



Experience of childhood abuse and later number of remaining teeth in older Japanese: a life-course study from Japan Gerontological Evaluation Study project

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Keywords:	Dental Health, Epidemiology, Tooth loss, Public health
Abstract:	<p>Objectives: From a life-course perspective, adverse childhood experiences (ACEs) such as childhood abuse are known risk factors for adult diseases and death throughout life. ACEs could also cause poor dental health in later life because they could induce poor dental health in childhood, initiate unhealthy behaviors, and lower immune and physiological functions. However, it is not known whether ACEs have a longitudinal adverse effect on dental health in older age. This study aimed to investigate the association between experience of childhood abuse until the age of 18 and current number of remaining teeth among a sample of older Japanese adults.</p> <p>Methods: A retrospective cohort study was conducted using the data from the Japan Gerontological Evaluation Study (JAGES); a large-scale, self-reported survey in 2013 including 27,525 community-dwelling Japanese aged ≥ 65 years (response rate=71.1%). The outcome, current number of remaining teeth was used categorically: ≥ 20, 10–19, 5–9, 1–4, and no teeth. Childhood abuse was defined as having any experience of physical abuse, psychological abuse, and psychological neglect up until the age of 18 years. Ordered logistic regression models were applied.</p> <p>Results: Of the 25,189 respondents who indicated their number of</p>

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	<p>remaining teeth (mean age: 73.9; male: 46.5%), 14.8% had experience of childhood abuse. Distributions of ≥ 20, 10-19, 5-9, 1-4, and no teeth were: 46.6%, 22.0%, 11.4%, 8.2%, and 11.8% among respondents with childhood abuse; while 52.3%, 21.3%, 10.3%, 6.6%, and 9.5% among respondents without childhood abuse. Childhood abuse was significantly associated with fewer remaining teeth after adjusting for covariates including socioeconomic status (odds ratio=1.14; 95% confidence interval: 1.06, 1.22).</p> <p>Conclusions: Childhood abuse could have a longitudinal adverse effect on later dental health in older age. This study emphasizes the importance of early life experiences on dental health throughout later life.</p>

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Title

Experience of childhood abuse and later **number of remaining teeth** in older Japanese:
a life-course study from Japan Gerontological Evaluation Study project

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Running title

Childhood abuse and number of teeth in older Japanese

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1 **Abstract**

2 **Objectives:** From a life-course perspective, adverse childhood experiences (ACEs) such
3 as childhood abuse are known risk factors for adult diseases and death throughout life.

4 ACEs could also cause poor dental health in later life because they could induce poor
5 dental health in childhood, initiate unhealthy behaviors, and lower immune and
6 physiological functions. However, **it is not known whether ACEs have a longitudinal**
7 **adverse effect** on dental health in older age. **This study aimed to** investigate the
8 association between experience of childhood abuse until the age of 18 and current
9 number of remaining teeth among a sample of older Japanese adults.

10 **Methods:** A retrospective cohort study was conducted using the data from the Japan
11 Gerontological Evaluation Study (JAGES); a large-scale, self-reported survey in 2013
12 including 27,525 community-dwelling Japanese aged ≥ 65 years (response rate=71.1%).
13 The outcome, current number of remaining teeth was used categorically: ≥ 20 , 10–19, 5–
14 9, 1–4, and no teeth. Childhood abuse was defined as having any experience of physical
15 abuse, psychological abuse, and psychological neglect up until the age of 18 years.
16 Ordered logistic regression models were applied.

17 **Results:** Of the 25,189 respondents who indicated their number of remaining teeth
18 (mean age: 73.9; male: 46.5%), 14.8% had experience of childhood abuse. Distributions
19 of ≥ 20 , 10–19, 5–9, 1–4, and no teeth were: 46.6%, 22.0%, 11.4%, 8.2%, and 11.8%
20 among respondents with childhood abuse; while 52.3%, 21.3%, 10.3%, 6.6%, and 9.5%
21 among respondents without childhood abuse. Childhood abuse was significantly
22 associated with fewer remaining teeth after adjusting for covariates including
23 socioeconomic status (odds ratio=1.14; 95% confidence interval: 1.06, 1.22).

