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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 (Japanese study of Stratification, Health, Income, and Neighborhood) study

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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 ratios (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 addition 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

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

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

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26 In this study, we first examined approximately three thousand workers aged
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28 25-50 years old in Japan to elucidate the associations between indicators of SEP
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30 (occupation, income wealth, education and SEP in childhood) and oral health. We then
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32 examined the mediation of socioeconomic disparities by workplace-related factors
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34 (social support in workplace, job stress, working hours and type of employment).
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37 38 39 **METHODS**

40 41 **Participants**

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43 We conducted the present study by using data from the J-SHINE (Japanese
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45 study of Stratification, Health, Income, and Neighborhood), the details of which have
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47 been previously described.²¹ In brief, between October 2010 and February 2011, 13,920
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49 community-dwelling residents aged 25 to 50 years were randomly selected from four
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51 municipalities in and around Tokyo, Japan. Of those who were invited, 4,385 men and
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53 women responded (31.6%) to the invitation; these individuals formed the baseline of the
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55 J-SHINE study. The questionnaire was self-administered using a computer-assisted
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6 personal interview format, unless the participants requested a face-to-face interview.
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8 We excluded participants who did not answer the question about self-rated oral health,
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10 or who responded that they were not active in the labor market (including homemakers
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12 and students); this result in 3,201 eligible participants.
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14 15 16 Measurements

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18 All measures in this study were obtained by self-report. Basic demographic
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20 variables included sex (men/women), age (25-29, 30-34, 35-39, 40-44, and 45-50 years
21
22 old), and marital status (yes/no). Self-rated oral health (SROH) was used to evaluate
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24 oral conditions. SROH is a screening tool that can evaluate needs of dental care among
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26 people, especially those who do not usually visit dentists, and its validity and high
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28 internal consistency have been confirmed.^{22, 23} SROH was assessed by the following
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30 question. *“Overall, how would you rate the health of your teeth and gums?”* Potential
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32 responses ranged from *“1.excellent, 2.good, 3.fair; 4.not so good or 5.poor”*. In the
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34 analysis, the outcome was dichotomized: “1.excellent and 2.good, 3.fair” as “Good SROH”,
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36 and “4.not so good and 5.poor” as “Poor SROH”.
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40 As indicators of SEP, we used annual household income, wealth, educational
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42 attainment, occupation, and economic situations during childhood. Annual household
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44 income was divided into three categories; less than JPY 5 million (Approximately GBD
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46 29,400), JPY 5 to 7.5 million (GBD 29,400-44,100), or more than JPY 7.5 million (GBD
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48 44,100). Wealth was divided into three categories; less than JPY 3 million (GBD 17,600),
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50 JPY 3 to 5 million (GBD 17,600-29,400), or more than JPY 5 million (GBD 29,400).
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52 Educational attainment was divided into three categories; high school or less,
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54 vocational/junior college, and university or more. Occupational class was divided into
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56 three categories; professionals, office workers or blue collar workers. Occupations were
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6 self-reported, but, in addition, a sociologist on the team (K.K.) examined each response
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8 to determine the correct classification based on the detailed job description provided by
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10 the participants. Our method of occupational classification was previously used in “The
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12 national survey of Social Stratification and social Mobility”, which has been conducted
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14 in Japan every ten years since 1955 and is regarded as the most academically valid
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16 classification of occupations in Japan.²⁴ Economic conditions in childhood were
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18 evaluated through the following questions. *“How would you rate the economic*
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20 *conditions in your household at age five (fifteen)?”* The answers were selected from
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22 *“1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well off”*. In the analysis, the
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24 answers were divided into three groups: “1.very difficult, 2. difficult”, “3.normal” and “4.
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26 well off 5. well off”. This question was derived from the Comprehensive Survey of Living
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28 Conditions, which is annually conducted by the Ministry of Health, Labour, and Welfare,
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30 and is regarded as a standard way to evaluate subjective economic situation in Japan.
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34 With regard to workplace-related factors, job stress, social support in
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36 workplace, working hours, and type of employment were used. Job stress was evaluated
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38 by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ).
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40 BJSQ has been validated for use with Japanese workers, and consists of lists the 84
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42 questions which assesses job stress, social support in workplace and subjective
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44 physical/mental symptoms.²⁵ BJSQ has been used in workplaces in Japan and was used
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46 in previous research in Japan.^{25, 26} One example of the seven questions on the job stress
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48 was *“I have to deal with a lot of tasks”*, and the answer was chosen from *“1.yes, 2.rather*
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50 *yes 3.rather no, 4.no”*. Aggregated scores for the seven questions were divided into
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52 tertiles. Social support in workplace consisted of six questions, which were also taken
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54 from BJSQ. One example of six questions was *“How reliable is your boss when you are*
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56 *in trouble?”*, and the answer was chosen from *“1.very, 2.fairly 3.to some extent, 4.not”*.
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6 Aggregated scores for the six questions were divided into tertiles. Working hours were
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8 divided into four groups: less than 40 hours per week, 40 to 50 hours per week, 50 to 60
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10 hours per week, or more than 60 hours per week. Type of employment was divided into
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12 three groups: permanent, precarious or self-employment.
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14 15 16 Statistical analysis

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

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46 The study was approved by the ethics committee of the Graduate School of
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48 Medicine and Faculty of Medicine, The University of Tokyo.
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51 52 Results

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54 Table 1 describes the basic characteristics of the study participants according
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56 to level of SROH. All of the characteristics except marital status were significantly
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5 associated with SROH. Poor SROH was more prevalent in men, older age-groups, blue
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7 collar workers, precarious workers, as well as those with lower income, lower wealth,
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9 lower educational attainment, higher childhood poverty, lower social support, higher
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11 stress and longer working hours.
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14 Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the
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16 associations between various indicators of SEP (occupation, income, wealth, education,
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18 and two indicators of childhood SEP) and poor SROH. All indicators of SEP were
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20 inversely associated with SROH. Blue collar workers had significantly higher OR of
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22 poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current income, wealth
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24 and SEP during childhood were also associated with poor SROH.
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26
27 Table 3 describes crude ORs and 95% CI for associations between
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29 workplace-related factors (job stress, social support in workplace, working hour and
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31 type of employment) and poor SROH. All of the factors were associated with poor SROH.
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33 Workers with the most stress as well as low social support had higher odds of poor
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35 SROH compared with those with less job stress or more social support. Those who
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37 reported working more than 60 hours per week had poorer SROH than those who
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39 worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had
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41 higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent
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43 workers.
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46 Table 4 shows the multivariate ORs and 95% CI for poor SROH. The
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48 associations between occupational class and poor SROH were substantially attenuated
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50 by work-related factors. Approximately 60% of the association between occupations and
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52 poor SROH was explained by the work-related factors.²⁷ In the multivariate model, all
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54 of the workplace-related factors (social support, job stress, type of employment and
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56 working hours) were significantly associated with poor SROH.
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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 less²⁸, 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

