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Examining the associations between oral health and social isolation: A cross-national comparative study between Japan and England

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ABSTRACT

In Western countries, the most important part of the face in communication is the mouth, whereas it is the eyes in Asian countries; thus oral health could be more important in social interactions in Western countries. Our aim was to examine differences in the association between oral health status and social isolation among older people by comparing Japan and England. We used cross-sectional information obtained from adults aged 65+ in two ongoing prospective cohort studies: The Japan Gerontological Evaluation Study (JAGES, N = 120,195) and the English Longitudinal Study of Ageing (ELSA, N = 3,958). The dependent variable, social isolation score (SIS) was calculated from five factors (marital status, social support from children, social support from family, social support from friends, and social participation). The independent variables were self-reported number of remaining teeth (0, 1–9, 10–19, ≥20) and denture use (≥20 teeth, 10–19 teeth with denture, 10–19 teeth without denture, 0–9 teeth with denture, 0–9 teeth without denture), while the covariates in the model were: sex, age, educational attainment, self-rated health, number of comorbidities, household annual equivalized income, mental health status, daily living activities, and smoking status. We examined associations between oral health status and SIS by applying an ordered logit model by country. Compared to England, more Japanese participants were socially isolated (1.4% vs. 5.8%), but fewer were edentulous (13.1% vs. 7.7%). In both countries, poorer oral health further increased the odds of being socially isolated. Pooled analysis of the ordered logit model with an interaction term showed that the association of number of remaining teeth with SIS was stronger in edentulous participants and in England (odds ratio = 1.50, 95% Confidence interval:1.26–1.80). In both countries, oral health was associated with social isolation; this association could be stronger in England than in Japan.

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1. Introduction

Oral health is closely determined by orofacial appearance (Larsson et al., 2021), which in turn affects day-to-day social interactions (Chakraborty et al., 2017). People with fewer remaining teeth are likely to feel embarrassment (Sato et al., 2015; Veyrune et al., 2005) and become homebound (Koyama et al., 2016a), reducing their opportunities for social interactions. In this aspect, oral diseases and tooth loss can play a significant role in reducing the quality of life and well-being of older adults (Gerritsen et al., 2010; Hassel et al., 2011; Tan et al., 2016; Yin et al., 2020).

Under the COVID-19 pandemic, mask-wearing behavior was reported to be different between countries. In Western countries, compliance with mask wearing is lower than in Asian countries (Miyazawa and Kaneko, 2020). Cultural background is suggested as the reason for this difference. In Western countries, people tend to focus on the mouth in communication in order to understand facial expression (Jack et al., 2012; Yuki et al., 2007). Given that the eyes are more difficult to control than the mouth when expressing emotion, individuals in cultures where emotional subduction is the norm (such as Asian countries) focus more strongly on the eyes than the mouth when interpreting emotion in others. By contrast, people in cultures where overt emotional expression is the norm (such as Western countries) tend to interpret emotions based on the position of the mouth, as it is the most expressive part of the face.

This evidence implies the possibility of greater social impact due to loss of teeth, especially becoming edentulous (i.e. no natural teeth) in cultures that place more emphasis on the mouth than the eyes in communication (Jack et al., 2012; Yuki et al., 2007). We think the effect of poorer oral health on social interactions is likely to be greater among Western people than Asian people.

Social isolation has been linked to a range of health problems (Cotterell et al., 2018). Socially isolated people have a higher risk of mortality (Leigh-Hunt et al., 2017; Saito et al., 2021). Among older people, in particular, social isolation is closely associated with premature death and other health indicators in Japan (Saito et al., 2015) and England (Shankar et al., 2011). In this study, we particularly focused on the number of remaining teeth and denture use as an indicator of oral health and compared the association between oral health status and social isolation among older people between Japan and England.

2. Materials and methods

2.1. Study population

We obtained cross-sectional data from two ongoing prospective cohort studies: the Japan Gerontological Evaluation Study (JAGES) and the English Longitudinal Study of Ageing (ELSA). The ELSA data we used was from the 2014 to 2015 (wave 7) survey, whereas the JAGES survey was conducted from 2016 to 2017. ELSA participants were older adults living independently in England and were 50 years old and over. The JAGES study participants, on the other hand, were community-dwellers aged $\geq$65 years old who were not receiving public disability insurance benefits. To match the age of the analyzed participants, only the data of individuals who were $\geq$65 years were included. The mean age of the included ELSA participants was 73.8 $\pm$ 7.0 years; 1,751 were men and 2,207 were women. The mean age of the included JAGES participants was 73.5 $\pm$ 6.1 years; 59,010 were men and 60,819 were women.

