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Title:

Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese: The Ohsaki Cohort 2006 Study

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Abstract

Objectives: To assess whether oral self-care (tooth-brushing, regular dental visits, and use of dentures) affects incident functional disability in elderly individuals with tooth loss.

Design: A 5.7-year prospective cohort study.

Setting: Ohsaki City, Japan.

Participants: 12,370 community-dwelling individuals aged 65 years and older.

Primary outcome measures: Incident functional disability (new LTCI certification).

Results: In comparison with participants who had ≥20 teeth, the HRs (95% CIs) for incident functional disability among participants who had 10-19 and 0-9 teeth were 1.15 (1.01-1.30) and 1.20 (1.07-1.34), respectively (*P*-trend <.05). However, the corresponding values for those who brushed their teeth ≥2 times per day were not significantly higher in the "10-19 teeth" and "0-9 teeth" groups [HRs (95% CI) 1.05 (0.91-1.21) for participants with 10-19 teeth, and 1.09 (0.96-1.23) for participants with 0-9 teeth], although HRs for those who brushed their teeth <2 times per day were significantly higher [HRs (95% CI) 1.32 (1.12-1.55) for participants with 10-19 teeth, and 1.33 (1.17-1.51) for participants with 0-9 teeth]. Such a negating association was not observed for other forms of oral self-care.

Conclusions: Tooth-brushing may partially negate the increased risk of incident functional disability associated with having fewer remaining teeth.

Key words: teeth, tooth-brushing, dental visit, denture, disability

Strengths and limitations of this study

- Our study is the first reported study to have demonstrated an impact of tooth brushing on the increased risk of incident functional disability resulting from having fewer remaining teeth.
- This is a large population-based cohort study involving 12,370 individuals and it can take into account considerable confounding factors.
- Although misclassification of the number of teeth and practicing oral self-care as a result of self-reporting might have occurred, the validity of these have also been confirmed by previous studies.

Introduction

As society ages, disability prevention has become an important public health issue. It has been pointed out by the WHO that oral health is an important component of healthy aging, particularly in the disadvantaged elderly.[1] Tooth loss is also known to be a risk factor for mortality in the elderly.[2,3] Periodontal disease, which is one of the main causes of tooth loss, is known to be related to coronary heart disease,[4] stroke,[4] and pneumonia,[5] which in turn are major causes of incident disability.[6] Recently, several studies have indicated that tooth loss is related to incident disability.[7,8] Therefore, there is a need to decrease the excess risk of functional disability in elderly adults with missing teeth.

It has been suggested that oral self-care has a preventative impact on mortality.[9] We have reported that individuals who practiced three types of oral self-care (tooth brushing, regular dental visits, and use of dentures) had a lower mortality risk than those who practiced none of the three.[9] Those who practiced oral self-care also had a lower risk of dementia and cardiovascular disease.[10,11] These findings suggest that there are possible pathways linking oral self-care to incident disability. Additionally, it has been reported that the intraoral environment affects the gut microbiota and may cause systemic inflammation,[12] implying a new pathway whereby poor oral hygiene may be linked to systemic disease. To our knowledge, however, only two studies have examined whether practicing oral care affects the risk of functional disability among older people with tooth loss, and those studies focused only on denture use[13] or regular dental visits.[14]

The aim of the present cohort study was to assess whether three types of oral self-care (tooth

brushing, regular dental visits, and use of dentures) have an impact on incident functional disability in individuals with tooth loss.

Materials and Methods

Study design, setting, and participants

The present study was based on data from the Ohsaki Cohort 2006 Study, whose design has been described in detail elsewhere.[15] In brief, the source population for the baseline survey comprised all men and women aged 65 years or older living in Ohsaki City, Miyagi Prefecture, northeastern Japan, on December 1, 2006. The survey included questions about the number of remaining teeth and oral self-care status, as well as items on history of disease, education level, smoking, alcohol drinking, body weight, height, psychological distress score, time spent walking per day, and food intake frequency.

The baseline survey was conducted between December 1 and December 15, 2006, and the follow-up survey between April 1, 2007 and November 30, 2012. A questionnaire was distributed by the heads of individual administrative districts to all individuals aged 65 years or older living in Ohsaki city, and then collected by mail. Among 31,694 subjects (12,750 men and 18,944 women) eligible for this analysis, 23,091 (9,605 men and 13,486 women) provided valid responses and formed the study cohort. Among the latter respondents, we excluded 6,333 individuals who did not provide written consent for review of their Long-term Care Insurance (LTCI) information, 2,102 who had already been certified as having a disability by the LTCI before the starting date of follow-up (March 30, 2007), 62 who had died or moved away before the starting date of follow-up, 188 for whom the Doctor's Opinion Paper had been unavailable, and 2,036 who left blank the item

concerning dental health status. Thus, 12,370 responses were analyzed for the purpose of this study.

During the 5.7-year period covered by the study, only 158 individuals were lost to follow-up because they moved away from the study area without developing any functional disability; thus, the follow-up rate was 98.7%. From 61,581 person-years, incident functional disability was recorded in 2,329 persons, and the number of all-cause deaths was 1,446.

Measurement of dental health status

In the baseline questionnaire, we asked respondents to classify the number of their remaining teeth into six categories: all (28 teeth), most (25-27 teeth), moderate (20-24 teeth), about half (10-19 teeth), few (1-9 teeth), and none (0 teeth). Then, we divided the respondents into three groups: 1) ≥20 teeth, 2) 10-19 teeth, and 3) 0-9 teeth.

We also asked whether they used dentures and whether they visited a dental clinic at least once a year. The respondents were asked to mark "yes" or "no" in reply. We also asked how many times participants brushed their teeth daily.

