Ill health-related variables

Number of teeth and present illness were considered as ill health-related variables. Self-reported current medical treatment for cancer, heart disease, stroke, hypertension, diabetes, obesity, hyperlipidemia, osteoporosis, arthritis, trauma, respiratory disease, gastrointestinal disease, liver disease, mental illness, visual/hearing impairment, dysphagia, urinary disease, sleep disorder, or other conditions was used as the variable present illness, dichotomized into yes and no.

Service-related variables

Data on the number of dentists working in hospitals or clinics were obtained from the Survey of Physicians, Dentists and Pharmacists conducted by the Ministry of Health, Labour and Welfare, Japan in 2010. Data on population in 2010 and area of inhabitable land of each municipality were obtained from the National Population Census Survey conducted by the Ministry of Internal Affairs and Communications, Japan. Number of dentists working in hospitals or clinics per 100,000 people and population density were calculated for each municipality. The number of dentists working in hospitals or clinics per 100,000 people was categorized into four groups (lowest, low middle, high middle, or highest) based on 25th, 50th, and 75th percentiles. Population density was categorized into four groups (metropolitan, urban, semi-urban, or rural-agricultural).

Social relationship variables

General trust, norms of reciprocity, and attachment to place were assessed by asking "Generally speaking, would you say that most people can be trusted?", "Would you say that most of the time people try to be helpful?", and "Do you feel attached to the area you live?" with possible answers dichotomized into yes and no (including "depends"). For social participation, respondents were asked whether they belonged to industrial and trade associations, volunteer groups, older people's clubs, sports groups or clubs, neighborhood associations or councils, or hobby clubs, with possible answers dichotomized into yes and no. The number of social groups was calculated for each subject.

Emotional and instrumental social support, both received and given, was evaluated by using the following questions: "Do you have someone who listens to your concerns and complaints?" (emotional social support received), "Do you listen to someone's concerns and complaints?" (emotional social support given), "Do you have someone who looks after you when you are sick and have to stay in bed for a few days?" (instrumental social support received), and "Do you look after someone when he/she is sick and stays in bed for a few days?" (instrumental social support given), with possible answers dichotomized into yes and no.

Social network was measured by the question, "How often do you see your friends?" with the following possible answers: "almost every day", "two or three times per week", "once a week", "once or twice per month", "several times per year", or "rarely".

We created local district (n = 561 for males, n = 562 for females) -level social capital variables by aggregating the individual-level data on general trust, norms of reciprocity, attachment to place, social support (both emotional and instrumental received and given), number of social groups, and meeting friends (% of subjects meeting friends at least several times a year). General trust, norms of reciprocity, attachment to place, and social support were categorized as cognitive social capital. Number of social groups and meeting friends were categorized as structural social capital. Local districts were categorized into four groups (lowest, low middle, high middle, or highest) based on 25th, 50th, and 75th percentiles for each variable.

Analysis

The following analyses were conducted in subjects with 19 or fewer teeth (25,630 males and 28,758 females). First, univariate PRs and 95% confidence intervals (CIs) were calculated for each independent variable with denture/bridge use as the dependent variable in each sex. Because the percentage of people using a denture/bridge was high (males: 68.1%, females: 67.6%), adjusted odds ratio derived from the logistic regression could no longer approximate PR [21]. Therefore, multilevel Poisson regression model with random intercepts and fixed slopes was used separately for males and females to calculate multilevel PRs, taking into account variations in the outcomes between local districts and municipalities using MLwiN 2.28 (Centre for Multilevel Modelling, University of Bristol, Bristol, UK), with denture/bridge use as the dependent variable [22]. In model 1, socio-demographics (age, marital status, educational attainment, and equivalent income), health status (number of teeth and present illness) and municipality-level characteristics (number of dentists working in hospitals or clinics per 100,000 people and population density) were added. In models 2 and 3, number of social groups and frequency of meeting friends, both of which were significantly associated with denture/bridge use in the previous univariate analysis, were added to model 1, respectively. Moreover, to examine the association between each local district-level social capital variable and denture/bridge use after adjusting for socio-demographics, health status and municipality-level characteristics, each local district-level social capital variable was added to model 1. In the model, corresponding individual level variable was also added to avoid ecological fallacy.

Table 1 Association between denture/bridge use and individual-level characteristics in males and females

	Males, n = 25630				Females, n = 28758			
	n	Denture/bridge users (%)	Univariate PR		n	Denture/bridge users (%)	Univariate PR	
Characteristic			**PR**	**95% CI**			**PR**	**95% CI**
Socio-demographics								
Age group (years)								
65 - 69	6699	69.7	1.00	(reference)	6923	68.5	1.00	(reference)
70 - 74	7081	68.1	0.98	(0.94-1.02)	7916	66.2	0.97	(0.93-1.01)
75 - 79	6118	66.5	0.95	(0.92-0.99)[a]	6880	67.5	0.99	(0.95-1.03)
80 - 84	3899	68.2	0.98	(0.93-1.03)	4443	68.2	1.00	(0.95-1.04)
≥ 85	1833	67.9	0.97	(0.92-1.04)	2596	69.3	1.01	(0.96-1.07)
Marital status								
Married	21449	68.7	1.00	(reference)	15547	67.3	1.00	(reference)
Separated/divorced	3216	65.9	0.96	(0.92-1.00)	11868	68.6	1.02	(0.99-1.05)
Never married	441	60.5	0.88	(0.78-0.99)[a]	604	66.2	0.98	(0.89-1.09)
Unknown/missing	524	63.9	0.93	(0.83-1.04)	739	59.8	0.89	(0.81-0.98)[a]
Educational attainment (years)								
< 6	453	62.7	1.00	(reference)	1028	66.4	1.00	(reference)
6 - 9	11161	62.6	1.00	(0.89-1.12)	13582	65.2	0.98	(0.91-1.06)
10 - 12	7877	70.7	1.13	(1.00-1.27)[a]	9512	70.2	1.06	(0.98-1.14)
≥ 13	5048	77.4	1.23	(1.10-1.39)[b]	3171	70.7	1.06	(0.98-1.16)
Missing	1091	66.0	1.05	(0.92-1.21)	1465	67.8	1.02	(0.93-1.12)
Equivalent income (10000 yen)								
< 50	739	60.1	1.00	(reference)	1625	60.9	1.00	(reference)
50 - 99	2192	59.6	0.99	(0.89-1.10)	3274	65.0	1.07	(0.99-1.15)
100 - 149	3214	62.2	1.04	(0.93-1.15)	3151	66.4	1.09	(1.01-1.18)[a]
150 - 200	5245	68.5	1.14	(1.03-1.26)[b]	4294	68.2	1.12	(1.04-1.20)[b]
200 - 299	5452	71.6	1.19	(1.08-1.32)[c]	4768	71.5	1.18	(1.09-1.26)[c]
300 - 399	3275	75.6	1.26	(1.14-1.39)[c]	2760	74.5	1.22	(1.13-1.32)[c]
≥ 400	2266	75.2	1.25	(1.13-1.39)[c]	2226	73.1	1.20	(1.11-1.30)[c]
Missing	3247	62.8	1.05	(0.94-1.16)	6660	63.4	1.04	(0.97-1.12)
Health status								
Number of teeth								
10 - 19	10407	64.9	1.00	(reference)	11129	62.1	1.00	(reference)
1 - 9	9786	73.5	1.13	(1.09-1.17)[c]	11565	73.7	1.19	(1.15-1.22)[c]
0	5437	64.5	0.99	(0.95-1.04)	6064	66.4	1.07	(1.03-1.11)[c]
Present illness								
No	6192	65.1	1.00	(reference)	6214	65.0	1.00	(reference)
Yes	17602	69.2	1.06	(1.03-1.10)[c]	20081	68.2	1.05	(1.01-1.09)[b]
Missing	1836	68.4	1.05	(0.99-1.12)	2463	69.7	1.07	(1.01-1.13)[a]
Social relationship								
General trust								
No	1075	64.6	1.00	(reference)	1273	64.8	1.00	(reference)
Yes	23326	68.3	1.06	(0.98-1.14)	26111	67.8	1.05	(0.98-1.12)
Missing	1229	68.1	1.05	(0.95-1.17)	1374	66.8	1.03	(0.94-1.13)

