RESEARCH ARTICLE

Early-life adversity and edentulism among Chinese older adults

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Abstract

Background: Emerging evidence indicate the relationship between ELA with oral health problems. However, most focus on single types of adversity. The association of cumulative ELA with edentulism, the final marker of disease burden for oral health, remains unclear.

Methods: Data came from 17,610 elderly participants in the China Health and Retirement Longitudinal Study (CHARLS). In 2014, the Life History Survey Questionnaire was utilized to evaluate the experience of threat and deprivation. Information on edentulism was evaluated through self-report from the follow-up in 2013, 2015, and 2018. By controlling for age, education, hukou residence, marital status, and disease history, logistic regression analyses were used to evaluate the relationships between distinct dimensions of ELA and risk of edentulism.

Results: Nearly half (49.8%) of the 17,610 older persons (mean [SD] age at baseline: 63.6 [9.4] years) reported experiencing early adversity due to threat-related ELA, and 77.9% reported having deprivation-related ELA. ELA characterised by threat was associated with edentulism in both male and female participants. Two forms of threat-related ELA exposure were linked to a 1.65-fold and 1.73-fold higher risk for edentulism in both male (95% CI 1.23, 2.21) and female participants (95% CI 1.31, 2.29), compared to no threat-related ELA exposure. Both male (95% CI 2.34, 4.24) and female participants (95% CI 2.49, 4.56) had a 3.15-fold and 3.37-fold higher risk for edentulism when exposed to three or more threat-related ELAs.

Conclusion: Our findings suggest that ELA marked by threat is linked to an increased risk of edentulism. The biological pathways between different dimensions of ELA and teeth loss should be clarified by future research.

Keywords: Deprivation, Early life adversity, Early life stress, Threat

Background

Chronic psychosocial stress experienced in childhood is thought to be associated with long-term health and disease risk. In particular, early life adversity (ELA)—experiences that represent a deviation from the expected environment and require adaptation, including childhood abuse, sexual assault, neglect, and chronic poverty—create risks for lifelong chronic diseases [1, 2]. Emerging evidence indicates the relationship between ELA and oral health problems [3–6]. The Japan Gerontological Evaluation Study (JAGES) reported a significant association between the experience of abuse in childhood and the reduction of residual teeth in old age. The experience of childhood abuse increased the risk of having fewer remaining teeth by 14% [4]. A cross-sectional study among Uruguayan people aged 65–74 found that the prevalence and severity of tooth loss were positively correlated with social factors such as poor socioeconomic status, use of public health services, and frequent drinking [7]. However, most previous work focused on single

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types of adversity, such as physical abuse [4] or poverty [5, 6].

Poor oral health, particularly edentulism, is considered a putative risk factor for frailty [7] and mortality [8]. It is a debilitating and irreversible condition and is described as the “final marker of disease burden for oral health” [9]. As Sussex pointed out from a sociological perspective on the “epidemic of edentulism”, among older New Zealanders, edentulism is influenced by the combined effects of geography, economics, the dental care system and the professional culture, especially economic and social disadvantage [10]. The relationship between ELA and oral health conditions is well established. For example, periodontal disease (PD), the leading cause of tooth loss, is one of the most prevalent chronic inflammatory conditions in the world. Engel's biopsychosocial model offers a more integrative theoretical orientation on how ELAs “get under the skin” to influence oral health outcomes. ELA induced consistent activation of the hypothalamic–pituitary–adrenal axis and the consequent release of the chronic stress hormone cortisol, placing a chronic burden on the body's neuroendocrine and immune functions [11]. The latter contributes to an elevated oral inflammatory load, demonstrated as hyperactive neutrophils that are pivotal to periodontal tissue damage [12]. In addition, studies have shown that a number of ELA, such as poverty and childhood maltreatment, reflect a chronic situation and are linked to particular gene expression patterns, characterized by upregulated transcripts involved in inflammation and downregulated transcripts involved in antiviral responses (termed conserved transcriptional response to adversity; CTRA) [13]. This transcriptional pathway is believed to encourage chronic low-grade inflammation in response to stressful events, providing a mechanistic link between ELA and the emergence of inflammation-related illnesses [14]. In the context of oral health, immune systems dysregulated by ELA may increase susceptibilities to pathogenic bacteria and oral infection, potentially leading to tooth decay or periodontal diseases, one of the proximal causes of tooth loss.