Measurements of other variables

K6 was used as an indicator of psychological distress.[16,17]. Using six questions, respondents were asked about their mental status over the last month. Total point scores ranged from 0 to 24. As the optimal cut-off point for mental illness in the validation study, we classified individuals with scores

of ≥13 as having psychological distress.[18]

The amount of energy intake (except that from alcohol-drinking) and protein intake was calculated based on the data from the baseline survey and divided into sex-specific tertiles. The survey included questions about the frequency of recent average consumption of 39 daily food items. For estimation of energy and protein intake from the food-frequency questionnaire (FFQ), a food composition table was used that corresponded to the items listed in the questionnaire.[19] A validation study of the FFQ had been conducted previously.[19]

LTCI system in Japan

In this study, we defined incident functional disability as certification for LTCI in Japan, which uses a nationally uniform standard of functional disability. LTCI is a mandatory system of social insurance to assist the daily activity of frail elderly individuals.[20,21] Everyone aged 40 years and over pays premiums, and everyone aged 65 years and over is eligible for formal caregiving services. When a person applies to the municipal government for benefits, an expert investigator visits his or her home and assesses the degree of functional disability using a questionnaire developed by the Ministry of Health, Labor, and Welfare. Then, the municipal government calculates the standardized scores for physical and mental functions on the basis of the certification survey sheet and assesses whether the applicant is eligible for LTCI benefits. If a person is judged to be thus eligible, the Municipal Certification Committee decides on one of seven levels of support, ranging from Support

Level 1 to 2, and Care Level 1 to Care Level 5. In brief, LTCI certification levels are defined as follows. Support Level 1: "limited in instrumental activities of daily living but independent in basic activities of daily living"; Care Level 2: "requiring assistance in at least one basic ADL task"; Care Level 5: "requiring care in all ADL tasks". A community-based study has shown that levels of LTCI certification are well related to the ability to perform activities of daily living, and with Mini-Mental State Examination scores [22]. LTCI certification has already been used as a measure of incident functional disability in the elderly.[7,23]

Follow-up and case details

Incident functional disability was defined as LTCI certification, which was set as our endpoint. The primary outcome was new LTCI certification (Support Level 1 or higher), and deaths without LTCI certification were treated as censored. We obtained a data set that included information on the date of LTCI certification, emigration, or death from Ohsaki City Government based on an agreement about the secondary use of data. LTCI certification information was provided, including care level information. All data were transferred from the Ohsaki City Government yearly each December under the agreement related to Epidemiologic Research and Privacy Protection.

Ethical issues

The return of completed questionnaires was considered to imply consent to participate in the study

involving the baseline survey data and subsequent follow-up of death and emigration. Information regarding LTCI certification status was confirmed after obtaining written consent returned from the participants at the time of the baseline survey. The Ethics Committee of Tohoku University Graduate School of Medicine reviewed and approved the study protocol.

Statistical analysis

Baseline characteristics were evaluated using the chi-squared test for categorical variables and analysis of variance for continuous variables. We used these methods to compare variables among groups with varying numbers of teeth.

First, we examined the relationship between the number of remaining teeth and incident functional disability in the entire study population. The Cox proportional hazards model was used to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for incident functional disability according to the categories for different numbers of remaining teeth. Participants having ≥20 teeth were used as a reference category. The multivariate models were adjusted for the following variables: age (65-69, 70-74, 75-79, 80-84, and ≥85 years), sex, education level (age upon final graduation from school <16, 16-18, ≥19 years, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m^2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 minutes per day, 30 minutes per day-1 hour per day, >1hour per day, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus),

psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Second, in comparison with individuals who had ≥20 teeth, we examined whether oral self-care factors ("tooth brushing ≥2 times per day", "visiting a dentist ≥1 times per year", and "use of dentures" being defined as "practicing oral self-care") were related to the risk of functional disability in individuals with <20 teeth. For this, participants were divided into the following five categories based on three oral self-care measures: 1) "having ≥20 teeth", 2) "practicing oral self-care and having 10-19 teeth", 3) "non-practicing and having 10-19 teeth", 4) "practicing and having 0-9 teeth", and 5) "non-practicing and having 0-9 teeth". Cox proportional hazards models were used to calculate the HRs and 95% CIs for incident functional disability to compare the four categories of missing teeth with the ≥20 teeth category.

All statistical analyses were performed with SAS version 9.4 (SAS Inc., Cary, NC, USA), and all statistical tests were 2-sided. Differences at P <0.05 were considered to be statistically significant.

Results

Baseline characteristics

In the study population, women accounted for 54.3% and the mean (SD) age was 73.5 (5.4) years. Table 1 shows the participant characteristics. Those who had more teeth were younger, and were less likely to be women, current smokers, and to have a history of stroke, myocardial infarction, or diabetes mellitus. Having more teeth was also related to being better educated, spending more time walking, being a current drinker, and having higher energy and protein intake.

Number of teeth and incident functional disability

The number of remaining teeth was significantly associated with a higher risk of incident functional disability. The multiple adjusted HRs (95% CIs) for incident functional disability among participants having 10-19 and 0-9 teeth were 1.15 (1.01-1.30) and 1.20 (1.07-1.34), respectively, compared with participants having ≥20 teeth (*P*-trend <.05) (see online supplementary table S1).

Oral self-care and incident functional disability

Table 2 shows the relationship between oral self-care (tooth-brushing, dental visits, and use of dentures) and incident functional disability in the five categories. Compared with participants who had 20 or more teeth, HRs for participants who brushed their teeth <2 times per day were significantly higher [multivariate HRs (95% CI) 1.32 (1.12-1.55) for participants with 10-19 teeth,

and 1.33 (1.17-1.51) for participants with 0-9 teeth], but HRs for participants who brushed their teeth ≥2 times per day were not significantly higher in the "10-19 teeth" and "0-9 teeth" groups [multivariate HRs (95% CI) 1.05 (0.91-1.21) for participants with 10-19 teeth, and 1.09 (0.96-1.23) for participants with 0-9 teeth]. There was no significant difference in the increased risk between these two subgroups, irrespective of whether or not participants undertook dental visits or used dentures.

Additionally, we compared HRs for participants who did and did not practice oral self-care in each of the "10-19 teeth" and "0-9 teeth" subgroups (Table 3). Compared with participants who brushed their teeth <2 times per day, HRs for participants who brushed their teeth ≥2 times per day were significantly lower [multivariate HRs (95% CI) 0.80 (0.66-0.96) for participants with 10-19 teeth (*P*-value <.001), and 0.81 (0.73-0.91) for participants with 0-9 teeth (*P*-value <.05)]. However, there was no significant difference in either of these subgroups, irrespective of whether or not participants undertook dental visits or used dentures.