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6 versus 41.4% for the poorest group. Thus, the pathway from lower household income to
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8 poor SROH might be through preventive dental service utilization.
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10 Our findings add to the previous literature by suggesting that occupational
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12 inequalities in oral health can be substantially explained by work-based factors, such as,
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14 social support in the workplace, job stress, working hours, and type of employment
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16 (precarious vs. permanent). These workplace-related factors might be targets for
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18 interventions to mitigate oral health disparities, i.e. in addition to intervening to
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20 improve socioeconomic conditions, it may be possible focus on working conditions to
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22 reduce oral health disparities.
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24 Social support has been reported to have a “stress-buffering effect” on
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26 cardiovascular diseases.³²⁻³⁴ Stress has been reported as one of the exacerbating factors
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28 for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk
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30 factor for gingivitis¹⁹, and Krejci CB, et al. suggested that stress may hasten the
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32 development and progression of periodontitis through the suppression of T-cell activity
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34 or a reduction in salivary IgA.^{17, 18} Precarious employment was also significantly
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36 associated with poor SROH in the multivariate model. Previous studies on precarious
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38 employment showed that this form of work is associated with job insecurity and
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40 psychological distress^{35, 36}, and, therefore, being in a precarious employment might also
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42 a risk factor of developing periodontitis or gingivitis via stress. The number of
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44 precarious employees has been increasing all over the world as well as in Japan. In
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46 Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in
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48 1985.³⁷
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52 Previous studies have suggested a consistent link between early life-course
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54 socioeconomic circumstances and health status in adulthood.^{3, 38, 39} Our study is
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56 consistent with previous research in showing an association between childhood SEP and
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6 oral health. Poulton R et al. examined 1,000 children in New Zealand and found that
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8 there was a clear social gradient of dental health (tooth cleanliness, gingival bleeding,
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10 periodontal disease, and tooth decay) across childhood SEP.³ In our study, when poverty
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12 during the childhood at age five or fifteen was added to the multivariate model, both
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14 poverty during childhood at age five and at age fifteen were associated with poorer
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16 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
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18 fifteen, respectively, not shown in tables). These two factors seemed to be independently
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20 associated with SROH, because coefficients of the other covariates in the multivariate
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22 model hardly changed before and after adding the childhood poverty variables to the
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24 multivariate model. Therefore, poverty during childhood appears to affect SROH in
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26 adulthood separately from sex, age, and the current workplace-related factors.
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31 · Limitations

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33 There are some limitations in this study. First, SROH is a subjective
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35 measurement. Some might argue that this type of measurement might be invalid,
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37 however, self-rated oral health has been examined and reported to be a well-validated
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39 and reliable index.^{22, 23} Jones JA et al. validated the association between a single-item
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41 self-report question and oral clinical examination among two hundred thirty-two
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43 community-dwelling participants. The question was *“How would you describe the*
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45 *health of your teeth and gums? Would you say it is excellent, very good, good, fair or*
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47 *poor?”*. They reported that the single-item self-reported question had a sensitivity of
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49 0.75 and a specificity of 0.67 in identifying persons with severe need for denture care,
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51 compared with the clinical examination.²² Secondly, the response rate was low. However,
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53 Takada et. al. compared the collected sample with the vital statistics in Census 2010 of
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55 the target population and reported that the obtained sample was properly equivalent
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6 with respect to age, sex, and education²¹. Therefore, it is likely that the results of the
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8 present study could be generalizable to the target population. Thirdly, the data used in
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10 this study was cross-sectional, not longitudinal, therefore, we cannot infer causality.
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12 Thus, low SEP could cause worse oral health; but the reverse is also possible, i.e. it is
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14 well described that poor dental status can lead to social stigma and adversely impact
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16 people's chances of employment and success in life.⁴⁰ Fourthly, we did not gather data
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18 on brushing frequency or use of interdental brush/dental flossing²⁹, and we could not
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20 include these factors in the analysis. Some studies reported that people with lower
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22 educational attainment or low income use interdental brush/dental flossing less, and
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24 this might explain the association between SEPs and poorer SROH. Finally, the
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26 questions which were used to evaluate job stress or social support in workplace were not
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28 validated although BJSQ, from which questions on social support and job stress were
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30 derived, have been well-validated.²⁵ Future studies should employ well-validated
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32 questions on job stress and social support.
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37 **Conclusion**

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

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7
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9
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31 and interpretation of data and the writing of the article and the decision to submit it for
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33 publication.
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37 **Competing interest:** None declared.
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41 **Contributorship statement:**
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44 All authors participated in conceptualizing the study, interpreting the data,
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46 and writing and critically reviewing the article. T. Tsuboya conducted data analysis and
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48 led the writing of the article.
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Table 1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH [†]		<i>p</i> -value*
	n	(%)	
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
Single	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 GBD 29,400) ‡	226	(32.3)	0.0012
5-7.5 million JPY (Approximately GBD 29,400-44,100) ‡	179	(26.6)	
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)	<.0001
3-5 million JPY (Approximately GBD 17,600-29,400) ‡	169	(30.2)	
More than 5 million JPY (Approximately GBD 29,400) ‡	173	(22.9)	
Education			
High school or less	263	(36.3)	<.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	<.0001
Normal	502	(25.7)	
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	<.0001
Normal	467	(24.8)	
Well-off, very well-off	180	(25.9)	

1	Job stress			
2	1st tertile(least stressful)	289	(25.2)	
3	2nd tertile	272	(25.2)	0.0017
4	3rd tertile(most stressful)	300	(31.3)	
5	Social support in workplace			
6	1st tertile(most supportive)	266	(23.4)	
7	2nd tertile	278	(29.1)	0.0014
8	3rd tertile(least supportive)	295	(29.8)	
9	Working hours per week			
10	<40	360	(26.7)	
11	40-50	162	(23.5)	
12	50-60	81	(26.3)	0.027
13	>60	67	(34.2)	
14	Type of employment			
15	Permanent	526	(25.3)	
16	Precarious	272	(30.9)	0.0083
17	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).

