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Title:

Oral health disparities across socioeconomic position: the influence of economic difficulties in childhood and current work-related factors, from J-SHINE (Japanese study of Stratification, Health, Income, and Neighborhood) study

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Abstract

Background. We quantified the association between socioeconomic position (SEP) and oral health, and examined the influence of economic difficulties in childhood and workplace-related factors on the association in Japan.

Methods. We cross-sectionally assessed self-rated oral health (SROH) among 3,201 workers aged 25-50 years old. Logistic regression model was used to estimate odds rations (ORs) for the association between SROH and each indicator of SEP (annual household income, wealth, educational attainment, occupation, and economic situation in childhood).

Results. Each indicator of SEP, including childhood SEP, was significantly inversely associated with SROH, and all of the workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) were also significantly associated with SROH. Compared with professionals, blue collar workers had significantly higher OR of poor SROH, and, the association was substantially explained by the workplace-related factors; ORs ranged from 1.44 in the age- and sex- adjusted model to 1.18 in the multivariate model. Poverty during childhood at age five and at age fifteen were associated with poorer SROH, and these two factors seemed to be independently associated with SROH

Conclusion. We found oral health disparity across SEP among workers in Japan. The association between occupation and SROH was mostly explained by job-related factors. Economic difficulties during childhood appear to affect SROH in adulthood separately from sex, age, and the current workplace-related factors. Improving childhood poverty and workplace environment may be an approach to reduce oral health disparities.

Strengths and limitations of this study

· Previous studies have shown an association between socioeconomic positions (SEP) in adulthood and oral health, however few have examined the relation between SEP in childhood and oral health in adulthood.

· Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we found evidence that economic difficulties during childhood as well as SEP in adulthood independently appeared to affect self-rated oral health (SROH) in adulthood among working men and women.

· Workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) substantially explained the association between occupation and SROH.

· The response rate was low, however, the obtained sample was properly equivalent with respect to age, sex, and education, compared with vital statistics in Census 2010 of the target population. Therefore, it is likely that the results of the present study could be generalizable to the target population.

Background

Oral health problems, such as dental caries, periodontal disease, and edentulism, afflict more than half of the population of the planet (3.9 billion people) and untreated dental caries is the most prevalent condition (35% across all ages) among the 291 conditions listed in the Global Burden of Disease 2010.[1, 2] Using disability-adjusted life years (DALYs), they estimated that the global burden of oral conditions would increase by approximately 20%, from 12.4 million years in 1990 to 15.0 million years in 2010.[1, 2] In additional to their high prevalence, oral health conditions are a major contributor to socioeconomic disparities in health.[3, 4]

Oral health is an exquisitely sensitive "mirror" of socioeconomic conditions – e.g. nutrition, preventive practices, and access to oral health care – as well as an important marker of future physical health conditions (e.g. cardiovascular disease).[5-8] The major indicators of socioeconomic positions (SEP) include income, wealth, education, and occupation.[9] SEP is associated not only with general health, but also with oral health. Some studies examined the associations between income/education and oral health; those who had higher income, or higher educational attainment had better oral health.[4, 10-13] On the other hand, there are fewer studies on the association between occupational class and oral health. To our knowledge, only four previous studies examined the association between occupation and oral health.[3, 14-16] Poulton et al. examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with combination of parental occupation in childhood with occupation in adulthood among 1,000 children in New Zealand; they reported clear social gradients among these oral conditions.[3] Morita et al. examined the association of occupations with oral conditions, based on approximately 16,000 Japanese workers; they reported that professionals had better oral conditions than

office workers and blue collar workers in Japan.[14, 15] Tsakos et al. reported clear social gradients in oral health, based on a sample of 6,600 community-dwelling English people aged 50 years and older.[16] However, none of these considered workplace-related factors, such as social support, working hours, type of employment or job stress, as potential mediators of the association between occupations and health. Workplace-related factors may be candidates for mitigating oral health disparities.

Psychological stress is a risk factor for oral diseases, such as periodontitis, and gingivitis.[17-20] Therefore, we hypothesized that job stress (including work hours) – as well as stress-buffering factors such as workplace social support – would mediate the association between occupational class and oral health.

In this study, we first examined approximately three thousand workers aged 25-50 years old in Japan to elucidate the associations between indicators of SEP (occupation, income wealth, education and SEP in childhood) and oral health. We then examined the mediation of socioeconomic disparities by workplace-related factors (social support in workplace, job stress, working hours and type of employment).

METHODS

Participants

We conducted the present study by using data from the J-SHINE (Japanese study of Stratification, Health, Income, and Neighborhood), the details of which have been previously described.[21] In brief, between October 2010 and February 2011, 13,920 community-dwelling residents aged 25 to 50 years were randomly selected from four municipalities in and around Tokyo, Japan. Of those who were invited, 4,385 men and women responded (31.6%) to the invitation; these individuals formed the baseline of the J-SHINE study. The questionnaire was self-administered using a computer-assisted

personal interview format, unless the participants requested a face-to-face interview. We excluded participants who did not answer the question about self-rated oral health, or who responded that they were not active in the labor market (including homemakers and students); this result in 3,201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (25-29, 30-34, 35-39, 40-44, and 45-50 years old), and marital status (yes/no). Self-rated oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that can evaluate needs of dental care among people, especially those who do not usually visit dentists, and its validity and high internal consistency have been confirmed.[22, 23] SROH was assessed by the following question. *"Overall, how would you rate the health of your teeth and gums?"* Potential responses ranged from *"1.excellent, 2.good, 3.fair, 4.not so good or 5.poor"*. In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good SROH", and "4.not so good and 5.poor" as "Poor SROH".

As indicators of SEP, we used annual household income, wealth, educational attainment, occupation, and economic situations during childhood. Annual household income was divided into three categories; less than JPY 5 million (Approximately GBD 29,400), JPY 5 to 7.5 million (GBD 29,400-44,100), or more than JPY 7.5 million (GBD 44,100). Wealth was divided into three categories; less than JPY 3 million (GBD 17,600), JPY 3 to 5 million (GBD 17,600-29,400), or more than JPY 5 million (GBD 29,400). Educational attainment was divided into three categories; high school or less, vocational/junior college, and university or more. Occupational class was divided into three categories; professionals, office workers or blue collar workers. Occupations were

self-reported, but, in addition, a sociologist on the team (K.K.) examined each response to determine the correct classification based on the detailed job description provided by the participants. Our method of occupational classification was previously used in "The national survey of Social Stratification and social Mobility", which has been conducted in Japan every ten years since 1955 and is regarded as the most academically valid classification of occupations in Japan.[24] Economic conditions in childhood were evaluated through the following questions. *"How would you rate the economic conditions in your household at age five (fifteen)?"* The answers were selected from *"1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off"*. In the analysis, the answers were divided into three groups: "1.very difficult, 2. difficult", "3.normal" and "4. well off 5. well off". This question was derived from the Comprehensive Survey of Living Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate subjective economic situation in Japan.

With regard to workplace-related factors, job stress, social support in workplace, working hours, and type of employment were used. Job stress was evaluated by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ). BJSQ has been validated for use with Japanese workers, and consists of lists the 84 questions which assesses job stress, social support in workplace and subjective physical/mental symptoms.[25] BJSQ has been used in workplaces in Japan and was used in previous research in Japan.[25, 26] One example of the seven questions on the job stress was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into tertiles. Social support in workplace consisted of six questions, which were also taken from BJSQ. One example of six questions was *"How reliable is your boss when you are in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*.

Aggregated scores for the six questions were divided into tertiles. Working hours were divided into four groups; less than 40 hours per week, 40 to 50 hours per week, 50 to 60 hours per week, or more than 60 hours per week. Type of employment was divided into three groups: permanent, precarious or self-employment.

Statistical analysis

Differences in background characteristics according to SROH (good or poor) were compared using the chi-square test (Table1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex- and age-adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office workers and blue collar workers, compared with professionals. We also calculated the ORs between each SEP and SROH (Table2), and the ORs between work-related factors and SROH (Table3). Additionally, we estimated the multivariate ORs for the association between occupations and SROH, adjusting for work-related factors, such as job stress social support in workplace, working hours, and type of employment (Table4). Dummy variables were used for missing data in all analysis. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses.

Ethics

The study was approved by the ethics committee of the Graduate School of Medicine and Faculty of Medicine, The University of Tokyo.

Results

Table 1 describes the basic characteristics of the study participants according to level of SROH. All of the characteristics except marital status were significantly

associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue collar workers, precarious workers, as well as those with lower income, lower wealth, lower educational attainment, higher childhood poverty, lower social support, higher stress and longer working hours.

Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the associations between various indicators of SEP (occupation, income, wealth, education, and two indicators of childhood SEP) and poor SROH. All indicators of SEP were inversely associated with SROH. Blue collar workers had significantly higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CI for associations between workplace-related factors (job stress, social support in workplace, working hour and type of employment) and poor SROH. All of the factors were associated with poor SROH. Workers with the most stress as well as low social support had higher odds of poor SROH compared with those with less job stress or more social support. Those who reported working more than 60 hours per week had poorer SROH than those who worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent workers.

Table 4 shows the multivariate ORs and 95% CI for poor SROH. The associations between occupational class and poor SROH were substantially attenuated by work-related factors. Approximately 60% of the association between occupations and poor SROH was explained by the work-related factors.[27] In the multivariate model, all of the workplace-related factors (social support, job stress, type of employment and working hours) were significantly associated with poor SROH.

Discussion

In the present study, we found oral health disparity across various indicators of SEP as well as childhood SEP among workers in Japan. Moreover, the association between occupations and SROH was substantially explained by job-related factors.

Our finding is notable for demonstrating oral health disparities even in a society, where citizens have access to dental services with relatively low out-of-pocket cost. Our findings are consistent with a previous study by Morita et al., which reported that there were clear oral health disparities across occupations.[15] We found oral health disparities across occupations as well as other indicators of SEP, including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation, income, wealth and parental occupation, among older individuals in England.[16]

One reason why people with higher SEP had better SROH may be related to preventive practices – e.g. dental flossing or use of interdental brush (interproximal brush). Neamatol et al. reported that students with doctorate or masters degrees flossed more than those with bachelor degree or less[28], while Tseveenjav et al. reported that people with higher educational attainment performed cleaning more than the others.[29] Another reason people in higher SEP had better SROH might be utilization of preventive dentistry. People with lower incomes tend to use preventive dental service less frequently[30, 31], and the difference of use in preventive service might explain the social gradient of SROH. In fact, in the present study, approximately one in three participants (32.3%) among the richest group made a preventive dental clinic visit in the past year, whereas only one in four participants (24.7%) among the poorest group did so. On the other hand, we did not observe a big difference among rich and poor participants in the use of dental services for treatment; 42.3% for the richest group

versus 41.4% for the poorest group. Thus, the pathway from lower household income to poor SROH might be through preventive dental service utilization.

Our findings add to the previous literature by suggesting that occupational inequalities in oral health can be substantially explained by work-based factors, such as, social support in the workplace, job stress, working hours, and type of employment (precarious vs. permanent). These workplace-related factors might be targets for interventions to mitigate oral health disparities, i.e. in addition to intervening to improve socioeconomic conditions, it may be possible focus on working conditions to reduce oral health disparities.

Social support has been reported to have a "stress-buffering effect" on cardiovascular diseases.[32-34] Stress has been reported as one of the exacerbating factors for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk factor for gingivitis[19], and Krejci CB, et al. suggested that stress may hasten the development and progression of periodontitis through the suppression of T-cell activity or a reduction in salivary IgA.[17, 18] Precarious employment was also significantly associated with poor SROH in the multivariate model. Previous studies on precarious employment showed that this form of work is associated with job insecurity and psychological distress[35, 36], and, therefore, being in a precarious employment might also a risk factor of developing periodontitis or gingivitis via stress. The number of precarious employees has been increasing all over the world as well as in Japan. In Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in 1985.[37]

Previous studies have suggested a consistent link between early life-course socioeconomic circumstances and health status in adulthood.[3, 38, 39] Our study is consistent with previous research in showing an association between childhood SEP and

oral health. Poulton R et al. examined 1,000 children in New Zealand and found that there was a clear social gradient of dental health (tooth cleanliness, gingival bleeding, periodontal disease, and tooth decay) across childhood SEP.[3] In our study, when poverty during the childhood at age five or fifteen was added to the multivariate model, both poverty during childhood at age five and at age fifteen were associated with poorer SROH (OR: 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen, respectively, not shown in tables). These two factors seemed to be independently associated with SROH, because coefficients of the other covariates in the multivariate model hardly changed before and after adding the childhood poverty variables to the multivariate model. Therefore, poverty during childhood appears to affect SROH in adulthood separately from sex, age, and the current workplace-related factors.

·Limitations

There are some limitations in this study. First, SROH is a subjective measurement. Some might argue that this type of measurement might be invalid, however, self-rated oral health has been examined and reported to be a well-validated and reliable index.[22, 23] Jones JA et al. validated the association between a single-item self-report question and oral clinical examination among two hundred thirty-two community-dwelling participants. The question was *"How would you describe the health of your teeth and gums? Would you say it is excellent, very good, good, fair or poor?"*. They reported that the single-item self-reported question had a sensitivity of 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care, compared with the clinical examination.[22] Secondly, the response rate was low. However, Takada et. al. compared the collected sample with the vital statistics in Census 2010 of the target population and reported that the obtained sample was properly equivalent

with respect to age, sex, and education[21]. Therefore, it is likely that the results of the present study could be generalizable to the target population. Thirdly, the data used in this study was cross-sectional, not longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is well described that poor dental status can lead to social stigma and adversely impact people's chances of employment and success in life.[40] Fourthly, we did not gather data on brushing frequency or use of interdental brush/dental flossing[29], and we could not include these factors in the analysis. Some studies reported that people with lower educational attainment or low income use interdental brush/dental flossing less, and this might explain the association between SEPs and poorer SROH. Finally, the questions which were used to evaluate job stress or social support in workplace were not validated although BJSQ, from which questions on social support and job stress were derived, have been well-validated.[25] Future studies should employ well-validated questions on job stress and social support.

Conclusion

We found oral health disparities across various SEPs, and that workplace-related factors substantially explained the association between occupations and SROH. Improving workplace environments may present a viable solution to reduce oral health disparities. Future studies on the effect of workplace-related factors on oral health should use longitudinal data to elucidate the causal association between the workplace-related factors and oral health.

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Contributorship statement:

All authors participated in conceptualizing the study, interpreting the data, and writing and critically reviewing the article. T. Tsuboya conducted data analysis and led the writing of the article.