Discussion

This cohort study investigated the association between oral self-care and incident functional disability. First, we found that tooth loss was significantly associated with an increased risk of incident functional disability, in agreement with previous studies.[7,8] However, even among participants who had fewer remaining teeth, the risk for those who brushed their teeth frequently was not significantly higher. Our study suggested that if individuals with fewer than 20 teeth practiced good oral self-care habits such as regular tooth-brushing, they might partially negate the expected increase in incident functional disability. The present study had a number of strengths: 1) it was a large population-based cohort study involving 12,370 individuals, 2) it had a follow-up rate of almost 100%, 3) it took into account considerable confounding factors, and 4) it is the first reported study to have demonstrated an impact of tooth brushing on the increased risk of incident functional disability resulting from having fewer remaining teeth.

There are several possible pathways linking oral self-care to incident functional disability. First, periodontal disease is related to systemic inflammation through oral inflammation.[24] Second, a recent report has suggested that swallowing of oral bacteria affects the gut microbiota, causing systemic inflammation.[12] Chronic inflammation is known to be a risk factor for atherosclerotic diseases including stroke[25] and dementia,[26] and may cause autoimmune disease, particularly rheumatoid arthritis.[27] These diseases and their symptoms are common causes of functional disability in the Japanese elderly population.[28] Indeed, a previous study has suggested that tooth brushing

ameliorates the risk of cardiovascular disease.[11] Therefore, better oral hygiene through tooth-brushing may reduce the risk of functional disability in the elderly.

The present study had several limitations. First, misclassification of the number of teeth and practicing oral self-care as a result of self-reporting might have occurred. However, the validity of the self-reported number of teeth has been confirmed by previous studies,[29] and similarly the validity of self-reported dental visits has also been confirmed.[30] Second, among the source population of 31,694, the rate of valid responses (72.9%, n =23,091) for this study was not high. In addition, the valid responses would have shown a bias toward healthier people living in the community. However, this bias would not have affected the internal validity of the association between oral self-care and incident functional disability. Third, we did not consider causes of incident functional disability. Thus, the mechanisms responsible for the reduction of incident functional disability risk resulting from oral self- care remained unidentified.

In conclusion, this study has shown that tooth-brushing may partially negate the increased risk of incident functional disability resulting from having fewer remaining teeth. Further studies will need to confirm the effects of oral self-care on incident functional disability in individuals with missing teeth.

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TABLES

Table1. Relationship Between Number of Teeth and Participant Characteristic (n=12,370)

Characteristic	Number of Teeth		
	≥20, n = 4,047	10-19, n = 3,108	0-9, n = 5,215
Women , %	50.0	53.4	58.2
Age, mean ± SD	71.3 ± 4.8	72.8 ± 5.2	75.6 ± 6.2
Body mass index, kg/m^2, %			
<18.5	3.2	4.9	6.2
18.5-24.9	63.8	64.0	65.3
≥25.0	32.9	31.1	28.5
Current smoking, %	11.0	14.5	14.6
Current alcohol drinking, %	46.1	41.3	31.7
Education < 16 years, %	22.9	27.2	33.7
Daily walking time ≥ 1 hour, %	29.3	29.1	26.0
Medical history, %			
Stroke	2.2	2.9	3.1
Hypertension	43.5	43.5	43.5
Myocardial infarction	3.8	4.4	5.9
Diabetes mellitus	10.5	11.5	12.6
Psychological distress, % [a]	3.4	4.2	5.6
Energy intake, kcal/d, mean ± SD [b]	1463.5 ± 406.9	1451.9 ± 401.7	1413.8 ± 393.7
Protein intake, g/d, mean ± SD	54.7 ± 14.0	53.6 ± 14.3	52.5 ± 14.4
Use of dentures, %	27.3	75.1	93.0
Tooth brushing (times/d)	2.0 ± 0.9	1.9 ± 1.1	1.8 ± 0.9
≥ 1 dental visits per year, %			
For treatment	57.3	63.5	43.8
For other reason	39.5	34.3	19.7

[a] Kessler six-item psychological distress scale score ≥ 13.

[b] Excluding alcohol.

SD = standard deviation.

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Table2. Relationship Between Oral Self-Care and Incident Functional Disability Stratified According to Number of Teeth (n=12,370).

Oral Self-care and Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
Tooth brushing					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with brushing teeth ≥2 per day	1,977	10,200	300 (15.2)	1.05 (0.91-1.22)	1.05 (0.91-1.21)
10-19 with brushing teeth <2 per day	1,131	5,529	230 (20.3)	1.44 (1.23-1.69)	1.32 (1.12-1.55)
0-9 with brushing teeth ≥2 per day	2,840	13,888	634 (22.3)	1.15 (1.01-1.30)	1.09 (0.96-1.23)
0-9 with brushing teeth <2 per day	2,375	10,812	689 (29.0)	1.52 (1.35-1.72)	1.33 (1.17-1.51)
≥1 dental visits per year					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	2,010	10,208	335 (16.7)	1.17 (1.02-1.35)	1.14 (0.99-1.32)
10-19 with no dental visits	1,098	5,521	195 (17.8)	1.23 (1.04-1.46)	1.16 (0.98-1.38)
0-9 with dental visits	2,343	11,502	528 (22.5)	1.26 (1.11-1.42)	1.15 (1.01-1.31)
0-9 with no dental visits	2,872	13,198	795 (27.7)	1.36 (1.21-1.54)	1.23 (1.09-1.39)
Use of dentures					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with use of dentures	2,333	11,770	411 (17.6)	1.18 (1.04-1.35)	1.15 (1.01-1.32)
10-19 with no use of dentures	775	3,958	119 (15.4)	1.22 (1.00-1.49)	1.13 (0.92-1.38)
0-9 with use of dentures	4,850	23,087	1220 (25.2)	1.29 (1.15-1.44)	1.19 (1.06-1.33)
0-9 with no use of dentures	365	1,613	103 (28.2)	1.66 (1.34-2.06)	1.35 (1.09-1.68)

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

2

Table 3. Sensitivity Analysis of the Relationship Between Oral Self-Care and Incident Functional Disability According to Number of Teeth (n=8,323).