Given that edentulism is relatively common in China with 4.5% of adults aged 65 to 74 years [15], the present study set out to identify ELA with indicators of edentulism among a representative population of 17,610 older adults from 450 villages/urban communities in 150 counties in 28 of China’s 30 provinces excluding Tibet across China, ad to provide an empirical basis for early prevention of edentulism and reduction of the health hazard effects of ELA.

We extended prior work by examining the relative associations of deprivation and threat as two forms of ELAs with edentulism. A recent conceptual model posits that two core underlying dimensions—threat and deprivation—encompass a wide variety of adverse experiences common in childhood [16–18]. Threat includes experiences involving harm or threat of harm, while deprivation involves an absence of expected inputs from the environment, such as cognitive and social stimulation. These dimensions cut across numerous adverse experiences that share the underlying experience of threat or deprivation to varying degrees. We hypothesized that ELA characterized by threat (i.e., physical abuse), in particular, would be associated with edentulism.

Methods

Study sample

Data was derived from the China Health and Retirement Longitudinal Study (CHARLS), which is a high quality nationally representative longitudinal survey of Chinese residents ages 45 or older and their spouses, including assessments of social, economic, and health status [19]. The baseline national wave of CHARLS was being fielded in 150 counties (or districts) and 450 villages (or resident) committees from 28 provinces (or autonomous regions, municipalities) in 2011, and three follow-up surveys were carried out in 2013 (wave 2), 2015 (wave 3) and 2018 (wave 4). Anthropometric measurements of height, weight, waist circumference, lung capacity, grip strength, speed of repeated chair stand, blood pressure, walking speed, and balance tests are conducted at every follow up wave, while blood-sample is collected once in every two follow-up cycles. All data were collected by face-to-face computer-assisted personal interviews (CAPI) with a response rate over 80% at baseline. By the time the follow-up was completed in 2018, the sample had covered a total of 19,000 respondents in 12,400 households.

Data from the baseline (2011) and follow-up waves were used in this investigation (2013, 2014, 2015 and 2018). Only male and female participants aged 50 and older at the time of the 2018 follow-up (n = 17,610; mean [SD] age at baseline, 65.3 [9.4] years) were included in our analytic sample.

Early life adversity exposure

The Life History Survey Questionnaire, which asked individuals if they suffered any of 11 particular adversities before the age of 17, was used to analyze multiple ELA events marked by threat and deprivation in the Wave of 2014. Threat-related ELA included the following six specific adversities: (1) Unsafe community dwelling (Was it safe being out alone at night in the neighborhood where you lived as a child?); (2) Peer bullying (When you were a child, how often were you picked on or bullied by kids in your school? Is it often, sometimes, rarely or never?); (3) Female guardian physical abuse (When you were growing up, did your female guardian ever hit you?); (4) Male
Edentulism

The outcome of interest in the present study is edentulism collected in the waves of 2013, 2015 and 2018. Edentulism was measured through respondent’s report on the core question, “Have you lost all your upper and lower natural permanent teeth?” (1 = yes; 0 = no) [19].

Covariates

Models were adjusted for age at the wave of 2018, baseline hukou residence (1 = rural, 2 = urban), baseline education level (1 = less than primary school, 2 = primary school, 3 = middle school, 4 = equal to or more than high school), marital status at the wave of 2018 (1 = married and lived with the spouse, 2 = widowed; 3 = others), disease history at the wave of 2018 (hypertension, diabetes, dyslipidemia, pulmonary disease, heart disease, kidney disease, disability, and depressive symptoms) and body mass index (BMI), of which BMI was from the physical examination questionnaire in 2015.

Statistical analysis

Stata 16.0 was used to analyze the data. First, descriptive statistics were calculated for the demographic factors (age, gender, education, hukou residence, and marital status), edentulism, ELA categories, and disease history.

Second, bivariate analysis employing Chi-square tests were used to investigate the association between edentulism prevalence and demographic factors as well as various types of ELA exposure. Third, logistic regression analyses were used to calculate the odds ratio and associated 95% confidence intervals (CIs) for various types of ELA exposure in connection to edentulism in males and females individually. We controlled for age, BMI, self-perceived health, education, hukou domicile, marital status, disease history, and threat/deprivation-related ELA in the results shown here. All statistical analyses were performed with a significance threshold of 0.05.