Table1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH†		*p-value**
	n	(%)	
Sex			
Men	529	(29.7)	*0.0002*
Women	334	(23.8)	
Age			
25-29	132	(22.5)	
30-34	138	(25.0)	
35-39	173	(27.2)	*0.0001*
40-44	175	(25.8)	
45-50	225	(33.8)	
Marital status			
Married	597	(27.9)	*0.14*
Single	269	(25.5)	
Occupations			
Specialists	83	(28.0)	
White collar workers	497	(24.9)	*0.0009*
Blue collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(Approximately GBD 29,400) ‡	226	(32.3)	
5-7.5 million JPY(Approximately GBD 29,400-44,100) ‡	179	(26.6)	*0.0012*
More than 7.5 mil JPY (Approximately GBD 44,100) ‡	250	(24.3)	
Wealth			
Less than 3 million JPY (Approximately GBD 17,600) ‡	201	(34.7)	
3-5 million JPY (Approximately GBD 17,600-29,400) ‡	169	(30.2)	*<.0001*
More than 5 million JPY (Approximately GBD 29,400) ‡	173	(22.9)	
Education			
High school or less	263	(36.3)	
Vocational/junior college	262	(26.9)	*<.0001*
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	
Normal	502	(25.7)	*<.0001*
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	
Normal	467	(24.8)	*<.0001*
Well-off, very well-off	180	(25.9)	

Job stress			
1st tertile(least stressful)	289	(25.2)	
2nd tertile	272	(25.2)	*0.0017*
3rd tertile(most stressful)	300	(31.3)	
Social support in workplace			
1st tertile(most supportive)	266	(23.4)	
2nd tertile	278	(29.1)	*0.0014*
3rd tertile(least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	
40-50	162	(23.5)	*0.027*
50-60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	
Precarious	272	(30.9)	*0.0083*
Self-employed	66	(27.3)	

* P-value was calculated by chi-squared test.
† The status of SROH was determined by the question: "Overall, how would you rate the health of your teeth and gums?". "Poor SROH" includes respondents of "not so good" and "poor", and "Good SROH" includes respondents of "excellent", "good" and "fair"
‡ Income and wealth were converted at 170 JPY (Japanese Yen) to 1 GBP (Great Britain Pound).

Table2. Age- and sex- adjusted odds ratios and 95% confidence intervals for associations between socioeconomic positions and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 - 1.39)	0.75
Blue collar workers	1.44	(1.07 - 1.95)	0.017
Household income			
Low	1.72	(1.38 - 2.16)	<.0001
Middle	1.18	(0.94 - 1.48)	0.15
High	1.00		
Wealth			
Low	1.93	(1.51 - 2.46)	<.0001
Middle	1.55	(1.20 - 1.99)	0.0007
High	1.00		
Educational attainment			
Low	1.98	(1.63 - 2.42)	<.0001
Middle	1.38	(1.14 - 1.68)	0.0012
High	1.00		
Economic situation at home when respondents were five years old			
Poor, very poor	1.61	(1.25 - 2.08)	0.0003
Normal	1.07	(0.86 - 1.34)	0.55
Well-off, very well-off	1.00		
Economic situation at home when respondents were fifteen years old			
Poor, very poor	1.53	(1.20 - 1.95)	0.0006
Normal	0.91	(0.74 - 1.11)	0.33
Well-off, very well-off	1.00		

Table3. Crude odds ratios and 95% confidence intervals for associations between workplace-related factors and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	1.00	(0.83 - 1.21)	*0.99*
3rd tertile(most stressful)	1.36	(1.12 - 1.64)	*0.0018*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.34	(1.10 - 1.63)	*0.0033*
3rd tertile(least supportive)	1.39	(1.14 - 1.68)	*0.001*
Working hours per week			
<40	1.19	(0.96 - 1.47)	*0.12*
40-50	1.00		
50-60	1.16	(0.85 - 1.58)	*0.34*
>60	1.69	(1.20 - 2.39)	*0.0027*
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 - 1.57)	*0.002*
Self-employed	1.10	(0.82 - 1.49)	*0.52*

Table4. Multivariate odds ratios and 95% confidence intervals for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.96	(0.72 - 1.29)	*0.79*
Blue collar workers	1.18	(0.86 - 1.61)	*0.31*
Sex			
Men	1.61	(1.32 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.86	(0.65 - 1.14)	*0.29*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.46*
40-44	1.00	(0.77 - 1.30)	*0.98*
45-50	1.52	(1.17 - 1.98)	*0.0016*
Marital status			
Married	1.00		
Single	0.99	(0.82 - 1.19)	*0.91*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.66*
3rd tertile(most stressful)	1.25	(1.02 - 1.54)	*0.03*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.031*
3rd tertile(least supportive)	1.24	(1.01 - 1.51)	*0.039*
Working hours per week			
<40	1.15	(0.92 - 1.45)	*0.23*
40-50	1.00		
50-60	1.05	(0.76 - 1.44)	*0.78*
>60	1.48	(1.04 - 2.11)	*0.031*
Type of employment			
Permanent	1.00		
Precarious	1.52	(1.22 - 1.90)	*0.0002*
Self-employed	1.11	(0.80 - 1.54)	*0.53*

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	#5
Methods			
Study design	4	Present key elements of study design early in the paper	#6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	#6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#6-9
Bias	9	Describe any efforts to address potential sources of bias	*#6*
Study size	10	Explain how the study size was arrived at	*#6*
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#6-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#9
		(*b*) Describe any methods used to examine subgroups and interactions	not applicable
		(*c*) Explain how missing data were addressed	#9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	not applicable
		(*e*) Describe any sensitivity analyses	not applicable
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#11
		(b) Give reasons for non-participation at each stage	#6
		(c) Consider use of a flow diagram	not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#11
		(b) Indicate number of participants with missing data for each variable of interest	#11
Outcome data	15*	Report numbers of outcome events or summary measures	#11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#11-12
		(*b*) Report category boundaries when continuous variables were categorized	not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	#13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	#13-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#15-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	#16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Oral health disparities across socioeconomic position: the influence of economic difficulties in childhood and current work-related factors, from J-SHINE study

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Oral health disparities across socioeconomic position: the influence of economic difficulties in childhood and current work-related factors, from J-SHINE study

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Abstract

Objectives: We investigated the association between socioeconomic position (SEP) and oral health, and examined the associations of economic difficulties in childhood and workplace-related factors on the association.

Design: Cross-sectional study

Participants: A total of 3,201 workers aged 25-50 years old, living in and around Tokyo, Japan

Outcome measures: Self-rated oral health (SROH). A logistic regression model was used to estimate odds ratios (ORs) for the association between poor SROH and each indicator of SEP (annual household income, wealth, educational attainment, occupation, and economic situation in childhood). Multiple imputation was used to address missing values.

Results: Each indicator of SEP, including childhood SEP, was significantly inversely associated with SROH, and all of the workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) were also significantly associated with SROH. Compared with professionals, blue collar workers had significantly higher OR of poor SROH, and, the association was substantially explained by the workplace-related factors; ORs ranged from 1.44 in the age- and sex- adjusted model to 1.18 in the multivariate model. Poverty during childhood at age five and at age fifteen were associated with poorer SROH, and these two factors seemed to be independently associated with SROH

Conclusions: We found oral health disparity across SEP among workers in Japan. Approximately 60% of the association between occupation and SROH was explained by job-related factors. Economic difficulties during childhood appear to affect SROH in adulthood separately from sex, age, and the current workplace-related factors.

Strengths and limitations of this study

- Previous studies have shown an association between socioeconomic positions (SEP) in adulthood and oral health, however few have examined the relation between SEP in childhood and oral health in adulthood.
- Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we found evidence that economic difficulties during childhood as well as SEP in adulthood independently appeared to affect self-rated oral health (SROH) in adulthood among working men and women.
- Workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) substantially explained the association between occupation and SROH.
- The response rate was low, however, the obtained sample was properly equivalent with respect to age, sex, and education, compared with vital statistics in Census 2010 of the target population.

Background

Oral health problems, such as dental caries, periodontal disease, and edentulism, afflict more than half of the population of the planet (3.9 billion people) and untreated dental caries is the most prevalent condition (35% across all ages) among the 291 conditions listed in the Global Burden of Disease 2010.[1 2] Using disability-adjusted life years (DALYs), which is an index of measuring disease burden in society, and is calculated as sum of years of life lost due to premature mortality and years lived with disability, Marcenes W, et al estimated that the global burden of oral conditions would increase by approximately 20% from 1990 to 2010.[1 2] In additional to their high prevalence, oral health conditions are a major contributor to socioeconomic disparities in health.[3 4]

Oral health reflects individuals' socioeconomic conditions as well as an important marker of future physical health conditions (e.g. cardiovascular disease).[4-8] The major indicators of socioeconomic positions (SEP) include income, wealth, education, and occupation.[9] SEP is associated not only with general health, but also with oral health. Some studies examined the associations between income/education and oral health; those who had higher income, or higher educational attainment had better oral health.[10-14] On the other hand, there are fewer studies on the association between occupational class and oral health. To our knowledge, only five previous studies examined the association between occupation and oral health.[3 15-18] Poulton et al. examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with combination of parental occupation in childhood with occupation in adulthood among 1,000 children in New Zealand; they reported significant social gradients among these oral conditions.[3] Sanders et al. examined data of 3,678 adults in Australia and reported that upper white collar

workers reported less social impact, measured by the 14-item Oral Health Impact Profile, than did workers in lower white-collar or blue-collar occupations.[18] Morita et al. examined the association of occupations with oral conditions, based on approximately 16,000 Japanese workers; they reported that professionals had better oral conditions than office workers and blue collar workers in Japan.[15 16] Tsakos et al. reported significant social gradients in oral health, based on a sample of 6,600 community-dwelling English people aged 50 years and older.[17] However, none of these considered workplace-related factors, such as social support, working hours, type of employment or job stress, as potential mediators of the association between occupations and oral health. Psychological stress is associated with the workplace-related factors as well as occupations, and, on the other hand, oral diseases, such as periodontitis and gingivitis, are also associated with psychological stress.[19-22] Therefore, workplace-related factors may be candidates for mitigating oral health disparities. and, we hypothesized that job stress (including work hours) – as well as stress-buffering factors such as workplace social support – would mediate the association between occupational class and oral health.

In this study, we first examined data of 3,201 workers aged 25-50 years old in Japan to elucidate the associations between indicators of SEP (occupation, income wealth, education and SEP in childhood) and oral health. We then examined the mediation of socioeconomic disparities by workplace-related factors (social support in workplace, job stress, working hours and type of employment).

METHODS

Participants

We conducted the present study by using data from the J-SHINE (Japanese

study of Stratification, Health, Income, and Neighborhood), the details of which have been previously described.[23] In brief, between October 2010 and February 2011, 13,920 community-dwelling residents aged 25 to 50 years were probabilistically and randomly selected from four municipalities in and around Tokyo, Japan, with using the Basic Resident Registration System. Independent survey agencies were contracted to conduct the surveys, and the professional surveyors who had more than three years of experience in conducting interview-based social surveys made contacts with the eligible individuals after attending training sessions to conduct the J-SHINE study. The main reasons the surveyors were not able to receive responses from the eligible participants were as follows: "inaccessible contact (n=4371)" and "refusal of invitation (n=3677)". Of those who were invited, 4,385 men and women responded (31.6%) to the invitation; these individuals formed the baseline of the J-SHINE study. A questionnaire was self-administered using a computer-assisted personal interview format, unless the participants requested a face-to-face interview. We excluded participants who did not answer the question about self-rated oral health, or who responded that they were not active in the labor market (including homemakers and students); this result in 3,201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and 45-50 years old), and marital status (categorized as married/not married). Self-rated oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that can evaluate needs of dental care among people, especially those who do not usually visit dentists, and its validity and high internal consistency have been confirmed.[24 25]

SROH was assessed by the following question. *"Overall, how would you rate the health of your teeth and gums?"* Potential responses ranged from *"1.excellent, 2.good, 3.fair, 4.not so good or 5.poor"*. In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good SROH", and "4.not so good and 5.poor" as "Poor SROH".

As indicators of SEP, we used annual household income, wealth, educational attainment, occupation, and economic situations during childhood. Annual household income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400), JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100). Wealth was based on household financial and other assets (e.g. stock, bond, and so on) and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment was divided into three categories; high school or less, vocational/junior college, and university or more. Occupational class was divided into three categories; professionals, office workers or blue collar workers. Occupations were self-reported, but, in addition, a sociologist on the team (K.K.) examined each response to determine the correct classification based on the detailed job description provided by the participants. Our method of occupational classification was previously used in "The national survey of Social Stratification and social Mobility", which has been conducted in Japan every ten years since 1955 and is regarded as the most valid classification of occupations in Japan.[26] Economic conditions in childhood were evaluated through the following questions. *"How would you rate the economic conditions in your household at age five?"* and *"How would you rate the economic conditions in your household at age fifteen?"* The answers were selected from *"1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off"*. In the analysis, the answers were divided into three groups: "1.very difficult, 2. difficult", "3.normal" and "4. well off 5. very well off". This question was derived from

the Comprehensive Survey of Living Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate subjective economic situation in Japan.

With regard to workplace-related factors, job stress, social support in workplace, working hours, and type of employment were used. Job stress was evaluated by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ). BJSQ has been validated for use with Japanese workers, and consists of lists the 84 questions which assesses job stress, social support in workplace and subjective physical/mental symptoms.[27] BJSQ has been used in workplaces in Japan and was used in previous research in Japan.[27 28] One example of the seven questions on the job stress was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into tertiles. Social support in workplace consisted of six questions, which were also taken from BJSQ. One example of six questions was *"How reliable is your boss when you are in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*. Aggregated scores for the six questions were divided into tertiles. Working hours were divided into four groups; less than 40 hours per week, 40 to 50 hours per week, 50 to 60 hours per week, or more than 60 hours per week. Type of employment was divided into three groups: permanent, precarious or self-employment.