Table 1 Association between denture/bridge use and individual-level characteristics in males and females *(Continued)*

Norms of reciprocity								
No	2237	66.5	1.00	(reference)	2517	66.9	1.00	(reference)
Yes	22089	68.4	1.03	(0.98-1.08)	24635	67.8	1.01	(0.96-1.07)
Missing	1304	66.9	1.01	(0.92-1.09)	1606	67.1	1.00	(0.93-1.08)
Attachment to place								
No	1219	67.8	1.00	(reference)	1285	65.8	1.00	(reference)
Yes	23754	68.2	1.01	(0.94-1.08)	26631	67.7	1.03	(0.96-1.10)
Missing	657	67.0	0.99	(0.88-1.11)	842	68.1	1.03	(0.93-1.15)
Emotional social support (received)								
No	1211	64.9	1.00	(reference)	727	64.1	1.00	(reference)
Yes	11573	66.7	1.03	(0.96-1.10)	12619	65.7	1.03	(0.93-1.13)
Missing	12846	69.8	1.07	(1.00-1.16)	15412	69.4	1.08	(0.99-1.19)
Emotional social support (given)								
No	2225	65.0	1.00	(reference)	1112	64.2	1.00	(reference)
Yes	13112	67.3	1.03	(0.98-1.09)	12703	65.8	1.02	(0.95-1.11)
Missing	10293	70.0	1.08	(1.02-1.14)[b]	14943	69.5	1.08	(1.00-1.17)[a]
Instrumental social support (received)								
No	1245	65.1	1.00	(reference)	1380	63.9	1.00	(reference)
Yes	15949	67.7	1.04	(0.97-1.12)	16461	66.9	1.05	(0.98-1.12)
Missing	8436	69.3	1.07	(0.99-1.15)	10917	69.3	1.08	(1.01-1.16)[a]
Instrumental social support (given)								
No	2929	64.8	1.00	(reference)	3855	66.7	1.00	(reference)
Yes	14467	68.2	1.05	(1.00-1.11)[a]	13287	66.6	1.00	(0.96-1.04)
Missing	8234	69.1	1.07	(1.01-1.12)[a]	11616	69.1	1.04	(0.99-1.08)
Number of social groups								
0	6074	66.4	1.00	(reference)	6693	66.5	1.00	(reference)
1	4390	68.5	1.03	(0.99-1.08)	4551	69.9	1.05	(1.01-1.10)[a]
2	3355	70.5	1.06	(1.01-1.12)[a]	3306	70.2	1.06	(1.00-1.11)[a]
3 - 6	5207	71.1	1.07	(1.02-1.12)[b]	3871	70.2	1.06	(1.01-1.11)[a]
Missing	6604	66.0	0.99	(0.95-1.04)	10337	65.6	0.99	(0.95-1.03)
Frequency of meeting friends								
Rarely	2866	64.5	1.00	(reference)	1891	64.5	1.00	(reference)
Several times a year	5163	69.5	1.08	(1.02-1.14)[b]	3127	68.7	1.07	(0.99-1.14)
1 or 2 times/month	4986	69.7	1.08	(1.02-1.14)[b]	5225	69.1	1.07	(1.00-1.14)[a]
Once/week	3595	69.1	1.07	(1.01-1.14)[a]	4965	68.2	1.06	(0.99-1.13)
2 or 3 times/week	4304	67.6	1.05	(0.99-1.11)	6979	67.2	1.04	(0.98-1.11)
Almost everyday	2930	68.2	1.06	(0.99-1.13)	4159	67.5	1.05	(0.98-1.12)
Missing	1786	65.3	1.01	(0.94-1.09)	2412	65.8	1.02	(0.95-1.10)

PR, prevalence ratio; CI, confidence interval.
[a], $p < 0.05$; [b], $p < 0.01$; [c], $p < 0.001$.

Results

The percentages of males and females using a denture/bridge were 68.1% and 67.6%, respectively. Table 1 shows the PRs (95% CIs) for denture/bridge use according to individual-level variables. In both sexes, high equivalent income, low number of teeth, present illness, involvement in two or more kinds of social groups, and meeting friends 1–2 times per month were significantly associated with denture/bridge use. Age group, marital status, educational attainment, and instrumental social support given were associated with denture/bridge use in males.

Table 2 Association between denture/bridge use and local district- and municipality-level characteristics in males and females