Oral Self-care and Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
10-19 teeth (n=3,108)					
Brushing teeth <2 per day	1,131	5,529	230 (20.3)	1.00 (reference)	1.00 (reference)
Brushing teeth ≥2 per day	1,977	10,200	300 (15.2)	0.73 (0.61-0.87)	0.80 (0.66-0.96)
No dental visits	1,098	5,521	195 (17.8)	1.00 (reference)	1.00 (reference)
≥1 dental visits per year	2,010	10,208	335 (16.7)	0.95 (0.79-1.13)	0.98 (0.82-1.17)
No use of dentures	775	3,958	119 (15.4)	1.00 (reference)	1.00 (reference)
Use of dentures	2,333	11,770	411 (17.6)	0.97 (0.79-1.19)	1.00 (0.81-1.23)
0-9 teeth (n=5,215)					
Brushing teeth <2 per day	2,375	10,812	689 (29.0)	1.00 (reference)	1.00 (reference)
Brushing teeth ≥2 per day	2,840	13,888	634 (22.3)	0.75 (0.67-0.84)	0.81 (0.73-0.91)
No dental visits	2,872	13,198	795 (27.7)	1.00 (reference)	1.00 (reference)
≥1 dental visits per year	2,343	11,502	528 (22.5)	0.92 (0.82-1.03)	0.94 (0.84-1.05)
No use of dentures	365	1,613	103 (28.2)	1.00 (reference)	1.00 (reference)
Use of dentures	4,850	23,087	1220 (25.2)	0.78 (0.64-0.96)	0.88 (0.71-1.07)

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

1

Supplementary table S1. Number of Teeth in Relation to Incident Functional Disability (n=12,370).

Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19	3,108	15,729	530 (17.1)	1.19 (1.05-1.35)	1.15 (1.01-1.30)
0-9	5,215	24,700	1,323 (25.4)	1.31 (1.18-1.47)	1.20 (1.07-1.34)
P-trend	-	-	-	<.001	.002

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Title: Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese: The Ohsaki Cohort 2006 Study

Authors: Shino Bando MSc, [1] Yasutake Tomata PhD, [1] Jun Aida DDS, PhD, [2] Kemmyo Sugiyama MD, PhD, [1] Yumi Sugawara PhD, [1] and Ichiro Tsuji MD, PhD [1]

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page or line numbers where the checklist items are located in this paper*
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Line 2-3, Page 1 Line 4, Page 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Line 1-18, Page 3
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Line 2-18, Page 5
Objectives	3	State specific objectives, including any prespecified hypotheses	Line 13, Page 5 Line 19, Page 5 - Line 1-2,Page 6
Methods			
Study design	4	Present key elements of study design early in the paper	Line 2, Page 7 – Line 1, Page 8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Line 4-13 page 7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Line 10, Page 7 – Line 1, Page 8 Line 9-16, page 10
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed	*(This is not a matched studies)*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Line 7, Page 8 - Line 16, Page 10
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Line 7, Page 8 - Line 7, Page 10
Bias	9	Describe any efforts to address potential sources of bias	Line 14, Page 11 - Line 2, Page12
Study size	10	Explain how the study size was arrived at	Line 4-6, 10-15, Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Line 18, Page 8 – Line 1, Page 9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Line 6,page 11-Line 14, page 12
		(*b*) Describe any methods used to examine subgroups and interactions	Line 7-8, Page 14
		(*c*) Explain how missing data were addressed	Line 14, Page 11 - Line 2, Page12
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	Line 2-5, Page 8
		(*e*) Describe any sensitivity analyses	Line 7-8, page 14

**Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese : The Ohsaki Cohort 2006 Study*

Results			
Participants	13	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Line 13, Page 7 – Line 1, Page 8
		(b) Give reasons for non-participation at each stage	Line 13, Page 7 – Line 1, Page 8
		(c) Consider use of a flow diagram	
Descriptive data	14	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Line2-7, Page 13 Table 1, Page 24
		(b) Indicate number of participants with missing data for each variable of interest	Line 15, Page 7 – Line 1, Page 8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Line 4-5, Page 8 Table 2, Page 25
Outcome data	15	*Cohort study*—Report numbers of outcome events or summary measures over time	Line 4-5, Page 8 Table 2, Page 25
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2, Page 25 Line 16, Page 13-Line 6, Page 14
		(*b*) Report category boundaries when continuous variables were categorized	Line 14, Page 11 - Line 2, Page12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Line 7-13, Page 14 Table 3, Page 26
Discussion			
Key results	18	Summarise key results with reference to study objectives	Line 3-6, Page 15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Line 3-12, Page 16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Line 3-8, Page 15 Line 13, Page 15-Line 2, Page16
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Line 9-12, Page 17

**Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese : The Ohsaki Cohort 2006 Study*

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Title:

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The number of supplementary material: 2 table

Abstract

Objectives: To assess whether oral self-care (tooth-brushing, regular dental visits, and use of dentures) affects incident functional disability in elderly individuals with tooth loss.

Design: A 5.7-year prospective cohort study.

Setting: Ohsaki City, Japan.

Participants: 12,370 community-dwelling individuals aged 65 years and older.

Primary outcome measures: Incident functional disability (new LTCI certification).

Results: The 5.7-year incidence rate of disability was 18.8%. In comparison with participants who had ≥20 teeth, the HRs (95% CIs) for incident functional disability among participants who had 10-19 and 0-9 teeth were 1.15 (1.01-1.30) and 1.20 (1.07-1.34), respectively (*P*-trend <.05). However, the corresponding values for those who brushed their teeth ≥2 times per day were not significantly higher in the "10-19 teeth" and "0-9 teeth" groups [HRs (95% CI) 1.05 (0.91-1.21) for participants with 10-19 teeth, and 1.09 (0.96-1.23) for participants with 0-9 teeth], although HRs for those who brushed their teeth <2 times per day were significantly higher [HRs (95% CI) 1.32 (1.12-1.55) for participants with 10-19 teeth, and 1.33 (1.17-1.51) for participants with 0-9 teeth]. Such a negating association was not observed for other forms of oral self-care.

Conclusions: Tooth-brushing may partially negate the increased risk of incident functional disability associated with having fewer remaining teeth.

Key words: teeth, tooth-brushing, dental visit, denture, disability

Strengths and limitations of this study

- Our study is the first reported study to have demonstrated an impact of tooth brushing on the increased risk of incident functional disability resulting from having fewer remaining teeth.
- This is a large population-based cohort study involving 12,370 individuals and it can take into account considerable confounding factors.
- Although misclassification of the number of teeth and practicing oral self-care as a result of self-reporting might have occurred, the validity of these have also been confirmed by previous studies.

