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

博士論文

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

（口腔セルフケアが高齢者の要介護リスクに与える影響 : 大崎コホート２００６研究）

東北大学大学院医学系研究科医科学専攻

情報健康医学講座公衆衛生学分野

坂東　志乃

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 maximum 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], HRs for those who brushed their teeth <2 times per day remained 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.

Background

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)] Inflammation caused by periodontal disease is one of the possible pathway linking tooth loss to functional disability. Besides being related to the diseases mentioned above, it is suggested that systemic inflammatory markers have been implicated as possible predictors of cognitive decline.[9)] Some studies have shown the association between tooth loss and incident cognitive disability.[10)-12)] Another possible pathway is associated with the mastication ability decline by tooth loss. Tooth loss affects dietary intake and nutritional status.[13)-14)] Mastication ability decline links to undernutrition and consequently might affect frailty in elderly. Tooth loss is irreversible, and the proportion of 80 years old people with less than 20 teeth is about 50% in Japan.[15)] Many elderly would be still exposed to the excess risk of disability by having fewer teeth. Therefore, it is a necessary to decrease the excess risk of functional disability in elderly with missing teeth, as well as to keep the number of teeth.

It has been suggested that oral self-care has a preventative impact on mortality.[16)] The previous study has 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.[16] Those who practiced oral self-care also had a lower risk of dementia and cardiovascular disease.[17),18] 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,[19] implying a new pathway whereby poor oral hygiene may be linked to systemic disease. Therefore, keeping oral hygiene by brushing teeth may remove plaque accumulation and prevent inflammation. 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[20] or regular dental visits.[21] These studies have shown that lack of these two kinds of oral self-cares are associated with risk of functional disability. Denture use may play a role in compensating for undernutrition from a mastication ability decline,[22] and having regular dental care may keep or promote oral health for the prevention and treatment of oral diseases.

Objectives

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.

Methods

I. 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.[23] 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, I 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 (Figure1).

During the maximum 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.

II. Measurement of dental health status

In the baseline questionnaire, respondents were asked 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, I divided the respondents into three groups: 1) ≥20 teeth, 2) 10-19 teeth, and 3) 0-9 teeth. The optimal dentition was defined as 1) ≥20 teeth, because having at least 20 teeth was not related to an impaired chewing ability.[24),25)] Following the classification of previous study,[16)] the suboptimal dentition [2)10-19 teeth] and the poor dentition [3) 0-9 teeth] were positioned as groups with tooth loss.

Also the respondents were 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. They were asked to mark “yes” or “no” in reply.

And they were asked how many times participants brushed their teeth daily.

III. Measurements of other variables

K6 was used as an indicator of psychological distress.[26),27)] 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, I classified individuals with scores of ≥13 as having psychological distress.[28)]

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.[29)] A validation study of the FFQ had been conducted previously.[29)]

IV. LTCI system in Japan

In this study, I 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.[30),31)] 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 [32]. LTCI certification has already been used as a measure of incident functional disability in the elderly.[7),33)]

V. 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. A data set were obtained 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.

VI. 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.

VII. Statistical analysis

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

First, I 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, I 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". The aim of retaining at least 20 teeth and not requiring prostheses, has been suggested in the World

Health Organization/International Dental Federation Goals for the Year 2000.[34] The Japanese Ministry of Health and Welfare has also promoted a movement to encourage citizens to retain 20 teeth or more at 80 years old, with the “80-20 (Eighty - Twenty) Campaign”.[35] Like these, people with “≥20 teeth” have been regarded as maintaining an acceptable level of oral health, and measures to keep the number of teeth have been already done. Thus, "≥20 teeth" was considered the reference group as in the previous studies,[7),9),20),21)] “10-19 teeth” and “0-9 teeth” were divided by whether or not practicing oral self-care as more proactively need for oral self-care. 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. To examine the possibility of reverse causality, I also analyzed that after excluding participants who censored within the first two years of follow-up. After the examination mentioned above, I conducted six additional analyses: 1) competing risk analyses when the competing event was disability-free death, 2) reanalyses by the reason for dental visits respectively, 3) reanalyses after dividing the participants with “0-9 teeth” into "1-9 teeth" and "0 teeth", 4) comparison between HR for participants who did and did not oral self-care participants in the subgroup of "10 - 19 teeth" and "0 - 9 teeth", 5) reanalyses with outcome at care level 2 or higher, and 6) reanalysis after participants who had 20 or more teeth divided into whether brushed their teeth or not.

All statistical analyses were performed with SAS version 9.4 (SAS Inc., Cary, NC,

USA), except for Kaplan–Meier curves, which were drawn using SPSS Statistics version 25.0 (IBM Corp., Chicago, IL, USA). All statistical tests were 2-sided. Differences at $P < 0.05$ were considered to be statistically significant.