Characteristic	Males				Females			
	n	Denture/bridge users (%)	Univariate PR		n	Denture/bridge users (%)	Univariate PR	
			PR	95% CI			PR	95% CI
Local district-level characteristics								
Cognitive social capital								
General trust (%)								
Lowest (<92.86)	85	68.6	1.00	(reference)	85	67.0	1.00	(reference)
Low middle (92.86 - 97.00)	304	67.8	0.99	(0.93-1.05)	304	67.5	1.01	(0.95-1.07)
High middle (97.01 - 99.99)	114	69.2	1.01	(0.94-1.08)	114	68.5	1.02	(0.96-1.09)
Highest (100.00)	58	69.8	1.02	(0.91-1.13)	59	68.2	1.02	(0.92-1.13)
Norms of reciprocity (%)								
Lowest (<84.91)	61	71.1	1.00	(reference)	61	68.0	1.00	(reference)
Low middle (84.91 - 91.17)	250	69.3	0.98	(0.90-1.06)	250	68.8	1.01	(0.93-1.10)
High middle (91.18 - 99.99)	237	67.0	0.94	(0.87-1.02)	234	66.7	0.98	(0.90-1.06)
Highest (100.00)	13	71.6	1.01	(0.77-1.32)	14	69.7	1.02	(0.81-1.30)
Attachment to place (%)								
Lowest (<91.03)	62	70.4	1.00	(reference)	63	68.3	1.00	(reference)
Low middle (91.03 - 97.11)	379	68.4	0.97	(0.90-1.05)	379	67.9	0.99	(0.92-1.07)
High middle (97.12 - 99.99)	84	66.4	0.94	(0.87-1.03)	84	66.3	0.97	(0.89-1.05)
Highest (100.00)	36	66.7	0.95	(0.81-1.10)	36	70.3	1.03	(0.89-1.18)
Emotional social support (received) (%)								
Lowest (<88.89)	142	71.9	1.00	(reference)	143	71.2	1.00	(reference)
Low middle (88.89 - 92.85)	139	69.7	0.97	(0.92-1.02)	139	69.5	0.98	(0.93-1.03)
High middle (92.86 - 95.44)	139	67.5	0.94	(0.89-0.99)[a]	139	67.5	0.95	(0.90-1.00)[a]
Highest (≥95.45)	138	65.7	0.91	(0.86-0.97)[b]	138	64.3	0.90	(0.86-0.95)[c]
Missing	3	45.6	0.63	(0.49-0.83)[c]	3	59.6	0.84	(0.69-1.01)
Emotional social support (given) (%)								
Lowest (<85.71)	129	69.4	1.00	(reference)	130	70.4	1.00	(reference)
Low middle (85.71 - 89.35)	151	69.0	0.99	(0.94-1.04)	151	67.8	0.96	(0.92-1.01)
High middle (89.36 - 92.09)	140	66.9	0.96	(0.91-1.01)	140	66.3	0.94	(0.90-0.99)[a]
Highest (≥92.10)	141	68.7	0.99	(0.94-1.04)	141	68.5	0.97	(0.92-1.03)
Instrumental social support (received) (%)								
Lowest (<88.89)	148	71.2	1.00	(reference)	148	70.4	1.00	(reference)
Low middle (88.89 - 92.26)	133	66.8	0.94	(0.89-0.99)[a]	133	66.7	0.95	(0.90-1.00)[a]
High middle (92.27 - 94.81)	140	68.4	0.96	(0.91-1.01)	140	67.9	0.97	(0.92-1.01)
Highest (≥94.82)	140	67.8	0.95	(0.90-1.00)	141	67.1	0.95	(0.91-1.00)
Instrumental social support (given) (%)								
Lowest (<77.42)	140	67.9	1.00	(reference)	141	69.1	1.00	(reference)
Low middle (77.42 - 81.87)	140	67.6	1.00	(0.95-1.05)	140	66.7	0.97	(0.92-1.01)
High middle (81.88 - 85.41)	141	67.5	0.99	(0.95-1.04)	141	67.5	0.98	(0.93-1.02)
Highest (≥85.42)	140	70.3	1.03	(0.98-1.09)	140	68.4	0.99	(0.94-1.04)

Table 2 Association between denture/bridge use and local district- and municipality-level characteristics in males and females *(Continued)*

Structural social capital								
Mean number of social groups								
Lowest (<1.280)	140	69.2	1.00	(reference)	141	70.4	1.00	(reference)
Low middle (1.280 - 1.483)	141	69.4	1.00	(0.95-1.06)	141	69.2	0.98	(0.94-1.03)
High middle (1.484 - 1.687)	139	68.1	0.98	(0.94-1.03)	139	67.7	0.96	(0.92-1.01)
Highest (≥1.688)	141	67.0	0.97	(0.92-1.02)	141	65.6	0.93	(0.89-0.97)[b]
Meeting friends (%)								
Lowest (<87.76)	136	69.8	1.00	(reference)	137	70.2	1.00	(reference)
Low middle (87.76 - 91.00)	142	68.6	0.98	(0.93-1.04)	142	68.8	0.98	(0.93-1.03)
High middle (91.01 - 93.32)	137	68.8	0.98	(0.93-1.04)	137	67.3	0.96	(0.91-1.01)
Highest (≥93.33)	143	66.4	0.95	(0.90-1.00)	143	66.4	0.95	(0.90-1.00)[a]
Missing	3	45.6	0.65	(0.50-0.85)[b]	3	59.6	0.85	(0.70-1.03)
Municipality-level characteristics								
Number of dentists per 100000 people								
Lowest (<47.29)	7	65.3	1.00	(reference)	7	65.7	1.00	(reference)
Low middle (47.29 - 53.97)	7	66.4	1.02	(0.96-1.07)	7	67.5	1.03	(0.98-1.08)
High middle (53.98 - 59.74)	7	67.7	1.04	(0.99-1.09)	7	67.4	1.03	(0.98-1.08)
Highest (≥59.75)	7	70.1	1.07	(1.02-1.13)[b]	7	68.5	1.04	(1.00-1.09)
Population density (/km^2)								
Rural-agricultural (<1000)	2	64.4	1.00	(reference)	2	64.6	1.00	(reference)
Semi-urban (1000–1499)	7	68.1	1.06	(1.02-1.10)[b]	7	68.4	1.06	(1.02-1.10)[b]
Urban (1500–3999)	6	70.6	1.10	(1.05-1.14)[c]	6	68.5	1.06	(1.02-1.10)[b]
Metropolitan (≥4000)	13	72.2	1.12	(1.08-1.17)[c]	13	72.0	1.12	(1.07-1.16)[c]

PR, prevalence ratio; CI, confidence interval.
n, number of local districts for local district-level characteristics and number of municipalities for municipality-level characteristics.
[a], $p < 0.05$; [b], $p < 0.01$; [c], $p < 0.001$.

Table 2 shows the PRs (95% CIs) for denture/bridge use according to local district- and municipality-level variables. Local district-level emotional and instrumental social support received, meeting friends, and municipality-level population density were significantly associated with denture/bridge use in both sexes. Municipality-level number of dentists working in hospitals or clinics per population was associated with denture/bridge use in males, and emotional social support given in females.

Table 3 shows the results of multilevel Poisson regression analyses. High educational attainment, high equivalent income, low number of teeth, present illness, and high population density were significantly associated with denture/bridge use in males ($p < 0.05$). High equivalent income, low number of teeth present, present illness, involvement in one or more social groups, and high population density were significantly associated with denture/bridge use in females ($p < 0.05$). In both the sexes, frequency of meeting friends was not significantly associated with denture/bridge use in model 3. Significance of the variables in model 1 did not change after adding the variable of frequency of meeting friends in both sexes.

All local district-level social capital variables were not associated with denture/bridge use.