Introduction

As society ages, disability prevention has become an important public health issue. It has been pointed out by the WHO that oral health is an important component of healthy aging, particularly in the disadvantaged elderly.[1] Tooth loss is also known to be a risk factor for mortality in the elderly.[2,3] Periodontal disease, which is one of the main causes of tooth loss, is known to be related to coronary heart disease,[4] stroke,[4] and pneumonia,[5] which in turn are major causes of incident disability.[6] Recently, several studies have indicated that tooth loss is related to incident disability.[7,8] Therefore, there is a need to decrease the excess risk of functional disability in elderly adults with missing teeth.

It has been suggested that oral self-care has a preventative impact on mortality.[9] We have reported that individuals who practiced three types of oral self-care (tooth brushing, regular dental visits, and use of dentures) had a lower mortality risk than those who practiced none of the three.[9] Those who practiced oral self-care also had a lower risk of dementia and cardiovascular disease.[10,11] These findings suggest that there are possible pathways linking oral self-care to incident disability. Additionally, it has been reported that the intraoral environment affects the gut microbiota and may cause systemic inflammation,[12] implying a new pathway whereby poor oral hygiene may be linked to systemic disease. To our knowledge, however, only two studies have examined whether practicing oral care affects the risk of functional disability among older people with tooth loss, and those studies focused only on denture use[13] or regular dental visits.[14]

The aim of the present cohort study was to assess whether three types of oral self-care (tooth

brushing, regular dental visits, and use of dentures) have an impact on incident functional disability in individuals with tooth loss.

Materials and Methods

Study design, setting, and participants

The present study was based on data from the Ohsaki Cohort 2006 Study, whose design has been described in detail elsewhere.[15] In brief, the source population for the baseline survey comprised all men and women aged 65 years or older living in Ohsaki City, Miyagi Prefecture, northeastern Japan, on December 1, 2006. The survey included questions about the number of remaining teeth and oral self-care status, as well as items on history of disease, education level, smoking, alcohol drinking, body weight, height, psychological distress score, time spent walking per day, and food intake frequency.

The baseline survey was conducted between December 1 and December 15, 2006, and the follow-up survey between April 1, 2007 and November 30, 2012. A questionnaire was distributed by the heads of individual administrative districts to all individuals aged 65 years or older living in Ohsaki city, and then collected by mail. Among 31,694 subjects (12,750 men and 18,944 women) eligible for this analysis, 23,091 (9,605 men and 13,486 women) provided valid responses and formed the study cohort. Among the latter respondents, we excluded 6,333 individuals who did not provide written consent for review of their Long-term Care Insurance (LTCI) information, 2,102 who had already been certified as having a disability by the LTCI before the starting date of follow-up (March 30, 2007), 62 who had died or moved away before the starting date of follow-up, 188 for whom the Doctor's Opinion Paper had been unavailable, and 2,036 who left blank the item

concerning dental health status. Thus, 12,370 responses were analyzed for the purpose of this study.

During the 5.7-year period covered by the study, only 158 individuals were lost to follow-up because they moved away from the study area without developing any functional disability; thus, the follow-up rate was 98.7%. From 61,581 person-years, incident functional disability was recorded in 2,329 persons, and the number of all-cause deaths was 1,446.

Measurement of dental health status

In the baseline questionnaire, we asked respondents to classify the number of their remaining teeth into six categories: all (28 teeth), most (25-27 teeth), moderate (20-24 teeth), about half (10-19 teeth), few (1-9 teeth), and none (0 teeth). Then, we divided the respondents into three groups: 1) ≥20 teeth, 2) 10-19 teeth, and 3) 0-9 teeth.

We also asked whether they used dentures and whether they visited a dental clinic (including as reasons "treatment" and "other reasons such as dental check-ups and scaling") at least once a year. The respondents were asked to mark "yes" or "no" in reply. We also asked how many times participants brushed their teeth daily.

Measurements of other variables

K6 was used as an indicator of psychological distress.[16,17] Using six questions, respondents were asked about their mental status over the last month. Total point scores ranged from 0 to 24. As the

optimal cut-off point for mental illness in the validation study, we classified individuals with scores of ≥13 as having psychological distress.[18]

The amount of energy intake (except that from alcohol-drinking) and protein intake was calculated based on the data from the baseline survey and divided into sex-specific tertiles. The survey included questions about the frequency of recent average consumption of 39 daily food items. For estimation of energy and protein intake from the food-frequency questionnaire (FFQ), a food composition table was used that corresponded to the items listed in the questionnaire.[19] A validation study of the FFQ had been conducted previously.[19]

LTCI system in Japan

In this study, we defined incident functional disability as certification for LTCI in Japan, which uses a nationally uniform standard of functional disability. LTCI is a mandatory system of social insurance to assist the daily activity of frail elderly individuals.[20,21] Everyone aged 40 years and over pays premiums, and everyone aged 65 years and over is eligible for formal caregiving services. When a person applies to the municipal government for benefits, an expert investigator visits his or her home and assesses the degree of functional disability using a questionnaire developed by the Ministry of Health, Labor, and Welfare. Then, the municipal government calculates the standardized scores for physical and mental functions on the basis of the certification survey sheet and assesses whether the applicant is eligible for LTCI benefits. If a person is judged to be thus eligible, the

Municipal Certification Committee decides on one of seven levels of support, ranging from Support Level 1 to 2, and Care Level 1 to Care Level 5. In brief, LTCI certification levels are defined as follows. Support Level 1: "limited in instrumental activities of daily living but independent in basic activities of daily living"; Care Level 2: "requiring assistance in at least one basic ADL task"; Care Level 5: "requiring care in all ADL tasks". A community-based study has shown that levels of LTCI certification are well related to the ability to perform activities of daily living, and with Mini-Mental State Examination scores [22]. LTCI certification has already been used as a measure of incident functional disability in the elderly.[7,23]

Follow-up and case details

Incident functional disability was defined as LTCI certification, which was set as our endpoint. The primary outcome was new LTCI certification (Support Level 1 or higher), and deaths without LTCI certification were treated as censored. We obtained a data set that included information on the date of LTCI certification, emigration, or death from Ohsaki City Government based on an agreement about the secondary use of data. LTCI certification information was provided, including care level information. All data were transferred from the Ohsaki City Government yearly each December under the agreement related to Epidemiologic Research and Privacy Protection.

