

ORIGINAL ARTICLE

Exposure to household dysfunction at childhood and later number of teeth among older Japanese adults: A life course study from the Japan Gerontological Evaluation Study

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Abstract

Objectives: The aim of this retrospective cohort study was to investigate the life course association between exposure to two household dysfunctions (father violence against mother and parental divorce) at childhood (≤ 18 years) with later number of remaining teeth (≥ 65 years) in functionally independent older Japanese population. This was the first study to investigate this research question in the Asian context.

Methods: The Japan Gerontological Evaluation study (JAGES) self-reported retrospective data gathered in 2013 was used ($n = 21,604$). Each household dysfunction was binary variable (Yes/No), while the five categories of the number of remaining teeth were ≥ 20 , 10–19, 5–9, 1–4, and no teeth. Sex-stratified ordered logistic regression models were used to calculate the odds ratios (OR) of having fewer teeth. The models were adjusted for age, economic adversity in childhood, educational attainment, comorbidities, and smoking status.

Results: Overall, 46.4% were men and a total of 1149 participants (5.3%) experienced household dysfunction at childhood [men = 642 (6.4%), women = 507 (4.4%)]. The regression models showed higher OR of having fewer teeth among men who experienced a household dysfunction [OR = 1.16; 95% Confidence interval (CI) = 1.00–1.36] than men who did not. This association was not observed among women [OR = 0.94; 95% CI = 0.79–1.13]. Similar magnitude and direction of the association was observed among men but not among women when the two components of household dysfunction were used separately and aggregated as exposure variables.

Conclusion: An exposure to a household dysfunction at childhood was associated with having fewer teeth in later life among men but not among women.

KEYWORDS

adverse childhood experience, dental public health, divorce, domestic violence, epidemiology

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INTRODUCTION

Adverse childhood experiences (ACEs) were associated with comorbidities such as stroke and depression, limitations to functional capacity and ability of daily living at older age, as well as an extensive list of health risky behaviors such as alcoholism and smoking, and were leading contributors to mortality [1–5]. In addition, gender differences were reported regarding the long-term adverse health, psychologic and economic consequences of exposure to ACEs. The adverse health consequences were stronger in women than men, and behavioral and psychological mechanisms were suggested to explain these gender differences [6–10]. Due to the high prevalence of exposure to at least one ACE; 36.3% among older Japanese adults [4], and 38.6% among adults aged 18 years or older in 39 countries worldwide [11, 12], the target 16.2 of the 2030 Agenda for sustainable development goals (SDGs) was to end violence against children which is an essential component of ACEs [13].

Household dysfunction is one of several parameters of ACEs. According to the World Health Organization (WHO) and several studies, it is considered a precursor of childhood abuse by their parents, or “the cause of the cause” of childhood abuse, which indirectly affect the psychological well-being of children in contrast to other ACEs such as sexual and physical abuse which directly affect it [13–15]. The exposure to household dysfunction in the form of a threat in the case of a father violence against mother and/or in the form of deprivation as in a parental divorce was used in previous studies examining ACEs and general health outcomes [1, 3–5].

On the oral health front, although there were several previous studies that examined the association between exposure to ACEs and later oral health outcomes including a study from our research group in Japan [16, 17], the studies related to exposure to household dysfunction as a component of ACEs and oral health in later life were limited. Only two previous studies from the United States investigated the effect of exposure to a household dysfunction at childhood and oral health in later life [18, 19]. One life course study demonstrated that exposure to parental divorce was associated with higher odds ratios (OR) of total tooth loss in later life [18]. The other study used an accumulated score of eight ACEs including two household dysfunctions (parental divorce and/or separation, and frequency of inter-parental violence). This study demonstrated a gradient increase in the association between the number of ACEs experienced with refraining from in-office dental scaling and with having six or more extracted teeth [19]. Considering that oral diseases are chronic and cumulative in nature and could be studied through applying the life course epidemiology theories such as the critical period and the accumulation of risk models [20], these two studies suggested adverse psycho-behavioral pathways resulting from chronic stress and effects of low socioeconomic status (SES) such as following a high sugar diet at childhood as mechanisms for tooth loss at older age [18, 19].