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24 **Conclusions:** Childhood abuse could have a longitudinal adverse effect on later dental
25 health in older age. This study emphasizes the importance of early life experiences on
26 dental health throughout later life.

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29 Introduction

30 The World Health Organization has highlighted **that** a good start to life should
31 be ensured for every child **in order** to provide the foundations for health and well-being
32 and to tackle health inequalities, **which can be observed even in the earliest stage of life**¹.
33 Every child has the right to live a healthy life free from violence². However, many
34 children have adverse childhood experiences (ACEs). For example, in Japan, 31.9% of
35 adults³ and worldwide 38.8% of adults⁴ have experienced one or more ACEs, **such as**
36 **interpersonal loss, parental substance abuse, physical or sexual abuse, neglect, and**
37 **economic adversity** during their childhood. Reducing ACEs is therefore an important
38 public health issue¹.

39 Life-course epidemiology has highlighted that ACEs are risk factors for later
40 adult diseases and death⁵. Two conceptual life-course models, critical period model and
41 accumulation of risk model, are suggested as possible pathways. In the critical period
42 model, exposures during critical or sensitive periods irreversibly change anatomical
43 structures, such as the hypothalamic–pituitary–adrenal axis, or psychological functions
44 and could result in disease later in life. In the accumulation of risk model, exposures in
45 early life stages and other risk factors accumulate throughout life and, in turn, damage
46 health later in life either independently or by interacting with each other^{6–8}.

47 ACEs could have a longitudinal adverse effect on oral health. In the critical
48 period model, physically abused children's teeth are sometimes injured. Fractured and
49 avulsed teeth were found among physically abused children, suggesting that the teeth of
50 abused children were injured by physical violence from a parent^{9,10}. If permanent teeth
51 were injured, later oral health would be influenced. Severe chronic stress induced by
52 ACEs could alter children's hypothalamic–pituitary–adrenal axis function and could

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6 53 irreversibly damage their immune systems¹¹. A compromised immune system is
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8 54 associated with periodontal disease in adulthood¹². Individuals who have experienced
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10 55 ACEs tend to exhibit addictive and unhealthy behaviors¹³ because their inhibitory
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12 56 control system has been damaged¹⁴. Such people tend to consume 'comfort' foods (such
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14 57 as energy-dense foods high in sugar and/or fat) to cope with stress¹⁵⁻¹⁷. Consumption of
15
16 58 these sugary food items is associated with both dental caries and overweight/obesity¹⁸.
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18 59 These eating habits in childhood could persist into adulthood^{19,20} and might contribute
19
20 60 to later poor dental health. Moreover, people with ACEs feel daily stress, which might
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22 61 result in a lower salivary flow rate through sympathetic nerve functioning²¹. A low
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24 62 salivary flow rate is a recognized risk factor for dental caries²². Thus, it is reasonable to
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26 63 assume that ACEs might induce poor dental health in adulthood.
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30 64 Among ACEs, childhood abuse warrants particular attention for dental health
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32 65 later in life since it could cause poor dental health in childhood. Valencia-Rojas et al.
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34 66 (2008) reported an association between child abuse and early childhood caries among
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36 67 Canadian children²³. Other studies have found an association between high levels of
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38 68 paternal punishment in childhood and dental injuries as well as dental caries
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40 69 experience^{24,25}. However, there are only a few life-course studies focusing on the effects
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42 70 of early childhood abuse on dental health outcomes in older age. With regard to dental
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44 71 health in middle age, Nicolau et al. (2007) reported that people with high paternal
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46 72 punishment in childhood had clinically examined poorer periodontal status at age 40¹².
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48 73 Listl et al. (2014) reported that people with childhood financial hardship had poorer
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50 74 chewing ability at 50 years of age²⁶. However, to our knowledge, no previous studies
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52 75 have examined the harmful effects of childhood abuse on dental health in older age. In
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54 76 particular, no study has examined the effect on tooth loss in middle or older age, which
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6 77 reflects one's dental health status across the life-course. We aimed to investigate the
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8 78 association between experience of childhood abuse and the number of remaining teeth
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10 79 among older adults in Japan.
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13 81 **Methods**