Discussion

The results of the present study showed that factors independently associated with denture/bridge use in both sexes were equivalent income, number of teeth, present illness, and population density, all of which are known to be associated with access to dental care [7]. In particular, individual financial status was strongly associated with denture/bridge use in the present study, which is in agreement with findings of a study conducted in one municipality in Japan [15]. Studies have suggested that low socioeconomic status is one of the barriers to dental attendance and that such barriers appear to have negative effects on oral health [23,24]. It is noteworthy that even in people with universal free access to dental services under the national healthcare insurance system in Japan, financial issues are a major factor affecting denture/bridge use.

Subjects presently having illness were more likely to use a denture/bridge in the present study. Systemic ill health and functional limitations have been reported as

Table 3 Multilevel prevalence ratios and 95% confidence intervals for denture/bridge use in males and females

	Males				Females			
	Model 1		Model 2		Model 1		Model 2	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Fixed effects								
Individual-level characteristics								
Age group (years) (reference 65–69)								
70 - 74	0.98	(0.94-1.02)	0.98	(0.94-1.02)	0.96	(0.92-1.00)[a]	0.96	(0.92-1.00)
75 - 79	0.96	(0.92-1.00)	0.96	(0.92-1.00)	0.97	(0.93-1.01)	0.97	(0.93-1.02)
80 - 84	0.98	(0.94-1.03)	0.99	(0.94-1.04)	0.98	(0.93-1.03)	0.99	(0.94-1.04)
≥ 85	0.99	(0.93-1.06)	1.00	(0.93-1.06)	0.99	(0.93-1.05)	1.00	(0.94-1.06)
Marital status (reference married)								
Separated/divorced	0.97	(0.93-1.02)	0.97	(0.93-1.02)	1.02	(0.99-1.06)	1.02	(0.99-1.05)
Never married	0.91	(0.80-1.03)	0.91	(0.81-1.03)	0.98	(0.89-1.08)	0.98	(0.89-1.08)
Unknown/missing	1.00	(0.89-1.11)	1.00	(0.90-1.12)	0.93	(0.84-1.02)	0.93	(0.85-1.03)
Educational attainment (years) (reference <6)								
6 - 9	0.97	(0.86-1.10)	0.97	(0.86-1.10)	0.99	(0.92-1.08)	0.99	(0.92-1.08)
10 - 12	1.07	(0.95-1.21)	1.07	(0.95-1.21)	1.06	(0.98-1.15)	1.06	(0.97-1.15)
≥ 13	1.15	(1.02-1.30)[a]	1.15	(1.01-1.30)[a]	1.07	(0.98-1.17)	1.06	(0.97-1.16)
Missing	1.00	(0.87-1.15)	1.00	(0.87-1.15)	1.02	(0.92-1.13)	1.02	(0.92-1.13)
Equivalent income (10000 yen) (reference <50)								
50 - 99	0.99	(0.89-1.10)	0.99	(0.89-1.10)	1.06	(0.99-1.15)	1.06	(0.99-1.15)
100 - 149	1.02	(0.92-1.13)	1.02	(0.92-1.13)	1.08	(1.00-1.17)[a]	1.08	(1.00-1.16)
150 - 200	1.10	(0.99-1.21)	1.09	(0.99-1.21)	1.11	(1.03-1.20)[b]	1.10	(1.03-1.19)[b]
200 - 299	1.14	(1.03-1.25)[a]	1.13	(1.02-1.25)[a]	1.16	(1.08-1.24)[c]	1.15	(1.07-1.23)[c]
300 - 399	1.18	(1.07-1.31)[b]	1.18	(1.06-1.30)[b]	1.20	(1.12-1.30)[c]	1.19	(1.10-1.29)[c]
≥ 400	1.18	(1.06-1.31)[b]	1.17	(1.05-1.30)[b]	1.18	(1.09-1.27)[c]	1.17	(1.08-1.26)[c]
Missing	1.04	(0.93-1.15)	1.03	(0.93-1.15)	1.03	(0.96-1.11)	1.03	(0.96-1.11)
Number of teeth (reference 10–19)								
1 - 9	1.16	(1.13-1.20)[c]	1.16	(1.13-1.20)[c]	1.21	(1.17-1.25)[c]	1.21	(1.18-1.25)[c]
0	1.05	(1.01-1.10)[b]	1.05	(1.01-1.10)[a]	1.12	(1.08-1.17)[c]	1.13	(1.08-1.17)[c]
Present illness (reference no)								
Yes	1.06	(1.02-1.10)[b]	0.94	(0.91-0.98)[b]	1.05	(1.01-1.09)[b]	0.95	(0.92-0.99)[b]
Missing	1.05	(0.99-1.12)	0.99	(0.94-1.05)	1.08	(1.02-1.14)[b]	1.03	(0.98-1.08)
Number of social groups (reference 0)								
1			1.02	(0.97-1.07)			1.05	(1.01-1.10)[a]
2			1.03	(0.98-1.09)			1.05	(1.00-1.11)[a]
3 - 6			1.05	(1.00-1.10)			1.06	(1.01-1.11)[a]
Missing			1.02	(0.97-1.06)			1.00	(0.97-1.04)
Municipality-level characteristics								
Number of dentists per 100000 people (reference lowest (<47.29))								
Low middle (47.29 - 53.97)	1.03	(0.98-1.09)	1.03	(0.98-1.09)	1.04	(0.99-1.10)	1.04	(0.99-1.10)
High middle (53.98 - 59.74)	0.99	(0.94-1.05)	0.99	(0.94-1.05)	0.97	(0.92-1.03)	0.97	(0.92-1.03)
Highest (≥59.75)	0.98	(0.93-1.04)	0.98	(0.93-1.04)	0.95	(0.89-1.00)	0.95	(0.89-1.00)

Table 3 Multilevel prevalence ratios and 95% confidence intervals for denture/bridge use in males and females *(Continued)*

Population density (reference rural-agricultural)								
Semi-urban	1.07	(1.02-1.12)[b]	1.07	(1.02-1.13)[b]	1.10	(1.04-1.15)[c]	1.10	(1.04-1.15)[c]
Urban	1.10	(1.04-1.16)[c]	1.10	(1.05-1.16)[c]	1.11	(1.05-1.17)[c]	1.11	(1.05-1.17)[c]
Metropolitan	1.12	(1.06-1.18)[c]	1.13	(1.07-1.19)[c]	1.17	(1.10-1.24)[c]	1.17	(1.10-1.25)[c]
Intercept	0.52	(0.44-0.60)[c]	0.54	(0.46-0.63)[c]	0.50	(0.45-0.56)[c]	0.51	(0.46-0.58)[c]
Random effects								
Local district-level variance (SE)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipality-level variance (SE)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Null model for males: Intercept, multilevel PR: 0.68 (0.66 - 0.69), $p < 0.001$, local district-level variance (SE): 0.000 (0.000), municipality-level variance (SE): 0.002 (0.001).
Null model for females: Intercept, multilevel PR: 0.67 (0.66 - 0.69), $p < 0.001$, local district-level variance (SE): 0.000 (0.000), municipality-level variance (SE): 0.002 (0.001).
PR, prevalence ratio; CI, confidence interval; SE, standard error.
[a], $p < 0.05$; [b], $p < 0.01$; [c], $p < 0.001$.

barriers to seeking dental health care [25]. The results of the present study do not corroborate these findings. However, this discrepancy can be explained as follows. First, all subjects in the present study were ADL independent; therefore, functional limitations were not barriers to seeking dental health care in the present study. Second, subjects presently having illness may be more likely to ask dentists as well as doctors to solve their health problems, because a study using dental and medical care insurance records of employees aged 20–39 years showed that individuals who consulted dentists tended to receive medical treatment more frequently [26].