Statistical analysis

Differences in background characteristics according to SROH (good or poor) were compared using the chi-square test (Table1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex- and age-adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office

workers and blue collar workers, compared with professionals. We also calculated the ORs between each SEP and SROH (Table2), and the ORs between work-related factors and SROH (Table3). Additionally, we estimated the multivariate ORs for the association between occupations and SROH, adjusting for work-related factors, such as job stress social support in workplace, working hours, and type of employment (Table4). With regard to missing data on explanatory variables, we carried out 2 separate analyses. In the first analysis, dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) (Appendix Table1). In the second analysis, we conducted multiple imputations for the missing data, included all variables shown in Table1. Interactions between sex and the other variables (age/marital status/job stress/social support in the workplace/working hour/type of employment) were tested by entering multiplicative interaction terms into the multivariate adjusted model, because employment situation in Japan is highly different in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses, and "Proc MI" and "Proc MIANALYZE" were used for the multiple imputations

Ethics

The study was approved by the ethics committee of the Graduate School of Medicine and Faculty of Medicine, The University of Tokyo.

Results

The distribution of answers for the SROH was as follows; 1.excellent (N of 407), 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table 1 describes the basic characteristics of the study participants according to level of SROH.

All of the characteristics except marital status were significantly associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue collar workers, precarious workers, as well as those with lower income, lower wealth, lower educational attainment, higher childhood poverty, lower social support, higher stress and longer working hours.

Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the associations between various indicators of SEP (occupation, income, wealth, education, and two indicators of childhood SEP) and poor SROH. All indicators of SEP were inversely associated with SROH. The association with SROH was significant only for the lowest levels in occupation, income and childhood SEP, while the association was comparatively larger in magnitude and significant for the intermediate levels as well as for the lowest levels in education and wealth. Blue collar workers had significantly higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CI for associations between workplace-related factors (job stress, social support in workplace, working hour and type of employment) and poor SROH. All of the factors were associated with poor SROH. Workers with the most stress as well as low social support had higher odds of poor SROH compared with those with less job stress or more social support. Those who reported working more than 60 hours per week had poorer SROH than those who worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent workers.

Table 4 shows the multivariate ORs and 95% CI for poor SROH from the multiple imputation models. The associations between occupational class and poor

SROH were substantially attenuated by work-related factors. Approximately 60% of the association between occupations and poor SROH was explained by the work-related factors.[28] In the multivariate model, all of the workplace-related factors (social support, job stress, type of employment and working hours) were significantly associated with poor SROH. Compared with the analysis that employed dummy categories for missing values (Appendix Table1), we found similar results after accounting for missing values using multiple imputations. None of the interactions were significant; occupation (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50), working hours (p=0.83), and type and employment (p=0.73).

Discussion

In the present study, we found oral health disparity across various indicators of SEP as well as childhood SEP among workers in Japan. Moreover, the association between occupations and SROH was substantially explained by job-related factors. Our finding is notable for demonstrating oral health disparities even in Japan, where the citizens, including children, have access to dental services with relatively low out-of-pocket cost. Our findings are consistent with a previous study by Morita et al., which reported that there were significant oral health disparities across occupations.[16] We found oral health disparities across occupations as well as other indicators of SEP, including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation, income, wealth and parental occupation, among older individuals in England.[17]

One reason why people with higher SEP had better SROH may be related to preventive practices – e.g. dental flossing or use of interdental brush (interproximal brush). Neamatol et al. reported that students with doctorate or masters degrees flossed

more than those with bachelor degree or less[29], while Tseveenjav et al. reported that people with higher educational attainment performed cleaning more than the others.[30] Another reason people in higher SEP had better SROH might be utilization of preventive dentistry. People with lower incomes tend to use preventive dental service less frequently[31 32], and the difference of use in preventive service might explain the social gradient of SROH. In fact, in the present study, approximately one in three participants (32.3%) among the richest group made a preventive dental clinic visit in the past year, whereas only one in four participants (24.7%) among the poorest group did so. On the other hand, we did not observe a big difference among rich and poor participants in the use of dental services for treatment; 42.3% for the richest group versus 41.4% for the poorest group. Thus, the pathway from lower household income to poor SROH might be through preventive dental service utilization.

Another explanation for the relationship between SEP and SROH might be through psychosocial factors. Baker et al reported that greater sense of coherence and higher self-esteem were linked to better oral health perceptions.[33] Therefore, these factors might be mediators between SEP and SROH because those who are in higher SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

Our findings add to the previous literature by suggesting that occupational inequalities in oral health can be substantially explained by work-based factors, such as, social support in the workplace, job stress, working hours, and type of employment (precarious vs. permanent). These workplace-related factors might be targets for interventions to mitigate oral health disparities, i.e. in addition to intervening to improve socioeconomic conditions, it may be possible focus on working conditions to reduce oral health disparities.

Social support has been reported to have a “stress-buffering effect” on

cardiovascular diseases.[34-36] Stress has been reported as one of the exacerbating factors for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk factor for gingivitis[21], and Krejci CB, et al. suggested that stress may hasten the development and progression of periodontitis through the suppression of T-cell activity or a reduction in salivary IgA.[19 20] Precarious employment was also significantly associated with poor SROH in the multivariate model. Previous studies on precarious employment showed that this form of work is associated with job insecurity and psychological distress[37 38], and, therefore, being in a precarious employment might also a risk factor of developing periodontitis or gingivitis via stress. The number of precarious employees has been increasing all over the world as well as in Japan. In Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in 1985.[39]

Previous studies have suggested a consistent link between early life-course socioeconomic circumstances and health status in adulthood.[3 5 40 41] Our study is consistent with previous research in showing an association between childhood SEP and oral health. Poulton R et al. examined 1,000 children in New Zealand and found that there was a significant social gradient of dental health (tooth cleanliness, gingival bleeding, periodontal disease, and tooth decay) across childhood SEP.[3] Thomson et al. examined 789 individuals and revealed that those who were in low socioeconomic status at age 5 years were more likely to have lost a tooth in adulthood because of caries and had greater prevalence and extent of periodontitis.[5] In our study, when poverty during the childhood at age five or fifteen was added to the multivariate model, both poverty during childhood at age five and at age fifteen were associated with poorer SROH (OR: 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen, respectively, not shown in tables). These two factors seemed to be independently

associated with SROH, because coefficients of the other covariates in the multivariate model hardly changed before and after adding the childhood poverty variables to the multivariate model. Therefore, poverty during childhood appears to affect SROH in adulthood separately from sex, age, and the current workplace-related factors.

·Limitations

There are some limitations in this study. First, SROH is a subjective measurement. Some might argue that this type of measurement might be invalid, however, self-rated oral health has been examined and reported to be a well-validated and reliable index.[24 25] Jones JA et al. validated the association between a single-item self-report question and oral clinical examination among two hundred thirty-two community-dwelling participants. The question was *"How would you describe the health of your teeth and gums? Would you say it is excellent, very good, good, fair or poor?"* They reported that the single-item self-reported question had a sensitivity of 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care, compared with the clinical examination.[24] The validation studies were conducted in English, and the present study was conducted in Japanese. As far as we know, no previous studies have validated the scale in Japanese yet. However, we have confirmed that poor SROH was significantly associated with number of removed tooth in the sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of remaining teeth and clinical examination in Japanese.[42] Therefore, this might support that the scale in Japanese is also valid. Future studies are needed to clarify the validity of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al. compared the collected sample with the vital statistics in Census 2010 of the target population and reported that the obtained sample was properly equivalent with respect

to age, sex, and education.[23] Therefore, it is likely that the selection bias does not matter in terms of age, sex and education. We are not able to discuss selection bias precisely because we do not have other information among non-responders, such as smoking habit, income and so on. Thirdly, the data used in this study was cross-sectional, not longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is well described that poor dental status can lead to social stigma and adversely impact people's chances of employment and success in life.[43] Attention should be given to the positive association between current poor SROH and economic disadvantage in childhood, because the assessments of economic disadvantage in childhood were based on the participants' recall (recall bias). Fourth, we did not gather data on brushing frequency or use of interdental brush/dental flossing[30], and we could not include these factors in the analysis. Some studies reported that people with lower educational attainment or low income use interdental brush/dental flossing less, and this might explain the association between SEPs and poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at workplace were not validated. However, both have been used in practice in Japan, and the internal consistency of the scale in the present participants was acceptably high: Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6 items for social support. Future studies should employ well-validated questions on job stress and social support.

Conclusion

We found oral health disparities across various SEPs, and that work-related factors could account for more than half the association between occupation and SROH . Improving workplace environments may present a viable solution to reduce oral health

disparities. Future studies on the effect of workplace-related factors on oral health should use longitudinal data to elucidate the causal association between the workplace-related factors and oral health.

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Table1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH [a]		*p-value* [b]
	n	(%)	
Sex			
Men	529	(29.7)	*0.0002*
Women	334	(23.8)	
Age			
25-29	132	(22.5)	
30-34	138	(25.0)	
35-39	173	(27.2)	*0.0001*
40-44	175	(25.8)	
45-50	225	(33.8)	
Marital status			
Married	597	(27.9)	*0.14*
Not married [c]	269	(25.5)	
Occupations			
Specialists	83	(28.0)	
White collar workers	497	(24.9)	*0.0009*
Blue collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(Approximately GBP 29,400) [d]	226	(32.3)	
5-7.5 million JPY(Approximately GBP 29,400-44,100) [d]	179	(26.6)	*0.0012*
More than 7.5 mil JPY (Approximately GBP 44,100) [d]	250	(24.3)	
Wealth (Household financial and other assets)			
Less than 3 million JPY (Approximately GBP 17,600) [d]	201	(34.7)	
3-5 million JPY (Approximately GBP 17,600-29,400) [d]	169	(30.2)	*<.0001*
More than 5 million JPY (Approximately GBP 29,400) [d]	173	(22.9)	
Education			
High school or less	263	(36.3)	
Vocational/junior college	262	(26.9)	*<.0001*
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	
Normal	502	(25.7)	*<.0001*
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	
Normal	467	(24.8)	*<.0001*
Well-off, very well-off	180	(25.9)	

Job stress			
1st tertile(least stressful)	289	(25.2)	
2nd tertile	272	(25.2)	*0.0017*
3rd tertile(most stressful)	300	(31.3)	
Social support in workplace			
1st tertile(most supportive)	266	(23.4)	
2nd tertile	278	(29.1)	*0.0014*
3rd tertile(least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	
40-50	162	(23.5)	*0.027*
50-60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	
Precarious	272	(30.9)	*0.0083*
Self-employed	66	(27.3)	

[a] The status of SROH was determined by the question: "Overall, how would you rate the health of your teeth and gums?". "Poor SROH" includes respondents of "not so good" and "poor", and "Good SROH" includes respondents of "excellent", "good" and "fair"

[b] P-value was calculated by chi-squared test.

[c]Divorced/separated and widow people were classified into “not married”.

[d] Income and wealth were converted at 170 JPY (Japanese Yen) to 1 GBP (Great Britain Pound).

Table2. Age- and sex- adjusted odds ratios and 95% confidence intervals for associations between socioeconomic positions and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 - 1.39)	0.75
Blue collar workers	1.44	(1.07 - 1.95)	0.017
Household income			
Lowest tertile	1.72	(1.38 - 2.16)	<.0001
Second tertile	1.18	(0.94 - 1.48)	0.15
Highest tertile (richest)	1.00		
Wealth (Household financial and other assets)			
Lowest tertile	1.93	(1.51 - 2.46)	<.0001
Second tertile	1.55	(1.20 - 1.99)	0.0007
Highest tertile (richest)	1.00		
Educational attainment			
High school or less	1.98	(1.63 - 2.42)	<.0001
Vocational/junior college	1.38	(1.14 - 1.68)	0.0012
University or more	1.00		
Economic situation at home when respondents were five years old			
Poor, very poor	1.61	(1.25 - 2.08)	0.0003
Normal	1.07	(0.86 - 1.34)	0.55
Well-off, very well-off	1.00		
Economic situation at home when respondents were fifteen years old			
Poor, very poor	1.53	(1.20 - 1.95)	0.0006
Normal	0.91	(0.74 - 1.11)	0.33
Well-off, very well-off	1.00		

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table3. Crude odds ratios and 95% confidence intervals for associations between workplace-related factors and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	1.00	(0.83 - 1.21)	*0.99*
3rd tertile(most stressful)	1.36	(1.12 - 1.64)	*0.0018*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.34	(1.10 - 1.63)	*0.0033*
3rd tertile(least supportive)	1.39	(1.14 - 1.68)	*0.001*
Working hours per week			
<40	1.19	(0.96 - 1.47)	*0.12*
40-50	1.00		
50-60	1.16	(0.85 - 1.58)	*0.34*
>60	1.69	(1.20 - 2.39)	*0.0027*
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 - 1.57)	*0.002*
Self-employed	1.10	(0.82 - 1.49)	*0.52*

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table4. Multivariate odds ratios and 95% confidence intervals from multiple imputation analysis for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.97	(0.73 - 1.29)	*0.82*
Blue collar workers	1.18	(0.86 - 1.61)	*0.29*
Sex			
Men	1.61	(1.33 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.88	(0.66 - 1.16)	*0.36*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.45*
40-44	0.99	(0.76 - 1.30)	*0.96*
45-50	1.49	(1.14 - 1.93)	*0.0033*
Marital status			
Married	1.00		
Not married [b]	1.01	(0.84 - 1.22)	*0.89*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.71*
3rd tertile(most stressful)	1.26	(1.03 - 1.54)	*0.025*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.029*
3rd tertile(least supportive)	1.23	(1.01 - 1.5)	*0.042*
Working hours per week			
<40	1.12	(0.88 - 1.43)	*0.35*
40-50	1.00		
50-60	1.06	(0.72 - 1.57)	*0.75*
>60	1.41	(0.99 - 2.01)	*0.06*
Type of employment			
Permanent	1.00		
Precarious	1.57	(1.26 - 1.96)	*<.0001*
Self-employed	1.12	(0.82 - 1.53)	*0.49*

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. Divorced/separated and widow people were classified into “not married”.

Title:

Oral health disparities across socioeconomic position: the influence of economic difficulties in childhood and current work-related factors, from J-SHINE study

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Abstract

Objectives: We investigated the association between socioeconomic position (SEP) and oral health, and examined the associations of economic difficulties in childhood and workplace-related factors on the association.

Design: Cross-sectional study

Participants: A total of 3,201 workers aged 25-50 years old, living in and around Tokyo, Japan

Outcome measures: Self-rated oral health (SROH). A logistic regression model was used to estimate odds ratios (ORs) for the association between poor SROH and each indicator of SEP (annual household income, wealth, educational attainment, occupation, and economic situation in childhood). Multiple imputation was used to address missing values.