Results

I. 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.

II. 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) (**Table 2**). Kaplan–Meier curves, indicated the cumulative proportion of participants remaining free from functional disability with number of teeth (**Figure 2**). This result implied that the proportional hazards assumption had not been violated. The cumulative functional disability-free proportion of participants who reported fewer teeth was lower throughout the follow-up period.

III. Oral self-care and incident functional disability

Table 3 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.

To examine possible reverse causality for the association between oral self-care and incident functional disability, I reanalyzed the association after excluding 1,024 participants who censored within the first two years of follow-up (**Table 4)**. However, the results for tooth-brushing did not change substantially.

Because 786 cases of death among 1,446 total cases were censored in the analysis, I conducted the competing risks regression model in order to avoid the possibility of an overestimation. The definition of the competing event was set as a disability-free death. Even in the competing risks regression model, the relationship between oral self-care and incident

functional disability did not change substantially (**Table 5**).

I analysed "dental visits for other reasons (such as dental check-ups and scaling)" as an exposure (**Table 6**). 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, I 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 7**). 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 I 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.

Because there was a possibility that some participants did not apply for LTCI if their functional disability was mild, I analyzed the outcome set to care level 2 or higher which was stricter than support level 1 (**Table 8**). Even in it, the relationship between tooth brushing and incident functional disability did not change substantially.

Finally, I conducted sensitivity analysis in 6 categories after participants who had 20

or more teeth also divided into whether brushed their teeth or not (**Table 9**). Compared with participants who had 20 or more teeth and brushed their teeth ≥2 times per day, HRs for participants who brushed their teeth <2 times per day were significantly higher in the "20 teeth", "10-19 teeth" and "0-9 teeth" groups, 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.

Discussion

This cohort study investigated the association between oral self-care and incident functional disability. First, I 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, I also observed the risk for those who visited a dentist for other reasons (such as dental check-ups and scaling) was not significantly higher, but the risk for those who did not visit a dentist remained significantly higher. Also about "dental visits for treatment", there were no significant differences in the increased risk, by whether or not participants undertook dental visits. 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.

In the present study, "use of denture" and "dental visits" did not show any significant difference by whether practicing or not, unlike tooth brushing. These results were not consistent with previous studies.[20),21)] These two previous studies demonstrated the relationship between oral self-care and functional disability, the present study is the first study that has demonstrated the impact of tooth brushing on incident functional disability. In the cohort study of 1,969 elderly Japanese by Shimazaki et al., compared with participants who had 20 or more teeth,

participants who had 19 or less teeth and those who did not wear dentures had a significantly higher risk of physical functional disability.[20] However, characteristics were different from those of present study subjects, because the subjects of their study were institutionalized elderly. In the cohort study of 834 community-dwelling elderly Japanese by Komiyama et al.,[21] there was no significant difference in risk of functional disability between participants with 20 or more teeth and those with 0-19 teeth who were receiving regular dental care. This is the only previous study investigating the community-dwelling elderly, although the sample size was not large enough. In consistency with previous studies would be partly attributable to the difference in study-setting and sample size between the previous studies and the present study.

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. To minimize the effects of reverse causality, I reanalyzed after excluding participants who censored within the first two years of follow-up; however, the association between oral self-care and incident functional disability did not change. It suggested that the present results are unlikely to be attributable to reverse causality.

There is possible pathway linking oral self-care to incident functional disability. First, periodontal disease is related to systemic inflammation through oral inflammation.[36] Second,

a recent report has suggested that swallowing of oral bacteria affects the gut microbiota, causing systemic inflammation.[19] Chronic inflammation is known to be a risk factor for atherosclerotic diseases including stroke[37] and dementia,[38] and may cause autoimmune disease, particularly rheumatoid arthritis.[39] These diseases and their symptoms are common causes of functional disability in the Japanese elderly population.[40] Indeed, a previous study has suggested that tooth brushing ameliorates the risk of cardiovascular disease.[18] Therefore, better oral hygiene through tooth-brushing may reduce the risk of functional disability in the elderly. Tooth loss might cause frailty in older people by contributing to undernutrition caused by a decrease in mastication ability.[13] However, I excluded items which related to nutritional status such as BMI, energy intake, and protein intake from adjustment items, but the results did not change substantially (data not shown). Additionally, although denture use may compensate for undernutrition from a mastication ability decline,[22] there was no significant difference in incident functional disability risk depending on whether or not the denture was used (**Table 7**). Therefore, the results of the present study did not support this pathway. Based on the above, tooth-brushing might be involved in a pathway that causes 'inflammation'. With the number of remained teeth decreasing, there was higher possibility that it has been exposed to inflammation by periodontal disease. Poor oral hygiene also causes oral bacteria, other than periodontitis bacteria, to grow and even people with few/no teeth can swallow the oral bacteria and cause systemic inflammation. Therefore, for people with fewer teeth, improving oral hygiene of teeth