Although both sexes shared the same factors associated with denture/bridge use, there were differences in factors associated with denture/bridge use between sexes. The results of the present study showed that females involved in one or more kinds of social groups were more likely to use a denture/bridge. These results agree with an interview study from the UK that showed that patients focused on the social significance of oral rehabilitation when defining the need for a removable partial denture [16].

High educational attainment was associated with denture/bridge use only in males. Few studies have reported gender difference in the association between educational attainment and oral health status and/or oral health behavior, probably because most of the studies analyzed the association including both sexes [8-10,23,24]. A study in a Japanese older population showed that males with the highest educational attainment showed healthier ageing and lower mortality compared to males with the lowest educational attainment; however, no such differences were seen among females [27]. These results suggest that educational attainment is associated with oral and systemic health in males, but not in females. Further studies that confirm the reproducibility of these findings are needed to explain the gender difference.

No social capital variables were associated with denture/bridge use. These results disagreed with those from a recent study that suggested that older people living in societies with rich social capital tend to have good oral health status, including having 20 or more teeth [18]. The results of the present study suggest that denture/bridge use was associated with personal factors, such as financial and social factors, but not social capital.

In contrast to social capital, high population density was associated with denture/bridge use in the present study. Because population density may be considered as surrogate information on socioeconomic status, it is possible that people living in richer areas tend to use denture/bridge.

The results of the present study show that target groups in which percentage of people using denture/bridge must be increased included people with low income and those living in the area with low population density. In addition, males with low educational attainment and females who do not have any social groups should be targeted. Taking this information into consideration, formulation of an intervention program for the target groups is recommended from the public health perspective.

The present study had a number of limitations. First, denture use was not distinguished from bridge use in the present study, which makes it difficult to interpret the results. A bridge is a fixed prosthesis and cannot be removed by patients; however, a denture can be removed by patients, and denture use is thus affected by patient compliance. To partially address this issue, we excluded subjects with 20 or more teeth and added number of teeth as a variable in the analyses.

Second, we did not obtain information regarding dental implants which is another type of dental prosthesis because dental implant is not covered by public health insurance in Japan. A recent national survey showed that 4.4%, 1.2% and 2.8% of the whole population aged 65–74, 75–84 and 85- had dental implants, respectively [5]. Additional studies adding information on dental implants are necessary to confirm the results of the present study in the future.

Third, the state of the denture such as stability and fit was unknown because this study was based on a self-administered questionnaire. Our previous study using a similar self-administered questionnaire showed that 13.7% of the participants with few teeth and dentures reported poorly fitted dentures [2]. Additional studies are needed to confirm the results of the present study using information on status of dentures.

Fourth, the measurements used were based on a self-administered questionnaire. Some forms of bias, such as social desirability bias [28], may have affected the results of the present study. Fifth, because this was a cross-sectional study, causal relationships are unclear.

Conclusions

Denture/bridge use was significantly associated with high economic status, present illness, and living in an area with high population density in both sexes among community-dwelling older Japanese having 19 or fewer teeth. Different factors were associated with denture/bridge use in males and females: high educational attainment in males and involvement in one or more social groups in females. Local district-level social capital was not associated with denture/bridge use.

Abbreviations

JAGES: Japan gerontological evaluation study; ADL: Activities of daily living; PR: Prevalence ratio; CI: Confidence interval.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

TY conceived the idea for the study, participated in its design, performed the statistical analysis and drafted the manuscript as the principal author. KK is the principal investigator of the JAGES project, helped to develop the idea of the study, participated in acquiring the data and the study design, and edited the manuscript. JA, KS, JM, and MN participated in data acquisition and study design and critically revised the manuscript. SF helped with data analysis and critically revised the manuscript. YH helped to develop the idea of the study, participated in the study design, and edited the manuscript. All authors read and approved the final manuscript.

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義歯などを使っている人は，経済的に豊かな人，男性では高学歴の人に 2 割多く，女性では社会参加をしている人で 1 割多い

歯が少ない 65 歳以上の高齢者において，義歯やブリッジを使用するか否かに関連する社会的要因が，54,388 名を対象とした調査で判明しました。郵送調査によって義歯やブリッジの使用状況と社会的要因との関連を検討しました。その結果，年齢，婚姻状態，治療中の疾患の有無，対象者が居住する自治体の人口当たり歯科医師数や人口密度などに関わらず，**歯が 19 本以下でも義歯やブリッジを使っている人は，経済的に豊かな人に多く，男性では高学歴の人，女性では社会参加をしている人に多いことがわかりました。**経済的な支援や社会参加を促す環境を整えることで歯が少なくても義歯を入れている人を増やすことができる可能性が示唆されました。