Results

Descriptive statistics for key variables are presented in Table 1. A total of 17,610 older adults in China were included in the study. Nearly 15.9% of older adults with an average age of 63.6 years (SD = 9.4, ranged 50–118 years) had lost all permanent teeth. Prevalence of edentulism was higher in older age groups, and was lower in adults who are male, married and living with the spouse, as well as those living in urban areas. Participants who experienced three or more types of threat-related ELA had a higher rate of edentulism (26.0%) than participants with no deprivation-related ELA (16.1%). Older adults who experienced three or more types of deprivation-related ELA had a higher rate of edentulism (24.0%) than participants with no deprivation-related ELA (13.6%).

Associations between distinct dimensions of ELA and edentulism are presented in Table 2. Logistic regression analysis showed threat, instead of deprivation, was associated with edentulism in Chinese adults aged 50 and older. Two types of threat-related ELA exposure were associated with 1.65-fold and 1.73-fold higher risk for edentulism in both male (95% CI 1.23, 2.21) and female participants (95% CI 1.31, 2.29) than those with no threat-related ELA exposure; three or more threat-related ELA exposure was associated with 3.15-fold and 3.37-fold higher risk for edentulism in both male (95% CI 2.34, 4.24) and female participants (95% CI 2.49, 4.56).

Discussion

The present study investigated the association of deprivation and threatening early growth adversity ELA with edentulism in this nationally representative sample of Chinese older adults and discovered that threat, but not deprivation, was associated with edentulism. High exposure to threat-related ELA was linked to edentulism in a dose–response relationship, with a significant 3.15- and 3.37-fold increase in the risk of edentulism among older men and women, respectively.

Our finding demonstrated that 15.9% of the Chinese older population reported edentulism, which is slightly
higher than national studies from US and Australia. The US Centers for Disease Control and Prevention (CDC) reported that the prevalence of edentulism in people aged 65 years and older was 12.9% in 2015–2018 [20]. Data from Australian National Adult Oral Health Study 2017–2018 reported a prevalence of 8.1% of edentulism in people aged 55–74 years [21]. However, our current finding on the prevalence of edentulism is similar with data from India (16.3%) and Russia (18%) according to the World Health Organization (WHO) Study on Global Ageing and Adult Health (SAGE) Wave 1 [22]. The higher detection rate of edentulism in the Chinese elder population compared to that of the USA and Australia might be associated with patterns of infrequent preventive dental care and lower national awareness about the importance of oral health. In addition, nearly 90% of Australians have access to fluoridated drinking water, and nearly 97% of Australian children and adults brush their teeth daily with fluoride toothpaste [23].

### Table 1: Participant characteristics

| Characteristic | N   | %/mean (SD) | Edentulism, % | N   | %/mean (SD) | Edentulism, % |
|----------------|-----|-------------|---------------|-----|-------------|---------------|
| Edentulism     | 16,868 | 15.9 | | Deprivation | 15,049 | 12.0 (1.9) |
| Sociodemographic covariates | | | | Biological mother absent | 15,049 | 7.2 |
| Sex            | 17,610 | | | 1 | 6841 | 45.5 |
| Female         | 9200 | 52.2 | 17.3 \(^{b}\) | 2 | 3430 | 22.8 |
| Male           | 8410 | 47.8 | 14.4 | ≥ 3 | 1455 | 9.7 |
| Education      | 17,610 | | | Marital status | 17,610 |
| < Primary      | 7931 | 45.0 | 22.6 \(^{b}\) | Married and lived with spouse | 13,700 | 77.8 |
| Primary school | 3597 | 20.4 | 13.6 \(^{b}\) | Widowed | 2475 | 14.1 |
| Middle school  | 3894 | 22.1 | 8.8 \(^{b}\) | Others | 1435 | 8.1 |
| ≥ High school  | 2188 | 12.4 | 7.2 | Hukou residence | 17,610 |
| Early life adversity (W1) | | | | Rural | 10,008 | 56.8 |
| Threat         | 15,323 | 0.9 (1.1) | | Urban | 7602 | 43.2 |
| Unsafe community dwelling | 15,323 | 8.5 | 21.7 \(^{a}\) | Current health conditions | 10,490 | 24.0 |
| Peer bullying   | 15,323 | 13.0 | 16.2 | Hypertension | 10,490 | 23.1 |
| Female guardian physical abuse | 15,323 | 23.7 | 18.8 \(^{a}\) | Diabetes | 10,490 | 5.9 |
| Male guardian physical abuse | 15,323 | 16.2 | 20.1 \(^{a}\) | Dyslipidemia | 10,490 | 10.4 |
| Sibling beat    | 15,323 | 6.2 | 20.5 \(^{a}\) | Pulmonary diseases | 10,490 | 10.7 |
| Parental conflict | 15,323 | 21.2 | 17.3 \(^{a}\) | Heart diseases | 10,490 | 20.1 |
| 0              | 7628 | 49.8 | 16.1 | Kidney diseases | 10,490 | 6.7 |
| 1              | 3945 | 25.7 | 16.7 | Disability | 13,983 | 3.3 |
| 2              | 2168 | 14.1 | 18.7 \(^{b}\) | Depressive symptoms | 15,323 | 18.9 |
| ≥ 3            | 1582 | 10.3 | 26.0 \(^{b}\) | Alcohol drinking | 17,610 | 26.0 |
| Age            | 17,610 | 10.9 (1.1) | | Current smoke | 17,610 | 15.1 |