Table 2. 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	<i>p</i> -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		

Table 3. 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	<i>p</i> -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

Table 4. 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	<i>p</i> -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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1 **Abstract**

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

5 Design: Cross-sectional study

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

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

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

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

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6 26 **Strengths and limitations of this study**
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8 · Previous studies have shown an association between socioeconomic positions
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10 (SEP) in adulthood and oral health, however few have examined the relation between
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12 SEP in childhood and oral health in adulthood.
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14 · Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we
15
16 found evidence that economic difficulties during childhood as well as SEP in adulthood
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18 independently appeared to affect self-rated oral health (SROH) in adulthood among
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20 working men and women.
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22 · Workplace-related factors (social support in the workplace, job stress, working
23
24 hours, and type of employment) substantially explained the association between
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26 occupation and SROH.
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28 · The response rate was low, however, the obtained sample was properly
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30 equivalent with respect to age, sex, and education, compared with vital statistics in
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32 Census 2010 of the target population.
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43 **Background**

44 Oral health problems, such as dental caries, periodontal disease, and
45 edentulism, afflict more than half of the population of the planet (3.9 billion people) and
46 untreated dental caries is the most prevalent condition (35% across all ages) among the
47 291 conditions listed in the Global Burden of Disease 2010.^{1,2} Using disability-adjusted
48 life years (DALYs), which is an index of measuring disease burden in society, and is
49 calculated as sum of years of life lost due to premature mortality and years lived with
50 disability, Marcenes W, et al estimated that the global burden of oral conditions would
51 increase by approximately 20% from 1990 to 2010.^{1,2} In addition to their high
52 prevalence, oral health conditions are a major contributor to socioeconomic disparities
53 in health.^{3,4}

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

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6 68 workers reported less social impact, measured by the 14-item Oral Health Impact
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8 69 Profile, than did workers in lower white-collar or blue-collar occupations.¹⁸ Morita et al.
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10 70 examined the association of occupations with oral conditions, based on approximately
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12 71 16,000 Japanese workers; they reported that professionals had better oral conditions
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14 72 than office workers and blue collar workers in Japan.^{15 16} Tsakos et al. reported
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16 73 significant social gradients in oral health, based on a sample of 6,600
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18 74 community-dwelling English people aged 50 years and older.¹⁷ However, none of these
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20 75 considered workplace-related factors, such as social support, working hours, type of
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22 76 employment or job stress, as potential mediators of the association between occupations
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24 77 and oral health. Psychological stress is associated with the workplace-related factors as
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26 78 well as occupations, and, on the other hand, oral diseases, such as periodontitis and
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28 79 gingivitis, are also associated with psychological stress.¹⁹⁻²² Therefore,
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30 80 workplace-related factors may be candidates for mitigating oral health disparities. and,
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32 81 we hypothesized that job stress (including work hours) – as well as stress-buffering
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34 82 factors such as workplace social support – would mediate the association between
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36 83 occupational class and oral health.

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39 84 In this study, we first examined data of 3,201 workers aged 25-50 years old in
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41 85 Japan to elucidate the associations between indicators of SEP (occupation, income
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43 86 wealth, education and SEP in childhood) and oral health. We then examined the
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45 87 mediation of socioeconomic disparities by workplace-related factors (social support in
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47 88 workplace, job stress, working hours and type of employment).

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51 52 90 **METHODS**

53 54 91 **Participants**

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56 92 We conducted the present study by using data from the J-SHINE (Japanese
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6 93 study of Stratification, Health, Income, and Neighborhood), the details of which have
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8 94 been previously described.²³ In brief, between October 2010 and February 2011, 13,920
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10 95 community-dwelling residents aged 25 to 50 years were probabilistically and randomly
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12 96 selected from four municipalities in and around Tokyo, Japan, with using the Basic
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14 97 Resident Registration System. Independent survey agencies were contracted to conduct
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16 98 the surveys, and the professional surveyors who had more than three years of
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18 99 experience in conducting interview-based social surveys made contacts with the eligible
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20 100 individuals after attending training sessions to conduct the J-SHINE study. The main
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22 101 reasons the surveyors were not able to receive responses from the eligible participants
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24 102 were as follows: “inaccessible contact (n=4371)” and “refusal of invitation (n=3677)”. Of
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26 103 those who were invited, 4,385 men and women responded (31.6%) to the invitation;
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28 104 these individuals formed the baseline of the J-SHINE study. A questionnaire was
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30 105 self-administered using a computer-assisted personal interview format, unless the
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32 106 participants requested a face-to-face interview. We excluded participants who did not
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34 107 answer the question about self-rated oral health, or who responded that they were not
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36 108 active in the labor market (including homemakers and students); this result in 3,201
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38 109 eligible participants.
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44 111 Measurements

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46 112 All measures in this study were obtained by self-report. Basic demographic
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48 113 variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and
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50 114 45-50 years old), and marital status (categorized as married/not married). Self-rated
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52 115 oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that
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54 116 can evaluate needs of dental care among people, especially those who do not usually
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56 117 visit dentists, and its validity and high internal consistency have been confirmed.^{24 25}
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6 118 SROH was assessed by the following question. *“Overall, how would you rate the health*
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8 *of your teeth and gums?”* Potential responses ranged from *“1.excellent, 2.good, 3.fair,*
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10 *4.not so good or 5.poor”*. In the analysis, the outcome was dichotomized:”1.excellent and
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12 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

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14 As indicators of SEP, we used annual household income, wealth, educational
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16 attainment, occupation, and economic situations during childhood. Annual household
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18 income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400),
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20 JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100).
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23 Wealth was based on household financial and other assets (e.g. stock, bond, and so on)
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25 and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million
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27 (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment
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29 was divided into three categories; high school or less, vocational/junior college, and
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31 university or more. Occupational class was divided into three categories; professionals,
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33 office workers or blue collar workers. Occupations were self-reported, but, in addition, a
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35 sociologist on the team (K.K.) examined each response to determine the correct
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37 classification based on the detailed job description provided by the participants. Our
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39 method of occupational classification was previously used in “The national survey of
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41 Social Stratification and social Mobility”, which has been conducted in Japan every ten
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43 years since 1955 and is regarded as the most valid classification of occupations in
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45 Japan.²⁶ Economic conditions in childhood were evaluated through the following
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47 questions. *“How would you rate the economic conditions in your household at age five?”*
48
49 and *“How would you rate the economic conditions in your household at age fifteen?”*The
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51 answers were selected from *“1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well*
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53 *off”*. In the analysis, the answers were divided into three groups: “1.very difficult, 2.
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55 difficult”, “3.normal” and “4. well off 5. very well off”. This question was derived from
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6 143 the Comprehensive Survey of Living Conditions, which is annually conducted by the
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8 144 Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate
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10 145 subjective economic situation in Japan.