Ethical issues

The return of completed questionnaires was considered to imply consent to participate in the study involving the baseline survey data and subsequent follow-up of death and emigration. Information regarding LTCI certification status was confirmed after obtaining written consent returned from the participants at the time of the baseline survey. The Ethics Committee of Tohoku University Graduate School of Medicine reviewed and approved the study protocol.

Statistical analysis

Baseline characteristics were evaluated using the chi-squared test for categorical variables and analysis of variance for continuous variables. We used these methods to compare variables among groups with varying numbers of teeth.

First, we examined the relationship between the number of remaining teeth and incident functional disability in the entire study population. The Cox proportional hazards model was used to calculate the hazard ratios (HRs) and 95% confidence intervals (CIs) for incident functional disability according to the categories for different numbers of remaining teeth. Participants having ≥20 teeth were used as a reference category. The multivariate models were adjusted for the following variables: age (65-69, 70-74, 75-79, 80-84, and ≥85 years), sex, education level (age upon final graduation from school <16, 16-18, ≥19 years, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m^2; <18.5, 18.5-24.9, ≥25.0,

missing), time spent walking daily (<30 minutes per day, 30 minutes per day-1 hour per day, >1 hour per day, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Second, in this analysis, we examined whether a higher risk of incident disability among participants with fewer teeth would persist irrespective of whether they practice oral self-care ("tooth brushing ≥2 times per day", "visiting a dentist ≥1 times per year", and "use of dentures" being defined as "practicing oral self-care"). For this, participants were divided into the following five categories based on three oral self-care measures: 1) "having ≥20 teeth", 2) "practicing oral self-care and having 10-19 teeth", 3) "non-practicing and having 10-19 teeth", 4) "practicing and having 0-9 teeth", and 5) "non-practicing and having 0-9 teeth". Cox proportional hazards models were used to calculate the HRs and 95% CIs for incident functional disability to compare the four categories of missing teeth with the ≥20 teeth category.

All statistical analyses were performed with SAS version 9.4 (SAS Inc., Cary, NC, USA), and all statistical tests were 2-sided. Differences at $P < 0.05$ were considered to be statistically significant.

Results

Baseline characteristics

In the study population, women accounted for 54.3% and the mean (SD) age was 73.5 (5.4) years. Table 1 shows the participant characteristics. Those who had more teeth were younger, and were less likely to be women, current smokers, and to have a history of stroke, myocardial infarction, or diabetes mellitus. Having more teeth was also related to being better educated, spending more time walking, being a current drinker, and having higher energy and protein intake.

Number of teeth and incident functional disability

The number of remaining teeth was significantly associated with a higher risk of incident functional disability. The multiple adjusted HRs (95% CIs) for incident functional disability among participants having 10-19 and 0-9 teeth were 1.15 (1.01-1.30) and 1.20 (1.07-1.34), respectively, compared with participants having ≥20 teeth (*P*-trend <.05) (see online supplementary table S1).

Oral self-care and incident functional disability

Table 2 shows the relationship between oral self-care (tooth-brushing, dental visits, and use of dentures) and incident functional disability in the five categories. Compared with participants who had 20 or more teeth, HRs for participants who brushed their teeth <2 times per day were significantly higher [multivariate HRs (95% CI) 1.32 (1.12-1.55) for participants with 10-19 teeth,

and 1.33 (1.17-1.51) for participants with 0-9 teeth], but HRs for participants who brushed their teeth ≥2 times per day were not significantly higher in the "10-19 teeth" and "0-9 teeth" groups [multivariate HRs (95% CI) 1.05 (0.91-1.21) for participants with 10-19 teeth, and 1.09 (0.96-1.23) for participants with 0-9 teeth]. There was no significant difference in the increased risk between these two subgroups, irrespective of whether or not participants undertook dental visits or used dentures.

We analysed "dental visits for other reasons (such as dental check-ups and scaling)" as an exposure (see online supplementary table S2). Compared with participants who had 20 or more teeth, only the HR for participants who had 10-19 teeth and visited a dentist was not significant. No such relationship was observed for "dental visits for treatment" as an exposure.

Additionally, we compared HRs for participants who did and did not practice oral self-care in each of the "10-19 teeth" and "0-9 teeth" subgroups (Table 3). Compared with participants who brushed their teeth <2 times per day, HRs for participants who brushed their teeth ≥2 times per day were significantly lower [multivariate HRs (95% CI) 0.80 (0.66-0.96) for participants with 10-19 teeth (*P*-value <.001), and 0.81 (0.73-0.91) for participants with 0-9 teeth (*P*-value <.05)]. However, there was no significant difference in either of these subgroups, irrespective of whether or not participants undertook dental visits or used dentures. When we conducted reanalysis after excluding the participants with "0 teeth", the results did not change substantially: 0.80 (0.69-0.94) for participants with 1-9 teeth.

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Discussion

This cohort study investigated the association between oral self-care and incident functional disability. First, we found that tooth loss was significantly associated with an increased risk of incident functional disability, in agreement with previous studies.[7,8] However, even among participants who had fewer remaining teeth, the risk for those who brushed their teeth frequently was not significantly higher. Among participants who had 10-19 teeth, we also observed a similar result for those who made dental visits for other reasons (such as dental check-ups and scaling). Our study suggested that if individuals with fewer than 20 teeth practiced good oral self-care habits such as regular tooth-brushing and preventive dental visits, they might partially negate the expected increase in incident functional disability. The present study had a number of strengths: 1) it was a large population-based cohort study involving 12,370 individuals, 2) it had a follow-up rate of almost 100%, 3) it took into account considerable confounding factors, and 4) it is the first reported study to have demonstrated an impact of tooth brushing on the increased risk of incident functional disability resulting from having fewer remaining teeth.