Results: Each indicator of SEP, including childhood SEP, was significantly inversely associated with SROH, and all of the workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) were also significantly associated with SROH. Compared with professionals, blue collar workers had significantly higher OR of poor SROH, and, the association was substantially explained by the workplace-related factors; ORs ranged from 1.44 in the age- and sex- adjusted model to 1.18 in the multivariate model. Poverty during childhood at age five and at age fifteen were associated with poorer SROH, and these two factors seemed to be independently associated with SROH

Conclusions: We found oral health disparity across SEP among workers in Japan. Approximately 60% of the association between occupation and SROH was explained by job-related factors. Economic difficulties during childhood appear to affect SROH in adulthood separately from sex, age, and the current workplace-related factors.

Strengths and limitations of this study

· Previous studies have shown an association between socioeconomic positions (SEP) in adulthood and oral health, however few have examined the relation between SEP in childhood and oral health in adulthood.

· Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we found evidence that economic difficulties during childhood as well as SEP in adulthood independently appeared to affect self-rated oral health (SROH) in adulthood among working men and women.

· Workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) substantially explained the association between occupation and SROH.

· The response rate was low, however, the obtained sample was properly equivalent with respect to age, sex, and education, compared with vital statistics in Census 2010 of the target population.

Background

Oral health problems, such as dental caries, periodontal disease, and edentulism, afflict more than half of the population of the planet (3.9 billion people) and untreated dental caries is the most prevalent condition (35% across all ages) among the 291 conditions listed in the Global Burden of Disease 2010.[1 2] Using disability-adjusted life years (DALYs), which is an index of measuring disease burden in society, and is calculated as sum of years of life lost due to premature mortality and years lived with disability, Marcenes W, et al estimated that the global burden of oral conditions would increase by approximately 20% from 1990 to 2010.[1 2] In additional to their high prevalence, oral health conditions are a major contributor to socioeconomic disparities in health.[3 4]

Oral health reflects individuals' socioeconomic conditions as well as an important marker of future physical health conditions (e.g. cardiovascular disease).[4-8] The major indicators of socioeconomic positions (SEP) include income, wealth, education, and occupation.[9] SEP is associated not only with general health, but also with oral health. Some studies examined the associations between income/education and oral health; those who had higher income, or higher educational attainment had better oral health.[10-14] On the other hand, there are fewer studies on the association between occupational class and oral health. To our knowledge, only five previous studies examined the association between occupation and oral health.[3 15-18] Poulton et al. examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with combination of parental occupation in childhood with occupation in adulthood among 1,000 children in New Zealand; they reported significant social gradients among these oral conditions.[3] Sanders et al. examined data of 3,678 adults in Australia and reported that upper white collar

workers reported less social impact, measured by the 14-item Oral Health Impact Profile, than did workers in lower white-collar or blue-collar occupations.[18] Morita et al. examined the association of occupations with oral conditions, based on approximately 16,000 Japanese workers; they reported that professionals had better oral conditions than office workers and blue collar workers in Japan.[15 16] Tsakos et al. reported significant social gradients in oral health, based on a sample of 6,600 community-dwelling English people aged 50 years and older.[17] However, none of these considered workplace-related factors, such as social support, working hours, type of employment or job stress, as potential mediators of the association between occupations and oral health. Psychological stress is associated with the workplace-related factors as well as occupations, and, on the other hand, oral diseases, such as periodontitis and gingivitis, are also associated with psychological stress.[19-22] Therefore, workplace-related factors may be candidates for mitigating oral health disparities. and, we hypothesized that job stress (including work hours) – as well as stress-buffering factors such as workplace social support – would mediate the association between occupational class and oral health.

In this study, we first examined data of 3,201 workers aged 25-50 years old in Japan to elucidate the associations between indicators of SEP (occupation, income wealth, education and SEP in childhood) and oral health. We then examined the mediation of socioeconomic disparities by workplace-related factors (social support in workplace, job stress, working hours and type of employment).

METHODS

Participants

We conducted the present study by using data from the J-SHINE (Japanese

study of Stratification, Health, Income, and Neighborhood), the details of which have been previously described.[23] In brief, between October 2010 and February 2011, 13,920 community-dwelling residents aged 25 to 50 years were probabilistically and randomly selected from four municipalities in and around Tokyo, Japan, with using the Basic Resident Registration System. Independent survey agencies were contracted to conduct the surveys, and the professional surveyors who had more than three years of experience in conducting interview-based social surveys made contacts with the eligible individuals after attending training sessions to conduct the J-SHINE study. The main reasons the surveyors were not able to receive responses from the eligible participants were as follows: "inaccessible contact (n=4371)" and "refusal of invitation (n=3677)". Of those who were invited, 4,385 men and women responded (31.6%) to the invitation; these individuals formed the baseline of the J-SHINE study. A questionnaire was self-administered using a computer-assisted personal interview format, unless the participants requested a face-to-face interview. We excluded participants who did not answer the question about self-rated oral health, or who responded that they were not active in the labor market (including homemakers and students); this result in 3,201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and 45-50 years old), and marital status (categorized as married/not married). Self-rated oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that can evaluate needs of dental care among people, especially those who do not usually visit dentists, and its validity and high internal consistency have been confirmed.[24 25]

SROH was assessed by the following question. *"Overall, how would you rate the health of your teeth and gums?"* Potential responses ranged from *"1.excellent, 2.good, 3.fair, 4.not so good or 5.poor"*. In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good SROH", and "4.not so good and 5.poor" as "Poor SROH".

As indicators of SEP, we used annual household income, wealth, educational attainment, occupation, and economic situations during childhood. Annual household income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400), JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100). Wealth was based on household financial and other assets (e.g. stock, bond, and so on) and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment was divided into three categories; high school or less, vocational/junior college, and university or more. Occupational class was divided into three categories; professionals, office workers or blue collar workers. Occupations were self-reported, but, in addition, a sociologist on the team (K.K.) examined each response to determine the correct classification based on the detailed job description provided by the participants. Our method of occupational classification was previously used in "The national survey of Social Stratification and social Mobility", which has been conducted in Japan every ten years since 1955 and is regarded as the most valid classification of occupations in Japan.[26] Economic conditions in childhood were evaluated through the following questions. *"How would you rate the economic conditions in your household at age five?"* and *"How would you rate the economic conditions in your household at age fifteen?"* The answers were selected from *"1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off"*. In the analysis, the answers were divided into three groups: "1.very difficult, 2. difficult", "3.normal" and "4. well off 5. very well off". This question was derived from

the Comprehensive Survey of Living Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate subjective economic situation in Japan.

With regard to workplace-related factors, job stress, social support in workplace, working hours, and type of employment were used. Job stress was evaluated by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ). BJSQ has been validated for use with Japanese workers, and consists of lists the 84 questions which assesses job stress, social support in workplace and subjective physical/mental symptoms.[27] BJSQ has been used in workplaces in Japan and was used in previous research in Japan.[27 28] One example of the seven questions on the job stress was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into tertiles. Social support in workplace consisted of six questions, which were also taken from BJSQ. One example of six questions was *"How reliable is your boss when you are in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*. Aggregated scores for the six questions were divided into tertiles. Working hours were divided into four groups; less than 40 hours per week, 40 to 50 hours per week, 50 to 60 hours per week, or more than 60 hours per week. Type of employment was divided into three groups: permanent, precarious or self-employment.

Statistical analysis

Differences in background characteristics according to SROH (good or poor) were compared using the chi-square test (Table1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex- and age-adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office

workers and blue collar workers, compared with professionals. We also calculated the ORs between each SEP and SROH (Table2), and the ORs between work-related factors and SROH (Table3). Additionally, we estimated the multivariate ORs for the association between occupations and SROH, adjusting for work-related factors, such as job stress social support in workplace, working hours, and type of employment (Table4). With regard to missing data on explanatory variables, we carried out 2 separate analyses. In the first analysis, dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) (Appendix Table1). In the second analysis, we conducted multiple imputations for the missing data, included all variables shown in Table1. Interactions between sex and the other variables (age/marital status/job stress/social support in the workplace/working hour/type of employment) were tested by entering multiplicative interaction terms into the multivariate adjusted model, because employment situation in Japan is highly different in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses, and "Proc MI" and "Proc MIANALYZE" were used for the multiple imputations

Ethics

The study was approved by the ethics committee of the Graduate School of Medicine and Faculty of Medicine, The University of Tokyo.

Results

The distribution of answers for the SROH was as follows; 1.excellent (N of 407), 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table 1 describes the basic characteristics of the study participants according to level of SROH.

All of the characteristics except marital status were significantly associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue collar workers, precarious workers, as well as those with lower income, lower wealth, lower educational attainment, higher childhood poverty, lower social support, higher stress and longer working hours.

Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the associations between various indicators of SEP (occupation, income, wealth, education, and two indicators of childhood SEP) and poor SROH. All indicators of SEP were inversely associated with SROH. The association with SROH was significant only for the lowest levels in occupation, income and childhood SEP, while the association was comparatively larger in magnitude and significant for the intermediate levels as well as for the lowest levels in education and wealth. Blue collar workers had significantly higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CI for associations between workplace-related factors (job stress, social support in workplace, working hour and type of employment) and poor SROH. All of the factors were associated with poor SROH. Workers with the most stress as well as low social support had higher odds of poor SROH compared with those with less job stress or more social support. Those who reported working more than 60 hours per week had poorer SROH than those who worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent workers.

Table 4 shows the multivariate ORs and 95% CI for poor SROH from the multiple imputation models. The associations between occupational class and poor

SROH were substantially attenuated by work-related factors. Approximately 60% of the association between occupations and poor SROH was explained by the work-related factors.[28] In the multivariate model, all of the workplace-related factors (social support, job stress, type of employment and working hours) were significantly associated with poor SROH. Compared with the analysis that employed dummy categories for missing values (Appendix Table1), we found similar results after accounting for missing values using multiple imputations. None of the interactions were significant; occupation (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50), working hours (p=0.83), and type and employment (p=0.73).

Discussion

In the present study, we found oral health disparity across various indicators of SEP as well as childhood SEP among workers in Japan. Moreover, the association between occupations and SROH was substantially explained by job-related factors. Our finding is notable for demonstrating oral health disparities even in Japan, where the citizens, including children, have access to dental services with relatively low out-of-pocket cost. Our findings are consistent with a previous study by Morita et al., which reported that there were significant oral health disparities across occupations.[16] We found oral health disparities across occupations as well as other indicators of SEP, including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation, income, wealth and parental occupation, among older individuals in England.[17]

One reason why people with higher SEP had better SROH may be related to preventive practices – e.g. dental flossing or use of interdental brush (interproximal brush). Neamatol et al. reported that students with doctorate or masters degrees flossed

more than those with bachelor degree or less[29], while Tseveenjav et al. reported that people with higher educational attainment performed cleaning more than the others.[30] Another reason people in higher SEP had better SROH might be utilization of preventive dentistry. People with lower incomes tend to use preventive dental service less frequently[31 32], and the difference of use in preventive service might explain the social gradient of SROH. In fact, in the present study, approximately one in three participants (32.3%) among the richest group made a preventive dental clinic visit in the past year, whereas only one in four participants (24.7%) among the poorest group did so. On the other hand, we did not observe a big difference among rich and poor participants in the use of dental services for treatment; 42.3% for the richest group versus 41.4% for the poorest group. Thus, the pathway from lower household income to poor SROH might be through preventive dental service utilization.

Another explanation for the relationship between SEP and SROH might be through psychosocial factors. Baker et al reported that greater sense of coherence and higher self-esteem were linked to better oral health perceptions.[33] Therefore, these factors might be mediators between SEP and SROH because those who are in higher SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

Our findings add to the previous literature by suggesting that occupational inequalities in oral health can be substantially explained by work-based factors, such as, social support in the workplace, job stress, working hours, and type of employment (precarious vs. permanent). These workplace-related factors might be targets for interventions to mitigate oral health disparities, i.e. in addition to intervening to improve socioeconomic conditions, it may be possible focus on working conditions to reduce oral health disparities.

Social support has been reported to have a “stress-buffering effect” on

cardiovascular diseases.[34-36] Stress has been reported as one of the exacerbating factors for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk factor for gingivitis[21], and Krejci CB, et al. suggested that stress may hasten the development and progression of periodontitis through the suppression of T-cell activity or a reduction in salivary IgA.[19 20] Precarious employment was also significantly associated with poor SROH in the multivariate model. Previous studies on precarious employment showed that this form of work is associated with job insecurity and psychological distress[37 38], and, therefore, being in a precarious employment might also a risk factor of developing periodontitis or gingivitis via stress. The number of precarious employees has been increasing all over the world as well as in Japan. In Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in 1985.[39]

Previous studies have suggested a consistent link between early life-course socioeconomic circumstances and health status in adulthood.[3 5 40 41] Our study is consistent with previous research in showing an association between childhood SEP and oral health. Poulton R et al. examined 1,000 children in New Zealand and found that there was a significant social gradient of dental health (tooth cleanliness, gingival bleeding, periodontal disease, and tooth decay) across childhood SEP.[3] Thomson et al. examined 789 individuals and revealed that those who were in low socioeconomic status at age 5 years were more likely to have lost a tooth in adulthood because of caries and had greater prevalence and extent of periodontitis.[5] In our study, when poverty during the childhood at age five or fifteen was added to the multivariate model, both poverty during childhood at age five and at age fifteen were associated with poorer SROH (OR: 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen, respectively, not shown in tables). These two factors seemed to be independently

associated with SROH, because coefficients of the other covariates in the multivariate model hardly changed before and after adding the childhood poverty variables to the multivariate model. Therefore, poverty during childhood appears to affect SROH in adulthood separately from sex, age, and the current workplace-related factors.

·Limitations

There are some limitations in this study. First, SROH is a subjective measurement. Some might argue that this type of measurement might be invalid, however, self-rated oral health has been examined and reported to be a well-validated and reliable index.[24 25] Jones JA et al. validated the association between a single-item self-report question and oral clinical examination among two hundred thirty-two community-dwelling participants. The question was *"How would you describe the health of your teeth and gums? Would you say it is excellent, very good, good, fair or poor?"* They reported that the single-item self-reported question had a sensitivity of 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care, compared with the clinical examination.[24] The validation studies were conducted in English, and the present study was conducted in Japanese. As far as we know, no previous studies have validated the scale in Japanese yet. However, we have confirmed that poor SROH was significantly associated with number of removed tooth in the sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of remaining teeth and clinical examination in Japanese.[42] Therefore, this might support that the scale in Japanese is also valid. Future studies are needed to clarify the validity of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al. compared the collected sample with the vital statistics in Census 2010 of the target population and reported that the obtained sample was properly equivalent with respect

to age, sex, and education.[23] Therefore, it is likely that the selection bias does not matter in terms of age, sex and education. We are not able to discuss selection bias precisely because we do not have other information among non-responders, such as smoking habit, income and so on. Thirdly, the data used in this study was cross-sectional, not longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is well described that poor dental status can lead to social stigma and adversely impact people's chances of employment and success in life.[43] Attention should be given to the positive association between current poor SROH and economic disadvantage in childhood, because the assessments of economic disadvantage in childhood were based on the participants' recall (recall bias). Fourth, we did not gather data on brushing frequency or use of interdental brush/dental flossing[30], and we could not include these factors in the analysis. Some studies reported that people with lower educational attainment or low income use interdental brush/dental flossing less, and this might explain the association between SEPs and poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at workplace were not validated. However, both have been used in practice in Japan, and the internal consistency of the scale in the present participants was acceptably high: Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6 items for social support. Future studies should employ well-validated questions on job stress and social support.