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13 146 With regard to workplace-related factors, job stress, social support in
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15 147 workplace, working hours, and type of employment were used. Job stress was evaluated
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17 148 by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ).
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19 149 BJSQ has been validated for use with Japanese workers, and consists of lists the 84
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21 150 questions which assesses job stress, social support in workplace and subjective
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23 151 physical/mental symptoms.²⁷ BJSQ has been used in workplaces in Japan and was used
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25 152 in previous research in Japan.^{27 28} One example of the seven questions on the job stress
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27 153 was *“I have to deal with a lot of tasks”*, and the answer was chosen from *“1.yes, 2.rather*
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29 154 *yes 3.rather no, 4.no”*. Aggregated scores for the seven questions were divided into
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31 155 tertiles. Social support in workplace consisted of six questions, which were also taken
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33 156 from BJSQ. One example of six questions was *“How reliable is your boss when you are*
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35 157 *in trouble?”*, and the answer was chosen from *“1.very, 2.fairly 3.to some extent, 4.not”*.
36
37 158 Aggregated scores for the six questions were divided into tertiles. Working hours were
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39 159 divided into four groups: less than 40 hours per week, 40 to 50 hours per week, 50 to 60
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41 160 hours per week, or more than 60 hours per week. Type of employment was divided into
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43 161 three groups: permanent, precarious or self-employment.
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48 163 Statistical analysis

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50 164 Differences in background characteristics according to SROH (good or poor)
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52 165 were compared using the chi-square test (Table1). We estimated logistic regression
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54 166 models for the association between poor SROH and SEP. We computed sex- and age-
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56 167 adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office
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6 168 workers and blue collar workers, compared with professionals. We also calculated the
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8 169 ORs between each SEP and SROH (Table2), and the ORs between work-related factors
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10 170 and SROH (Table3). Additionally, we estimated the multivariate ORs for the association
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12 171 between occupations and SROH, adjusting for work-related factors, such as job stress
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14 172 social support in workplace, working hours, and type of employment (Table4). With
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16 173 regard to missing data on explanatory variables, we carried out 2 separate analyses. In
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18 174 the first analysis, dummy variables were used for missing data, with creation of a
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20 175 categorical indicator for missing responses (missing category) (Appendix Table1). In the
21
22 176 second analysis, we conducted multiple imputations for the missing data, included all
23
24 177 variables shown in Table1. Interactions between sex and the other variables
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26 178 (age/marital status/job stress/social support in the workplace/working hour/type of
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28 179 employment) were tested by entering multiplicative interaction terms into the
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30 180 multivariate adjusted model, because employment situation in Japan is highly different
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32 181 in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical
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34 182 analyses, and “Proc MI” and “Proc MIANALYZE” were used for the multiple
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36 183 imputations
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43 185 Ethics

44 186 The study was approved by the ethics committee of the Graduate School of
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46 187 Medicine and Faculty of Medicine, The University of Tokyo.
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49 189 Results

50 190 The distribution of answers for the SROH was as follows; 1.excellent (N of 407),
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52 191 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table
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54 192 1 describes the basic characteristics of the study participants according to level of SROH.
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6 193 All of the characteristics except marital status were significantly associated with SROH.
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8 194 Poor SROH was more prevalent in men, older age-groups, blue collar workers,
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10 195 precarious workers, as well as those with lower income, lower wealth, lower educational
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12 196 attainment, higher childhood poverty, lower social support, higher stress and longer
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14 197 working hours.

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16 198 Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the
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18 199 associations between various indicators of SEP (occupation, income, wealth, education,
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20 200 and two indicators of childhood SEP) and poor SROH. All indicators of SEP were
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22 201 inversely associated with SROH. The association with SROH was significant only for
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24 202 the lowest levels in occupation, income and childhood SEP, while the association was
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26 203 comparatively larger in magnitude and significant for the intermediate levels as well as
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28 204 for the lowest levels in education and wealth. Blue collar workers had significantly
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30 205 higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current
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32 206 income, wealth and SEP during childhood were also associated with poor SROH.

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35 207 Table 3 describes crude ORs and 95% CI for associations between
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37 208 workplace-related factors (job stress, social support in workplace, working hour and
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39 209 type of employment) and poor SROH. All of the factors were associated with poor SROH.
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41 210 Workers with the most stress as well as low social support had higher odds of poor
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43 211 SROH compared with those with less job stress or more social support. Those who
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45 212 reported working more than 60 hours per week had poorer SROH than those who
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47 213 worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had
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49 214 higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent
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51 215 workers.

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54 216 Table 4 shows the multivariate ORs and 95% CI for poor SROH from the
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56 217 multiple imputation models. The associations between occupational class and poor
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6 218 SROH were substantially attenuated by work-related factors. Approximately 60% of the
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8 219 association between occupations and poor SROH was explained by the work-related
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10 220 factors.²⁸ In the multivariate model, all of the workplace-related factors (social support,
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12 221 job stress, type of employment and working hours) were significantly associated with
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14 222 poor SROH. Compared with the analysis that employed dummy categories for missing
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16 223 values (Appendix Table1), we found similar results after accounting for missing values
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18 224 using multiple imputations. None of the interactions were significant; occupation
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20 225 (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50),
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22 226 working hours (p=0.83), and type and employment (p=0.73).
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27 228 **Discussion**