\(^{a}\) Compared with no adversity exposure group
\(^{b}\) Compared with the lowest group

P < 0.05; \(^{\#}\) P < 0.01; \(^{\parallel}\) P < 0.001

### Table 2: The associations between distinct dimensions of early life adversity and edentulism

| Early life adversity (ELA) | Adjusted odds ratio (95%CI) |
|----------------------------|-----------------------------|
|                            | Male                       | Female                     |
| Threat-related ELA\(^{a}\) |                           |                            |
| 0                          | Ref                        | Ref                        |
| 1                          | 1.44 (1.12, 1.86)\(^{b}\)  | 1.19 (0.95, 1.49)          |
| 2                          | 1.65 (1.23, 2.21)\(^{a}\)  | 1.73 (1.31, 2.29)\(^{a}\)  |
| ≥ 3                        | 3.15 (2.34, 4.24)\(^{a}\)  | 3.37 (2.49, 4.56)\(^{a}\)  |
| Deprivation-related ELA\(^{b}\) |                     |                            |
| 0                          | Ref                        | Ref                        |
| 1                          | 0.85 (0.64, 1.14)          | 1.08 (0.83, 1.39)          |
| 2                          | 0.82 (0.60, 1.13)          | 1.20 (0.90, 1.59)          |
| ≥ 3                        | 0.97 (0.68, 1.39)          | 1.25 (0.90, 1.73)          |
| Age                        | 1.10 (1.09, 1.11)\(^{a}\)  | 1.09 (1.08, 1.10)\(^{a}\)  |

\(^{a}\) Adjusted for age, BMI, education, household annual income, hukou residence, marital status, disease history and deprivation-related ELA
\(^{b}\) Adjusted for age, BMI, education, household annual income, hukou residence, marital status, disease history and threat-related ELA

P < 0.05; \(^{\#}\) P < 0.01; \(^{\parallel}\) P < 0.001
role in preventing dental caries in Australia [24, 25]. As
dental caries is considered a major cause of tooth loss
[26], caries prevention reduces the risk of tooth loss.

Our study has the following advantages, First CHARLS
represents the samples of the middle-aged and the
elderly, through a rigorous multi-stage probability sam-
pling procedure to select study participants, and use
effective quality control, which contains a wide range of
information, meet the science related to the aging prob-
lem and the need of policy research, and in harmony with
the leading international research, Ensure cross-study comparability of results [19]. Second, this survey is the
first to study the relationship between ELA and edentu-
ivism through two dimensions of abuse and deprivation,
which is innovative.