by brushing their teeth is more meaningful than people with optimal dentition. 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. Validity of tooth brushing have not been confirmed, however, the validity of the self-reported number of teeth,[41] dental visits,[42] and denture[43] have been confirmed by previous studies. Second, among the source population of 31,694, the rate of valid responses (72.9%, n =23,091) for this study was not high. The valid responses would have shown a bias toward healthier people living in the community. In addition, among the participants who made valid response, the number of those included in the present analysis was 12,370 (53.6%), and the number of those who were not included was 10,721 (46.4%). Mortality between December 1, 2006 and November 30, 2012 was lower in the analysis subjects (11.7%) than in the non-analysis subjects (25.5%). Also, the proportion of participants with 20 teeth or more was lower in the non-analysis subjects (22.9%) than in the analysis subjects (32.7%). Thus, the present study would have been biased toward healthier people in the community. However, this bias would not have affected the internal validity of the association between oral self-care and incident functional disability. Because it was a healthier bias related to the participants as a whole and it was not a biasing biased towards any of the comparison groups, even if there was any healthier bias, the results of the present study would have been underestimated. Third, not all candidates applied for LTCI certification; therefore, we cannot deny the possibility of differential misclassification. But, according to the

result when the outcome was set to the care level 2 or higher (**Table 8**), it was considered that the results for tooth-brushing did not change substantially which means this issue may not affect present main findings. Fourth, although I 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, I did not include them as adjustment items. If these items were adjusted, it was predicted that the effect of oral self-care would be attenuated. Regarding the cognitive function of the participants, it would have been better if there were sophisticated measures or clinical data such as Mini Mental State Examination scores,[44] but we did not have them. Fifth, we had no follow-up data on oral self-care and number of teeth. However, there is evidence showing stability of oral health related behaviour such as tooth brushing; with respect to frequency of brushing and flossing were 69-74% and 80-84% of men and women remained in the same category for 8 years. Thus small changes in oral health behaviour are unlikely to affect the present findings.[45] Regarding the number of teeth, tooth loss was related to the whole participants, so the results of the present study would have been underestimated. Additionally, the follow-up period was as short as 5.7 years, it was considered that the tooth loss was not so significant as to affect the present study. Sixth, I 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. Based on the above limitations, it was

considered that accumulating prospective studies including information such as causative diseases will lead to elucidation of the mechanism. Furthermore, it will be necessary to verify that the effect of oral self-care is a real issue or not by conducting randomized controlled trial.

Conclusion

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.

References

1. Beard J OcA, Cassels A. World report on ageing and health. *World Health Organization* 2015;http://www.who.int/ageing/publications/world-report-2015/en/ (accessed Aug 20, 2018).

2. Abnet CC, Qiao YL, Dawsey SM, et al. Tooth loss is associated with increased risk of total death and death from upper gastrointestinal cancer, heart disease, and stroke in a Chinese population-based cohort. *Int J Epidemiol* 2005;34(2):467-74.

3. Holm-Pedersen P, Schultz-Larsen K, Christiansen N, et al. Tooth loss and subsequent disability and mortality in old age. *J Am Geriatr Soc* 2008;56(3):429-35.

4. Janket SJ, Baird AE, Chuang SK, et al. Meta-analysis of periodontal disease and risk of coronary heart disease and stroke. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003;95(5):559-69.

5. Azarpazhooh A, Leake JL. Systematic review of the association between respiratory diseases and oral health. *J Periodontol* 2006;77(9):1465-82.

6. Wolff JL, Boult C, Boyd C, et al. Newly reported chronic conditions and onset of functional dependency. *J Am Geriatr Soc* 2005;53(5):851-5.

7. Aida J, Kondo K, Hirai H, et al. Association between dental status and incident disability in an older Japanese population. *J Am Geriatr Soc* 2012;60(2):338-43.

8. Tsakos G, Watt RG, Rouxel PL, et al. Tooth loss associated with physical and cognitive

decline in older adults. *J Am Geriatr Soc* 2015;63(1):91-9.

9.Schram MT, Euser SM, de Craen AJ et al. Systemic markers of inflammation and cognitive decline in old age. *J Am Geriatr Soc* 2007;55:708–716.

10. Kaye EK, Valencia A, Baba N et al. Tooth loss and periodontal disease predict poor cognitive function in older men. *J Am Geriatr Soc* 2010;58:713–718.

11. Stein PS, Kryscio RJ, Desrosiers M et al. Tooth loss, apolipoprotein E, and decline in delayed word recall. *J Dent Res* 2010;89:473–477.

12. Stein PS, Desrosiers M, Donegan SJ et al. Tooth loss, dementia and neuropathology in the Nun Study. *J Am Dent Assoc* 2007;138:1314–1322.