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30 229 In the present study, we found oral health disparity across various indicators of
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32 230 SEP as well as childhood SEP among workers in Japan. Moreover, the association
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34 231 between occupations and SROH was substantially explained by job-related factors. Our
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36 232 finding is notable for demonstrating oral health disparities even in Japan, where the
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38 233 citizens, including children, have access to dental services with relatively low
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40 234 out-of-pocket cost. Our findings are consistent with a previous study by Morita et al.,
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42 235 which reported that there were significant oral health disparities across occupations.¹⁶
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44 236 We found oral health disparities across occupations as well as other indicators of SEP,
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46 237 including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients
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48 238 across occupation, income, wealth and parental occupation, among older individuals in
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50 239 England.¹⁷
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53 240 One reason why people with higher SEP had better SROH may be related to
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55 241 preventive practices – e.g. dental flossing or use of interdental brush (interproximal
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57 242 brush). Neamatol et al. reported that students with doctorate or masters degrees flossed
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6 243 more than those with bachelor degree or less²⁹, while Tseveenjav et al. reported that
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8 244 people with higher educational attainment performed cleaning more than the others.³⁰
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10 245 Another reason people in higher SEP had better SROH might be utilization of
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12 246 preventive dentistry. People with lower incomes tend to use preventive dental service
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14 247 less frequently^{31 32}, and the difference of use in preventive service might explain the
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16 248 social gradient of SROH. In fact, in the present study, approximately one in three
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18 249 participants (32.3%) among the richest group made a preventive dental clinic visit in
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20 250 the past year, whereas only one in four participants (24.7%) among the poorest group
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22 251 did so. On the other hand, we did not observe a big difference among rich and poor
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24 252 participants in the use of dental services for treatment; 42.3% for the richest group
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26 253 versus 41.4% for the poorest group. Thus, the pathway from lower household income to
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28 254 poor SROH might be through preventive dental service utilization.

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31 255 Another explanation for the relationship between SEP and SROH might be
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33 256 through psychosocial factors. Baker et al reported that greater sense of coherence and
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35 257 higher self-esteem were linked to better oral health perceptions.³³ Therefore, these
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37 258 factors might be mediators between SEP and SROH because those who are in higher
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39 259 SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

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41 260 Our findings add to the previous literature by suggesting that occupational
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43 261 inequalities in oral health can be substantially explained by work-based factors, such as,
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45 262 social support in the workplace, job stress, working hours, and type of employment
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47 263 (precarious vs. permanent). These workplace-related factors might be targets for
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49 264 interventions to mitigate oral health disparities, i.e. in addition to intervening to
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51 265 improve socioeconomic conditions, it may be possible focus on working conditions to
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53 266 reduce oral health disparities.

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56 267 Social support has been reported to have a “stress-buffering effect” on
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6 268 cardiovascular diseases.³⁴⁻³⁶ Stress has been reported as one of the exacerbating factors
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8 269 for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk
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10 270 factor for gingivitis²¹, and Krejci CB, et al. suggested that stress may hasten the
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12 271 development and progression of periodontitis through the suppression of T-cell activity
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14 272 or a reduction in salivary IgA.^{19 20} Precarious employment was also significantly
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16 273 associated with poor SROH in the multivariate model. Previous studies on precarious
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18 274 employment showed that this form of work is associated with job insecurity and
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20 275 psychological distress^{37 38}, and, therefore, being in a precarious employment might also
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22 276 a risk factor of developing periodontitis or gingivitis via stress. The number of
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24 277 precarious employees has been increasing all over the world as well as in Japan. In
25
26 278 Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in
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28 279 1985.³⁹

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31 280 Previous studies have suggested a consistent link between early life-course
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33 281 socioeconomic circumstances and health status in adulthood.^{3 5 40 41} Our study is
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35 282 consistent with previous research in showing an association between childhood SEP and
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37 283 oral health. Poulton R et al. examined 1,000 children in New Zealand and found that
38
39 284 there was a significant social gradient of dental health (tooth cleanliness, gingival
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41 285 bleeding, periodontal disease, and tooth decay) across childhood SEP.³ Thomson et al.
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43 286 examined 789 individuals and revealed that those who were in low socioeconomic status
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45 287 at age 5 years were more likely to have lost a tooth in adulthood because of caries and
46
47 288 had greater prevalence and extent of periodontitis.⁵ In our study, when poverty during
48
49 289 the childhood at age five or fifteen was added to the multivariate model, both poverty
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51 290 during childhood at age five and at age fifteen were associated with poorer SROH (OR:
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53 291 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen,
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55 292 respectively, not shown in tables). These two factors seemed to be independently
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6 293 associated with SROH, because coefficients of the other covariates in the multivariate
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8 294 model hardly changed before and after adding the childhood poverty variables to the
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10 295 multivariate model. Therefore, poverty during childhood appears to affect SROH in
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12 296 adulthood separately from sex, age, and the current workplace-related factors.
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16 298 ·Limitations

17
18 299 There are some limitations in this study. First, SROH is a subjective
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20 300 measurement. Some might argue that this type of measurement might be invalid,
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22 301 however, self-rated oral health has been examined and reported to be a well-validated
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24 302 and reliable index.^{24 25} Jones JA et al. validated the association between a single-item
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26 303 self-report question and oral clinical examination among two hundred thirty-two
27
28 304 community-dwelling participants. The question was *“How would you describe the*
29
30 305 *health of your teeth and gums? Would you say it is excellent, very good, good, fair or*
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32 306 *poor?”* They reported that the single-item self-reported question had a sensitivity of 0.75
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34 307 and a specificity of 0.67 in identifying persons with severe need for denture care,
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36 308 compared with the clinical examination.²⁴ The validation studies were conducted in
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38 309 English, and the present study was conducted in Japanese. As far as we know, no
39
40 310 previous studies have validated the scale in Japanese yet. However, we have confirmed
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42 311 that poor SROH was significantly associated with number of removed tooth in the
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44 312 sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of
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46 313 remaining teeth and clinical examination in Japanese.⁴² Therefore, this might support
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48 314 that the scale in Japanese is also valid. Future studies are needed to clarify the validity
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50 315 of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al.
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52 316 compared the collected sample with the vital statistics in Census 2010 of the target
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54 317 population and reported that the obtained sample was properly equivalent with respect
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6 318 to age, sex, and education.²³ Therefore, it is likely that the selection bias does not matter
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8 319 in terms of age, sex and education. We are not able to discuss selection bias precisely
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10 320 because we do not have other information among non-responders, such as smoking
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12 321 habit, income and so on. Thirdly, the data used in this study was cross-sectional, not
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14 322 longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral
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16 323 health; but the reverse is also possible, i.e. it is well described that poor dental status
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18 324 can lead to social stigma and adversely impact people's chances of employment and
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20 325 success in life.⁴³ Attention should be given to the positive association between current
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22 326 poor SROH and economic disadvantage in childhood, because the assessments of
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24 327 economic disadvantage in childhood were based on the participants' recall (recall bias).
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27 328 Fourth, we did not gather data on brushing frequency or use of interdental brush/dental
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29 329 flossing³⁰, and we could not include these factors in the analysis. Some studies reported
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31 330 that people with lower educational attainment or low income use interdental
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33 331 brush/dental flossing less, and this might explain the association between SEPs and
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35 332 poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at
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37 333 workplace were not validated. However, both have been used in practice in Japan, and
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39 334 the internal consistency of the scale in the present participants was acceptably high:
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41 335 Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6
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43 336 items for social support. Future studies should employ well-validated questions on job
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45 337 stress and social support.
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339 **Conclusion**

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

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6 343 disparities. Future studies on the effect of workplace-related factors on oral health
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8 344 should use longitudinal data to elucidate the causal association between the
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10 345 workplace-related factors and oral health.
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17
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23
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32
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34
35 357 critically for important intellectual content. TT, JA, IK, KK, and KO approved the final
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37 358 version of the manuscript.
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55
56 367 and interpretation of data and the writing of the article and the decision to submit it for
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368 publication.