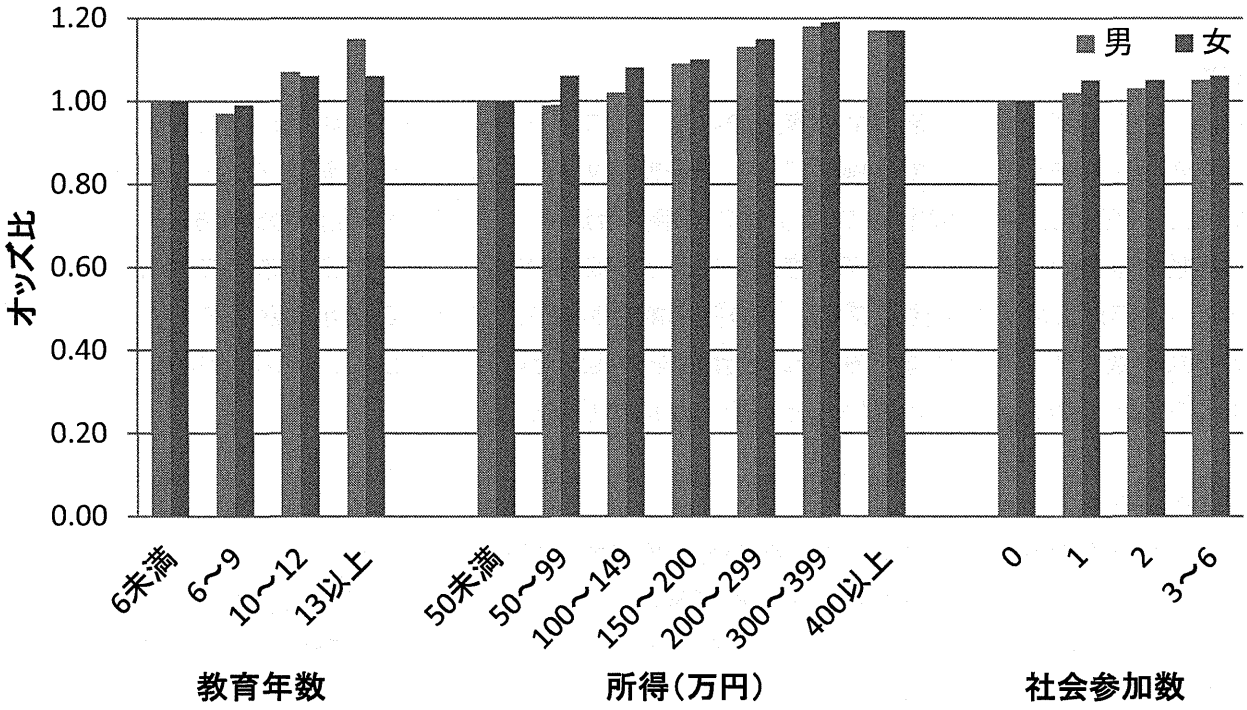

図　男女別のブリッジ･義歯使用のオッズ比

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＜背景＞

国の調査では 65～69 歳，70～74 歳，75～79 歳の人で義歯やブリッジによる治療が必要にもかかわらず治療を行っていない人がそれぞれ 29%，19%，14%存在することが報告されています。近年の研究によって，歯が少なくても義歯を使用することで認知症発症や転倒のリスクが抑制される

可能性が報告されました(Yamamoto ら, Psychosomatic Medicine, 2012; Yamamoto ら, BMJ Open, 2012)。今後，義歯やブリッジによる治療が必要な人々に提供される必要があります。

そこで本研究では歯が少ない高齢者において，どのような社会的要因が義歯やブリッジの使用に関連するのかを検討しました。

＜方法＞

2010～2012 年実施の JAGES（日本老年学的評価研究）プロジェクトで分析対象項目を含む調査票に回答し，自分の歯が 19 本以下と回答した 28 自治体在住の 65 歳以上で要介護認定を受けていない 54,388 名を対象としました。男女別に，義歯・ブリッジの使用と，個人の年齢，婚姻状態，教育歴，所得，歯数（0 本，1～9 本，10～19 本），治療中の疾患の有無，社会参加の数（業界団体，ボランティアグループ，老人クラブ，スポーツ関係のクラブ，町内会，趣味関係のグループの 6 種類のなかの該当数）および市町村ごとの人口当たりの歯科医師数および人口密度を統計学的手法で調整したマルチレベルポアソン回帰分析を行いました。

＜結果＞

年齢，婚姻状態，歯数，治療中の疾患の有無，人口当たり歯科医師数および人口密度を調整しても，男女とも所得の多い人で義歯やブリッジを使用する人が多く，特に年収 50 万円未満の人に比べて 300 万円以上の人は義歯やブリッジの使用割合が約 1.2 倍高いことがわかりました（図）。さらに男性では教育年数が長い人ほど義歯やブリッジの使用が多く，特に 6 年未満の教育年数の人に比べて 13 年以上の人は義歯やブリッジの使用割合が約 1.2 倍高いことがわかりました。女性では社会参加の数に明らかな関連がみられ，社会参加の数がゼロの人に比べて 1 つ以上の人は約 1.1 倍，義歯やブリッジの使用割合が高いことが明らかになりました。

＜研究の意義＞

これらの結果から，歯が少ないにもかかわらず義歯やブリッジを使用していない人は，男女とも経済的に恵まれていない人々である可能性が示唆されました。国民皆保険制度の整ったわが国においても，さらに経済的な負担を考慮して，義歯やブリッジによる治療が受けられる仕組み作りが必要であると考えられます。

また，女性においては社会参加を積極的に行っている人ほど義歯やブリッジを使用していることから，地域において社会参加の機会が増えるような環境を整えることで，義歯やブリッジの使用者が増え，合わせて将来的に要介護になる人々を減らすことができる可能性も示唆されました。

論文発表

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市民「健康づくりサポーター」との協働で進めるお口の健康づくり

神奈川県藤沢市における取り組み

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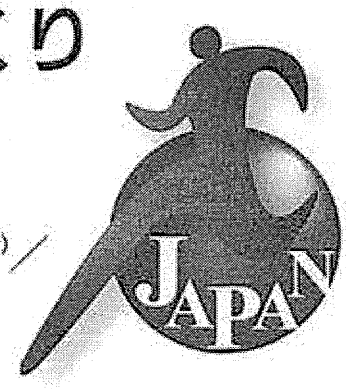

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Individual- and community-level social gradients of edentulousness

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Individual- and community-level social gradients of edentulousness

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Abstract

Background

Community-level factors as well as individual-level factors affect individual health. To date, no studies have examined the association between community-level social gradient and edentulousness. The aim of this study was to investigate individual- and community-level social inequalities in edentulousness and to determine any explanatory factors in this association.

Methods

We analyzed the data from the Japan Gerontological Evaluation Study (JAGES). In 2010–2012, 112,123 subjects aged 65 or older responded to the questionnaire survey (response rate = 66.3%). Multilevel logistic regression analysis was applied to determine the association between community-level income and edentulousness after accounting for individual-level income and demographic covariates. Then, we estimated the probability of edentulousness by individual- and community-level incomes after adjusted for covariates.

Results

Of 79,563 valid participants, the prevalence of edentulousness among 39,550 men (49.7%) and 40,013 women (50.3%) were both 13.8%. Living in communities with higher mean incomes and having higher individual-level incomes were significantly associated with a lower risk of edentulousness (odds ratios [ORs] by 10,000 USD increments were 0.37 (95% confidence interval [CI] [0.22-0.63]) for community-level and 0.85 (95% CI [0.84-0.86]) for individual-level income). Individual- and community-level social factors, including density of dental clinics, partially explained the social gradients. However, in the fully adjusted model, both community- and individual-level social gradients of edentulousness remained significant (ORs = 0.43 (95% CI [0.27-0.67]) and 0.90 (95% CI [0.88-0.91]), respectively). One standard deviation changes in community- and individual-level incomes were associated with 0.78 and 0.84 times lower odds of edentulousness, respectively. In addition, compared to men, women living in communities with higher average incomes had a significantly lower risk of edentulousness (p-value for interaction < 0.001).