13. Sheiham A, Steele JG, Marcenes W et al. The relationship among dental status, nutrient intake, and nutritional status in older people. *J Dent Res* 2001;80:408–413.

14. Sheiham A, Steele JG, Marcenes W et al. The impact of oral health on stated ability to eat certain foods;: Findings from the National Diet and Nutrition Survey of Older People in Great Britain. *Gerodontology* 1999;16:11–20.

15. Ministry of Health Labour, and Welfare. Survey of Dental Diseases, 2016. https://www.mhlw.go.jp/toukei/list/62-28.html (accessed Dec 11,2018).

16. Hayasaka K, Tomata Y, Aida J, et al. Tooth loss and mortality in elderly Japanese adults: effect of oral care. *J Am Geriatr Soc* 2013;61(5):815-20.

17. Yamamoto T, Kondo K, Hirai H, et al. Association between self-reported dental health status

and onset of dementia: a 4-year prospective cohort study of older Japanese adults from the Aichi Gerontological Evaluation Study (AGES) Project. *Psychosom Med* 2012;74(3):241-8.

18. de Oliveira C, Watt R, Hamer M. Toothbrushing, inflammation, and risk of cardiovascular disease: results from Scottish Health Survey. *BMJ* 2010;340:c2451.

19. Arimatsu K, Yamada H, Miyazawa H, et al. Oral pathobiont induces systemic inflammation and metabolic changes associated with alteration of gut microbiota. *Scientific reports* 2014;4:4828.

20. Shimazaki Y, Soh I, Saito T, et al. Influence of dentition status on physical disability, mental impairment, and mortality in institutionalized elderly people. *J Dent Res* 2001;80(1):340-5.

21. Komiyama T, Ohi T, Miyoshi Y, et al. Association Between Tooth Loss, Receipt of Dental Care, and Functional Disability in an Elderly Japanese Population: The Tsurugaya Project. *J Am Geriatr Soc* 2016;64(12):2495-502.

22. Savoca MR, Arcury TA, Leng X, et al. Impact of denture usage patterns on dietary quality and food avoidance among older adults. *J Nutr Gerontol Geriatr* 2011;30(1):86-102.

23. Kuriyama S, Nakaya N, Ohmori-Matsuda K, et al. The Ohsaki Cohort 2006 Study: design of study and profile of participants at baseline. *J Epidemiol* 2010;20(3):253-8.

24. Agerberg G, Carlsson GE. Chewing ability in relation to dental and general health. *Acta*

Odontol Scand 1981;39:147–153.

25. Aukes JN, Käyser AF, Felling AJ. The subjective experience of mastication in subjects with shortened dental arches. *J Oral Rehabil*1988;15:321–324.

26. Kessler RC, Barker PR, Colpe LJ, et al. Screening for serious mental illness in the general population. *Arch Gen Psychiatry* 2003;60(2):184-9.

27. Furukawa TA, Kawakami N, Saitoh M, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res* 2008;17(3):152-8.

28. Kuriyama S, Nakaya N, Ohmori-Matsuda K, et al. Factors associated with psychological distress in a community-dwelling Japanese population: the Ohsaki Cohort 2006 Study. *J Epidemiol* 2009;19(6):294-302.

29. Ogawa K, Tsubono Y, Nishino Y, et al. Validation of a food-frequency questionnaire for cohort studies in rural Japan. *Public Health Nutr* 2003;6(2):147-57.

30. Imahashi K, Kawagoe M, Eto F, et al. Clinical status and dependency of the elderly requiring long-term care in Japan. *Tohoku J Exp Med* 2007;212(3):229-38.

31. Ministry of Health Labour, and Welfare. Long-Term Care, Health and Welfare Services for the Elderly. http://www.mhlw.go.jp/english/policy/care-welfare/care-welfare-elderly/. (accessed Aug 20, 2018.)

32. Arai Y, Zarit SH, Kumamoto K, et al. Are there inequities in the assessment of dementia

under Japan's LTC insurance system? *Int J Geriatr Psychiatry* 2003;18(4):346-52.

33. Tomata Y, Watanabe T, Sugawara Y, et al. Dietary patterns and incident functional disability in elderly Japanese: the Ohsaki Cohort 2006 study. *J Gerontol A Biol Sci Med Sci* 2014;69(7):843-51.

34. Fédération Dentaire International. Global goals for oral health for year 2000. Int Dent J 1982;32:74–77.

35. Ministry of Health, Labour and Welfare Japan. Overview 8020 (Eighty‐Twenty) Campaign. Ministry of Health, Labour and Welfare Japan. https://www.mhlw.go.jp/english/wp/wp-hw3/dl/2-075.pdf (accessed Dec 13, 2018.)

