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

Design: Cross-sectional study.

Participants: A total of 3201 workers aged 25–50 years, 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 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 a 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-adjusted and sex-adjusted model to 1.18 in the multivariate model. Poverty during childhood at age 5 and at age 15 was 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 3201 workers aged 25–50 years 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 the disease burden in society, and is calculated as the 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 addition 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 (eg, cardiovascular disease).[4–8] The major indicators of socioeconomic positions (SEPs) 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 the best of our knowledge, only five previous studies have examined the association between occupation and oral health.[3 15–18] Poulton *et al*[3] examined the association of dental health (tooth cleanliness, gingival bleeding, periodontal disease and tooth decay) with a combination of parental occupation in childhood with occupation in adulthood among 1000 children in New Zealand; they reported significant social gradients among these oral conditions. Sanders *et al*[18] examined data of 3678 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. Morita *et al*[15 16] 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. Tsakos *et al*[17] reported significant social gradients in oral health, based on a sample of 6600 community-dwelling English people aged 50 years and older. 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 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. Also, we hypothesised 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 3201 workers aged 25–50 years 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) study, the details of which have been previously described.[23] In brief, between October 2010 and February 2011, 13 920 community-dwelling residents aged 25–50 years were probabilistically and randomly selected from four municipalities in and around Tokyo, Japan, using the Basic Resident Registration System. Independent survey agencies were contracted to conduct the surveys, and professional surveyors who had more than 3 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 that surveyors were not able to receive responses from eligible participants were as follows: 'inaccessible contact (n=4371)' and 'refusal of invitation (n=3677)'. Of those who were invited, 4385 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 (SROH), or those who responded that they were not active in the labour market (including homemakers and students); this result in 3201 eligible participants.

Measurements

All measures in this study were obtained by self-report. Basic demographic variables included sex (men/women), age (categorised as 25–29, 30–34, 35–39, 40–44 and 45–50 years) and marital status (categorised as married/not married). 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 to (5) poor." In the analysis, the outcome was dichotomised: "(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 Japanese yen (JPY) 5 million (approximately Great Britain pound (GBP) 29 400), JPY 5–7.5 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 (eg, stock, bonds and so on) and was divided into tertiles: less than JPY 3 million (GBP 17 600), JPY 3–5 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 (KK) 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 10 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 the 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 a list of 84 questions which assesses job stress, social support in the 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 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, 40–50, 50–60 or more than 60 h/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 χ^2 test (table 1). We estimated logistic regression models for the association between poor SROH and SEP. We computed sex-adjusted and age-adjusted OR and 95% CIs for poor SROH among office workers and blue-collar workers, compared with professionals. We also calculated ORs between each SEP and SROH (table 2), and ORs between work-related factors and SROH (table 3). 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 the workplace, working hours and type of employment (table 4). With regard to missing data on explanatory variables, we carried out two separate analyses. In the first analysis, dummy variables were used for missing data, with creation of a categorical indicator for missing responses (missing category) (see online supplementary appendix table S1). In the second analysis, we conducted multiple imputations for the missing data, included all variables shown in table 1. 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 the employment situation in Japan is highly different in men and women. SAS V.9.3 (SAS Institute, Cary, North Carolina, USA) was used for all statistical analyses, and 'Proc MI' and 'Proc MIANALYZE' were used for the multiple imputations.

RESULTS

The distribution of answers for 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 the 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-adjusted and age-adjusted ORs and 95% CIs 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. While the association with SROH was significant only for the lowest levels in occupation, income and childhood SEP, it 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 a significantly higher OR of poor SROH (1.44, 95% CI 1.07 to 1.95). Educational attainment, current income, wealth and SEP during childhood were also associated with poor SROH.

Table 3 describes crude ORs and 95% CIs for associations between workplace-related factors (job stress, social support in the 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 h/week had poorer SROH than those who worked 40–50 h/week (OR=1.69, 95% CI 1.20 to 2.39). Precarious workers had higher OR for poor oral health (1.32, 95% CI 1.11 to 1.57), compared with permanent workers.

Table 1 Characteristics of participants by status of self-rated oral health (SROH) among 3201 men and women aged 25–50 years in Japan during 2010–2011