14 82 Study design and setting

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18 83 This study was a retrospective cohort study investigating the association between
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21 84 experience of childhood abuse and current dental health status in older age. We used
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23 85 data from the Japan Gerontological Evaluation Study (JAGES) project, in particular
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25 86 from the 2013 JAGES survey which was conducted between October 2013 and
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27 87 February 2014. JAGES is an ongoing prospective cohort study aiming to investigate the
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29 88 association between social and behavioral factors and community-dwelling older
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31 89 people's health in multiple cities in Japan²⁷. In the 2013 JAGES survey, 30
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33 90 municipalities in 14 of the 47 prefectures in Japan were included. Self-administered
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35 91 questionnaires were mailed to 193,694 community-dwelling residents aged ≥ 65 years.
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37 92 Random sampling from small administrative regions was used to select participants in
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39 93 17 large municipalities, while all eligible residents in 13 small municipalities were
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41 94 included. One in five participants were randomly sent the questionnaire containing
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43 95 questions on experience of childhood abuse (N=38,731).
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48 97 Measurement

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51 98 We used the number of remaining teeth for the outcome. The data were gathered using
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53 99 the following single question: "How many remaining teeth do you have? Including teeth
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55 100 covered by crowns. The total number of remaining teeth of an adult, including wisdom
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6 101 teeth, should be 32.” Response choices were: ≥ 20 teeth, 10–19 teeth, 5–9 teeth, 1–4
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8 102 teeth, and no teeth. **Self-reported number of teeth was used in another study²⁸**. We coded
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10 103 these five categories from “ ≥ 20 teeth” as 1 to “No teeth” as 5 and used these as an
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12 104 ordered variable for the analyses.

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14 105 Our main predictor was experience of childhood abuse up to the age of 18,
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16 106 which was determined from the following three questions with response choices of
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18 107 “Yes/No”: “I was beaten by a parent and injured”, (Answering “Yes” meant having an
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20 108 experience of physical abuse), “I was insulted and verbally abused by a parent”
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22 109 (Answering “Yes” meant having an experience of psychological abuse), and “I have
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24 110 been loved by a parent” (Answering “No” meant having an experience of psychological
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26 111 neglect). These questions were derived from the Adverse Childhood Experiences
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28 112 Study²⁹. We defined having any one of these experiences as a main exposure.

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30 113 **The following** variables were adjusted to estimate the independent effect of
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32 114 childhood abuse: age (65-69, 70-74, 75-79, 80-84, and ≥ 85 years old), sex
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34 115 (male/female), economic adversity in childhood (Yes/No), years of education (<6, 6-9,
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36 116 10-12, and ≥ 13), longest occupation (“high occupational status”: professional/technical
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38 117 and administrative positions, and “low occupational status”: clerical, sales/service and
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40 118 skilled/labor positions, agriculture/forestry/fishery workers, the self-employed, other
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42 119 occupations, and those with no occupation), and current household equivalent annual
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44 120 income (“low”: <16,000 USD, “middle”: 16,000-24,999 USD, and “high”: $\geq 25,000$
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46 121 USD; 100 JPY=1 USD), self-reported co-morbid status (diabetes/stroke/depression),
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48 122 and smoking status (current smoker/cessation/never smoker).

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55 124 Statistical analyses

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6 125 Multivariable ordered logistic regression models were fitted to estimate the
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8 126 odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth.
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10 127 We first examined crude association (model 1) and adjusted for age and sex (model 2).
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12 128 Then, we constructed a model to evaluate how socioeconomic status (SES) explains the
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14 129 association (model 3) and a model in which all covariates were adjusted (model 4).
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16 130 Additionally, we examined the association between number of remaining teeth and each
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18 131 type of childhood abuse experience as well as the total number of childhood abuse
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20 132 experiences. People with missing information on the number of remaining teeth were
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22 133 excluded from the analyses. Missing information on other variables was categorized as
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24 134 dummy variables at first. Then, to account for bias due to missing information, we
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26 135 assumed missing at random and created ten multiple imputed datasets using the
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28 136 multivariate normal imputation method³⁰. All variables in our main models were
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30 137 included in the imputation models. Estimated parameters were combined using Rubin's
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32 138 combination methods³¹. All analyses were conducted using Stata 13.1 software (Stata
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34 139 Corp, College Station, TX).