Thus, the existing evidence about the association between household dysfunction and oral health is insufficient especially in the Asian context. Hence, by targeting a functionally independent population of older adults in Japan, the aim of this study was to investigate the life course association between exposure to two household dysfunctions (father violence against mother and parental divorce) at childhood and the later number of remaining teeth, and to explore the existence of a gender difference in this association.

METHODS

Study design and setting

This study was a retrospective cohort study investigating the life course association between exposure to a household dysfunction at childhood and the later number of remaining teeth. The data gathered in 2013 from the Japan Gerontological Evaluation Study (JAGES) was used in this study. The JAGES is an ongoing cohort investigating the health, social and behavioral statuses of the functionally independent Japanese population aged 65 years and older [21]. In 2013, the JAGES survey was sent by postal mail to 193,694 participants from 30 municipalities located in 14 of the 47 prefectures in Japan. Residents aged 65 years and older were recruited using simple random sampling in 17 large municipalities, while all residents from this age group were recruited in 13 small municipalities. In late 2022 one large municipality withdrew from the JAGES, and its participants' data was deleted from the JAGES datasets because the contracted period for data usage ended. The JAGES survey included main questions that were sent to all the targeted participants, and subsidiary questions that were sent to one in five randomly selected participants within the targeted participants. Questions related to the exposures of this study were part of the subsidiary questions.

Inclusion criteria

The inclusion criteria were answering the subsidiary questions and being a functionally independent participant. Some participants in the JAGES were not functionally independent. The JAGES questionnaire included a question to filter-out these participants. Those who answered “I need and receive nursing care or assistance” to the question “Do you receive nursing care or assistance for walking, bathing, and/or using a toilet in your daily life?” were excluded.

Outcome variables

The outcome variable was the self-reported number of remaining teeth. The JAGES questionnaire included the

following question about the number of remaining teeth “How many natural teeth do you currently have? Natural teeth include replanted teeth, crowned teeth, and wisdom teeth. There is a total of 32 permanent teeth.” With its five categorical answers as follows; “20 or more teeth, 10 to 19 teeth, 5 to 9 teeth, 1 to 4 teeth, and no natural teeth.” Those with missing data about their number of teeth were excluded.

Exposures

The two components of household dysfunction in this study were the exposure to father violence against mother and parental divorce at childhood. The exposure to a household dysfunction at childhood, before the age of 18, was utilized as the main exposure. Then, each of the two components was used as a separate exposure. Followed by an analysis using the aggregated number of exposures to these household dysfunctions as an independent variable. In the JAGES subsidiary questionnaire, the following two questions were used “Did you experience your father being violent with your mother before the age of 18?” and “Did you experience your parents’ divorce before the age of 18?” The answers were binary (yes/no). Retrospective self-reports of exposure to ACEs by older age groups were validated in previous studies showing that older people tend to remember their childhood fairly well, however, with a tendency toward social desirability bias in reporting (i.e., substantial rate of false negative and rare false positive reports of exposure to ACEs) [22, 23].

Confounders

In this study, age, SES, comorbidities, and smoking status measured in 2013 were adjusted as confounders based on prior literature. The exposure to economic adversity at childhood and the years of formal education were used as SES confounders. They were asked using the following

two questions in the JAGES “Did you experience financial trouble before the age of 18.” The answers were binary (Yes/no). And “How many years of formal education have you had?” The answers were “Less than 6 year, 6 to 9 years, 10 to 12 years, 13 years or more and Other.” Based on a previous study from the JAGES examining the association between other ACEs and number of teeth, having stroke, diabetes mellitus, or depression were used as comorbidities representing general health status (binary questions, yes/no) [17]. Also, smoking status is a behavior associated with tooth loss [24, 25]. It was included as a confounder in this study. The JAGES question for smoking status was “Do you smoke cigarettes?” with its categorical answer “Yes, used to smoke, and Never smoked.”