Conclusion

We found oral health disparities across various SEPs, and that work-related factors could account for more than half the association between occupation and SROH . Improving workplace environments may present a viable solution to reduce oral health

disparities. Future studies on the effect of workplace-related factors on oral health should use longitudinal data to elucidate the causal association between the workplace-related factors and oral health.

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publication.

Data sharing: No additional data are available.

Table1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH [a]		*p-value* [b]
	n	(%)	
Sex			
Men	529	(29.7)	*0.0002*
Women	334	(23.8)	
Age			
25-29	132	(22.5)	
30-34	138	(25.0)	
35-39	173	(27.2)	*0.0001*
40-44	175	(25.8)	
45-50	225	(33.8)	
Marital status			
Married	597	(27.9)	*0.14*
Not married [c]	269	(25.5)	
Occupations			
Specialists	83	(28.0)	
White collar workers	497	(24.9)	*0.0009*
Blue collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(Approximately GBP 29,400) [d]	226	(32.3)	
5-7.5 million JPY(Approximately GBP 29,400-44,100) [d]	179	(26.6)	*0.0012*
More than 7.5 mil JPY (Approximately GBP 44,100) [d]	250	(24.3)	
Wealth (Household financial and other assets)			
Less than 3 million JPY (Approximately GBP 17,600) [d]	201	(34.7)	
3-5 million JPY (Approximately GBP 17,600-29,400) [d]	169	(30.2)	*<.0001*
More than 5 million JPY (Approximately GBP 29,400) [d]	173	(22.9)	
Education			
High school or less	263	(36.3)	
Vocational/junior college	262	(26.9)	*<.0001*
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	
Normal	502	(25.7)	*<.0001*
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	
Normal	467	(24.8)	*<.0001*
Well-off, very well-off	180	(25.9)	

Job stress			
1st tertile(least stressful)	289	(25.2)	
2nd tertile	272	(25.2)	*0.0017*
3rd tertile(most stressful)	300	(31.3)	
Social support in workplace			
1st tertile(most supportive)	266	(23.4)	
2nd tertile	278	(29.1)	*0.0014*
3rd tertile(least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	
40-50	162	(23.5)	*0.027*
50-60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	
Precarious	272	(30.9)	*0.0083*
Self-employed	66	(27.3)	

[a] The status of SROH was determined by the question: "Overall, how would you rate the health of your teeth and gums?". "Poor SROH" includes respondents of "not so good" and "poor", and "Good SROH" includes respondents of "excellent", "good" and "fair"

[b] P-value was calculated by chi-squared test.

[c]Divorced/separated and widow people were classified into “not married”.

[d] Income and wealth were converted at 170 JPY (Japanese Yen) to 1 GBP (Great Britain Pound).

Table2. Age- and sex- adjusted odds ratios and 95% confidence intervals for associations between socioeconomic positions and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 - 1.39)	0.75
Blue collar workers	1.44	(1.07 - 1.95)	0.017
Household income			
Lowest tertile	1.72	(1.38 - 2.16)	<.0001
Second tertile	1.18	(0.94 - 1.48)	0.15
Highest tertile (richest)	1.00		
Wealth (Household financial and other assets)			
Lowest tertile	1.93	(1.51 - 2.46)	<.0001
Second tertile	1.55	(1.20 - 1.99)	0.0007
Highest tertile (richest)	1.00		
Educational attainment			
High school or less	1.98	(1.63 - 2.42)	<.0001
Vocational/junior college	1.38	(1.14 - 1.68)	0.0012
University or more	1.00		
Economic situation at home when respondents were five years old			
Poor, very poor	1.61	(1.25 - 2.08)	0.0003
Normal	1.07	(0.86 - 1.34)	0.55
Well-off, very well-off	1.00		
Economic situation at home when respondents were fifteen years old			
Poor, very poor	1.53	(1.20 - 1.95)	0.0006
Normal	0.91	(0.74 - 1.11)	0.33
Well-off, very well-off	1.00		

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table3. Crude odds ratios and 95% confidence intervals for associations between workplace-related factors and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	1.00	(0.83 - 1.21)	*0.99*
3rd tertile(most stressful)	1.36	(1.12 - 1.64)	*0.0018*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.34	(1.10 - 1.63)	*0.0033*
3rd tertile(least supportive)	1.39	(1.14 - 1.68)	*0.001*
Working hours per week			
<40	1.19	(0.96 - 1.47)	*0.12*
40-50	1.00		
50-60	1.16	(0.85 - 1.58)	*0.34*
>60	1.69	(1.20 - 2.39)	*0.0027*
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 - 1.57)	*0.002*
Self-employed	1.10	(0.82 - 1.49)	*0.52*

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table4. Multivariate odds ratios and 95% confidence intervals from multiple imputation analysis for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.97	(0.73 - 1.29)	*0.82*
Blue collar workers	1.18	(0.86 - 1.61)	*0.29*
Sex			
Men	1.61	(1.33 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.88	(0.66 - 1.16)	*0.36*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.45*
40-44	0.99	(0.76 - 1.30)	*0.96*
45-50	1.49	(1.14 - 1.93)	*0.0033*
Marital status			
Married	1.00		
Not married [b]	1.01	(0.84 - 1.22)	*0.89*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.71*
3rd tertile(most stressful)	1.26	(1.03 - 1.54)	*0.025*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.029*
3rd tertile(least supportive)	1.23	(1.01 - 1.5)	*0.042*
Working hours per week			
<40	1.12	(0.88 - 1.43)	*0.35*
40-50	1.00		
50-60	1.06	(0.72 - 1.57)	*0.75*
>60	1.41	(0.99 - 2.01)	*0.06*
Type of employment			
Permanent	1.00		
Precarious	1.57	(1.26 - 1.96)	*<.0001*
Self-employed	1.12	(0.82 - 1.53)	*0.49*

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. Divorced/separated and widow people were classified into “not married”.

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Appendix Table1. Multivariate odds ratios and 95% confidence intervals for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.96	(0.72 - 1.29)	*0.79*
Blue collar workers	1.18	(0.86 - 1.61)	*0.31*
Sex			
Men	1.61	(1.32 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.86	(0.65 - 1.14)	*0.29*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.46*
40-44	1.00	(0.77 - 1.30)	*0.98*
45-50	1.52	(1.17 - 1.98)	*0.0016*
Marital status			
Married	1.00		
Not married	0.99	(0.82 - 1.19)	*0.91*

Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.66*
3rd tertile(most stressful)	1.25	(1.02 - 1.54)	*0.03*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.031*
3rd tertile(least supportive)	1.24	(1.01 - 1.51)	*0.039*
Working hours per week			
<40	1.15	(0.92 - 1.45)	*0.23*
40-50	1.00		
50-60	1.05	(0.76 - 1.44)	*0.78*
>60	1.48	(1.04 - 2.11)	*0.031*
Type of employment			
Permanent	1.00		
Precarious	1.52	(1.22 - 1.90)	*0.0002*
Self-employed	1.11	(0.80 - 1.54)	*0.53*

Dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) in the analysis.

Appendix Table2. Association between poor self-rated oral health (SROH) and self-reported number of removed tooth

		Number of removed tooth						
		0	**1**	**2**	**3**	**4**	**More than 4**	***p-value*** [b]
Poor SROH [a]	**Number (%)**	300 (17.2)	112 (30.0)	94 (34.7)	67 (45.0)	52 (48.6)	135 (58.4)	*<.0001*
Total		1740	373	271	149	107	231	

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. The chi-square test was performed to calculate the p-value.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	#5
Methods			
Study design	4	Present key elements of study design early in the paper	#5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	#5-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#6-9
Bias	9	Describe any efforts to address potential sources of bias	*#6*
Study size	10	Explain how the study size was arrived at	*#6*
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#6-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#8-9
		(*b*) Describe any methods used to examine subgroups and interactions	#9
		(*c*) Explain how missing data were addressed	#9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	not applicable
		(*e*) Describe any sensitivity analyses	not applicable
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#9
		(b) Give reasons for non-participation at each stage	#9
		(c) Consider use of a flow diagram	not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#9
		(b) Indicate number of participants with missing data for each variable of interest	#9
Outcome data	15*	Report numbers of outcome events or summary measures	#9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#10
		(*b*) Report category boundaries when continuous variables were categorized	not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	#11
Discussion			
Key results	18	Summarise key results with reference to study objectives	#11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	#14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	#14-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Early life-course socioeconomic position, adult work-related factors and oral health disparities: Cross-sectional analysis of the J-SHINE study.

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Abstract

Objectives: We investigated the association between socioeconomic position (SEP) and oral health, and examined the associations of economic difficulties in childhood and workplace-related factors on the association.

Design: Cross-sectional study

Participants: A total of 3,201 workers aged 25-50 years old, living in and around Tokyo, Japan, from the J-SHINE (Japanese study of Stratification, Health, Income, and Neighborhood) study. The response rate was 31.6%.

Outcome measures: Self-rated oral health (SROH). A logistic regression model was used to estimate odds ratios (ORs) for the association between poor SROH and each indicator of SEP (annual household income, wealth, educational attainment, occupation, and economic situation in childhood). Multiple imputation was used to address missing values.

Results: Each indicator of SEP, including childhood SEP, was significantly inversely associated with SROH, and all of the workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) were also significantly associated with SROH. Compared with professionals, blue collar workers had significantly higher OR of poor SROH, and, the association was substantially explained by the workplace-related factors; ORs ranged from 1.44 in the age- and sex- adjusted model to 1.18 in the multivariate model. Poverty during childhood at age five and at age fifteen were associated with poorer SROH, and these two factors seemed to be independently associated with SROH

Conclusions: We found oral health disparity across SEP among workers in Japan. Approximately 60% of the association between occupation and SROH was explained by job-related factors. Economic difficulties during childhood appear to affect SROH in

adulthood separately from sex, age, and the current workplace-related factors.

Strengths and limitations of this study

- Previous studies have shown an association between socioeconomic positions (SEP) in adulthood and oral health, however few have examined the relation between SEP in childhood and oral health in adulthood.
- Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we found evidence that economic difficulties during childhood as well as SEP in adulthood independently appeared to affect self-rated oral health (SROH) in adulthood among working men and women.
- Workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) substantially explained the association between occupation and SROH.
- The response rate was low, however, the obtained sample was properly equivalent with respect to age, sex, and education, compared with vital statistics in Census 2010 of the target population.

Background

Oral health problems, such as dental caries, periodontal disease, and edentulism, afflict more than half of the population of the planet (3.9 billion people) and untreated dental caries is the most prevalent condition (35% across all ages) among the 291 conditions listed in the Global Burden of Disease 2010.[1 2] Using disability-adjusted life years (DALYs), which is an index of measuring disease burden in society, and is calculated as sum of years of life lost due to premature mortality and years lived with disability, Marcenes et al estimated that the global burden of oral conditions would increase by approximately 20% from 1990 to 2010.[1 2] In additional to their high prevalence, oral health conditions are a major contributor to socioeconomic disparities in health.[3 4]

Oral health reflects individuals' socioeconomic conditions as well as an important marker of future physical health conditions (e.g. cardiovascular disease).[4-8] The major indicators of socioeconomic positions (SEP) include income, wealth, education, and occupation.[9] SEP is associated not only with general health, but also with oral health. Some studies examined the associations between income/education and oral health; those who had higher income, or higher educational attainment had better oral health.[10-14] On the other hand, there are fewer studies on the association between occupational class and oral health. To our knowledge, only five previous studies examined the association between occupation and oral health.[3 15-18] Poulton et al. examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with combination of parental occupation in childhood with occupation in adulthood among 1,000 children in New Zealand; they reported significant social gradients among these oral conditions.[3] Sanders et al. examined data of 3,678 adults in Australia and reported that upper white collar

workers reported less social impact, measured by the 14-item Oral Health Impact Profile, than did workers in lower white-collar or blue-collar occupations.[18] Morita et al. examined the association of occupations with oral conditions, based on approximately 16,000 Japanese workers; they reported that professionals had better oral conditions than office workers and blue collar workers in Japan.[15 16] Tsakos et al. reported significant social gradients in oral health, based on a sample of 6,600 community-dwelling English people aged 50 years and older.[17] However, none of these considered workplace-related factors, such as social support, working hours, type of employment or job stress, as potential mediators of the association between occupations and oral health. Psychological stress is associated with the workplace-related factors as well as occupations, and, on the other hand, oral diseases, such as periodontitis and gingivitis, are also associated with psychological stress.[19-22] Therefore, workplace-related factors may be candidates for mitigating oral health disparities. and, we hypothesized that job stress (including work hours) – as well as stress-buffering factors such as workplace social support – would mediate the association between occupational class and oral health.

In this study, we first examined data of 3,201 workers aged 25-50 years old in Japan to elucidate the associations between indicators of SEP (occupation, income wealth, education and SEP in childhood) and oral health. We then examined the mediation of socioeconomic disparities by workplace-related factors (social support in workplace, job stress, working hours and type of employment).