36. Loos BG. Systemic markers of inflammation in periodontitis. *J Periodontol* 2005;76(11 Suppl):2106-15.

37. Joshipura K, Zevallos JC, Ritchie CS. Strength of evidence relating periodontal disease and atherosclerotic disease. *Compend Contin Educ Dent* 2009;30(7):430-9.

38. Heneka MT, O'Banion MK. Inflammatory processes in Alzheimer's disease. *J Neuroimmunol* 2007;184(1-2):69-91.

39. Okada M, Kobayashi T, Ito S, et al. Periodontal treatment decreases levels of antibodies to Porphyromonas gingivalis and citrulline in patients with rheumatoid arthritis and periodontitis. *J Periodontol* 2013;84(12):e74-84.

40. Ministry of Health Labour, and Welfare. Comprehensive Survey of Living Conditions,

Summary Report, 2010. http://www.mhlw.go.jp/english/database/db-hss/dl/report_gaikyo_2010.pdf. (accessed Aug 20, 2018.)

41. Matsui D, Yamamoto T, Nishigaki M, et al. Validity of self-reported number of teeth and oral health variables. *BMC Oral Health* 2016;17(1):17.

42. Gilbert GH, Rose JS, Shelton BJ. A prospective study of the validity of data on self-reported dental visits. *Community Dent Oral Epidemiol* 2002;30(5):352-62.

43. Pitiphat W, Garcia RI, Douglass CW,et al. Validation of Self-reported Oral Health Measures. *J Public Health Dent.* 2002 Spring;62(2):122-8.

44. Folstein MF, Folstein SE, McHugh PR : ”Mini-Mental State”. A practical method for grading the cognitive state of patients for the clinician *J Psychiatr Res* 1975;12;189-198.

45. Astrøm AN. Stability of oral health-related behaviour in a Norwegian cohort between the ages of 15 and 23 years. *Community Dent Oral Epidemiol* 2004;32:354-62.

Figure

Figure1. Flowchart of study participants.