Statistical analysis

Sex-stratified descriptive statistics followed by sex-stratified ordered logistic regression were used to examine the association between the exposures and having fewer teeth. Parametric multivariate imputation by chained equations (MICE) using 100 chained iterations to create 10 imputed datasets was used to address the missing data and to account for the bias of missing information. For sensitivity analyses, and to verify the multiple imputation method, the same analyses were re-examined using a complete dataset scenario after creating dummy variables for the missing data. As supplementary analyses, to verify the sex-difference hypothesis, the data was analyzed after combining men and women together to test the magnitude of the association in the whole sample using the imputed data. In all ordered logistic regression analyses, three models were used; model 1 was age adjusted, model 2 was age and SES adjusted, and model 3 was a fully adjusted model including all confounders. A directed acyclic graphs (DAGitty) version 3.0 was used to illustrate the hypothesized framework of this study (Figure 1). Stata/MP

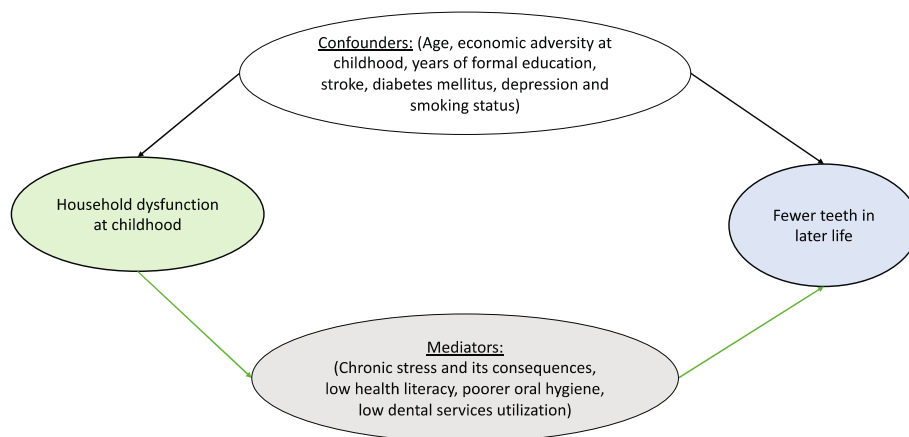


FIGURE 1 The hypothesized framework using the directed acyclic graph (DAG) for the association between exposure to household dysfunction at childhood and later number of teeth. [Color figure can be viewed at wileyonlinelibrary.com]

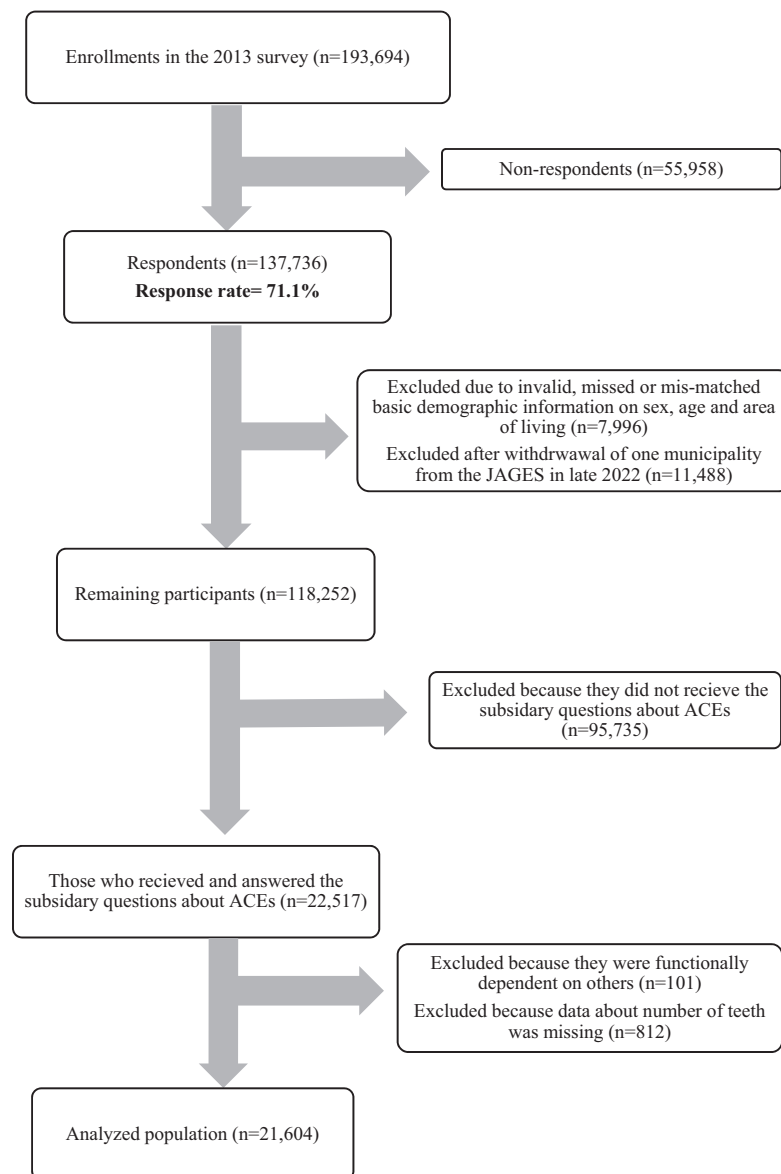
16.1 software from StataCorp LP (College Station, Texas, United States) was used for the analyses, and the STROBE guidelines for cohort studies were followed (Data S1).