2.2. Variables

2.2.1. Dependent variable: Social isolation

Consistent with previous studies (Ikeda et al., 2020; Tsuji et al., 2020; Taiji et al., 2021), we used a partially modified version of the Social Isolation Score (SIS) to measure social isolation. The SIS comprises the following five indicators: marital status, the presence of children or other immediate family members who provide support, monthly contact with friends or the presence of friends who provide support, and participation in any organizations, religious groups, or committees. The response to each question was assigned one point if the participants were: (1) not married or cohabitating with a partner; (2) did not live with their children or had no one to provide emotional or instrumental social support; (3) did not have immediate family members who could provide emotional or instrumental social support; (4) had face-to-face contact with friends less than once a month or did not have any friends who could provide emotional or instrumental social support; and (5) did not participate in any organizations, religious groups, or committees. The total possible score ranged from 0 to 5, and higher scores were indicative of greater social isolation. We classified the participants into the following five groups based on their scores on the index: 0, 1, 2, 3, and 4–5 points.

2.2.2. Independent variable: Oral health status (1. Number of remaining teeth, 2. denture use)

Participants were asked to indicate their number of remaining teeth and denture use, which we used as independent variables in this study. Number of remaining teeth and denture use were self-reported. The validity of the number of remaining teeth measure has been well established with respect to objective measures (Ando et al., 1997; Simila et al., 2018; Yamamoto et al., 2012), and the denture use measure modified in a previous study has already been used (Koyama et al., 2016a). For number of remaining teeth in an independent variable analysis, we categorized the responses as follows: no teeth, 1–9 teeth, 10–19 teeth, and 20 teeth or more. For denture use as an independent variable, we categorized the responses as follows: 20 teeth or more, 10–19 teeth and denture use, 10–19 teeth and no denture, 0–9 teeth and denture use, 0–9 teeth and no denture.

2.2.3. Covariates

The following sociodemographic characteristics, health-related behaviors, and health statuses were included in the model as covariates: age, sex, educational attainment, self-rated health, number of comorbidities, household annual equivalized income, mental health status, activities of daily living (ADL), and smoking status. Educational attainment was categorized as follows: $\leq$ 15 years and $\geq$16 years of education. Self-rated health was categorized as follows: excellent/very good, good, fair, and bad/very bad. Household annual equivalized income was classified into quintiles. Mental health status was measured using eight items from the Center for Epidemiologic Studies Depression Scale (CES-D) in ELSA (Gallagher et al., 2016) and the Geriatric Depression Scale (GDS-15) in JAGES [24]. To identify possible depressive cases, the CES-D cut-off point was $\geq$4 (Gallagher et al., 2016) while that for the GDS-15 was $\geq$5 (Burke et al., 1991), which we applied in this study. Comorbidities were ascertained from the total number of medical diagnoses of cancer, heart disease, stroke, hypertension, diabetes, and psychiatric disorders. ADL was used as a covariate to examine the differences in the research designs and target populations of ELSA and JAGES. In JAGES, older adults who had been receiving public disability insurance benefits were not eligible for inclusion in the study, whereas, in ELSA, functionally independent older adults were the target population. ADL was measured using participant responses to three questions that assessed the presence of difficulties in walking, bathing or showering, and using the toilet. Participants who reported one or more difficulties were considered to be partially disabled. Smoking status was categorized as: never smoker, former smoker, and current smokers.

2.3. Statistical analysis

The difference in descriptive distribution of each variable in the two cohorts was tested by the chi-square test. We calculated the prevalence for respondents with SIS according to oral health status, as mentioned above. First, we used ordered logistic regression analysis to calculate the odds ratios (ORs) and 95% confidence intervals (95% CIs) of number of

remaining teeth as an associated variable with SIS in reference to the first category of SIS. Second, another ordered logistic regression analysis was used to calculate the ORs and 95% CIs of denture use as an associated variable with SIS in reference to the first category of SIS. We used ordered logistic regression analysis as our dependent variable (SIS) had more than two ordered response categories. Estimates were adjusted for all covariates (age, sex, educational attainment, self-rated health, number of comorbidities, household annual equivalized income, mental health status, ADL, and smoking status). We created and used survey weights (stata command; "*pweight*") and the reciprocal of the participants in each dataset was used as the sampling weight for the difference in sample size between JAGES and ELSA. To assess whether the association of oral health and social isolation differed by country, we added an interaction term (oral health status × country) to the data in which the two cohorts were pooled, taking 20 or more remaining teeth and Japan as the reference category. We only used the complete data set. A p-value < 0.05 was considered statistically significant. All analyses were conducted using Stata version 15.1 (Stata Corp, College Station, TX).

