporosis from the database. And the study was limited by the sample size and thus unable to verify the correlation between early childbearing and edentulism in the non-rural household registration population. Additionally, this study did not account for all potential variables that might influence the relationship between women's reproductive history and edentulism. Many potential factors, such as oral hygiene awareness and access to dental care, may also play significant roles in the development of edentulism. The omission of these variables means that the study's conclusions could be influenced by these untested factors, thereby affecting the robustness and generalizability of the findings. Recognizing these limitations is crucial for accurately interpreting the study results and highlights the need for further research. Future studies should focus on investigating the pathogenic mechanisms and controlling for the aforementioned confounding factors to enhance our understanding of the relationship between women's reproductive history and edentulism. However, previous studies have explored the relationship between female reproductive behavior and oral health [27, 28, 76], and these results are similar to this study, what is more worth mentioning is that even after controlling for confounding factors such as oral health awareness and access to dental care, these studies still reached conclusions similar to those of the present study [27, 28], which strongly supports the reliability of our findings.

Conclusion

This study examined the relationship between the reproductive history of middle-aged and elderly Chinese women and edentulous jaws. High parity and early childbearing are significantly associated with a higher prevalence of edentulous jaws. The likelihood of having edentulous jaws is lowest at age 26. As the party increases, the risk of developing edentulous jaws in later life rises significantly. Age also plays a key role in this relationship. This study offers data support for identifying gender-specific risk factors for edentulous jaws in Chinese women and assessing the impact of reproductive behavior. Additionally, recommendations are provided to help reduce the prevalence of edentulous jaws.

Abbreviations

CHARLS	China Health and Retirement Longitudinal Study
OR	Odd ratio
AOR	Adjusted Odd ratio
95%CI	95%Confidence interval
SD	Standard deviation

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-025-06132-w.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

Supplementary Material 5.

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Authors' contributions
The conceptualization and design of this study were accomplished by WRJ and DWC. WRJ subsequently conducted the research and drafted the initial manuscript. WRJ, DWC and LYT participated in the data analysis. WRJ and DX participated in the data interpretation. SJL, SJK and LSY assisted in revising the draft. All authors read and approved the final manuscript.

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Data availability
The investigation analyzed the data that is accessible to the public, and the dataset can be accessed at the following link: https://charls.pku.edu.cn/

Declarations

Ethics approval and consent to participation
This study was carried out based on data extracted from the CHARLS public database, and all methods were performed according to the relevant guidelines and regulations. Written informed consent was obtained from all participants or their legal agents before the commencement of any study process. The ethics approval for the collection of CHARLS data has been approved by the Peking University Biomedical Ethics Review Committee (IRB00001052-11015), and all procedures were performed in accordance with the 1964 Declaration of Helsinki and its later amendments or with comparable ethical standards.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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