Characteristic	Poor SROH* n	(%)	p Value†
Sex			
Men	529	(29.7)	0.0002
Women	334	(23.8)	
Age			
25–29	132	(22.5)	0.0001
30–34	138	(25.0)	
35–39	173	(27.2)	
40–44	175	(25.8)	
45–50	225	(33.8)	
Marital status			
Married	597	(27.9)	0.14
Not married‡	269	(25.5)	
Occupations			
Specialists	83	(28.0)	0.0009
White-collar workers	497	(24.9)	
Blue-collar workers	287	(31.5)	
Annual household income			
Less than 5 million JPY(approximately GBP 29 400)§	226	(32.3)	0.0012
5–7.5 million JPY(approximately GBP 29 400–44 100)§	179	(26.6)	
More than 7.5 million JPY (approximately GBP 44 100)§	250	(24.3)	
Wealth (household financial and other assets)			
Less than 3 million JPY (approximately GBP 17 600)§	201	(34.7)	<0.0001
3–5 million JPY (approximately GBP 17 600–29 400)§	169	(30.2)	
More than 5 million JPY (approximately GBP 29 400)§	173	(22.9)	
Education			
High school or less	263	(36.3)	<0.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were 5 years old			
Poor, very poor	226	(34.8)	<0.0001
Normal	502	(25.7)	
Well off, very well off	133	(23.5)	
Economic situation at home when respondents were 15 years old			
Poor, very poor	216	(35.9)	<0.0001
Normal	467	(24.8)	
Well off, very well off	180	(25.9)	
Job stress			
1st tertile (least stressful)	289	(25.2)	0.0017
2nd tertile	272	(25.2)	
3rd tertile (most stressful)	300	(31.3)	
Social support in workplace			
1st tertile (most supportive)	266	(23.4)	0.0014
2nd tertile	278	(29.1)	
3rd tertile (least supportive)	295	(29.8)	
Working hours per week			
<40	360	(26.7)	0.027
40–50	162	(23.5)	
50–60	81	(26.3)	
>60	67	(34.2)	
Type of employment			
Permanent	526	(25.3)	0.0083
Precarious	272	(30.9)	
Self-employed	66	(27.3)	

*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."
†p Value was calculated by χ^2 test.
‡Divorced/separated and widowed people were classified into "not married".
§Income and wealth were converted at 170 JPY (Japanese yen) to 1 GBP (Great Britain pound).

Table 2 Age-adjusted and sex-adjusted ORs and 95% CIs for associations between socioeconomic positions and poor self-rated oral health (SROH) among 3201 men and women aged 25–50 years in Japan during 2010–2011

Independent variable	OR	95% CI	p Value
Occupations			
Professionals	1.00		
Office workers	1.05	(0.79 to 1.39)	0.75
Blue-collar workers	1.44	(1.07 to 1.95)	0.017
Household income			
Lowest tertile	1.72	(1.38 to 2.16)	<0.0001
Second tertile	1.18	(0.94 to 1.48)	0.15
Highest tertile (richest)	1.00		
Wealth (household financial and other assets)			
Lowest tertile	1.93	(1.51 to 2.46)	<0.0001
Second tertile	1.55	(1.20 to 1.99)	0.0007
Highest tertile (richest)	1.00		
Educational attainment			
High school or less	1.98	(1.63 to 2.42)	<0.0001
Vocational/junior college	1.38	(1.14 to 1.68)	0.0012
University or more	1.00		
Economic situation at home when respondents were 5 years old			
Poor, very poor	1.61	(1.25 to 2.08)	0.0003
Normal	1.07	(0.86 to 1.34)	0.55
Well off, very well off	1.00		
Economic situation at home when respondents were 15 years old			
Poor, very poor	1.53	(1.20 to 1.95)	0.0006
Normal	0.91	(0.74 to 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 to (5) Poor." In the analysis, the outcome was dichotomised: "(1) excellent and (2) good, (3) Fair" as "Good SROH," and "(4) not so good and (5) Poor" as "Poor SROH".

Table 4 shows the multivariate ORs and 95% CIs 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 (see online supplementary appendix table S1), 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 the 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 costs. For most of the adult patients, 70% of dental care payments are covered by the universal healthcare insurance. For people aged 70 years or older, 80% of the payments are covered.[29] Besides, copayments among children are reimbursed in more than half of the local governments, depending on their policies. Our findings are consistent with a previous study by Morita *et al*,[16] which reported that there were significant oral health disparities across occupations. We found oral health disparities across occupations as well as other indicators of SEP, including income, wealth and childhood SEP. Tsakos *et al*[17] reported social gradients across occupation, income, wealth and parental occupation among older individuals in England.

One reason why people with higher SEP had better SROH may be related to preventive practices—for example, dental flossing or use of an interdental brush (interproximal brush). Neamatol *et al*[30] reported that students of doctorate and masters degrees flossed more often than those of bachelor or associate degrees, while Tseveenjav *et al*[31] reported that people with a higher educational attainment performed cleaning more than the others. Another reason why people in higher SEP

Table 3 Crude ORs and 95% CIs for associations between workplace-related factors and poor self-rated oral health (SROH) among 3201 men and women aged 25–50 years in Japan during 2010–2011