Conclusions

Individual- and community-level social inequalities in dental health were observed. Public health policies should account for social determinants of oral health when reducing oral health inequalities.

Keywords

Dental public health, Edentulous/edentulism, Income inequality, Gender differences, Multilevel analysis

Background

Severe tooth loss is the 36th most prevalent condition among 291 diseases and it caused a loss of 106 disability-adjusted life-years per 100,000 population [1]. Prevalence of severe tooth loss increases with age. Approximately 20% of the older population experienced severe tooth loss [2]. Severe tooth loss causes chewing difficulties and poor nutritional status [3]. It also affects general health status. For example, tooth loss predicts the onset of future co-morbidities such as dementia [4] and mortality [5].

Recent studies showed that the prevalence of severe tooth loss differed by socioeconomic group [6-8]. These health inequalities are caused by social determinants of health and can be observed on social gradients [9]. Adverse social conditions such as lower income and lower educational attainment affect the health of not only the most disadvantaged people, but also the entire population within a society [10,11]. The differences in social conditions create a stepwise gradient of health conditions between social groups [12,13]. The total loss of teeth (i.e., edentulousness) reflects the social determinants of an individual's life-course, as it is the result of oral health behavior, oral diseases, and the community health care system [14]. Reducing oral health inequalities is an urgent matter for both researchers and policymakers [15-17]. Furthermore, determining the factors that affect oral health inequalities is important for future public health interventions.

Recent studies have demonstrated that not only individual factors, but also community-level social determinants such as income inequalities or community-level mean income affect the health of individuals and facilitate health inequalities [7,8,18]. Because community factors potentially affect the health of all residents in an area, it is important to understand their effects on health. However, to the best of our knowledge, no study has examined both the individual- and community-level social gradients of edentulousness. Thus, the aims of the present study were: 1) to investigate the association between individual- and community-level incomes and edentulousness, 2) to determine the explanatory factors for edentulousness inequalities, and 3) to investigate gender differences within the socioeconomic inequalities of edentulousness.

Methods

Data collection

We used cross-sectional data from the Japan Gerontological Evaluation Study (JAGES) cohort study in Japan. The JAGES project is an ongoing prospective cohort study investigating social and behavioral factors associated with the loss of health related to functional decline or cognitive impairment among individuals aged 65 years or older [6,19,20]. Between August 2010 and January 2012, a total of 169,215 community-dwelling people aged 65 years and older were randomly selected from 31 municipalities in 12 prefectures in Japan and mailed a set of questionnaires. In total, 112,123 people in 31 municipalities participated (response rate = 66.3%). We used data from 79,563 participants without missing responses.

Outcome variable

The outcome variable for the present analysis was edentulousness (i.e., edentulous or dentulous). Current dental status was measured by a self-administered questionnaire.

Respondents were asked "What is the status of your dental health?" with four choices: 1) I have 20 or more natural teeth, 2) I have 10 to 19 natural teeth, 3) I have 1 to 9 natural teeth, or 4) I have no natural teeth. We categorized answers 1–3 as "dentulous" and answer 4 as "edentulous."

Main predictors

We used two income variables as the main predictors. The individual-level equivalent household income was obtained and calculated from the questionnaire. The community-level mean income was obtained from national census data [21]. Both income variables were used as continuous variables and the unit used was 10,000 USD (1 USD = 100 JPY).

Individual-level socio-demographic covariates

Sex, age (65–69, 70–74, 75–79, 80–84 and >84 years old), marital status (currently married, widowed, divorced, never married, and other), and educational attainment (years of school education received (<6, 6–9, 10–12, >12 years, and other)) were used as individual-level socio-demographic covariates. Marital status [22-24] and educational attainment [25,26] were associated with general and oral health status. In addition, both variables in this study were associated with income level. Therefore we included these variables as covariates.

Community-level socio-demographic covariate

Density of dental clinics is a proxy for access to dental care in communities. A previous study in Japan indicated that density of dental clinics was an appropriate proxy for access to care [27]. Dental status is associated with access to dental care [27]. Density of dental clinics is likely to be higher in urban areas than rural areas [28]. Generally, urban areas are richer than rural areas [29]. Thus, we used density of dental clinics as a covariate of community-level income in this analysis. Density of dental clinics in each municipality in 2010 were obtained from the census data and used as the community-level variable [30].

Data analysis

In our dataset, 79,563 individuals (individual-level) were nested across 30 municipalities (community-level). We have hypothesized that oral health is affected not only by individual-level socioeconomic status but also by community-level social conditions. To examine the contextual effect of community-level income on edentulousness, we applied a 2-level multilevel logistic regression analysis with random intercepts and fixed slopes. To determine explanatory factors in the association between individual- and community-level incomes and edentulousness, we built the models as follows. Model 1 tested the association between individual-and community-level incomes and edentulousness. Model 2 tested the association between income variables and edentulousness after adjusting for age, sex, and marital status. Model 3 added educational attainment into Model 2. Model 4 was the fully adjusted model, adding the community-level variable (density of dental clinics) into Model 3. To determine gender differences in the effect of both individual- and community-level incomes on dental health, interaction terms were included in the fully adjusted model. To evaluate the degrees of individual- and community-level variances in edentulousness, median odds ratios (ORs) were calculated [31]. To compare the degrees of the association between individual- and community-level income variables and edentulousness, we constructed a fully adjusted model with standardized income variables. When non-standardized income variables were included

into the models, they were grand mean centered. Analysis were conducted using MLwiN version 2.28 (Centre for Multilevel Modelling, University of Bristol, UK).

Ethical considerations

Ethical approval for the study was obtained from the Ethics Committee at Nihon Fukushi University, Japan (Approval number: 10–05).

Results

The average ages of 39,550 men (49.7%) and 40,013 women (50.3%) were 73.5 (SD = 5.97) and 73.7 (SD = 6.17) years old, respectively. The prevalence of edentulousness was 13.8% for both men and women. Table 1 shows the demographic distribution of the variables by dental status. Edentulous individuals had significantly lower incomes and lived in communities with lower mean incomes ($p < 0.001$).