2.4. Ethical considerations

The ELSA investigators received ethical approval for all waves of the study from the National Health Service Research Ethics Committees under the National Research and Ethics Service (Oldfield et al., 2020). The JAGES protocols were approved by the ethics committee of Tohoku University (No.21–40).

3. Results

Table 1 shows the demographic characteristics and health profiles of ELSA and JAGES participants. Prevalence of social isolation tended to be higher in Japan: The prevalence of SIS 4+ (= most isolated) in England and Japan was 1.4% (n = 57) and 5.8% (n = 7000), respectively (chi-square p-value<0.001). Supplementary Table 1 shows the descriptive associations between oral health status and SIS. Among edentulous people, the proportions of those who were socially isolated (SIS 4+) were 4.7% (n = 24) in the English participants and 9.3% (n = 857) in the Japanese participants, respectively. Conversely, among participants with 20 or more teeth, the corresponding proportions were only 0.6% (n = 14) in the English participants and 4.5% (n = 3,026) in the Japanese participants.

The results of the ordered logistic regression analyses showed having fewer remaining teeth was positively associated with the SIS score in both countries (JAGES; OR = 1.24, 95%CI = 1.19–1.30, ELSA; 1.76, 95%CI = 1.45–2.14, Table 2, Supplementary Tables 2 and 3). Additionally, compared with participants who had 20 or more teeth, participants who had 0-9 teeth and no dentures were associated with a higher SIS score in both countries (JAGES; OR = 1.78, 95%CI = 1.65–1.92, ELSA; 3.45, 95%CI = 1.88–6.83, Table 2, Supplementary Tables 4 and 5).

Pooled analysis of the ordered logistic regression with the interaction term indicated the association of number of remaining teeth and SIS was stronger in England (Table 3). Thus, the association, participants with fewer teeth tended to be socially isolated, could be seen to be stronger among those in England, although those in Japan were, on average, more isolated. Among participants who had 0-9 teeth and used dentures or no denture, the association of denture use and SIS was stronger in England (0–9 teeth and used dentures; OR = 1.43, 95%CI = 1.24–1.65, 0–9 teeth and no dentures; OR = 1.81, 95%CI = 1.02–3.19).

Table 1
Characteristics of participants in each cohort (JAGES n = 119,829, ELSA n = 3958).

	JAGES		ELSA		p-value[b]
	Number	%	Number	%	
Social isolation score					<0.001
0 (low)	21,345	17.8	1,418	35.8	
1	39,460	32.9	1,504	38.0	
2	34,957	29.2	732	18.5	
3	17,067	14.2	247	6.2	
4+ (high)	7,000	5.8	57	1.4	
Number of remaining teeth					<0.001
No teeth	9,215	7.7	520	13.1	
1–9	17,665	14.7	410	10.4	
10–19	25,067	20.9	825	20.8	
20+	67,882	56.7	2,203	55.7	
Denture use					<0.001
0-9 teeth & no denture	2,705	2.3	60	1.52	
0-9 teeth & denture use	24,175	20.2	870	22.0	
10-19 teeth & no denture	7,824	6.5	293	7.4	
10-19 teeth & denture use	17,243	14.4	528	13.3	
20+ teeth	67,882	56.7	2,207	55.8	
Sex					<0.001
Man	59,010	49.3	1,751	44.2	
Woman	60,819	50.8	2,207	55.8	
Age					<0.001
65–69	39,779	33.2	1,327	33.5	
70–74	33,205	27.7	1,014	25.6	
75–79	26,006	21.7	864	21.8	
80–84	14,225	11.9	460	11.6	
85+	6614	5.5	292	7.4	
Educational attainment					<0.001
≤15	34,566	28.9	1,839	46.5	
≥16	85,263	71.2	2,119	53.5	
Self-rated health					<0.001
Excellent, very good	17,816	14.9	1,530	38.7	
Good	85,725	71.5	1,339	33.8	
Fair	14,169	11.8	810	20.5	
Bad, very bad	2,119	1.8	278	7.0	
Number of comorbidities					<0.001
None (0)	50,356	42.0	3,317	83.8	
1	49,001	40.9	574	14.5	
2	14,683	12.3	55	1.4	
3+	5,789	4.8	12	0.3	
Household annual equivalized income					<0.001
Poorest	10,578	8.8	649	16.4	
Poorer	35,670	29.8	885	22.4	
Middle	24,912	20.8	906	22.9	
Higher	16,336	13.6	859	21.7	
Highest	32,333	27.0	659	16.7	
Mental health status (GDS-15, CES-D)[a]					<0.001
Not depressed	94,368	78.8	3,499	88.4	
Depressed	25,461	21.3	459	11.6	
ADL					<0.001
Independent	113,789	95.0	3,537	89.4	
Partially dependent	6,040	5.0	421	10.6	
Smoking status					<0.001
Current smoker	69,798	58.3	292	7.4	
Former smoker	36,558	30.5	2,270	57.3	
Never smoker	13,473	11.2	1,396	35.3	

ADL; activity of daily living.
[a] Cut off point; GDS (in JAGES) < 5 or ≥5, CES-D (in ELSA) < 4 or ≥4.
[b] p-value calculated by chi-square test.