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370 **Data sharing:** No additional data are available.

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Table 1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH ^a		<i>p</i> -value ^b
	n	(%)	
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 ^c	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) ^d	226	(32.3)	0.0012
5-7.5 million JPY (Approximately GBP 29,400-44,100) ^d	179	(26.6)	
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)	<.0001
3-5 million JPY (Approximately GBP 17,600-29,400) ^d	169	(30.2)	
More than 5 million JPY (Approximately GBP 29,400) ^d	173	(22.9)	
Education			
High school or less	263	(36.3)	<.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	<.0001
Normal	502	(25.7)	
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	<.0001
Normal	467	(24.8)	
Well-off, very well-off	180	(25.9)	

1	Job stress			
2	1st tertile(least stressful)	289	(25.2)	
3	2nd tertile	272	(25.2)	0.0017
4	3rd tertile(most stressful)	300	(31.3)	
5	Social support in workplace			
6	1st tertile(most supportive)	266	(23.4)	
7	2nd tertile	278	(29.1)	0.0014
8	3rd tertile(least supportive)	295	(29.8)	
9	Working hours per week			
10	<40	360	(26.7)	
11	40-50	162	(23.5)	
12	50-60	81	(26.3)	0.027
13	>60	67	(34.2)	
14	Type of employment			
15	Permanent	526	(25.3)	
16	Precarious	272	(30.9)	0.0083
17	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).

Table 2. 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	<i>p</i> -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".

Table 3. 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	<i>p</i> -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".

Table 4. 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	<i>p</i> -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

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5 a. SROH was assessed by the following question. “Overall, how would you rate the health of your
6 teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or
7 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good
8 SROH”, and “4.not so good and 5.poor” as “Poor SROH”.
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12 b. Divorced/separated and widow people were classified into “not married”.
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For peer review only

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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3: Tohoku Gakuin University, Department Human Science, Sendai, Japan

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.

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26 **Strengths and limitations of this study**

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

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

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

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

43 Background

44 Oral health problems, such as dental caries, periodontal disease, and
45 edentulism, afflict more than half of the population of the planet (3.9 billion people) and
46 untreated dental caries is the most prevalent condition (35% across all ages) among the
47 291 conditions listed in the Global Burden of Disease 2010.^{1,2} Using disability-adjusted
48 life years (DALYs), which is an index of measuring disease burden in society, and is
49 calculated as sum of years of life lost due to premature mortality and years lived with
50 disability, Marcenes W, et al estimated that the global burden of oral conditions would
51 increase by approximately 20% from 1990 to 2010.^{1,2} In addition to their high
52 prevalence, oral health conditions are a major contributor to socioeconomic disparities
53 in health.^{3,4}

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

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6 68 workers reported less social impact, measured by the 14-item Oral Health Impact
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8 69 Profile, than did workers in lower white-collar or blue-collar occupations.¹⁸ Morita et al.
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10 70 examined the association of occupations with oral conditions, based on approximately
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12 71 16,000 Japanese workers; they reported that professionals had better oral conditions
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14 72 than office workers and blue collar workers in Japan.^{15 16} Tsakos et al. reported
15
16 73 significant social gradients in oral health, based on a sample of 6,600
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18 74 community-dwelling English people aged 50 years and older.¹⁷ However, none of these
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20 75 considered workplace-related factors, such as social support, working hours, type of
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22 76 employment or job stress, as potential mediators of the association between occupations
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24 77 and oral health. Psychological stress is associated with the workplace-related factors as
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26 78 well as occupations, and, on the other hand, oral diseases, such as periodontitis and
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28 79 gingivitis, are also associated with psychological stress.¹⁹⁻²² Therefore,
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30 80 workplace-related factors may be candidates for mitigating oral health disparities. and,
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33 81 we hypothesized that job stress (including work hours) – as well as stress-buffering
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35 82 factors such as workplace social support – would mediate the association between
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37 83 occupational class and oral health.

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39 84 In this study, we first examined data of 3,201 workers aged 25-50 years old in
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41 85 Japan to elucidate the associations between indicators of SEP (occupation, income
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43 86 wealth, education and SEP in childhood) and oral health. We then examined the
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45 87 mediation of socioeconomic disparities by workplace-related factors (social support in
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47 88 workplace, job stress, working hours and type of employment).

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51 52 90 **METHODS**

53 54 91 **Participants**

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56 92 We conducted the present study by using data from the J-SHINE (Japanese
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6 93 study of Stratification, Health, Income, and Neighborhood), the details of which have
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8 94 been previously described.²³ In brief, between October 2010 and February 2011, 13,920
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10 95 community-dwelling residents aged 25 to 50 years were **probabilistically and** randomly
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12 96 selected from four municipalities in and around Tokyo, Japan, **with using the Basic**
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14 97 **Resident Registration System. Independent survey agencies were contracted to conduct**
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16 98 **the surveys, and the professional surveyors who had more than three years of**
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18 99 **experience in conducting interview-based social surveys made contacts with the eligible**
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20 100 **individuals after attending training sessions to conduct the J-SHINE study. The main**
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22 101 **reasons the surveyors were not able to receive responses from the eligible participants**
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24 102 **were as follows: “inaccessible contact (n=4371)” and “refusal of invitation (n=3677)”.** Of
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26 103 those who were invited, 4,385 men and women responded (31.6%) to the invitation;
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28 104 these individuals formed the baseline of the J-SHINE study. **A** questionnaire was
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30 105 self-administered using a computer-assisted personal interview format, unless the
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32 106 participants requested a face-to-face interview. We excluded participants who did not
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34 107 answer the question about self-rated oral health, or who responded that they were not
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36 108 active in the labor market (including homemakers and students); this result in 3,201
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38 109 eligible participants.