Ethical approval

Ethical approval for the JAGES project was obtained from the Ethics Committee of Nihon Fukushi University. Ethical approval for the JAGES 2013 survey and this study was obtained from the same committee, application number (13, 14). Participants were provided with an explanation of the survey and notified that participation was voluntary. Returning an answered questionnaire was considered a consent for participation.

RESULTS

The total number of the analyzed sample of this study was 21,604 participants. Figure 2 showed the flow diagram of the study participants. Tables 1 and 2 showed the descriptive statistics of men and women respectively. Men represented 46.4% of the sample, and the mean age was 73.7 years with SD of ± 6.1 years. Overall, 642 men (6.4% of men) experienced household dysfunction in their childhood, while this proportion was 507 for women (4.4% of women). This accounted for 1149 participants (5.3%) from the whole sample. Men who experienced exposure to household dysfunction tended to have fewer teeth than men who did not. On the other hand, women who experienced household dysfunction tended to have more teeth than women who did not experience household dysfunction. Men and women who



Abbreviations; ACEs=Adverse childhood experiences

FIGURE 2 Flow diagram of the participants in 2013.

TABLE 1 Descriptive statistics of men by number of remaining teeth ($n = 10,027$).

	Total		Number of remaining teeth				
	No.	%	≥20 teeth (%)	10–19 teeth (%)	5–9 teeth (%)	1–4 teeth (%)	No teeth (%)
<i>Exposure to household dysfunction^a</i>							
Yes	642	6.4	48.1	22.3	10.9	8.6	10.1
No	8925	89.0	50.9	21	10.5	7.1	10.6
Missing	460	4.6	35.2	23.9	12.6	9.1	19.1
<i>Age groups</i>							
65–69	3034	30.3	61.2	19.5	8.3	5.1	5.7
70–74	3035	30.3	55	22	9.3	5.8	7.9
75–79	2164	21.6	43.3	22.5	12.5	8.6	13.1
80–84	1258	12.5	33.2	21.4	14.5	10.6	20.3
85 and more	536	5.3	23.5	20.3	14.2	15.1	26.9
<i>Economic adversity at childhood</i>							
Yes	5423	54.1	49.5	22	10.4	7.3	10.8
No	4506	44.9	50.4	20.4	10.8	7.3	11.1
Missing	98	1.0	54.1	13.3	10.2	7.1	15.3
<i>Years of formal education</i>							
Less than 6 years	97	1.0	33	21.6	15.5	13.4	16.5
6–9 years	3726	37.2	41.5	22	12.8	9	14.8
10–12 years	3535	35.3	52.4	21.6	9.8	6.4	9.7
13 years or more	2546	25.4	60.1	19.2	8.3	5.7	6.8
Other	46	0.5	39.1	32.6	8.7	8.7	10.9
Missing	77	0.8	40.3	22.1	15.6	6.5	15.6
<i>Diabetes</i>							
No	7845	78.2	50.4	21.4	10.3	7.2	10.7
Yes	1684	16.8	47.6	21.3	11.4	7.4	12.4
Missing	498	5.0	50.8	18.1	12.9	8.2	10
<i>Stroke</i>							
No	9083	90.6	50.3	21.4	10.3	7.1	10.9
Yes	446	4.4	41.5	20.6	13.2	10.8	13.9
Missing	498	5.0	50.8	18.1	12.9	8.2	10
<i>Depression</i>							
No	9454	94.3	49.9	21.4	10.5	7.2	11.1
Yes	75	0.7	58.7	18.7	10.7	8	4
Missing	498	5.0	50.8	18.1	12.9	8.2	10
<i>Smoking status</i>							
Yes	1812	18.1	39.8	23.7	13	9.2	14.2
Used to smoke	3108	31.0	50.5	21.4	10.9	7.1	10.2
Never	4994	49.8	53.8	20	9.4	6.6	10.2
Missing	113	1.1	29.2	26.5	16.8	11.5	15.9
Total	10,027	100	50	21.2	10.6	7.3	11