METHODS

Participants

We conducted the present study by using data from the J-SHINE (Japanese

study of Stratification, Health, Income, and Neighborhood), the details of which have been previously described.[23] In brief, between October 2010 and February 2011, 13,920 community-dwelling residents aged 25 to 50 years were probabilistically and randomly selected from four municipalities in and around Tokyo, Japan, with using the Basic Resident Registration System. Independent survey agencies were contracted to conduct the surveys, and the professional surveyors who had more than three years of experience in conducting interview-based social surveys made contacts with the eligible individuals after attending training sessions to conduct the J-SHINE study. The main reasons the surveyors were not able to receive responses from the eligible participants were as follows: "inaccessible contact (n=4371)" and "refusal of invitation (n=3677)". Of those who were invited, 4,385 men and women responded (31.6%) to the invitation; these individuals formed the baseline of the J-SHINE study. A questionnaire was self-administered using a computer-assisted personal interview format, unless the participants requested a face-to-face interview. We excluded participants who did not answer the question about self-rated oral health, or who responded that they were not active in the labor market (including homemakers and students); this result in 3,201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and 45-50 years old), and marital status (categorized as married/not married). Self-rated oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that can evaluate needs of dental care among people, especially those who do not usually visit dentists, and its validity and high internal consistency have been confirmed.[24 25]

SROH was assessed by the following question. *"Overall, how would you rate the health of your teeth and gums?"* Potential responses ranged from *"1.excellent, 2.good, 3.fair, 4.not so good or 5.poor"*. In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good SROH", and "4.not so good and 5.poor" as "Poor SROH".

As indicators of SEP, we used annual household income, wealth, educational attainment, occupation, and economic situations during childhood. Annual household income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400), JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100). Wealth was based on household financial and other assets (e.g. stock, bond, and so on) and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment was divided into three categories; high school or less, vocational/junior college, and university or more. Occupational class was divided into three categories; professionals, office workers or blue collar workers. Occupations were self-reported, but, in addition, a sociologist on the team (K.K.) examined each response to determine the correct classification based on the detailed job description provided by the participants. Our method of occupational classification was previously used in "The national survey of Social Stratification and social Mobility", which has been conducted in Japan every ten years since 1955 and is regarded as the most valid classification of occupations in Japan.[26] Economic conditions in childhood were evaluated through the following questions. *"How would you rate the economic conditions in your household at age five?"* and *"How would you rate the economic conditions in your household at age fifteen?"* The answers were selected from *"1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off"*. In the analysis, the answers were divided into three groups: "1.very difficult, 2. difficult", "3.normal" and "4. well off 5. very well off". This question was derived from

the Comprehensive Survey of Living Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate subjective economic situation in Japan.

With regard to workplace-related factors, job stress, social support in workplace, working hours, and type of employment were used. Job stress was evaluated by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ). BJSQ has been validated for use with Japanese workers, and consists of lists the 84 questions which assesses job stress, social support in workplace and subjective physical/mental symptoms.[27] BJSQ has been used in workplaces in Japan and was used in previous research in Japan.[27 28] One example of the seven questions on the job stress was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into tertiles. Social support in workplace consisted of six questions, which were also taken from BJSQ. One example of six questions was *"How reliable is your boss when you are in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*. Aggregated scores for the six questions were divided into tertiles. Working hours were divided into four groups; less than 40 hours per week, 40 to 50 hours per week, 50 to 60 hours per week, or more than 60 hours per week. Type of employment was divided into three groups: permanent, precarious or self-employment.

Statistical analysis

Differences in background characteristics according to SROH (good or poor) were compared using the chi-square test (Table1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex- and age-adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office

workers and blue collar workers, compared with professionals. We also calculated the ORs between each SEP and SROH (Table2), and the ORs between work-related factors and SROH (Table3). Additionally, we estimated the multivariate ORs for the association between occupations and SROH, adjusting for work-related factors, such as job stress social support in workplace, working hours, and type of employment (Table4). With regard to missing data on explanatory variables, we carried out 2 separate analyses. In the first analysis, dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) (Appendix Table1). In the second analysis, we conducted multiple imputations for the missing data, included all variables shown in Table1. Interactions between sex and the other variables (age/marital status/job stress/social support in the workplace/working hour/type of employment) were tested by entering multiplicative interaction terms into the multivariate adjusted model, because employment situation in Japan is highly different in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses, and "Proc MI" and "Proc MIANALYZE" were used for the multiple imputations

Ethics

The study of J-SHINE was approved by the ethics committee of the Graduate School of Medicine and Faculty of Medicine, The University of Tokyo. The data analyzed in this study are de-identified data made available to researchers who are registered as members of the J-SHINE research team

Results

The distribution of answers for the SROH was as follows; 1.excellent (N of 407),

2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table 1 describes the basic characteristics of the study participants according to level of SROH. All of the characteristics except marital status were significantly associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue collar workers, precarious workers, as well as those with lower income, lower wealth, lower educational attainment, higher childhood poverty, lower social support, higher stress and longer working hours.

Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the associations between various indicators of SEP (occupation, income, wealth, education, and two indicators of childhood SEP) and poor SROH. All indicators of SEP were inversely associated with SROH. The association with SROH was significant only for the lowest levels in occupation, income and childhood SEP, while the association was comparatively larger in magnitude and significant for the intermediate levels as well as for the lowest levels in education and wealth. Blue collar workers had significantly higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CI for associations between workplace-related factors (job stress, social support in workplace, working hour and type of employment) and poor SROH. All of the factors were associated with poor SROH. Workers with the most stress as well as low social support had higher odds of poor SROH compared with those with less job stress or more social support. Those who reported working more than 60 hours per week had poorer SROH than those who worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent workers.

Table 4 shows the multivariate ORs and 95% CI for poor SROH from the multiple imputation models. The associations between occupational class and poor SROH were substantially attenuated by work-related factors. Approximately 60% of the association between occupations and poor SROH was explained by the work-related factors.[28] In the multivariate model, all of the workplace-related factors (social support, job stress, type of employment and working hours) were significantly associated with poor SROH. Compared with the analysis that employed dummy categories for missing values (Appendix Table1), we found similar results after accounting for missing values using multiple imputations. None of the interactions were significant; occupation (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50), working hours (p=0.83), and type and employment (p=0.73).

Discussion

In the present study, we found oral health disparity across various indicators of SEP as well as childhood SEP among workers in Japan. Moreover, the association between occupations and SROH was substantially explained by job-related factors. Our finding is notable for demonstrating oral health disparities even in Japan. The Japanese universal health coverage includes most of dental service as well as medical services, and the citizens, including children and older adults, have access to dental services with relatively low out-of-pocket cost. For most of adult patients, 70 % of dental care payments are covered by the universal health care insurance. For people with 70 or older, 80% of the payments are covered.[29] Besides, the copayments among children are reimbursed in more than half of local governments, depending on their policies. Our findings are consistent with a previous study by Morita et al., which reported that there were significant oral health disparities across occupations.[16] We found oral health

disparities across occupations as well as other indicators of SEP, including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation, income, wealth and parental occupation, among older individuals in England.[17]

One reason why people with higher SEP had better SROH may be related to preventive practices – e.g. dental flossing or use of interdental brush (interproximal brush). Neamatol et al. reported that students with doctorate or masters degrees flossed more than those with bachelor degree or less[30], while Tseveenjav et al. reported that people with higher educational attainment performed cleaning more than the others.[31] Another reason people in higher SEP had better SROH might be utilization of preventive dentistry. People with lower incomes tend to use preventive dental service less frequently[32 33], and the difference of use in preventive service might explain the social gradient of SROH. In fact, in the present study, approximately one in three participants (32.3%) among the richest group made a preventive dental clinic visit in the past year, whereas only one in four participants (24.7%) among the poorest group did so. On the other hand, we did not observe a big difference among rich and poor participants in the use of dental services for treatment; 42.3% for the richest group versus 41.4% for the poorest group. Thus, the pathway from lower household income to poor SROH might be through preventive dental service utilization.

Another explanation for the relationship between SEP and SROH might be through psychosocial factors. Baker et al reported that greater sense of coherence and higher self-esteem were linked to better oral health perceptions.[34] Therefore, these factors might be mediators between SEP and SROH because those who are in higher SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

Our findings add to the previous literature by suggesting that occupational inequalities in oral health can be substantially explained by work-based factors, such as,

social support in the workplace, job stress, working hours, and type of employment (precarious vs. permanent). These workplace-related factors might be targets for interventions to mitigate oral health disparities, i.e. in addition to intervening to improve socioeconomic conditions, it may be possible focus on working conditions to reduce oral health disparities.

Social support has been reported to have a "stress-buffering effect" on cardiovascular diseases.[35-37] Stress has been reported as one of the exacerbating factors for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk factor for gingivitis[21], and Krejci CB, et al. suggested that stress may hasten the development and progression of periodontitis through the suppression of T-cell activity or a reduction in salivary IgA.[19 20] Precarious employment was also significantly associated with poor SROH in the multivariate model. Previous studies on precarious employment showed that this form of work is associated with job insecurity and psychological distress[38 39], and, therefore, being in a precarious employment might also a risk factor of developing periodontitis or gingivitis via stress. The number of precarious employees has been increasing all over the world as well as in Japan. In Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in 1985.[40]

Previous studies have suggested a consistent link between early life-course socioeconomic circumstances and health status in adulthood.[3 5 41 42] Our study is consistent with previous research in showing an association between childhood SEP and oral health. Poulton R et al. examined 1,000 children in New Zealand and found that there was a significant social gradient of dental health (tooth cleanliness, gingival bleeding, periodontal disease, and tooth decay) across childhood SEP.[3] Thomson et al. examined 789 individuals and revealed that those who were in low socioeconomic status

at age 5 years were more likely to have lost a tooth in adulthood because of caries and had greater prevalence and extent of periodontitis.[5] In our study, when poverty during the childhood at age five or fifteen was added to the multivariate model, both poverty during childhood at age five and at age fifteen were associated with poorer SROH (OR: 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen, respectively, not shown in tables). These two factors seemed to be independently associated with SROH, because coefficients of the other covariates in the multivariate model hardly changed before and after adding the childhood poverty variables to the multivariate model. Therefore, poverty during childhood appears to affect SROH in adulthood separately from sex, age, and the current workplace-related factors. In Japan, school children do receive oral checkups for free, however, they do not receive free dental care. Therefore, economic difficulties during childhood might result in oral health disparities during childhood, leading to oral health disparities during adults.

·Limitations

There are some limitations in this study. First, SROH is a subjective measurement. Some might argue that this type of measurement might be invalid, however, self-rated oral health has been examined and reported to be a well-validated and reliable index.[24 25] Jones JA et al. validated the association between a single-item self-report question and oral clinical examination among two hundred thirty-two community-dwelling participants. The question was *"How would you describe the health of your teeth and gums? Would you say it is excellent, very good, good, fair or poor?"* They reported that the single-item self-reported question had a sensitivity of 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care, compared with the clinical examination.[24] The validation studies were conducted in

English, and the present study was conducted in Japanese. As far as we know, no previous studies have validated the scale in Japanese yet. However, we have confirmed that poor SROH was significantly associated with number of removed tooth in the sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of remaining teeth and clinical examination in Japanese.[43] Therefore, this might support that the scale in Japanese is also valid. Future studies are needed to clarify the validity of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al. compared the collected sample with the vital statistics in Census 2010 of the target population and reported that the obtained sample was properly equivalent with respect to age, sex, and education.[23] Therefore, it is likely that the selection bias does not matter in terms of age, sex and education. We are not able to discuss selection bias precisely because we do not have other information among non-responders, such as smoking habit, income and so on. Thirdly, the data used in this study was cross-sectional, not longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is well described that poor dental status can lead to social stigma and adversely impact people's chances of employment and success in life.[44] Attention should be given to the positive association between current poor SROH and economic disadvantage in childhood, because the assessments of economic disadvantage in childhood were based on the participants' recall (recall bias). Fourth, we did not gather data on brushing frequency or use of interdental brush/dental flossing[31], and we could not include these factors in the analysis. Some studies reported that people with lower educational attainment or low income use interdental brush/dental flossing less, and this might explain the association between SEPs and poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at workplace were not validated. However, both have been used in practice in Japan, and

the internal consistency of the scale in the present participants was acceptably high: Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6 items for social support. Future studies should employ well-validated questions on job stress and social support.

Conclusion

We found oral health disparities across various SEPs, and that work-related factors could account for more than half the association between occupation and SROH . Improving workplace environments may present a viable solution to reduce oral health disparities. Future studies on the effect of workplace-related factors on oral health should use longitudinal data to elucidate the causal association between the workplace-related factors and oral health.

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Table1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH [a]		*p-value* [b]
	n	(%)	
Sex			
Men	529	(29.7)	*0.0002*
Women	334	(23.8)	
Age			
25-29	132	(22.5)	
30-34	138	(25.0)	
35-39	173	(27.2)	*0.0001*
40-44	175	(25.8)	
45-50	225	(33.8)	
Marital status			
Married	597	(27.9)	*0.14*
Not married [c]	269	(25.5)	
Occupations			
Specialists	83	(28.0)	
White collar workers	497	(24.9)	*0.0009*
Blue collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(Approximately GBP 29,400) [d]	226	(32.3)	
5-7.5 million JPY(Approximately GBP 29,400-44,100) [d]	179	(26.6)	*0.0012*
More than 7.5 mil JPY (Approximately GBP 44,100) [d]	250	(24.3)	
Wealth (Household financial and other assets)			
Less than 3 million JPY (Approximately GBP 17,600) [d]	201	(34.7)	
3-5 million JPY (Approximately GBP 17,600-29,400) [d]	169	(30.2)	*<.0001*
More than 5 million JPY (Approximately GBP 29,400) [d]	173	(22.9)	
Education			
High school or less	263	(36.3)	
Vocational/junior college	262	(26.9)	*<.0001*
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	
Normal	502	(25.7)	*<.0001*
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	
Normal	467	(24.8)	*<.0001*
Well-off, very well-off	180	(25.9)	

Job stress			
1st tertile(least stressful)	289	(25.2)	
2nd tertile	272	(25.2)	*0.0017*
3rd tertile(most stressful)	300	(31.3)	
Social support in workplace			
1st tertile(most supportive)	266	(23.4)	
2nd tertile	278	(29.1)	*0.0014*
3rd tertile(least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	
40-50	162	(23.5)	*0.027*
50-60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	
Precarious	272	(30.9)	*0.0083*
Self-employed	66	(27.3)	

[a] The status of SROH was determined by the question: "Overall, how would you rate the health of your teeth and gums?". "Poor SROH" includes respondents of "not so good" and "poor", and "Good SROH" includes respondents of "excellent", "good" and "fair"

[b] P-value was calculated by chi-squared test.

[c]Divorced/separated and widow people were classified into “not married”.

[d] Income and wealth were converted at 170 JPY (Japanese Yen) to 1 GBP (Great Britain Pound).