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41 141 Ethical considerations

42 142 Ethical approval for this study was obtained from the Ethics Committee at Nihon
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44 143 Fukushi University (13-14). The questionnaires with encrypted codes and explanations
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46 144 of this study were sent to the participants by mail. Therefore, the researchers cannot
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48 145 identify individual participants. The participants were informed that their participation
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50 146 was voluntary and returning the self-administered questionnaire by mail was taken as
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52 147 consent.

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149 **Results**

150 Of the 38,731 people who were mailed the survey, 27,525 responded (response
151 rate=71.1%). After excluding those whose information on sex and age was missing or
152 invalid and those whose information on the number of remaining teeth was missing,
153 25,189 (65.0%) participants were included in the final analyses (mean age was 73.9
154 (standard deviation = 6.2, ranged between 65 and 100); male =46.5%). The prevalence
155 of any experience of childhood abuse was 14.8% (1.4% physical abuse, 5.3%
156 psychological abuse, 11.3% psychological neglect; 12.1%, 2.1%, and 0.6% had one, two,
157 and three types of abuse, respectively). The characteristics associated with fewer
158 remaining teeth were having an experience of childhood abuse, older age, male sex,
159 having economic adversity in childhood, low years of education, low occupational
160 status, low income, diabetes, stroke, and current smoking (Table 1).

161 Ordered logistic regression analyses using multiply imputed datasets to account
162 for bias due to missing information showed that an experience of any type of childhood
163 abuse was significantly associated with fewer remaining teeth (model 1: OR [95% CI] =
164 1.27 [1.19, 1.35]) (Table 2). The association was significant after adjusting for age and
165 sex (model 2: OR [95% CI] =1.28 [1.20, 1.37]). SES partly attenuated the association
166 (model 3: OR [95% CI] =1.15 [1.08, 1.23]), and it remained significant after adjusting
167 for other covariates (model 4: OR [95% CI] =1.14 [1.06, 1.22]). In addition, each type
168 of childhood abuse was significantly associated with fewer remaining teeth (Table 3).
169 The ORs increased as the number of different types of childhood abuse increased.
170 Analyses including missing predictor information as dummy variables showed similar
171 outcomes (Appendices 1 & 2).

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6 173 **Discussion**

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8 174 We found a significant association between experience of childhood abuse and
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10 175 fewer remaining teeth in older age. Experience of childhood abuse increased the risk of
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12 176 having fewer remaining teeth by 14% after controlling for covariates. Each type of
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14 177 childhood abuse had a significant association, and a biological gradient was observed.

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17 178 This is the first study to investigate the long-term adverse effect of childhood
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19 179 abuse on dental health in older age. We used large samples from 30 municipalities in
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21 180 Japan. However, this study has several limitations. First, recall bias may have been
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23 181 present since older respondents retrospectively answered questions about their
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25 182 experience of childhood abuse. However, we targeted community-dwelling,
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27 183 non-disabled older residents and Havari and Mazzonna (2011) reported that older
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29 184 people robustly remember their childhood circumstances³². In addition, we adjusted for
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31 185 depression, which can induce recall bias for experience of childhood abuse. Thus, we
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33 186 believe the problem of recall bias is not a serious flaw in this study. Second, we used a
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35 187 self-reported outcome. However, the validity of the self-reported number of remaining
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37 188 teeth was elucidated using clinical examination data from the sample of JAGES 2010
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39 189 survey³³. Third, we could not consider respondents' dental health status in childhood or
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41 190 their dental health behavior because of a lack of information. However, these are not
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43 191 confounders because it is unreasonable to assume that poor dental health or unhealthy
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45 192 dental health behavior causes child abuse. Rather, they are mediators that connect
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47 193 childhood abuse to poor dental health in older age. Thus, experience of childhood abuse
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49 194 is associated with fewer remaining teeth in older age even if the association is explained
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51 195 by poor dental health or unhealthy dental behavior. Fourth, because of lack of
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53 196 information, the reason and age of losing teeth were unknown. Furthermore specific
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6 197 clinical data on dental health status (e.g. periodontitis and dental caries) at each life
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8 198 stage would be useful to investigate the mechanisms whereby child abuse affects dental
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10 199 status in older age. Fifth, we could not evaluate sexual abuse because it might recall the
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12 200 severe traumatic experience. Sexual abuse is known as a severe risk factor for adult
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14 201 disease⁴ and thus, could have a strong harmful longitudinal effect on dental health in
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16 202 older age. Sixth, external validity might be limited because our samples were not
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18 203 randomly selected from older Japanese population, and sampling rate differ among
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20 204 cities; however, the distribution of number of remaining teeth was similar to that of the
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22 205 Japanese national sample (data not shown). Seventh, residual confounding might exist
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24 206 because the association between experience of childhood abuse and number of
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26 207 remaining teeth was not large.