There are several possible pathways linking oral self-care to incident functional disability. First, periodontal disease is related to systemic inflammation through oral inflammation.[24] Second, a recent report has suggested that swallowing of oral bacteria affects the gut microbiota, causing systemic inflammation.[12] Chronic inflammation is known to be a risk factor for atherosclerotic diseases including stroke[25] and dementia,[26] and may cause autoimmune disease, particularly

rheumatoid arthritis.[27] These diseases and their symptoms are common causes of functional disability in the Japanese elderly population.[28] Indeed, a previous study has suggested that tooth brushing ameliorates the risk of cardiovascular disease.[11] Therefore, better oral hygiene through tooth-brushing may reduce the risk of functional disability in the elderly.

The present study had several limitations. First, misclassification of the number of teeth and practicing oral self-care as a result of self-reporting might have occurred. However, the validity of the self-reported number of teeth has been confirmed by previous studies,[29] and similarly the validity of self-reported dental visits has also been confirmed.[30] Second, among the source population of 31,694, the rate of valid responses (72.9%, n =23,091) for this study was not high. In addition, the valid responses would have shown a bias toward healthier people living in the community. However, this bias would not have affected the internal validity of the association between oral self-care and incident functional disability. Third, we did not consider causes of incident functional disability. Thus, the mechanisms responsible for the reduction of incident functional disability risk resulting from oral self- care remained unidentified. Fourth, although we observed the preventive association even after adjusting for major characteristics/behaviour, not all potential confounding factors were considered. For example, although cognitive function and income might be possible confounders, we did not include them as adjustment items.

In conclusion, this study has shown that tooth-brushing may partially negate the increased risk of incident functional disability resulting from having fewer remaining teeth. Further studies will

need to confirm the effects of oral self-care on incident functional disability in individuals with missing teeth.

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Data sharing statement: No additional data are available.

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TABLES

Table1. Relationship Between Number of Teeth and Participant Characteristic (n=12,370)

Characteristic	Number of Teeth		
	≥20, n = 4,047	10-19, n = 3,108	0-9, n = 5,215
Women , %	50.0	53.4	58.2
Age, mean ± SD	71.3 ± 4.8	72.8 ± 5.2	75.6 ± 6.2
Body mass index, kg/m^2, %			
<18.5	3.2	4.9	6.2
18.5-24.9	63.8	64.0	65.3
≥25.0	32.9	31.1	28.5
Current smoking, %	11.0	14.5	14.6
Current alcohol drinking, %	46.1	41.3	31.7
Education < 16 years, %	22.9	27.2	33.7
Daily walking time ≥ 1 hour, %	29.3	29.1	26.0
Medical history, %			
Stroke	2.2	2.9	3.1
Hypertension	43.5	43.5	43.5
Myocardial infarction	3.8	4.4	5.9
Diabetes mellitus	10.5	11.5	12.6
Psychological distress, % [a]	3.4	4.2	5.6
Energy intake, kcal/d, mean ± SD [b]	1463.5 ± 406.9	1451.9 ± 401.7	1413.8 ± 393.7
Protein intake, g/d, mean ± SD	54.7 ± 14.0	53.6 ± 14.3	52.5 ± 14.4
Use of dentures, %	27.3	75.1	93.0
Tooth brushing (times/d)	2.0 ± 0.9	1.9 ± 1.1	1.8 ± 0.9
≥ 1 dental visits per year, %			
For treatment	57.3	63.5	43.8
For other reasons	39.5	34.3	19.7

[a] Kessler six-item psychological distress scale score ≥ 13.

[b] Excluding alcohol.

SD = standard deviation.

Table2. Relationship Between Oral Self-Care and Incident Functional Disability Stratified According to Number of Teeth (n=12,370).

Oral Self-care and Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
Tooth brushing					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with brushing teeth ≥2 per day	1,977	10,200	300 (15.2)	1.05 (0.91-1.22)	1.05 (0.91-1.21)
10-19 with brushing teeth <2 per day	1,131	5,529	230 (20.3)	1.44 (1.23-1.69)	1.32 (1.12-1.55)
0-9 with brushing teeth ≥2 per day	2,840	13,888	634 (22.3)	1.15 (1.01-1.30)	1.09 (0.96-1.23)
0-9 with brushing teeth <2 per day	2,375	10,812	689 (29.0)	1.52 (1.35-1.72)	1.33 (1.17-1.51)
≥1 dental visits per year					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	2,010	10,208	335 (16.7)	1.17 (1.02-1.35)	1.14 (0.99-1.32)
10-19 with no dental visits	1,098	5,521	195 (17.8)	1.23 (1.04-1.46)	1.16 (0.98-1.38)
0-9 with dental visits	2,343	11,502	528 (22.5)	1.26 (1.11-1.42)	1.15 (1.01-1.31)
0-9 with no dental visits	2,872	13,198	795 (27.7)	1.36 (1.21-1.54)	1.23 (1.09-1.39)
Use of dentures					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with use of dentures	2,333	11,770	411 (17.6)	1.18 (1.04-1.35)	1.15 (1.01-1.32)
10-19 with no use of dentures	775	3,958	119 (15.4)	1.22 (1.00-1.49)	1.13 (0.92-1.38)
0-9 with use of dentures	4,850	23,087	1220 (25.2)	1.29 (1.15-1.44)	1.19 (1.06-1.33)
0-9 with no use of dentures	365	1,613	103 (28.2)	1.66 (1.34-2.06)	1.35 (1.09-1.68)

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Table 3. Sensitivity Analysis of the Relationship Between Oral Self-Care and Incident Functional Disability According to Number of Teeth (n=8,323).

Oral Self-care and Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
10-19 teeth (n=3,108)					
Brushing teeth <2 per day	1,131	5,529	230 (20.3)	1.00 (reference)	1.00 (reference)
Brushing teeth ≥2 per day	1,977	10,200	300 (15.2)	0.73 (0.61-0.87)	0.80 (0.66-0.96)
No dental visits	1,098	5,521	195 (17.8)	1.00 (reference)	1.00 (reference)
≥1 dental visits per year	2,010	10,208	335 (16.7)	0.95 (0.79-1.13)	0.98 (0.82-1.17)
No use of dentures	775	3,958	119 (15.4)	1.00 (reference)	1.00 (reference)
Use of dentures	2,333	11,770	411 (17.6)	0.97 (0.79-1.19)	1.00 (0.81-1.23)
0-9 teeth (n=5,215)					
Brushing teeth <2 per day	2,375	10,812	689 (29.0)	1.00 (reference)	1.00 (reference)
Brushing teeth ≥2 per day	2,840	13,888	634 (22.3)	0.75 (0.67-0.84)	0.81 (0.73-0.91)
No dental visits	2,872	13,198	795 (27.7)	1.00 (reference)	1.00 (reference)
≥1 dental visits per year	2,343	11,502	528 (22.5)	0.92 (0.82-1.03)	0.94 (0.84-1.05)
No use of dentures	365	1,613	103 (28.2)	1.00 (reference)	1.00 (reference)
Use of dentures	4,850	23,087	1220 (25.2)	0.78 (0.64-0.96)	0.88 (0.71-1.07)

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Supplementary table S1. Number of Teeth in Relation to Incident Functional Disability (n=12,370).

Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19	3,108	15,729	530 (17.1)	1.19 (1.05-1.35)	1.15 (1.01-1.30)
0-9	5,215	24,700	1,323 (25.4)	1.31 (1.18-1.47)	1.20 (1.07-1.34)
P-trend	-	-	-	<.001	.002

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

Title: Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese: The Ohsaki Cohort 2006 Study

Authors: Shino Bando MSc, [1] Yasutake Tomata PhD, [1] Jun Aida DDS, PhD, [2] Kemmyo Sugiyama MD, PhD, [1] Yumi Sugawara PhD, [1] and Ichiro Tsuji MD, PhD [1]

Supplementary Table S2. The Relationship Between the Reason for the Dental Visits and Incident Functional Disability According to Number of Teeth (n=12,370).

Dental visits and Number of Teeth	Participants, n	Person-years	Events, n (%)	Hazard Ratio (95% Confidence Interval)	
				Model 1*[1]	Model 2*[2]
≥1 dental visits for treatment per year					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	1,972	10,015	330 (16.7)	1.17 (1.02-1.35)	1.15 (0.99-1.32)
10-19 with no dental visits	1,136	5,713	200 (17.6)	1.23 (1.04-1.45)	1.15 (0.98-1.36)
0-9 with dental visits	2,284	11,214	513 (22.5)	1.25 (1.10-1.42)	1.14 (1.00-1.30)
0-9 with no dental visits	2,931	13,484	810 (27.6)	1.36 (1.21-1.54)	1.24 (1.10-1.40)
≥1 dental visits for other reasons per year					
≥20	4,047	21,152	476 (11.8)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	1,065	5,464	169 (15.9)	1.11 (0.93-1.33)	1.07 (0.90-1.28)
10-19 with no dental visits	2,043	2,043	361 (17.7)	1.23 (1.07-1.41)	1.19 (1.03-1.36)
0-9 with dental visits	1,026	4,983	240 (23.4)	1.35 (1.15-1.58)	1.21 (1.03-1.42)
0-9 with no dental visits	4,189	19,716	1083 (25.9)	1.30 (1.17-1.46)	1.19 (1.06-1.34)

*[1]Model 1: Adjusted for age (65-69, 70-74, 75-79, 80-84, and ≥85 y) and sex.

*[2]Model 2: Adjusted for model 1 + education level (age upon final graduation from school <16, 16-18, ≥19 y, missing), smoking (never, former, current, missing), alcohol drinking (never, former, current, missing), body mass index (kg/m2; <18.5, 18.5-24.9, ≥25.0, missing), time spent walking daily (<30 min/d, 30 min/d-1h/d, >1h/d, missing), history of disease (stroke, hypertension, myocardial infarction, diabetes mellitus), psychological distress score (<13, ≥13, missing), energy intake (sex-specific tertile, missing), and protein intake (sex-specific tertile, missing).

*[3]Other reason is getting dental checkup and scaling, for example.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page or line numbers where the checklist items are located in this paper*
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Line 2-3, Page 1 Line 4, Page 3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Line 1-18, Page 3
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Line 2-18, Page 5
Objectives	3	State specific objectives, including any prespecified hypotheses	Line 13, Page 5 Line 19, Page 5 - Line 1-2,Page 6
Methods			
Study design	4	Present key elements of study design early in the paper	Line 2, Page 7 – Line 1, Page 8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Line 4-13 page 7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Line 10, Page 7 – Line 1, Page 8 Line 10-17, page 10
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed	*(This is not a matched studies)*
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Line 7, Page 8 - Line 17, Page 10
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Line 7, Page 8 - Line 8, Page 10
Bias	9	Describe any efforts to address potential sources of bias	Line 16, Page 11 - Line 4, Page12
Study size	10	Explain how the study size was arrived at	Line 4-6, 10-15, Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Line 18, Page 8 – Line 2, Page 9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Line 8,page 11-Line 16, page 12
		(*b*) Describe any methods used to examine subgroups and interactions	Line 7-8, Page 14 Line 11-12, Page 14
		(*c*) Explain how missing data were addressed	Line 16, Page 11 - Line 4, Page12
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	Line 2-5, Page 8
		(*e*) Describe any sensitivity analyses	Line 11-12, page 14

**Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese : The Ohsaki Cohort 2006 Study*

Results			
Participants	13	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Line 13, Page 7 – Line 1, Page 8
		(b) Give reasons for non-participation at each stage	Line 13, Page 7 – Line 1, Page 8
		(c) Consider use of a flow diagram	
Descriptive data	14	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Line2-7, Page 13 Table 1, Page 25
		(b) Indicate number of participants with missing data for each variable of interest	Line 15, Page 7 – Line 1, Page 8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Line 4-5, Page 8 Table 2, Page 26
Outcome data	15	*Cohort study*—Report numbers of outcome events or summary measures over time	Line 4-5, Page 8 Table 2, Page 26
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2, Page 26 Line 16, Page 13-Line 6, Page 14
		(*b*) Report category boundaries when continuous variables were categorized	Line 16, Page 11 - Line 4, Page12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Line 7-19, Page 14 Table 3, Page 27 Supplementary Table S2, Page 29
Discussion			
Key results	18	Summarise key results with reference to study objectives	Line 3-7, Page 16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Line 5-17, Page 17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Line 3-10, Page 16 Line 15, Page 16-Line 4, Page17
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Line 10-13, Page 19

**Impact of Oral Self-care on Incident Functional Disability in Elderly Japanese : The Ohsaki Cohort 2006 Study*