Independent variable	OR	95% CI	p Value
Job stress			
1st tertile (least stressful)	1.00		
2nd tertile	1.00	(0.83 to 1.21)	0.99
3rd tertile (most stressful)	1.36	(1.12 to 1.64)	0.0018
Social support in workplace			
1st tertile (most supportive)	1.00		
2nd tertile	1.34	(1.10 to 1.63)	0.0033
3rd tertile (least supportive)	1.39	(1.14 to 1.68)	0.001
Working hours per week			
<40	1.19	(0.96 to 1.47)	0.12
40–50	1.00		
50–60	1.16	(0.85 to 1.58)	0.34
>60	1.69	(1.20 to 2.39)	0.0027
Type of employment			
Permanent	1.00		
Precarious	1.32	(1.11 to 1.57)	0.002
Self-employed	1.10	(0.82 to 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 to (5) poor." In the analysis, the outcome was dichotomised: "(1) excellent and (2) good, (3) Fair" as "Good SROH," and "(4) not so good and (5) poor" as "Poor SROH".

Table 4 Multivariate ORs and 95% CIs from multiple imputation analysis for associations with poor self-rated oral health (SROH) among 3201 men and women aged 25–50 years in Japan during 2010–2011

Independent variable	OR	95% CI	p Value
Occupations			
Professionals	1.00		
Office workers	0.97	(0.73 to 1.29)	0.82
Blue-collar workers	1.18	(0.86 to 1.61)	0.29
Sex			
Men	1.61	(1.33 to 1.96)	<0.0001
Women	1.00		
Age			
25–29	0.88	(0.66 to 1.16)	0.36
30–34	1.00		
35–39	1.10	(0.85 to 1.44)	0.45
40–44	0.99	(0.76 to 1.30)	0.96
45–50	1.49	(1.14 to 1.93)	0.0033
Marital status			
Married	1.00		
Not married†	1.01	(0.84 to 1.22)	0.89
Job stress			
1st tertile (least stressful)	1.00		
2nd tertile	0.96	(0.79 to 1.17)	0.71
3rd tertile (most stressful)	1.26	(1.03 to 1.54)	0.025
Social support in workplace			
1st tertile (most supportive)	1.00		
2nd tertile	1.25	(1.02 to 1.52)	0.029
3rd tertile (least supportive)	1.23	(1.01 to 1.5)	0.042
Working hours per week			
<40	1.12	(0.88 to 1.43)	0.35
40–50	1.00		
50–60	1.06	(0.72 to 1.57)	0.75
>60	1.41	(0.99 to 2.01)	0.06
Type of employment			
Permanent	1.00		
Precarious	1.57	(1.26 to 1.96)	<0.0001
Self-employed	1.12	(0.82 to 1.53)	0.49

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 to (5) poor." In the analysis, the outcome was dichotomised: "(1) excellent and (2) good, (3) Fair" as "Good SROH," and "(4) not so good and (5) Poor" as "Poor SROH."
†Divorced/separated and widowed people were classified into "not married".

had better SROH might be utilisation 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 utilisation.

Another explanation for the relationship between SEP and SROH might be through psychosocial factors. Baker *et al*[34] reported that a greater sense of coherence and higher self-esteem were linked to better oral health perceptions. Therefore, these factors might be mediators between SEP and SROH because those who are in higher SEP, including occupations, have, in general, a 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, that is, in addition to intervening to improve socioeconomic conditions, it may be possible to 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 *et al*[21] reported that stress was a significant risk factor for gingivitis, and Krejci *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 be 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, compared with only 16.4% 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 *et al*[3] examined 1000 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. Thomson *et al*[5] examined 789 individuals and revealed that those who belonged to a low socioeconomic status group at age 5 were more likely to have lost a tooth in adulthood because of caries and had a greater prevalence and extent of periodontitis. In our study, when poverty during childhood at age 5 or 15 was added to the multivariate model, poverty during childhood at age 5 and at age 15 was associated with poorer SROH (OR 1.60, 95% CI 1.23 to 2.08 at age 5, and OR 1.47, 95% CI 1.15 to 1.87 at age 15, 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, schoolchildren do receive oral check-ups 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 adulthood.

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, SROH has been examined and reported to be a well-validated and reliable index.[24 25] Jones *et al* validated the association between a single-item self-report question and an oral clinical examination among 232 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 a 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 the number of removed tooth in the sample (see online supplementary appendixtable S2). Ando *et al*[43] confirmed the validity of the self-reported number of remaining teeth and of the clinical examination in Japanese. Therefore, this might support the theory that the scale in Japanese is also valid. Future studies are needed to clarify the validity of the scale in Japanese. Second, 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 most 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. Third, the data used in this study was cross-sectional, not longitudinal, and therefore we cannot infer causality. Thus, low SEP could cause worse oral health; however, the reverse is also possible, that is, 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 therefore 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 seven items for job stress and the six items for social support at the 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 α coefficient was 0.90 for the seven items for job stress, and 0.91 for the six 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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