Table 1 The demographic distribution of variables by dental status (n = 79,563)

Categorical variables		**Dentulousness n (%)**	**Edentulousness n (%)**	**p-value**
Sex	Male	34,083 (86.2)	5,467 (13.8)	0.798†
	Female	34,507 (86.2)	5,506 (13.8)	
Age	65-69ys	23,239 (94.6)	1,327 (5.4)	p < 0.001†
	70-74ys	21,560 (90.3)	2,314 (9.7)	
	75-79ys	14,212 (83.2)	2,877 (16.8)	
	80-84ys	6,899 (72.8)	2.573 (27.2)	
	>84ys	2,680 (58.7)	1,882 (41.3)	
Marital status	Married	52,769 (88.1)	7,115 (11.9)	p < 0.001†
	Widowed	12,185 (78.6)	3,311 (21.4)	
	Divorced	2,007 (86.7)	307 (13.3)	
	Never married	1,316 (88.4)	173 (11.6)	
	Other	313 (82.4)	67 (17.6)	
Educational attainment	<6ys	1,120 (61.70	694 (38.3)	p < 0.001†
	6-9ys	27,979 (82.7)	5,853 (17.3)	
	10-12ys	25,428 (89.4)	3,023 (10.6)	
	>12ys	13,650 (91.3)	1,299 (8.7)	
	Other	413 (79.9)	104 (20.1)	
Continuous variables		Mean (SE)		
Density of dental clinics (per 10 thousand population)		4.45 (±0.837)	4.31 (±0.699)	p < 0.001‡
Individual income (10 thousand US dollars*)		2.39 (±1.553)	1.95 (±1.467)	p < 0.001‡
Community income (10 thousand dollars*)		3.18 (±0.297)	3.09 (±0.285)	p < 0.001‡

† p-value for chi-squared test.
‡ p-value for *t*-test.
*1 US Dollar = 100 Japanese Yen.

Table 2 shows the results of the multivariate multilevel analysis. In the intercept-only model (not shown), there was a significant difference in edentulousness between municipalities (community-level variance: $\Omega\gamma = 0.262$, SE = 0.069). The median OR in the model was 1.629, which indicated that if a person moved to another municipality with a higher probability of poor dental status, their median risk of edentulousness would increase 1.629 times.

Table 2 Association of edentulousness with individual- and community-level variables determined by multilevel logistic regression (n = 79,563)

	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)	Model 5 OR (95%CI)	Model 6 OR (95%CI)
Fixed effect						
Individual-variables						
Individual income (10 thousand US dollars)	0.85 (0.84-0.86)	0.87 (0.86-0.88)	0.90 (0.88-0.91)	0.90 (0.88-0.91)	0.90 (0.88-0.92)	0.90 (0.88-0.91)
Educational attainment (ref:>12ys)			1.00	1.00	1.00	1.00
<6ys			2.19 (1.94-2.47)	2.19 (1.94-2.47)	2.19 (1.94-2.47)	2.19 (1.93-2.48)
6-9ys			1.61 (1.50-1.73)	1.61 (1.51-1.73)	1.62 (1.51-1.73)	1.62 (1.51-1.73)
10-12ys			1.15 (1.07-1.24)	1.15 (1.07-1.24)	1.16 (1.08-1.24)	1.16 (1.08-1.25)
Other			1.79 (1.41-2.28)	1.80 (1.42-2.28)	1.80 (1.42-2.28)	1.80 (1.42-2.29)
Community-variables						
Community income (10 thousand US dollars)	0.37 (0.22-0.63)	0.39 (0.25-0.61)	0.41 (0.27-0.63)	0.43 (0.27-0.67)	0.43 (0.27-0.67)	0.53 (0.33-0.85)
Density of dental clinics (per 10 thousand population)				0.96 (0.78-1.19)	0.96 (0.78-1.19)	0.96 (0.78-1.18)
Interaction term (Sex*Individual income)					0.98 (0.95-1.02)	
Interaction term (Sex*Community income)						0.63 (0.54-0.73)
Random effects (SE)	0.148 (0.039)	0.105 (0.028)	0.095 (0.026)	0.095 (0.026)	0.095 (0.026)	0.095 (0.026)
Median OR	1.443	1.362	1.342	1.342	1.342	1.342

Model 1: Adjusted for individual- and community-level incomes.
Model 2: Model 1 + age, sex, and marital status.
Model 3: Model 2 + educational attainment.
Model 4 (full model): Model 3 + community-variable (density of dental clinics).
Model 5,6: Model 4 + each interaction term.
*1 US Dollar = 100 Japanese Yen.

Univariate analyses showed that both individual- and community-level incomes were associated with lower risk for edentulousness; ORs of individual- and community-level incomes were 0.84 (95% confidential interval [CI] [0.84–0.86]) and 0.33 (95% CI [0.19–0.60]), respectively. Then, we included both income variables into the same model. Having a 10,000 USD higher income and living in a community with a 10,000 USD higher mean income were associated with 0.85 times and 0.37 times lower risk for edentulousness, respectively (Model 1). Individual characteristics mediated these relationships by 13.5% (individual-level income) and 3.4% (community-level income), respectively (Model 2, calculated from the ORs [32]). Educational attainment further attenuated the ORs of individual- and community-level income variables by 20.5% and 3.8%, respectively (Model 3). The community-level covariate, density of dental clinics, only mediated the association between community-level income and edentulousness (2.1% reduction of the OR, Model 4). Even after considering all covariates, there remained significant geographical differences and individual- and community-level social gradients for edentulousness (Model 4). When standardized income variables were included in Model 4 instead of non-standardized income variables, ORs for individual- and community-level income variables were 0.84 (95% CI [0.82–0.87]) and 0.78 (95% CI [0.68–0.89]), respectively. There was a significant interaction between gender and community-level income, although the interaction between gender and individual-level income was non-significant (Models 5 and 6). Compared to men, women living in areas with higher community-level incomes had a lower probability of edentulousness (Figure 1). For individual-level income, similar social gradients were observed among both men and women (Figure 1).

Figure 1 Gender difference in the association between individual- and community-level incomes and probability of edentulousness. Compared to men, women living in areas with higher community-level incomes had a lower probability of edentulousness.

Discussion

To the best of our knowledge, this study was the first to examine both the individual-and community-level social gradients of edentulousness using a multilevel analysis. This large-scale multilevel analysis demonstrated that not only individual-level income but also community-level income showed social gradients for edentulousness. Present study also investigated the factors which associated between income inequalities and dental status. Individual socioeconomic characteristic partially mediated the association between both individual- and community-level incomes and edentulousness. The community's socio-demographic characteristic also partially mediated the association between community-level income and edentulousness. However, even after adjusting for all covariates, individual- and community-level social gradients remained. In addition, compared to men, women living in municipalities with higher community-level incomes derived greater oral health benefits from the social environment.

The present study reports similar result to previous studies using non-oral health outcomes, which have suggested that community-level social factors affect population health [18]. Those systematic review and meta-analysis showed that poor community-level socioeconomic environment increased resident mortality [18]. A meta-analysis of 11 studies with smaller sample sizes indicated that living in areas with low socioeconomic status increased mortality 1.11 times compared to areas with high socioeconomic status [18]. Another meta-analysis of seven studies with larger sample sizes also demonstrated that living in low socioeconomic status areas increased mortality 1.07 times [18]. In oral health studies,