^aExposure to at least one of the two household dysfunctions.

were; older in age, with fewer years of education, diabetic, had stroke and smokers had higher proportions of having fewer teeth.

The ordered logistic regression analyses (Table 3) showed that exposure to a household dysfunction, or any

of its two components, or the accumulated exposure to the two components were associated with having fewer teeth among men but not among women.

There was a tendency for the multivariable-adjusted odds ratio of having fewer teeth to increase with increase

TABLE 2 Descriptive statistics of women by number of remaining teeth ($n = 11,557$).

	Total		Number of remaining teeth				
	No.	%	≥20 teeth (%)	10–19 teeth (%)	5–9 teeth (%)	1–4 teeth (%)	No teeth (%)
<i>Exposure to household dysfunction^a</i>							
Yes	507	4.4	55.6	22.7	8.9	4.9	7.9
No	10,493	90.6	53.3	21.5	10.1	6.2	8.9
Missing	577	5.0	35.2	27	13.5	10.7	13.5
<i>Age groups</i>							
65–69	3299	28.5	67.2	20.6	6.3	3.1	2.7
70–74	3519	30.4	57.6	23.2	9.2	5.1	4.9
75–79	2532	21.9	45.9	22	13	8	11.1
80–84	1516	13.1	34.5	22.6	14.3	10.7	17.9
85 and more	711	6.1	20.3	18	14.8	13.1	33.9
<i>Economic adversity at childhood</i>							
Yes	4651	40.2	51.4	22	10.1	6.9	9.6
No	6776	58.5	53.4	21.6	10.2	6	8.8
Missing	150	1.3	43.3	25.3	14.7	7.3	9.3
<i>Years of formal education</i>							
Less than 6 years	233	2.0	21.5	18.5	13.3	11.2	35.6
6–9 years	4874	42.1	44.1	23.3	12	8.1	12.5
10–12 years	4475	38.7	58.8	21.1	9	5.1	5.9
13 years or more	1761	15.2	64.7	19.9	7.7	3.5	4.2
Other	66	0.6	56.1	22.7	9.1	7.6	4.5
Missing	168	1.5	40.5	20.8	13.1	13.1	12.5
<i>Diabetes</i>							
No	9680	83.6	53.1	21.5	10	6.4	8.9
Yes	1218	10.5	46.1	23.2	12.4	7	11.3
Missing	679	5.9	54.6	23.3	9.6	4.6	8
<i>Stroke</i>							
No	10,664	92.1	52.4	21.8	10.2	6.4	9.2
Yes	234	2.0	49.1	16.7	14.1	10.3	9.8
Missing	679	5.9	54.6	23.3	9.6	4.6	8
<i>Depression</i>							
No	10,762	93.0	52.4	21.7	10.2	6.5	9.2
Yes	136	1.2	49.3	24.3	15.4	2.9	8.1
Missing	679	5.9	54.6	23.3	9.6	4.6	8
<i>Smoking status</i>							
Yes	361	3.1	36.3	29.4	12.7	6.6	15
Used to smoke	268	2.3	45.5	30.6	11.6	4.1	8.2
Never	10,761	93.0	53.4	21.2	10.1	6.4	8.8
Missing	187	1.6	37.4	26.7	12.8	9.1	13.9
Total	11,577	100	52.5	21.8	10.2	6.4	9.1

^aExposure to at least one of the two household dysfunctions.

in number of household dysfunctions experienced among men. There was no such association among women. Adding age, SES, comorbidities and behavioral confounders in a step wise manner attenuated the effect size of the

association between the exposures and having fewer teeth in all analyses.