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30 208 Although there has been little focus on the association between experience of
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32 209 childhood abuse and dental health in older populations, our study is consistent with
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34 210 previous life-course studies on ACEs and dental health in adulthood^{26,34-36}. Poulton et al.
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36 211 (2002) investigated the long-lasting negative influences of socioeconomic disadvantage
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38 212 on adult dental health; people who grew up in families with low SES had a threefold
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40 213 increase in adult periodontal disease and dental caries at the age of 26³⁴. The association
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42 214 remained significant when Thomson et al. (2004) additionally considered dental health
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44 215 status in childhood³⁵. However, these studies focused only on early adult or middle-aged
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46 216 populations. To our knowledge, our present study is the first to investigate the
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48 217 association between experience of childhood abuse and dental health in an older
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50 218 population.

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53 219 One of the major reasons for tooth loss in Japan is dental caries and their
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55 220 sequela³⁷, and it is reasonable to expect that older people with experiences of childhood

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6 221 abuse to have more dental caries during childhood^{23,24,38}. Children who are abused by
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8 222 their caregivers tend to have dental neglect³⁹. In addition, such children tend to prefer
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10 223 comfort foods (such as these containing high sugar) and sweet taste because of their
11
12 224 high stress and damaged inhibitory control systems^{17,40}. Unfortunately, these exposures,
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14 225 which cause dental caries, have a major effect in this critical period because children's
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16 226 young permanent teeth are more susceptible to demineralization⁴¹.

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19 227 Another major reason for tooth loss in Japan is periodontal disease³⁷, and child
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21 228 abuse might influence fewer remaining teeth in older age via periodontal disease. A
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23 229 study of a middle-aged population showed that adults who experienced high levels of
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25 230 paternal punishment during childhood had poor periodontal status at the age of 40¹².
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27 231 Adults with childhood abuse experience are more likely to smoke¹³ and thus, easily
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29 232 develop periodontal disease. In addition, some previous studies have suggested that
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31 233 children with ACEs have impaired immune systems and altered hypothalamic function,
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33 234 which affects the adaptive responses of organs to stressors¹¹. An epigenetic DNA
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35 235 modification is suggested to be associated with this change, which could last until
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37 236 adulthood¹¹. This could make people vulnerable to stress- and immune function-related
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39 237 diseases, such as periodontal disease¹².

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42 238 SES would be one of the other risk factors linking experience of childhood
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44 239 abuse and fewer remaining teeth in older age. Children who experience abuse are more
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46 240 likely to have low SES in adulthood and at older ages⁴². Low SES is associated with
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48 241 dental diseases and unhealthy behavior⁴³. In fact, the association between experience of
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50 242 child abuse and number of remaining teeth in older age was partly explained by SES in
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52 243 the present study.
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6 244 The importance of childhood circumstances is recognised by the World Health
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8 245 Organization¹. To reduce child abuse requires multi-strategy approaches operating at
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10 246 individual, social, societal and community levels². Societal and community strategies
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12 247 include development of legal frameworks such as banning any physical punishment of
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14 248 children. Social relationship strategies include home visitation programs and training
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16 249 programs for parents to improve their parenting skills. In Japan, home visitation
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18 250 programs at age of 1-2 months and age of 4 months are conducted, however, it is
19
20 251 questionable whether two home visits would reduce parents' stress⁴⁴. Individual
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22 252 strategies include increasing access to pre-and postnatal welfare services and support.
23
24 253 **Such multilevel strategies might be able to reduce child abuse.**