Table2. Age- and sex- adjusted odds ratios and 95% confidence intervals for associations between socioeconomic positions and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 - 1.39)	0.75
Blue collar workers	1.44	(1.07 - 1.95)	0.017
Household income			
Lowest tertile	1.72	(1.38 - 2.16)	<.0001
Second tertile	1.18	(0.94 - 1.48)	0.15
Highest tertile (richest)	1.00		
Wealth (Household financial and other assets)			
Lowest tertile	1.93	(1.51 - 2.46)	<.0001
Second tertile	1.55	(1.20 - 1.99)	0.0007
Highest tertile (richest)	1.00		
Educational attainment			
High school or less	1.98	(1.63 - 2.42)	<.0001
Vocational/junior college	1.38	(1.14 - 1.68)	0.0012
University or more	1.00		
Economic situation at home when respondents were five years old			
Poor, very poor	1.61	(1.25 - 2.08)	0.0003
Normal	1.07	(0.86 - 1.34)	0.55
Well-off, very well-off	1.00		
Economic situation at home when respondents were fifteen years old			
Poor, very poor	1.53	(1.20 - 1.95)	0.0006
Normal	0.91	(0.74 - 1.11)	0.33
Well-off, very well-off	1.00		

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table3. Crude odds ratios and 95% confidence intervals for associations between workplace-related factors and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	1.00	(0.83 - 1.21)	*0.99*
3rd tertile(most stressful)	1.36	(1.12 - 1.64)	*0.0018*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.34	(1.10 - 1.63)	*0.0033*
3rd tertile(least supportive)	1.39	(1.14 - 1.68)	*0.001*
Working hours per week			
<40	1.19	(0.96 - 1.47)	*0.12*
40-50	1.00		
50-60	1.16	(0.85 - 1.58)	*0.34*
>60	1.69	(1.20 - 2.39)	*0.0027*
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 - 1.57)	*0.002*
Self-employed	1.10	(0.82 - 1.49)	*0.52*

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table4. Multivariate odds ratios and 95% confidence intervals from multiple imputation analysis for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.97	(0.73 - 1.29)	*0.82*
Blue collar workers	1.18	(0.86 - 1.61)	*0.29*
Sex			
Men	1.61	(1.33 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.88	(0.66 - 1.16)	*0.36*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.45*
40-44	0.99	(0.76 - 1.30)	*0.96*
45-50	1.49	(1.14 - 1.93)	*0.0033*
Marital status			
Married	1.00		
Not married [b]	1.01	(0.84 - 1.22)	*0.89*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.71*
3rd tertile(most stressful)	1.26	(1.03 - 1.54)	*0.025*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.029*
3rd tertile(least supportive)	1.23	(1.01 - 1.5)	*0.042*
Working hours per week			
<40	1.12	(0.88 - 1.43)	*0.35*
40-50	1.00		
50-60	1.06	(0.72 - 1.57)	*0.75*
>60	1.41	(0.99 - 2.01)	*0.06*
Type of employment			
Permanent	1.00		
Precarious	1.57	(1.26 - 1.96)	*<.0001*
Self-employed	1.12	(0.82 - 1.53)	*0.49*

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. Divorced/separated and widow people were classified into “not married”.

Title:

Early life-course socioeconomic position, adult work-related factors and oral health disparities: Cross-sectional analysis of the J-SHINE study.

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Abstract

Objectives: We investigated the association between socioeconomic position (SEP) and oral health, and examined the associations of economic difficulties in childhood and workplace-related factors on the association.

Design: Cross-sectional study

Participants: A total of 3,201 workers aged 25-50 years old, living in and around Tokyo, Japan, from the J-SHINE (Japanese study of Stratification, Health, Income, and Neighborhood) study. The response rate was 31.6%.

Outcome measures: Self-rated oral health (SROH). A logistic regression model was used to estimate odds ratios (ORs) for the association between poor SROH and each indicator of SEP (annual household income, wealth, educational attainment, occupation, and economic situation in childhood). Multiple imputation was used to address missing values.

Results: Each indicator of SEP, including childhood SEP, was significantly inversely associated with SROH, and all of the workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) were also significantly associated with SROH. Compared with professionals, blue collar workers had significantly higher OR of poor SROH, and, the association was substantially explained by the workplace-related factors; ORs ranged from 1.44 in the age- and sex- adjusted model to 1.18 in the multivariate model. Poverty during childhood at age five and at age fifteen were associated with poorer SROH, and these two factors seemed to be independently associated with SROH

Conclusions: We found oral health disparity across SEP among workers in Japan. Approximately 60% of the association between occupation and SROH was explained by job-related factors. Economic difficulties during childhood appear to affect SROH in

adulthood separately from sex, age, and the current workplace-related factors.

Strengths and limitations of this study

- Previous studies have shown an association between socioeconomic positions (SEP) in adulthood and oral health, however few have examined the relation between SEP in childhood and oral health in adulthood.
- Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we found evidence that economic difficulties during childhood as well as SEP in adulthood independently appeared to affect self-rated oral health (SROH) in adulthood among working men and women.
- Workplace-related factors (social support in the workplace, job stress, working hours, and type of employment) substantially explained the association between occupation and SROH.
- The response rate was low, however, the obtained sample was properly equivalent with respect to age, sex, and education, compared with vital statistics in Census 2010 of the target population.

Background

Oral health problems, such as dental caries, periodontal disease, and edentulism, afflict more than half of the population of the planet (3.9 billion people) and untreated dental caries is the most prevalent condition (35% across all ages) among the 291 conditions listed in the Global Burden of Disease 2010.[1 2] Using disability-adjusted life years (DALYs), which is an index of measuring disease burden in society, and is calculated as sum of years of life lost due to premature mortality and years lived with disability, Marcenes et al estimated that the global burden of oral conditions would increase by approximately 20% from 1990 to 2010.[1 2] In additional to their high prevalence, oral health conditions are a major contributor to socioeconomic disparities in health.[3 4]

Oral health reflects individuals' socioeconomic conditions as well as an important marker of future physical health conditions (e.g. cardiovascular disease).[4-8] The major indicators of socioeconomic positions (SEP) include income, wealth, education, and occupation.[9] SEP is associated not only with general health, but also with oral health. Some studies examined the associations between income/education and oral health; those who had higher income, or higher educational attainment had better oral health.[10-14] On the other hand, there are fewer studies on the association between occupational class and oral health. To our knowledge, only five previous studies examined the association between occupation and oral health.[3 15-18] Poulton et al. examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with combination of parental occupation in childhood with occupation in adulthood among 1,000 children in New Zealand; they reported significant social gradients among these oral conditions.[3] Sanders et al. examined data of 3,678 adults in Australia and reported that upper white collar

workers reported less social impact, measured by the 14-item Oral Health Impact Profile, than did workers in lower white-collar or blue-collar occupations.[18] Morita et al. examined the association of occupations with oral conditions, based on approximately 16,000 Japanese workers; they reported that professionals had better oral conditions than office workers and blue collar workers in Japan.[15 16] Tsakos et al. reported significant social gradients in oral health, based on a sample of 6,600 community-dwelling English people aged 50 years and older.[17] However, none of these considered workplace-related factors, such as social support, working hours, type of employment or job stress, as potential mediators of the association between occupations and oral health. Psychological stress is associated with the workplace-related factors as well as occupations, and, on the other hand, oral diseases, such as periodontitis and gingivitis, are also associated with psychological stress.[19-22] Therefore, workplace-related factors may be candidates for mitigating oral health disparities. and, we hypothesized that job stress (including work hours) – as well as stress-buffering factors such as workplace social support – would mediate the association between occupational class and oral health.

In this study, we first examined data of 3,201 workers aged 25-50 years old in Japan to elucidate the associations between indicators of SEP (occupation, income wealth, education and SEP in childhood) and oral health. We then examined the mediation of socioeconomic disparities by workplace-related factors (social support in workplace, job stress, working hours and type of employment).

METHODS

Participants

We conducted the present study by using data from the J-SHINE (Japanese

study of Stratification, Health, Income, and Neighborhood), the details of which have been previously described.[23] In brief, between October 2010 and February 2011, 13,920 community-dwelling residents aged 25 to 50 years were probabilistically and randomly selected from four municipalities in and around Tokyo, Japan, with using the Basic Resident Registration System. Independent survey agencies were contracted to conduct the surveys, and the professional surveyors who had more than three years of experience in conducting interview-based social surveys made contacts with the eligible individuals after attending training sessions to conduct the J-SHINE study. The main reasons the surveyors were not able to receive responses from the eligible participants were as follows: "inaccessible contact (n=4371)" and "refusal of invitation (n=3677)". Of those who were invited, 4,385 men and women responded (31.6%) to the invitation; these individuals formed the baseline of the J-SHINE study. A questionnaire was self-administered using a computer-assisted personal interview format, unless the participants requested a face-to-face interview. We excluded participants who did not answer the question about self-rated oral health, or who responded that they were not active in the labor market (including homemakers and students); this result in 3,201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and 45-50 years old), and marital status (categorized as married/not married). Self-rated oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that can evaluate needs of dental care among people, especially those who do not usually visit dentists, and its validity and high internal consistency have been confirmed.[24 25]

SROH was assessed by the following question. *"Overall, how would you rate the health of your teeth and gums?"* Potential responses ranged from *"1.excellent, 2.good, 3.fair, 4.not so good or 5.poor"*. In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good SROH", and "4.not so good and 5.poor" as "Poor SROH".

As indicators of SEP, we used annual household income, wealth, educational attainment, occupation, and economic situations during childhood. Annual household income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400), JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100). Wealth was based on household financial and other assets (e.g. stock, bond, and so on) and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment was divided into three categories; high school or less, vocational/junior college, and university or more. Occupational class was divided into three categories; professionals, office workers or blue collar workers. Occupations were self-reported, but, in addition, a sociologist on the team (K.K.) examined each response to determine the correct classification based on the detailed job description provided by the participants. Our method of occupational classification was previously used in "The national survey of Social Stratification and social Mobility", which has been conducted in Japan every ten years since 1955 and is regarded as the most valid classification of occupations in Japan.[26] Economic conditions in childhood were evaluated through the following questions. *"How would you rate the economic conditions in your household at age five?"* and *"How would you rate the economic conditions in your household at age fifteen?"* The answers were selected from *"1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off"*. In the analysis, the answers were divided into three groups: "1.very difficult, 2. difficult", "3.normal" and "4. well off 5. very well off". This question was derived from

the Comprehensive Survey of Living Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate subjective economic situation in Japan.

With regard to workplace-related factors, job stress, social support in workplace, working hours, and type of employment were used. Job stress was evaluated by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ). BJSQ has been validated for use with Japanese workers, and consists of lists the 84 questions which assesses job stress, social support in workplace and subjective physical/mental symptoms.[27] BJSQ has been used in workplaces in Japan and was used in previous research in Japan.[27 28] One example of the seven questions on the job stress was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into tertiles. Social support in workplace consisted of six questions, which were also taken from BJSQ. One example of six questions was *"How reliable is your boss when you are in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*. Aggregated scores for the six questions were divided into tertiles. Working hours were divided into four groups; less than 40 hours per week, 40 to 50 hours per week, 50 to 60 hours per week, or more than 60 hours per week. Type of employment was divided into three groups: permanent, precarious or self-employment.

Statistical analysis

Differences in background characteristics according to SROH (good or poor) were compared using the chi-square test (Table1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex- and age-adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office

workers and blue collar workers, compared with professionals. We also calculated the ORs between each SEP and SROH (Table2), and the ORs between work-related factors and SROH (Table3). Additionally, we estimated the multivariate ORs for the association between occupations and SROH, adjusting for work-related factors, such as job stress social support in workplace, working hours, and type of employment (Table4). With regard to missing data on explanatory variables, we carried out 2 separate analyses. In the first analysis, dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) (Appendix Table1). In the second analysis, we conducted multiple imputations for the missing data, included all variables shown in Table1. Interactions between sex and the other variables (age/marital status/job stress/social support in the workplace/working hour/type of employment) were tested by entering multiplicative interaction terms into the multivariate adjusted model, because employment situation in Japan is highly different in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical analyses, and "Proc MI" and "Proc MIANALYZE" were used for the multiple imputations

Ethics

The study of J-SHINE was approved by the ethics committee of the Graduate School of Medicine and Faculty of Medicine, The University of Tokyo. The data analyzed in this study are de-identified data made available to researchers who are registered as members of the J-SHINE research team

Results

The distribution of answers for the SROH was as follows; 1.excellent (N of 407),

2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table 1 describes the basic characteristics of the study participants according to level of SROH. All of the characteristics except marital status were significantly associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue collar workers, precarious workers, as well as those with lower income, lower wealth, lower educational attainment, higher childhood poverty, lower social support, higher stress and longer working hours.

Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the associations between various indicators of SEP (occupation, income, wealth, education, and two indicators of childhood SEP) and poor SROH. All indicators of SEP were inversely associated with SROH. The association with SROH was significant only for the lowest levels in occupation, income and childhood SEP, while the association was comparatively larger in magnitude and significant for the intermediate levels as well as for the lowest levels in education and wealth. Blue collar workers had significantly higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CI for associations between workplace-related factors (job stress, social support in workplace, working hour and type of employment) and poor SROH. All of the factors were associated with poor SROH. Workers with the most stress as well as low social support had higher odds of poor SROH compared with those with less job stress or more social support. Those who reported working more than 60 hours per week had poorer SROH than those who worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent workers.

Table 4 shows the multivariate ORs and 95% CI for poor SROH from the multiple imputation models. The associations between occupational class and poor SROH were substantially attenuated by work-related factors. Approximately 60% of the association between occupations and poor SROH was explained by the work-related factors.[28] In the multivariate model, all of the workplace-related factors (social support, job stress, type of employment and working hours) were significantly associated with poor SROH. Compared with the analysis that employed dummy categories for missing values (Appendix Table1), we found similar results after accounting for missing values using multiple imputations. None of the interactions were significant; occupation (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50), working hours (p=0.83), and type and employment (p=0.73).