The sensitivity analyses using a complete case scenario after creating dummy variables for the missing data

TABLE 3 The aggregated findings for the association between the exposures and having fewer remaining teeth for men and women using ordered logistic regression models after multiple imputation ($n = 21,604$).

	Men ($n = 10,027$)						Women ($n = 11,557$)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<i>Exposure to household dysfunction^a</i>												
No	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	1.19*	1.02 1.38	1.18*	1.01 1.37	1.16*	1.00 1.36	1.04	0.88 1.24	0.98	0.82 1.17	0.94	0.79 1.13
<i>Exposure to parental divorce</i>												
No	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	1.23	0.97 1.55	1.17	0.92 1.48	1.15	0.90 1.45	0.97	0.74 1.27	0.91	0.70 1.19	0.88	0.67 1.15
<i>Exposure to father violence against mother</i>												
No	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	1.21*	1.02 1.44	1.21*	1.02 1.44	1.19*	1.00 1.42	1.13	0.92 1.37	1.05	0.86 1.29	1.01	0.82 1.24
<i>Number of household dysfunctions experienced</i>												
0	1.00		1.00		1.00		1.00		1.00		1.00	
1	1.16	0.99 1.35	1.14	0.97 1.33	1.13	0.97 1.32	1.04	0.87 1.25	0.98	0.82 1.18	0.95	0.79 1.13
2	1.74	0.96 3.17	1.64	0.90 2.99	1.43	0.78 2.60	1.16	0.56 2.39	1.01	0.48 2.10	0.96	0.46 1.98

Note: Each exposure was separately included into models 1, 2, and 3. Model 1 is adjusted for age. Model 2 is adjusted for age, economic adversity in childhood, and education attainment. Model 3 is adjusted for all confounders (i.e., age, economic adversity in childhood, education attainment, stroke, diabetes, depression, and smoking status). All p values were >0.05 except those with the sign “***” p values <0.05 .

Abbreviations: CI, confidence interval; OR, odds ratio.

^aExposure to at least one of the two household dysfunctions.

(Tables S1 and S2) showed similar findings among men and women. Table S3 showed the summary of the missing and the imputed data.

Table S4 showed the descriptive statistics of the whole sample without sex-stratification. The supplementary regression analyses for men and women (Table S5) showed no association between the exposures and having fewer teeth in the fully adjusted models. The data driven approach of the observed findings of these supplementary analyses confirmed the hypothesized sex-difference of the main analyses.

DISCUSSION

The findings showed that an exposure to a household dysfunction at childhood or the accumulated exposure to its two components was associated with having fewer teeth at later life among men. Men who had more exposure to household dysfunctions tended to have a higher odds of having fewer teeth at later life. However, the effect sizes of these associations among men were of a small magnitude, suggesting that the exposure to household dysfunctions at childhood could be a risk factor for tooth loss at later life among men. No such association between all examined exposures and having fewer teeth was observed among women.

The findings for men were consistent with the two previous cohort studies that demonstrated having worse oral health outcomes at later life after exposure to household dysfunction at childhood [18, 19]. The two previous