254

255 **Conclusion**

256 This study showed that older people with experience of childhood abuse had
257 significantly fewer remaining teeth at age ≥ 65 . Our study highlighted the importance of
258 the early stages for dental health throughout life. **Legal frameworks to prevent child
259 abuse, building social relationships for parents, and spreading welfare service
260 information would enhance** a good start in life for all children, and such **strategies** may
261 also have a beneficial effect on oral health across the life-course.

262

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Table 1. Participant demographic characteristics and number of remaining teeth before applying multiple imputations (n=25,189)

	No. of remaining teeth					
	Total n	20+ %	10-19 %	5-9 %	1-4 %	0 %
Total	25189	50.6	21.5	10.6	7.0	10.2
Experience of childhood abuse						
No	20211	52.3	21.3	10.3	6.6	9.5
Yes	3730	46.6	22.0	11.4	8.2	11.8
Missing	1248	35.3	22.9	14.0	10.3	17.5
Age years old)						
65-69	7139	63.9	20.4	7.4	4.1	4.2
70-74	7554	55.8	22.6	9.5	5.5	6.6
75-79	5585	44.4	22.3	12.7	8.6	12.1
80-84	3370	34.0	21.8	14.5	10.6	19.2
≥85	1541	21.8	18.7	14.8	14.8	29.9
Sex						
Male	11700	49.0	21.4	10.8	7.5	11.3
Female	13489	52.0	21.6	10.4	6.6	9.3
Economic adversity in childhood						
No	12588	52.3	21.0	10.4	6.5	9.7
Yes	11230	50.2	22.0	10.4	7.2	10.1
Missing	1371	38.0	22.7	13.6	9.8	15.9
Years of education						
<6	418	23.9	19.6	14.8	12.4	29.2
6-9	9888	42.2	22.8	12.6	8.8	13.7
10-12	9268	55.4	21.4	9.6	5.7	7.9
≥13	5131	61.4	19.4	8.1	5.2	5.9
Missing	484	38.8	22.3	13.4	10.7	14.7
Occupation						
High occupational status	5346	57.3	20.6	8.9	5.8	7.5
Low occupational status	16731	50.5	21.3	10.7	7.0	10.5
Missing	3112	39.6	24.1	13.3	9.2	13.8
Income						
Low	7836	43.8	22.9	12.5	8.5	12.3
Middle	6347	56.3	21.2	8.7	6.0	7.8
High	6202	59.9	19.3	8.4	4.9	7.5

1		Missing	4804	42.2	22.5	12.8	8.9	13.6
2								
3	Diabetes							
4		No	20395	51.3	21.4	10.4	7.0	9.9
5		Yes	3380	46.0	22.4	12.0	7.5	12.2
6		Missing	1414	51.7	21.1	11.0	6.2	10.0
7								
8	Depression							
9		No	23518	50.5	21.5	10.6	7.1	10.3
10		Yes	257	49.4	21.8	14.0	6.2	8.6
11		Missing	1414	51.7	21.1	11.0	6.2	10.0
12								
13	Stroke							
14		No	22948	50.8	21.6	10.5	7.0	10.1
15		Yes	827	42.2	21.0	12.5	9.9	14.4
16		Missing	1414	51.7	21.1	11.0	6.2	10.0
17								
18	Smoking status							
19		Current smoker	2554	38.1	24.8	13.0	8.9	15.1
20		Cessation	3895	49.1	22.1	11.5	7.2	10.2
21		Never smoker	18350	53.0	20.8	10.0	6.7	9.5
22		Missing	390	34.9	25.9	14.6	10.0	14.6
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Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth after applying multiple imputations (n =25,189)