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111 Measurements

112 All measures in this study were obtained by self-report. Basic demographic
113 variables included sex (men/women), age (**categorized as** 25-29, 30-34, 35-39, 40-44, and
114 45-50 years old), and marital status (**categorized as married/not married**). Self-rated
115 oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that
116 can evaluate needs of dental care among people, especially those who do not usually
117 visit dentists, and its validity and high internal consistency have been confirmed.^{24 25}

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6 118 SROH was assessed by the following question. *“Overall, how would you rate the health*
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8 *of your teeth and gums?”* Potential responses ranged from *“1.excellent, 2.good, 3.fair,*
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10 *4.not so good or 5.poor”*. In the analysis, the outcome was dichotomized:”1.excellent and
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121 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

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

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6 143 the Comprehensive Survey of Living Conditions, which is annually conducted by the
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8 144 Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate
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10 145 subjective economic situation in Japan.

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13 146 With regard to workplace-related factors, job stress, social support in
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15 147 workplace, working hours, and type of employment were used. Job stress was evaluated
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17 148 by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ).
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19 149 BJSQ has been validated for use with Japanese workers, and consists of lists the 84
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21 150 questions which assesses job stress, social support in workplace and subjective
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23 151 physical/mental symptoms.²⁷ BJSQ has been used in workplaces in Japan and was used
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25 152 in previous research in Japan.^{27 28} One example of the seven questions on the job stress
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27 153 was *“I have to deal with a lot of tasks”*, and the answer was chosen from *“1.yes, 2.rather*
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29 154 *yes 3.rather no, 4.no”*. Aggregated scores for the seven questions were divided into
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31 155 tertiles. Social support in workplace consisted of six questions, which were also taken
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33 156 from BJSQ. One example of six questions was *“How reliable is your boss when you are*
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35 157 *in trouble?”*, and the answer was chosen from *“1.very, 2.fairly 3.to some extent, 4.not”*.
36
37 158 Aggregated scores for the six questions were divided into tertiles. Working hours were
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39 159 divided into four groups: less than 40 hours per week, 40 to 50 hours per week, 50 to 60
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41 160 hours per week, or more than 60 hours per week. Type of employment was divided into
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43 161 three groups: permanent, precarious or self-employment.
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48 163 Statistical analysis

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50 164 Differences in background characteristics according to SROH (good or poor)
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52 165 were compared using the chi-square test (Table1). We estimated logistic regression
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54 166 models for the association between poor SROH and SEP. We computed sex- and age-
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56 167 adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office
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6 168 workers and blue collar workers, compared with professionals. We also calculated the
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8 169 ORs between each SEP and SROH (Table2), and the ORs between work-related factors
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10 170 and SROH (Table3). Additionally, we estimated the multivariate ORs for the association
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12 171 between occupations and SROH, adjusting for work-related factors, such as job stress
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14 172 social support in workplace, working hours, and type of employment (Table4). With
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16 173 regard to missing data on explanatory variables, we carried out 2 separate analyses. In
17
18 174 the first analysis, dummy variables were used for missing data, with creation of a
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20 175 categorical indicator for missing responses (missing category) (Appendix Table1). In the
21
22 176 second analysis, we conducted multiple imputations for the missing data, included all
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24 177 variables shown in Table1. Interactions between sex and the other variables
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26 178 (age/marital status/job stress/social support in the workplace/working hour/type of
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28 179 employment) were tested by entering multiplicative interaction terms into the
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30 180 multivariate adjusted model, because employment situation in Japan is highly different
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32 181 in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical
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34 182 analyses, and “Proc MI” and “Proc MIANALYZE” were used for the multiple
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36 183 imputations
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185 Ethics

186 The study was approved by the ethics committee of the Graduate School of
187 Medicine and Faculty of Medicine, The University of Tokyo.
188

189 Results

190 The distribution of answers for the SROH was as follows; 1.excellent (N of 407),
191 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table
192 1 describes the basic characteristics of the study participants according to level of SROH.

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6 193 All of the characteristics except marital status were significantly associated with SROH.
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8 194 Poor SROH was more prevalent in men, older age-groups, blue collar workers,
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10 195 precarious workers, as well as those with lower income, lower wealth, lower educational
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12 196 attainment, higher childhood poverty, lower social support, higher stress and longer
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14 197 working hours.

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16 198 Table 2 shows the sex- and age- adjusted odds ratios and 95% CI for the
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18 199 associations between various indicators of SEP (occupation, income, wealth, education,
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20 200 and two indicators of childhood SEP) and poor SROH. All indicators of SEP were
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22 201 inversely associated with SROH. The association with SROH was significant only for
23
24 202 the lowest levels in occupation, income and childhood SEP, while the association was
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26 203 comparatively larger in magnitude and significant for the intermediate levels as well as
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28 204 for the lowest levels in education and wealth. Blue collar workers had significantly
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30 205 higher OR of poor SROH (1.44, 95% CI: 1.07-1.95). Educational attainment, current
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32 206 income, wealth and SEP during childhood were also associated with poor SROH.

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34
35 207 Table 3 describes crude ORs and 95% CI for associations between
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37 208 workplace-related factors (job stress, social support in workplace, working hour and
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39 209 type of employment) and poor SROH. All of the factors were associated with poor SROH.
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41 210 Workers with the most stress as well as low social support had higher odds of poor
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43 211 SROH compared with those with less job stress or more social support. Those who
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45 212 reported working more than 60 hours per week had poorer SROH than those who
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47 213 worked 40-50 hours per week (OR: 1.69, 95%CI 1.20-2.39). Precarious workers had
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49 214 higher OR for poor oral health (1.32, 95% CI: 1.11-1.57), compared with permanent
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51 215 workers.