studies suggested psychological barriers such as shame, anxiety, and fear of being judged by dental professionals regarding their bad oral health as pathways for limited access to dental services and eventual tooth loss [18, 19]. Also, factors associated with low SES such as low health literacy, poorer oral hygiene, low dental services utilization, engagement in aggressive violent behaviors, smoking, and alcoholism which eventually lead to tooth loss were hypothesized as a mediator to explain the association [1, 18, 19, 26, 27]. In addition and based on the accumulation of risk model, chronic stress due to exposure to ACEs compromise the immune system [17, 28, 29]. A compromised immune system is a risk factor for having periodontal diseases and subsequent tooth loss [30, 31]. Also, decreased salivary flow as a result of chronic stress was a risk factor for caries and eventual tooth loss [32, 33]. Furthermore and based on the critical period model, the exposure to ACEs during the biological developmental stages of the body causes irreversible alteration in critical hormonal anatomic structures such as the pituitary and adrenal glands and the hypothalamus, which cause hormonal and immune system malfunction in response to psychological stress at later life such as the vulnerability to addictive behaviors [17, 26–29]. An addictive behavior of high consumption of sugary food and beverages to cope with the chronic stress might lead to overweight and obesity and was associated with increased dental caries [10, 34–36].

The presence of sex difference in the findings was also consistent with previous studies examining the association between ACEs and general health outcomes [6–9].

However, these studies demonstrated stronger adverse general health outcomes among women than men, which was opposite to the findings of this study examining an oral health outcome (number of teeth) and demonstrated that men had fewer teeth than women. One way to explain the sex difference in the findings might be women's better ability to cope with stress and better emotional reasoning than men. On the neuro-biological level, men were less able to reappraise and regulate the negative emotions such as stress than women [37]. Also, a British study showed that health and psychological resiliency were higher among older women than men [38]. Another way to explain the sex difference is oral health behaviors. A review of gender difference in oral health showed that men were more likely to ignore their oral health, have poorer oral hygiene habits, develop periodontal diseases, and visit dentists less frequently, while women demonstrated greater oral health literacy and better oral health behaviors than men [39].

The strength points for this study included that it was the first study to investigate this association in the Asian context. In addition, a large sample size was analyzed which improves the statistical power and the precision of the estimates. On the other hand, our findings should be interpreted with caution considering its limitations. First, the exposure variables may be subjected to recall bias because the data regarding ACEs was retrospectively collected from older population. However, the participants of this study were functionally independent, and older people tend to remember their childhood situation fairly well [23]. Second, the inherent sensitive nature of the exposures and the shame culture in Japan might have resulted in underreporting the history of exposure to ACEs or introduced social desirability bias, which might have underestimated the findings [22, 23, 40, 41]. Third, the data gathering limitations over the very long follow up period (at least 47 years in this study) made it difficult to assess the effect of the time varying confounders over the life course. However, the methodology used is simple and valid in assessing life course related studies [17–19]. Fourth, the findings might not be generalized to the general population in Japan because this sample, although relatively large, was not nationally representative.

Public health implications

Economic stress and poverty were among risk factors of divorce and family instability in Japan [42, 43]. Upstream approaches such as social and civil policies ensuring economic and employment stability of household heads might help improve family stability [44, 45]. In addition, social and public health interventions limiting household dysfunctions such as regular marriage counseling before and during marriage, child protection programs, and regular child monitoring of families at risk through a nurse

home visitation to ensure safe nurturing environments for children would be economically beneficial and would relieve the pressure endured on the health-care systems due to children's exposure to ACEs [46]. Also, raising parental awareness regarding the adverse health effects of children's exposure to household dysfunction and other ACEs through positive parenting educational programs aiming to improve parenting skills, strengthen parent-child attachment and developing children's psychological resilience could help moderate the harmful effects of ACEs on general health and oral health as well [15, 47, 48]. Future studies are needed to assess the causal and mediating pathways that could explain this association considering the time-temporal effects of possible confounders over the life course. However, this might be difficult due to data gathering limitations during the long period of the life course studies.

CONCLUSION

An exposure to a household dysfunction at childhood was associated with having fewer teeth at later life among men but not among women. There was an increased tendency for having fewer teeth with the increase in number of household dysfunctions experienced among men but not among women. Economic as well as public health interventions to improve the family stability were suggested to mitigate the adverse effects of household dysfunction.

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DATA AVAILABILITY STATEMENT

The data from the Japan Gerontological Evaluation Study (JAGES) are available upon a request submitted to the JAGES data management office. Applications for data usage are accepted online from the JAGES website. <https://www.jages.net/>.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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