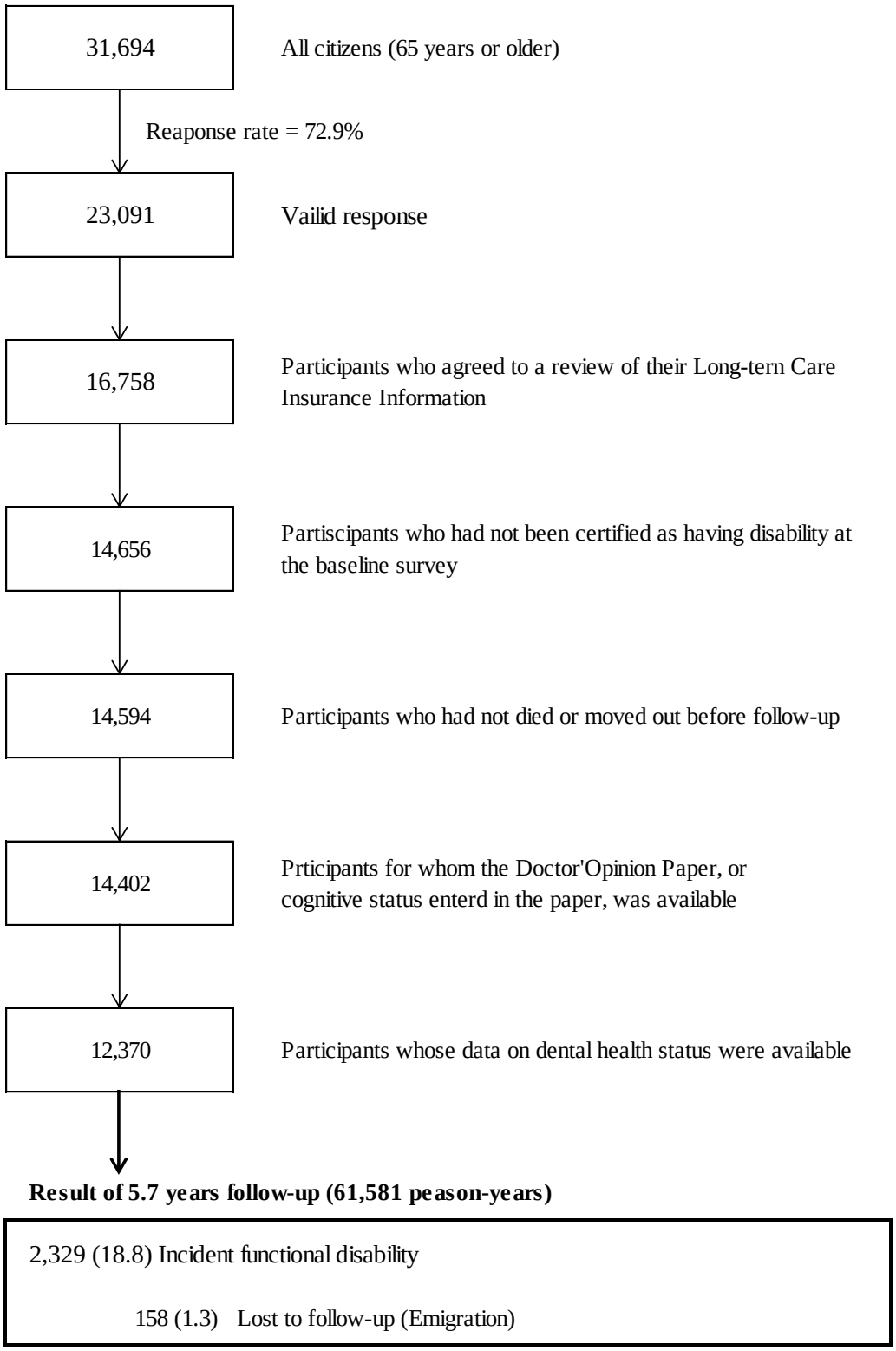
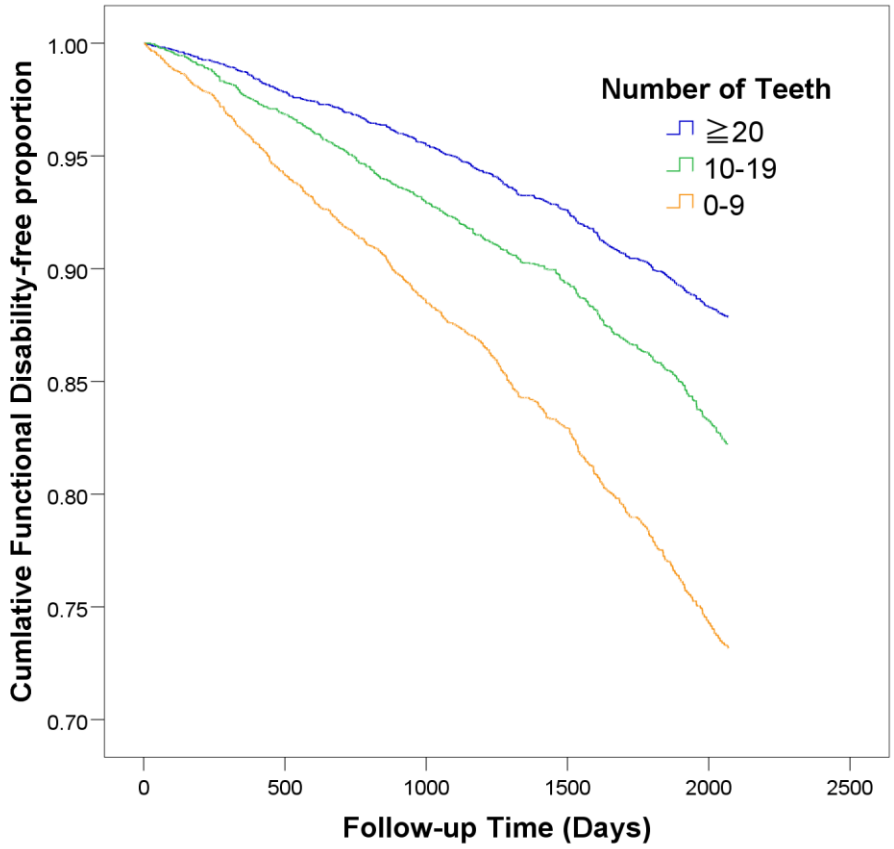


Figure2. The Kaplan-Meier survival curves for the cumulative proportion of participants remaining free from functional disability with number of teeth.



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**	**P-value**
Women , %	50.0	53.4	58.2	<.0001
Age, mean ± SD	71.3 ± 4.8	72.8 ± 5.2	75.6 ± 6.2	<.0001
Body mass index, kg/m^2, %				<.0001
<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	<.001
Current alcohol drinking, %	46.1	41.3	31.7	<.001
Education < 16 years, %	22.9	27.2	33.7	<.001
Daily walking time ≥ 1 hour, %	29.3	29.1	26.0	<.001
Medical history, %				
Stroke	2.2	2.9	3.1	.039
Hypertension	43.5	43.5	43.5	.998
Myocardial infarction	3.8	4.4	5.9	<.0001
Diabetes mellitus	10.5	11.5	12.6	.005
Psychological distress, % [a]	3.4	4.2	5.6	<.001
Energy intake, kcal/d, mean ± SD [b]	1463.5 ± 406.9	1451.9 ± 401.7	1413.8 ± 393.7	<.0001
Protein intake, g/d, mean ± SD	54.7 ± 14.0	53.6 ± 14.3	52.5 ± 14.4	<.0001
Use of dentures, %	27.3	75.1	93.0	<.0001
Tooth brushing (times/d)	2.0 ± 0.9	1.9 ± 1.1	1.8 ± 0.9	<.0001
≥ 1 dental visits per year, %				
For treatment	57.3	63.5	43.8	<.0001
For other reasons	39.5	34.3	19.7	<.0001

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

[b] Excluding alcohol.