4. Discussion

To the best of our knowledge, this is the first study to explore the association of oral health status with social isolation by considering countries with distinct cultural differences. In both countries, having fewer remaining teeth and not using dentures were associated with greater social isolation but the association was higher in England, as we hypothesized. Furthermore, even if they use dentures, participants in England could be more isolated. Our results suggest that higher social impact can be placed on maintaining teeth in Western culture than in Eastern culture.

Our finding of a stronger association between oral health and social isolation in England than in Japan is in line with previous studies. Studies making a cultural comparison of emotional communications between the West and East have found that, in terms of facial features, the mouth is more important in the West, and eyes are more important in

Table 2
Association between social isolation and oral health status through ordered logistic regression in each cohort.

	JAGES	ELSA
	Multivariate OR (95% CI)[a]	Multivariate OR (95% CI)[a]
Number of teeth		
No teeth	1.24(1.19–1.30)	1.76(1.45–2.14)
1–9	1.21(1.18–1.25)	1.54(1.25–1.89)
10–19	1.08(1.05–1.11)	1.13(0.98–1.32)
20+	1.00(reference)	1.00(reference)
Denture use		
0-9 teeth & no denture	1.78(1.65–1.92)	3.45(1.88–6.33)
0-9 teeth & denture use	1.17(1.14–1.21)	1.58(1.35–1.85)
10-19 teeth & no denture	1.24(1.19–1.30)	1.29(1.03–1.61)
10-19 teeth & denture use	1.02(0.99–1.05)	1.05(0.88–1.25)
20+ teeth	1.00(reference)	1.00(reference)

OR; odd ratio, CI; confidence interval.
[a] Adjusted for sex, age, educational attainment, self-rated health, number of comorbidities, household annual equivalized income, mental health status, ADL, smoking status.

Table 3
Association between social isolation and oral health status through ordered logistic regression in the pooled analysis (N = 123,787).

	Multivariate OR (95% CI)[a]		Multivariate OR (95% CI)[a]
Number of teeth		Denture use	
No teeth	1.21 (1.15–1.27)	0-9 teeth & no denture	1.83 (1.69–1.44)
1–9	1.19 (1.15–1.24)	0-9 teeth & denture use	1.14 (1.10–1.19)
10–19	1.07 (1.04–1.10)	10-19 teeth & no denture	1.27 (1.21–1.33)
20+	1.00 (reference)	10-19 teeth & denture use	0.99 (0.96–1.03)
		20+ teeth	1.00 (reference)
Country		**Country**	
ELSA	0.29 (0.27–0.32)	ELSA	0.29 (0.27–0.32)
JAGES	1.00 (reference)	JAGES	1.00 (reference)
Number of teeth × country		**Denture use × country**	
No teeth × ELSA	1.50 (1.26–1.80)	0-9 teeth & no denture × ELSA	1.81 (1.02–3.19)
1-9 teeth × ELSA	1.33 (1.09–1.61)	0-9 teeth & denture use × ELSA	1.43 (1.24–1.65)
10-19 teeth × ELSA	1.09 (0.95–1.26)	10-19 teeth & no denture × ELSA	1.02 (0.82–1.27)
20+ teeth × ELSA	1.00 (reference)	10-19 teeth & denture use × ELSA	1.11 (0.94–1.31)
		20+ teeth × ELSA	1.00 (reference)

OR; odd ratio, CI; confidence interval.
[a] Adjusted for sex, age, educational attainment, self-rated health, number of comorbidities, household annual equivalized income, mental health status, ADL, smoking status.

the East (Yuki et al., 2007). In cultures where overt emotional expression is the norm, such as Western culture, the more dynamically expressive mouth is considered a clearer representation of emotion. In contrast, in cultures where emotional restraint is the norm, such as East Asia, it is difficult to recognize emotion from the mouth. However, because the muscles around the eyes are more difficult to control than those around the mouth, the eyes are considered a clearer representation of the true emotional state of others (Yuki et al., 2007). Another previous study from Japan showed that vision, hearing and tooth loss were independently associated with a low frequency of social interactions among community-dwelling older adults, and the magnitude of these impairments on social interactions was largest in vision, followed by tooth and hearing loss (Igarashi et al., 2021). This cultural difference is also thought to be reflected in attitudes toward orthodontic treatment. The prevalence of orthodontic treatment need in Eastern Asian countries was 46.5% (Komazaki et al., 2012) which was higher than in the UK, at 21% (figures are given for the whole of the UK and are not broken down by constituent countries) (Chestnutt et al., 2006), and other European countries (Eslamipour et al., 2018).