	Model 1		Model 2		Model 3		Model 4	
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
Experience of childhood abuse								
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference
Yes	1.27	(1.19, 1.35)	1.28	(1.20, 1.37)	1.15	(1.08, 1.23)	1.14	(1.06, 1.22)

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Table 3. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth, different type of childhood abuse and its accumulation; after applying multiple imputations (n =25,189); each exposures were separately included into models

	Model 1		Model 2		Model 3		Model 4		
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	
Physical abuse									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.63	(1.35, 1.97)	1.66	(1.37, 2.02)	1.42	(1.17, 1.72)	1.41	(1.16, 1.71)	
Psychological abuse									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.23	(1.11, 1.36)	1.30	(1.18, 1.44)	1.21	(1.09, 1.35)	1.20	(1.08, 1.34)	
Psychological neglect									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.25	(1.16, 1.34)	1.25	(1.16, 1.34)	1.10	(1.02, 1.19)	1.09	(1.01, 1.17)	
Number of childhood abuse									
0	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
1	1.26	(1.17, 1.35)	1.26	(1.17, 1.36)	1.14	(1.06, 1.23)	1.13	(1.05, 1.21)	
≥2	1.32	(1.14, 1.52)	1.38	(1.20, 1.60)	1.20	(1.04, 1.40)	1.19	(1.03, 1.38)	

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, longest occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Appendix 1. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth with missing information on predictors included as dummy variables (n =25,189)

	Model 1		Model 2		Model 3		Model 4	
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
Experience of childhood abuse								
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference
Yes	1.27	(1.19, 1.35)	1.29	(1.20, 1.37)	1.15	(1.07, 1.23)	1.13	(1.06, 1.21)

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Appendix 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth, different type of childhood abuse and its accumulation; missing information on predictors was coded as dummy variables (n =25189); each exposures were separately included into models

	Model 1		Model 2		Model 3		Model 4		
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	
Physical abuse									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.73	(1.43, 2.09)	1.73	(1.43, 2.09)	1.44	(1.19, 1.75)	1.44	(1.18, 1.74)	
Psychological abuse									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.25	(1.13, 1.39)	1.32	(1.19, 1.47)	1.23	(1.11, 1.37)	1.22	(1.10, 1.36)	
Psychological neglect									
No	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
Yes	1.24	(1.16, 1.34)	1.25	(1.16, 1.34)	1.09	(1.01, 1.17)	1.07	(1.00, 1.16)	
Number of childhood abuse									
0	1.00	reference	1.00	reference	1.00	reference	1.00	reference	
1	1.26	(1.17, 1.35)	1.26	(1.17, 1.36)	1.13	(1.05, 1.22)	1.12	(1.04, 1.21)	
≥2	1.32	(1.15, 1.52)	1.40	(1.21, 1.61)	1.21	(1.05, 1.40)	1.19	(1.03, 1.38)	

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, longest occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Table legends

Table 1. Participant demographic characteristics and number of remaining teeth before applying multiple imputations (n=25,189)

Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth after applying multiple imputations (n =25,189)

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Table 3. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer remaining teeth, different type of childhood abuse and its accumulation; after applying multiple imputations (n =25,189); each exposures were separately included into models

Model 1: crude OR

Model 2: model 1 + age and sex were adjusted

Model 3: model 2 + economic adversity in childhood, years of education, longest occupation, and income were adjusted

Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted

Appendix 1. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer

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6 remaining teeth with missing information on predictors included as dummy variables (n
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8 =25,189)

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10 Model 1: crude OR

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12 Model 2: model 1 + age and sex were adjusted

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14 Model 3: model 2 + economic adversity in childhood, years of education, occupation,
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16 and income were adjusted

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18 Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted
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24 Appendix 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for having fewer
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26 remaining teeth, different type of childhood abuse and its accumulation; missing
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28 information on predictors was coded as dummy variables (n =25189); each exposures
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30 were separately included into models
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33 Model 1: crude OR

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35 Model 2: model 1 + age and sex were adjusted

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37 Model 3: model 2 + economic adversity in childhood, years of education, longest
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39 occupation, and income were adjusted

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41 Model 4: model 3 + diabetes, depression, stroke, and smoking status were adjusted
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