SD = standard deviation.

Table 2. Number of Teeth in Relation to Incident Functional Disability (n=12,370).

				Hazard Ratio (95% Confidence Interval)	
Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**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).

Table 3. Relationship Between Oral Self-Care and Incident Functional Disability Stratified According to Number of Teeth (n=12,370).

				Hazard Ratio (95% Confidence Interval)	
Oral Self-care and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**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 4. Sensitivity analysis for Relationship Between Oral Self-Care and Incident Functional Disability Stratified According to Number of Teeth After Excluding Participants who Censored within the First Two Years of Follow-up (n=11,346).

				Hazard Ratio (95% Confidence Interval)	
Oral Self-care and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**Model 1[*1]**	**Model 2[*2]**
Tooth brushing					
≥20	3,851	20,958	353	1.00 (reference)	1.00 (reference)
10-19 with brushing teeth ≥2 per day	1,857	10,060	217	1.04 (0.87-1.23)	1.03 (0.87-1.22)
10-19 with brushing teeth <2 per day	1,024	5,417	161	1.43 (1.18-1.72)	1.31 (1.08-1.58)
0-9 with brushing teeth ≥2 per day	2,580	13,630	455	1.16 (1.01-1.34)	1.11 (0.96-1.28)
0-9 with brushing teeth <2 per day	2,034	10,466	445	1.46 (1.27-1.69)	1.29 (1.11-1.49)
≥1 dental visits per year					
≥20	3,851	20,958	353	1.00 (reference)	1.00 (reference)
10-19 with dental visits	1,871	10,051	295	1.16 (0.98-1.36)	1.13 (0.96-1.33)
10-19 with no dental visits	1,010	5,426	83	1.20 (0.99-1.47)	1.13 (0.93-1.38)
0-9 with dental visits	2,135	11,282	837	1.27 (1.10-1.47)	1.17 (1.01-1.36)
0-9 with no dental visits	2,479	12,814	63	1.32 (1.14-1.52)	1.20 (1.04-1.38)
Use of dentures					
≥20	3,851	20,958	353	1.00 (reference)	1.00 (reference)
10-19 with use of dentures	2,160	11,581	241	1.18 (1.01-1.38)	1.15 (0.98-1.34)
10-19 with no use of dentures	721	3,896	137	1.15 (0.91-1.47)	1.07 (0.84-1.37)
0-9 with use of dentures	4,310	22,544	378	1.28 (1.12-1.46)	1.18 (1.03-1.35)
0-9 with no use of dentures	304	1,552	522	1.52 (1.16-1.99)	1.26 (0.96-1.66)

*[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 5. Relation between Oral Self-care and Incident Functional Disability. (Competing-risks Model) (n=12,370).

Oral Self-care and Number of Teeth	Participants, n	Person-years	Events, n (%)	Competitive events†, n (%)	Hazard Ratio (95% Confidence Interval) Model 1*1	Hazard Ratio (95% Confidence Interval) Model 2*2
Tooth brushing						
≥20	4,047	21,152	476 (11.8)	177 (4.4)	1.00 (reference)	1.00 (reference)
10-19 with brushing teeth ≥2 per day	1,977	10,200	300 (15.2)	89 (4.5)	1.05 (0.91-1.21)	1.05 (0.91-1.21)
10-19 with brushing teeth <2 per day	1,131	5,529	230 (20.3)	102 (9.0)	1.41 (1.20-1.65)	1.30 (1.10-1.52)
0-9 with brushing teeth ≥2 per day	2,840	13,888	634 (22.3)	186 (6.6)	1.14 (1.00-1.29)	1.09 (0.96-1.24)
0-9 with brushing teeth <2 per day	2,375	10,812	689 (29.0)	232 (9.8)	1.48 (1.31-1.67)	1.30 (1.15-1.48)
≥1 dental visits per year						
≥20	4,047	21,152	476 (11.8)	177 (4.4)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	2,010	10,208	335 (16.7)	115 (5.7)	1.17 (1.02-1.35)	1.15 (1.00-1.32)
10-19 with no dental visits	1,098	5,521	195 (17.8)	76 (6.9)	1.20 (1.01-1.42)	1.13 (0.95-1.34)
0-9 with dental visits	2,343	11,502	528 (22.5)	160 (6.8)	1.25 (1.10-1.42)	1.15 (1.01-1.31)
0-9 with no dental visits	2,872	13,198	795 (27.7)	258 (9.0)	1.32 (1.17-1.50)	1.21 (1.07-1.37)
Use of dentures						
≥20	4,047	21,152	476 (11.8)	177 (4.4)	1.00 (reference)	1.00 (reference)
10-19 with use of dentures	2,333	11,770	411 (17.6)	144 (6.2)	1.18 (1.03-1.34)	1.15 (1.00-1.31)
10-19 with no use of dentures	775	3,958	119 (15.4)	47 (6.1)	1.20 (0.98-1.47)	1.12 (0.91-1.37)
0-9 with use of dentures	4,850	23,087	1220 (25.2)	369 (7.6)	1.27 (1.14-1.42)	1.18 (1.05-1.32)
0-9 with no use of dentures	365	1,613	103 (28.2)	49 (13.4)	1.55 (1.24-1.95)	1.27 (1.00-1.61)

*[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).