There are several limitations in this research. First,
the self-reported nature of edentulism assessment may
lead to biased information. However, previous stud-
ies have shown relatively high agreement between the
self-reported and clinically-assessed number of teeth in
national surveys [27]. Second, the current study obtained
ELA through retrospective self-report, which is inevi-
tably subject to recall bias. Third, detailed information
on the cause and duration of tooth loss, as well as peri-
odental diseases or oral hygiene behaviors at different life
stages, is not available in the present study. Fourth, this
report only stays in quantitative research and lacks qual-
itative research, which needs to be further supplemented
in subsequent studies. Furthermore, specific clinical data
on dental health status at each life stage would be use-
ful to investigate the mechanisms whereby ELA affects
dental status In older age. Despite the limitations, the
current study is the first study to elucidate the relation-
ship between distinct dimensions of ELA and edentulism
using a representative sample of adults in China.

The current study found an association between threat-
related ELA, instead of deprivation-related ELA, with
risk of edentulism. Most previous studies regarding the
relationships between threat-related ELA and edentulism
focused on single forms of ELA indicators [4]. Thus this
finding is an extension of previous work considering the
complex and interrelated nature of co-occurring expo-
sure to ELA-related threats. The mechanism by which
threat-related ELA causes edentulism is unclear. Recent
evidence shows the association between ELA involving
threats (e.g., violence exposure) with accelerated biol-
ogical ageing across multiple indicators [28, 29], e.g., tel-
omere shortening. Telomere length has been associated
with impaired periodontal homeostasis and the patho-
physiology of periodontitis [30], and loss of periodontal
attachment has also been negatively correlated with tel-
omere length, resulting in alveolar bone resorption [31]
and possibly tooth loss.

In contrast, individuals exposed to deprivation-
related ELA—including those characterized by neglect,
lack of primary caregivers and chronic material depri-
vation (food shortage)—do not tend to exhibit a high
risk for edentulism that is associated with threat. This
finding is consistent with the 2012 Health and Retire-
ment Study (HRS) in the United States demonstrating
childhood financial hardship was not associated with
odds of edentulism in later life [32]. Changes in social
and economic position throughout the course of a per-
son’s life may have a greater impact on their oral health
later in life than ELA exposure associated with depriva-
tion. In contrast, current research suggests that people
who suffer deprivation are more likely to have ongoing
challenges in a number of cognitive domains, includ-
ing linguistic skills and executive functioning [33, 34].
Future research on the probable mechanisms by which
dental care services and teeth loss are influenced by dis-
advantaged childhood environments would be helpful.

The present study provides support for the associa-
tion between ELA with edentulism in a representative
sample of the older Chinese population. ELA preven-
tion ought to be taken into account when developing
appropriate preventive measures and treatments to
enhance child welfare and parent–child connections,
which may eventually aid in reducing oral health dis-
parities. By encouraging early intervention and facili-
tating suitable preventive treatment, policies and
initiatives seeking to reduce lifetime cumulative expo-
sures to adversities will close the oral health gap.

Conclusions
Our finding demonstrates that a specific dimension
of ELA (i.e., threat but not deprivation) was associ-
ated with edentulism in the representative sample of
older adults in China, provides preliminary evidence
of biological aging in oral health effects of the different
dimensions of ELA. Future research should clarify the
biological pathways between different dimensions of
ELA and increased risk of edentulism.

Abbreviations
ELA: Early life adversity; CHARLS: China Health and Retirement Longitudinal
Study; JAGES: Japan Gerontological Evaluation Study; CDC: Centers for Disease
Control and Prevention; HDI: Human Development Index; BMI: Body Mass
Index; WHO: World Health Organization; SAGE: Study on Global Ageing and
Adult Health; HRS: Health and Retirement Study; SD: Standard Deviation; CI:
Confidence interval; OR: Odds ratio.

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Author contributions
All authors have made substantial contributions to conception and design of the study. SY and CX conceptualized and designed this study. SY analyzed and interpreted the data. TZQ, CX, SY, LY and HCL revised manuscript for intellectual content. All authors read and approved the final manuscript.

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Availability of data and materials
Please contact China Health and Retirement Longitudinal Study (CHARLS) for data requests at http://charls.pku.edu.cn/.

Declarations

Ethics approval and consent to participate
This paper used data from China Health and Retirement Longitudinal Study (CHARLS). Ethical approval for all the CHARLS waves was granted from the Institutional Review Board at Peking University. The IRB approval number for the main household survey, including anthropometrics, is IRB00001052-11015; the IRB approval number for biomarker collection, was IRB00001052-11014. All participants signed the informed consent at the time of participation.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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