Discussion

In the present study, we found oral health disparity across various indicators of SEP as well as childhood SEP among workers in Japan. Moreover, the association between occupations and SROH was substantially explained by job-related factors. Our finding is notable for demonstrating oral health disparities even in Japan. The Japanese universal health coverage includes most of dental service as well as medical services, and the citizens, including children and older adults, have access to dental services with relatively low out-of-pocket cost. For most of adult patients, 70 % of dental care payments are covered by the universal health care insurance. For people with 70 or older, 80% of the payments are covered.[29] Besides, the copayments among children are reimbursed in more than half of local governments, depending on their policies. Our findings are consistent with a previous study by Morita et al., which reported that there were significant oral health disparities across occupations.[16] We found oral health

disparities across occupations as well as other indicators of SEP, including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation, income, wealth and parental occupation, among older individuals in England.[17]

One reason why people with higher SEP had better SROH may be related to preventive practices – e.g. dental flossing or use of interdental brush (interproximal brush). Neamatol et al. reported that students with doctorate or masters degrees flossed more than those with bachelor degree or less[30], while Tseveenjav et al. reported that people with higher educational attainment performed cleaning more than the others.[31] Another reason people in higher SEP had better SROH might be utilization of preventive dentistry. People with lower incomes tend to use preventive dental service less frequently[32 33], and the difference of use in preventive service might explain the social gradient of SROH. In fact, in the present study, approximately one in three participants (32.3%) among the richest group made a preventive dental clinic visit in the past year, whereas only one in four participants (24.7%) among the poorest group did so. On the other hand, we did not observe a big difference among rich and poor participants in the use of dental services for treatment; 42.3% for the richest group versus 41.4% for the poorest group. Thus, the pathway from lower household income to poor SROH might be through preventive dental service utilization.

Another explanation for the relationship between SEP and SROH might be through psychosocial factors. Baker et al reported that greater sense of coherence and higher self-esteem were linked to better oral health perceptions.[34] Therefore, these factors might be mediators between SEP and SROH because those who are in higher SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

Our findings add to the previous literature by suggesting that occupational inequalities in oral health can be substantially explained by work-based factors, such as,

social support in the workplace, job stress, working hours, and type of employment (precarious vs. permanent). These workplace-related factors might be targets for interventions to mitigate oral health disparities, i.e. in addition to intervening to improve socioeconomic conditions, it may be possible focus on working conditions to reduce oral health disparities.

Social support has been reported to have a "stress-buffering effect" on cardiovascular diseases.[35-37] Stress has been reported as one of the exacerbating factors for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk factor for gingivitis[21], and Krejci CB, et al. suggested that stress may hasten the development and progression of periodontitis through the suppression of T-cell activity or a reduction in salivary IgA.[19 20] Precarious employment was also significantly associated with poor SROH in the multivariate model. Previous studies on precarious employment showed that this form of work is associated with job insecurity and psychological distress[38 39], and, therefore, being in a precarious employment might also a risk factor of developing periodontitis or gingivitis via stress. The number of precarious employees has been increasing all over the world as well as in Japan. In Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in 1985.[40]

Previous studies have suggested a consistent link between early life-course socioeconomic circumstances and health status in adulthood.[3 5 41 42] Our study is consistent with previous research in showing an association between childhood SEP and oral health. Poulton R et al. examined 1,000 children in New Zealand and found that there was a significant social gradient of dental health (tooth cleanliness, gingival bleeding, periodontal disease, and tooth decay) across childhood SEP.[3] Thomson et al. examined 789 individuals and revealed that those who were in low socioeconomic status

at age 5 years were more likely to have lost a tooth in adulthood because of caries and had greater prevalence and extent of periodontitis.[5] In our study, when poverty during the childhood at age five or fifteen was added to the multivariate model, both poverty during childhood at age five and at age fifteen were associated with poorer SROH (OR: 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen, respectively, not shown in tables). These two factors seemed to be independently associated with SROH, because coefficients of the other covariates in the multivariate model hardly changed before and after adding the childhood poverty variables to the multivariate model. Therefore, poverty during childhood appears to affect SROH in adulthood separately from sex, age, and the current workplace-related factors. In Japan, school children do receive oral checkups for free, however, they do not receive free dental care. Therefore, economic difficulties during childhood might result in oral health disparities during childhood, leading to oral health disparities during adults.

·Limitations

There are some limitations in this study. First, SROH is a subjective measurement. Some might argue that this type of measurement might be invalid, however, self-rated oral health has been examined and reported to be a well-validated and reliable index.[24 25] Jones JA et al. validated the association between a single-item self-report question and oral clinical examination among two hundred thirty-two community-dwelling participants. The question was *"How would you describe the health of your teeth and gums? Would you say it is excellent, very good, good, fair or poor?"* They reported that the single-item self-reported question had a sensitivity of 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care, compared with the clinical examination.[24] The validation studies were conducted in

English, and the present study was conducted in Japanese. As far as we know, no previous studies have validated the scale in Japanese yet. However, we have confirmed that poor SROH was significantly associated with number of removed tooth in the sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of remaining teeth and clinical examination in Japanese.[43] Therefore, this might support that the scale in Japanese is also valid. Future studies are needed to clarify the validity of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al. compared the collected sample with the vital statistics in Census 2010 of the target population and reported that the obtained sample was properly equivalent with respect to age, sex, and education.[23] Therefore, it is likely that the selection bias does not matter in terms of age, sex and education. We are not able to discuss selection bias precisely because we do not have other information among non-responders, such as smoking habit, income and so on. Thirdly, the data used in this study was cross-sectional, not longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is well described that poor dental status can lead to social stigma and adversely impact people's chances of employment and success in life.[44] Attention should be given to the positive association between current poor SROH and economic disadvantage in childhood, because the assessments of economic disadvantage in childhood were based on the participants' recall (recall bias). Fourth, we did not gather data on brushing frequency or use of interdental brush/dental flossing[31], and we could not include these factors in the analysis. Some studies reported that people with lower educational attainment or low income use interdental brush/dental flossing less, and this might explain the association between SEPs and poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at workplace were not validated. However, both have been used in practice in Japan, and

the internal consistency of the scale in the present participants was acceptably high: Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6 items for social support. Future studies should employ well-validated questions on job stress and social support.

Conclusion

We found oral health disparities across various SEPs, and that work-related factors could account for more than half the association between occupation and SROH . Improving workplace environments may present a viable solution to reduce oral health disparities. Future studies on the effect of workplace-related factors on oral health should use longitudinal data to elucidate the causal association between the workplace-related factors and oral health.

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Table1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH [a]		*p-value* [b]
	n	(%)	
Sex			
Men	529	(29.7)	*0.0002*
Women	334	(23.8)	
Age			
25-29	132	(22.5)	
30-34	138	(25.0)	
35-39	173	(27.2)	*0.0001*
40-44	175	(25.8)	
45-50	225	(33.8)	
Marital status			
Married	597	(27.9)	*0.14*
Not married [c]	269	(25.5)	
Occupations			
Specialists	83	(28.0)	
White collar workers	497	(24.9)	*0.0009*
Blue collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(Approximately GBP 29,400) [d]	226	(32.3)	
5-7.5 million JPY(Approximately GBP 29,400-44,100) [d]	179	(26.6)	*0.0012*
More than 7.5 mil JPY (Approximately GBP 44,100) [d]	250	(24.3)	
Wealth (Household financial and other assets)			
Less than 3 million JPY (Approximately GBP 17,600) [d]	201	(34.7)	
3-5 million JPY (Approximately GBP 17,600-29,400) [d]	169	(30.2)	*<.0001*
More than 5 million JPY (Approximately GBP 29,400) [d]	173	(22.9)	
Education			
High school or less	263	(36.3)	
Vocational/junior college	262	(26.9)	*<.0001*
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	
Normal	502	(25.7)	*<.0001*
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	
Normal	467	(24.8)	*<.0001*
Well-off, very well-off	180	(25.9)	

Job stress			
1st tertile(least stressful)	289	(25.2)	
2nd tertile	272	(25.2)	*0.0017*
3rd tertile(most stressful)	300	(31.3)	
Social support in workplace			
1st tertile(most supportive)	266	(23.4)	
2nd tertile	278	(29.1)	*0.0014*
3rd tertile(least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	
40-50	162	(23.5)	*0.027*
50-60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	
Precarious	272	(30.9)	*0.0083*
Self-employed	66	(27.3)	

[a] The status of SROH was determined by the question: "Overall, how would you rate the health of your teeth and gums?". "Poor SROH" includes respondents of "not so good" and "poor", and "Good SROH" includes respondents of "excellent", "good" and "fair"

[b] P-value was calculated by chi-squared test.

[c]Divorced/separated and widow people were classified into “not married”.

[d] Income and wealth were converted at 170 JPY (Japanese Yen) to 1 GBP (Great Britain Pound).

Table2. Age- and sex- adjusted odds ratios and 95% confidence intervals for associations between socioeconomic positions and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 - 1.39)	0.75
Blue collar workers	1.44	(1.07 - 1.95)	0.017
Household income			
Lowest tertile	1.72	(1.38 - 2.16)	<.0001
Second tertile	1.18	(0.94 - 1.48)	0.15
Highest tertile (richest)	1.00		
Wealth (Household financial and other assets)			
Lowest tertile	1.93	(1.51 - 2.46)	<.0001
Second tertile	1.55	(1.20 - 1.99)	0.0007
Highest tertile (richest)	1.00		
Educational attainment			
High school or less	1.98	(1.63 - 2.42)	<.0001
Vocational/junior college	1.38	(1.14 - 1.68)	0.0012
University or more	1.00		
Economic situation at home when respondents were five years old			
Poor, very poor	1.61	(1.25 - 2.08)	0.0003
Normal	1.07	(0.86 - 1.34)	0.55
Well-off, very well-off	1.00		
Economic situation at home when respondents were fifteen years old			
Poor, very poor	1.53	(1.20 - 1.95)	0.0006
Normal	0.91	(0.74 - 1.11)	0.33
Well-off, very well-off	1.00		

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table3. Crude odds ratios and 95% confidence intervals for associations between workplace-related factors and poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011.

Independent variable	odds ratio	95% confidence interval	*p-value*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	1.00	(0.83 - 1.21)	*0.99*
3rd tertile(most stressful)	1.36	(1.12 - 1.64)	*0.0018*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.34	(1.10 - 1.63)	*0.0033*
3rd tertile(least supportive)	1.39	(1.14 - 1.68)	*0.001*
Working hours per week			
<40	1.19	(0.96 - 1.47)	*0.12*
40-50	1.00		
50-60	1.16	(0.85 - 1.58)	*0.34*
>60	1.69	(1.20 - 2.39)	*0.0027*
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 - 1.57)	*0.002*
Self-employed	1.10	(0.82 - 1.49)	*0.52*

SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

Table4. Multivariate odds ratios and 95% confidence intervals from multiple imputation analysis for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.97	(0.73 - 1.29)	*0.82*
Blue collar workers	1.18	(0.86 - 1.61)	*0.29*
Sex			
Men	1.61	(1.33 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.88	(0.66 - 1.16)	*0.36*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.45*
40-44	0.99	(0.76 - 1.30)	*0.96*
45-50	1.49	(1.14 - 1.93)	*0.0033*
Marital status			
Married	1.00		
Not married [b]	1.01	(0.84 - 1.22)	*0.89*
Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.71*
3rd tertile(most stressful)	1.26	(1.03 - 1.54)	*0.025*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.029*
3rd tertile(least supportive)	1.23	(1.01 - 1.5)	*0.042*
Working hours per week			
<40	1.12	(0.88 - 1.43)	*0.35*
40-50	1.00		
50-60	1.06	(0.72 - 1.57)	*0.75*
>60	1.41	(0.99 - 2.01)	*0.06*
Type of employment			
Permanent	1.00		
Precarious	1.57	(1.26 - 1.96)	*<.0001*
Self-employed	1.12	(0.82 - 1.53)	*0.49*

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. Divorced/separated and widow people were classified into “not married”.

Appendix Table1. Multivariate odds ratios and 95% confidence intervals for associations with poor self-rated oral health among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Independent variable	odds ratio	95% confidence interval	*p-value*
Occupations			
Professionals	1.00		
Office workers	0.96	(0.72 - 1.29)	*0.79*
Blue collar workers	1.18	(0.86 - 1.61)	*0.31*
Sex			
Men	1.61	(1.32 - 1.96)	*<.0001*
Women	1.00		
Age			
25-29	0.86	(0.65 - 1.14)	*0.29*
30-34	1.00		
35-39	1.10	(0.85 - 1.44)	*0.46*
40-44	1.00	(0.77 - 1.30)	*0.98*
45-50	1.52	(1.17 - 1.98)	*0.0016*
Marital status			
Married	1.00		
Not married	0.99	(0.82 - 1.19)	*0.91*

Job stress			
1st tertile(least stressful)	1.00		
2nd tertile	0.96	(0.79 - 1.17)	*0.66*
3rd tertile(most stressful)	1.25	(1.02 - 1.54)	*0.03*
Social support in workplace			
1st tertile(most supportive)	1.00		
2nd tertile	1.25	(1.02 - 1.52)	*0.031*
3rd tertile(least supportive)	1.24	(1.01 - 1.51)	*0.039*
Working hours per week			
<40	1.15	(0.92 - 1.45)	*0.23*
40-50	1.00		
50-60	1.05	(0.76 - 1.44)	*0.78*
>60	1.48	(1.04 - 2.11)	*0.031*
Type of employment			
Permanent	1.00		
Precarious	1.52	(1.22 - 1.90)	*0.0002*
Self-employed	1.11	(0.80 - 1.54)	*0.53*

Dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) in the analysis.

Appendix Table2. Association between poor self-rated oral health (SROH) and self-reported number of removed tooth

		Number of removed tooth						
		0	**1**	**2**	**3**	**4**	**More than 4**	***p-value*** [b]
Poor SROH [a]	**Number (%)**	300 (17.2)	112 (30.0)	94 (34.7)	67 (45.0)	52 (48.6)	135 (58.4)	*<.0001*
Total		1740	373	271	149	107	231	

a. SROH was assessed by the following question. “Overall, how would you rate the health of your teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

b. The chi-square test was performed to calculate the p-value.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	#1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	#2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	#4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	#5
Methods			
Study design	4	Present key elements of study design early in the paper	#5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	#5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	#5-6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	#6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	#6-9
Bias	9	Describe any efforts to address potential sources of bias	*#6*
Study size	10	Explain how the study size was arrived at	*#6*
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	#6-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	#8-9
		(*b*) Describe any methods used to examine subgroups and interactions	#9
		(*c*) Explain how missing data were addressed	#9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	not applicable
		(*e*) Describe any sensitivity analyses	not applicable
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	#9
		(b) Give reasons for non-participation at each stage	#9
		(c) Consider use of a flow diagram	not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	#9
		(b) Indicate number of participants with missing data for each variable of interest	#9
Outcome data	15*	Report numbers of outcome events or summary measures	#9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	#10
		(*b*) Report category boundaries when continuous variables were categorized	not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	#11
Discussion			
Key results	18	Summarise key results with reference to study objectives	#11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	#14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	#14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	#14-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	#16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.