There are several possible pathways that link oral health with social isolation. Oral health, including loss of teeth, affects oral health quality of life which includes oral functions such as eating, speaking, smiling, and contact with other people in both East Asia and Europe (Steele et al., 2004; Tan et al., 2016). A previous study which used JAGES found that having fewer teeth and no dentures was associated with future risk of being homebound among older people (Koyama et al., 2016a), while a study based on ELSA identified oral health-related quality of life as an independent risk factor for loneliness amongst older adults (Rouxel et al., 2017). Being homebound and increasing in loneliness increase the risk of social isolation (Nicholson, 2012; Victor et al., 2005). The association between having fewer remaining teeth and a higher social isolation score and the association between not using dentures and a higher social isolation score were observed in both English and Japanese older people in the present study.

Our study suggests the possibility that maintaining and improving oral health could reduce the risk of social isolation among older people and future studies, such as intervention studies to validate the positive role of oral health to prevent older adults from social isolation, are needed. Even if they use dentures, participants in England could be more isolated. The prevalence of edentulousness and social inequalities in tooth loss was higher in England than in Japan (Ito et al., 2020). In both Japan and England dental treatment is covered, to a certain extent, by national health coverage (NHS, 2020; Zaitsu et al., 2018). However, coverage and treatment costs are somewhat different. On average, in 2015, dental care expenditure per capita in the whole of the UK is higher than in Japan, at $220,59 and $192,03, respectively (Righolt et al., 2018) (health costs apply to all the countries of the UK). For example, to make a lower jaw full denture set in Japan, costs JPY10,000–15,000 ($92.80–139.20; depending on the number of dental visits) (Health Insurance Claims Review and Reimbursement Services, 2020), while it costs £ 269.3 ($333.39) in the UK (NHS, 2020). Dental health status could be poorer, in England than in Japan due to the higher dental treatment costs, for example an individual may be unable to replace dentures when necessary.

The present study has several limitations. First, there are differences in the study designs used in the two cohort studies. Specifically, JAGES did not use nationally-representative respondents because the municipalities which participated in JAGES were not randomly selected, although the participants in each municipality were a representative sample. Additionally, older adults who had a disability were excluded from JAGES but not from ELSA; this may have led to a potential selection bias. To address the possibility of such a bias, we excluded participants of ELSA who were 64 years of age or younger and controlled for ADL in the regression analysis. Moreover, the comparability of some of the covariates that were used in the present study is limited to a certain degree. Finally, the information about remaining teeth was collected only at the wave 7 in ELSA which limits the scope to make our study cross-sectional. Therefore, we cannot determine the time temporal relationships. Social support, one of the social isolation score factors, is associated with the use of dental services among older people (Koyama et al., 2016b; Rouxel et al., 2015; Tsakos et al., 2013). Social support is likely to be a cue for a dental visit and may even influence the treatment received (McGrath and Bedi, 2002). Therefore, social isolation may also be detrimental to oral health. Future longitudinal studies will be able to determine temporal changes between oral health status and social isolation over time.

In conclusion, in both Japan and England, oral health status was associated with social isolation. This association could be stronger in England than in Japan.

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Declaration of competing interest

The authors declare no potential conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.113895.

Author contributions

Shihoko Koyama, Conceptualization, Writing – original draft, Software, Formal analysis. **Masashige Saito**, Conceptualization, Resources, Writing – review & editing, Project administration, Funding acquisition. **Noriko Cable**, Formal analysis, Resources, Writing – review & editing, Project administration, Funding acquisition. **Takaaki Ikeda**, Software, Writing – review & editing. **Taishi Tsuji**, Software, Writing – review & editing. **Taiji Noguchi**, Software, Writing – review & editing. **Hazem Abbas**, Writing – review & editing. **Ken Osaka**, Supervision. **Katsunori Kondo**, Data Collection, Supervision. **Isao Miyashiro**, Writing – review & editing, Supervision. **Richard G Watt**, Writing – review & editing, Supervision. **Jun Aida**, Conceptualization, Writing – original draft, Software, Formal analysis, Supervision, Project administration

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