† Competing event was defined as disability-free death

Table 6. The Relationship Between the Reason for the Dental Visits and Incident Functional Disability According to Number of Teeth (n=12,370).

				Hazard Ratio (95% Confidence Interval)	
Dental visits and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**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	1,083 (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.

Table 7. Sensitivity Analysis of the Relationship Between Oral Self-Care and Incident Functional Disability According to Number of Teeth (n=8,323).

				Hazard Ratio (95% Confidence Interval)	
Oral Self-care and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**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).

Table 8. Relationship Between Oral Self-Care and Incident Functional Disability (LTCI certification levels are Care level 2 or higher) Stratified According to Number of Teeth (n=12,370).

				Hazard Ratio (95% Confidence Interval)	
Oral Self-care and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**Model 1[*1]**	**Model 2[*2]**
Tooth brushing					
≥20	4,047	21,152	190 (6.9)	1.00 (reference)	1.00 (reference)
10-19 with brushing teeth ≥2 per day	1,977	10,200	102 (5.2)	0.96 (0.75-1.22)	0.95 (0.74-1.21)
10-19 with brushing teeth <2 per day	1,131	5,529	100 (8.8)	1.51 (1.18-1.93)	1.36 (1.07-1.74)
0-9 with brushing teeth ≥2 per day	2,840	13,888	218 (7.7)	1.09 (0.89-1.33)	1.02 (0.83-1.25)
0-9 with brushing teeth <2 per day	2,375	10,812	291 (12.3)	1.55 (1.28-1.87)	1.32 (1.09-1.61)
≥1 dental visits per year					
≥20	4,047	21,152	190 (6.9)	1.00 (reference)	1.00 (reference)
10-19 with dental visits	2,010	10,208	118 (5.9)	1.06 (0.84-1.33)	1.01 (0.80-1.27)
10-19 with no dental visits	1,098	5,521	84 (7.7)	1.40 (1.08-1.81)	1.31 (1.01-1.70)
0-9 with dental visits	2,343	11,502	183 (7.8)	1.12 (0.91-1.38)	1.01 (0.82-1.25)
0-9 with no dental visits	2,872	13,198	326 (11.4)	1.47 (1.22-1.78)	1.30 (1.07-1.58)
Use of dentures					
≥20	4,047	21,152	190 (6.9)	1.00 (reference)	1.00 (reference)
10-19 with use of dentures	2,333	11,770	144 (6.2)	1.07 (0.86-1.33)	1.02 (0.82-1.27)
10-19 with no use of dentures	775	3,958	58 (7.5)	1.54 (1.15-2.07)	1.42 (1.05-1.90)
0-9 with use of dentures	4,850	23,087	462 (9.5)	1.26 (1.06-1.51)	1.14 (0.95-1.37)
0-9 with no use of dentures	365	1,613	47 (12.9)	1.82 (1.31-2.51)	1.41 (1.01-1.96)

*[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 9. Relationship Between Tooth brushing and Incident Functional Disability According to Number of Teeth, When Divided into 6 Categories. (n=12,370).

				HR (95% CI)	
Tooth brushing and Number of Teeth	**Participants, n**	**Person-years**	**Events, n (%)**	**Model 1*1**	**Model 2*2**
≥20 with brushing teeth ≥2 per day	2,758	14,560	282(10.2)	1.00 (ref)	1.00 (ref)
≥20 with brushing teeth <2 per day	1,289	6,593	194(15.1)	1.37 (1.14-1.64)	1.28 (1.06-1.54)
10-19 with brushing teeth ≥2 per day	1,977	10,200	300(15.2)	1.18 (1.00-1.39)	1.15 (0.98-1.35)
10-19 with brushing teeth <2 per day	1,131	5,529	230(20.3)	1.62 (1.36-1.94)	1.45 (1.22-1.74)
0-9 with brushing teeth ≥2 per day	2,840	13,888	634(22.3)	1.29 (1.11-1.49)	1.20 (1.04-1.38)
0-9 with brushing teeth <2 per day	2,375	10,812	689(29.0)	1.71 (1.48-1.98)	1.47 (1.27-1.70)

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

*2Model 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).