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53
54 216 Table 4 shows the multivariate ORs and 95% CI for poor SROH from the
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56 217 multiple imputation models. The associations between occupational class and poor

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6 218 SROH were substantially attenuated by work-related factors. Approximately 60% of the
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8 219 association between occupations and poor SROH was explained by the work-related
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10 220 factors.²⁸ In the multivariate model, all of the workplace-related factors (social support,
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12 221 job stress, type of employment and working hours) were significantly associated with
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14 222 poor SROH. Compared with the analysis that employed dummy categories for missing
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16 223 values (Appendix Table1), we found similar results after accounting for missing values
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18 224 using multiple imputations. None of the interactions were significant: occupation
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20 225 (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50),
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22 226 working hours (p=0.83), and type and employment (p=0.73).
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27 228 Discussion

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30 229 In the present study, we found oral health disparity across various indicators of
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32 230 SEP as well as childhood SEP among workers in Japan. Moreover, the association
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34 231 between occupations and SROH was substantially explained by job-related factors. Our
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36 232 finding is notable for demonstrating oral health disparities even in Japan, where the
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38 233 citizens, including children, have access to dental services with relatively low
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40 234 out-of-pocket cost. Our findings are consistent with a previous study by Morita et al.,
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42 235 which reported that there were significant oral health disparities across occupations.¹⁶
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44 236 We found oral health disparities across occupations as well as other indicators of SEP,
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46 237 including income, wealth, and childhood SEP. Tsakos, et al. reported social gradients
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48 238 across occupation, income, wealth and parental occupation, among older individuals in
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50 239 England.¹⁷

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52 240 One reason why people with higher SEP had better SROH may be related to
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54 241 preventive practices – e.g. dental flossing or use of interdental brush (interproximal
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56 242 brush). Neamatol et al. reported that students with doctorate or masters degrees flossed
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6 243 more than those with bachelor degree or less²⁹, while Tseveenjav et al. reported that
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8 244 people with higher educational attainment performed cleaning more than the others.³⁰
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10 245 Another reason people in higher SEP had better SROH might be utilization of
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12 246 preventive dentistry. People with lower incomes tend to use preventive dental service
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14 247 less frequently^{31 32}, and the difference of use in preventive service might explain the
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16 248 social gradient of SROH. In fact, in the present study, approximately one in three
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18 249 participants (32.3%) among the richest group made a preventive dental clinic visit in
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20 250 the past year, whereas only one in four participants (24.7%) among the poorest group
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22 251 did so. On the other hand, we did not observe a big difference among rich and poor
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24 252 participants in the use of dental services for treatment; 42.3% for the richest group
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26 253 versus 41.4% for the poorest group. Thus, the pathway from lower household income to
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28 254 poor SROH might be through preventive dental service utilization.

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31 255 Another explanation for the relationship between SEP and SROH might be
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33 256 through psychosocial factors. Baker et al reported that greater sense of coherence and
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35 257 higher self-esteem were linked to better oral health perceptions.³³ Therefore, these
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37 258 factors might be mediators between SEP and SROH because those who are in higher
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39 259 SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

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42 260 Our findings add to the previous literature by suggesting that occupational
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44 261 inequalities in oral health can be substantially explained by work-based factors, such as,
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46 262 social support in the workplace, job stress, working hours, and type of employment
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48 263 (precarious vs. permanent). These workplace-related factors might be targets for
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50 264 interventions to mitigate oral health disparities, i.e. in addition to intervening to
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52 265 improve socioeconomic conditions, it may be possible focus on working conditions to
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54 266 reduce oral health disparities.

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57 267 Social support has been reported to have a “stress-buffering effect” on
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6 268 cardiovascular diseases.³⁴⁻³⁶ Stress has been reported as one of the exacerbating factors
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8 269 for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk
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10 270 factor for gingivitis²¹, and Krejci CB, et al. suggested that stress may hasten the
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12 271 development and progression of periodontitis through the suppression of T-cell activity
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14 272 or a reduction in salivary IgA.^{19 20} Precarious employment was also significantly
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16 273 associated with poor SROH in the multivariate model. Previous studies on precarious
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18 274 employment showed that this form of work is associated with job insecurity and
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20 275 psychological distress^{37 38}, and, therefore, being in a precarious employment might also
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22 276 a risk factor of developing periodontitis or gingivitis via stress. The number of
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24 277 precarious employees has been increasing all over the world as well as in Japan. In
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26 278 Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in
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28 279 1985.³⁹

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31 280 Previous studies have suggested a consistent link between early life-course
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33 281 socioeconomic circumstances and health status in adulthood.^{3 5 40 41} Our study is
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35 282 consistent with previous research in showing an association between childhood SEP and
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37 283 oral health. Poulton R et al. examined 1,000 children in New Zealand and found that
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39 284 there was a **significant** social gradient of dental health (tooth cleanliness, gingival
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41 285 bleeding, periodontal disease, and tooth decay) across childhood SEP.³ Thomson et al.
42
43 286 **examined 789 individuals and revealed that those who were in low socioeconomic status**
44
45 287 **at age 5 years were more likely to have lost a tooth in adulthood because of caries and**
46
47 288 **had greater prevalence and extent of periodontitis.**⁵ In our study, when poverty during
48
49 289 the childhood at age five or fifteen was added to the multivariate model, both poverty
50
51 290 during childhood at age five and at age fifteen were associated with poorer SROH (OR:
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53 291 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen,
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55 292 respectively, not shown in tables). These two factors seemed to be independently
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6 293 associated with SROH, because coefficients of the other covariates in the multivariate
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8 294 model hardly changed before and after adding the childhood poverty variables to the
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10 295 multivariate model. Therefore, poverty during childhood appears to affect SROH in
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12 296 adulthood separately from sex, age, and the current workplace-related factors.
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16 298 ·Limitations

17
18 299 There are some limitations in this study. First, SROH is a subjective
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20 300 measurement. Some might argue that this type of measurement might be invalid,
21
22 301 however, self-rated oral health has been examined and reported to be a well-validated
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24 302 and reliable index.^{24 25} Jones JA et al. validated the association between a single-item
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26 303 self-report question and oral clinical examination among two hundred thirty-two
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28 304 community-dwelling participants. The question was *“How would you describe the*
29
30 305 *health of your teeth and gums? Would you say it is excellent, very good, good, fair or*
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32 306 *poor?”* They reported that the single-item self-reported question had a sensitivity of 0.75
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34 307 and a specificity of 0.67 in identifying persons with severe need for denture care,
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36 308 compared with the clinical examination.²⁴ The validation studies were conducted in
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38 309 English, and the present study was conducted in Japanese. As far as we know, no
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40 310 previous studies have validated the scale in Japanese yet. However, we have confirmed
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42 311 that poor SROH was significantly associated with number of removed tooth in the
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44 312 sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of
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46 313 remaining teeth and clinical examination in Japanese.⁴² Therefore, this might support
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48 314 that the scale in Japanese is also valid. Future studies are needed to clarify the validity
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50 315 of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al.
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52 316 compared the collected sample with the vital statistics in Census 2010 of the target
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54 317 population and reported that the obtained sample was properly equivalent with respect
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6 318 to age, sex, and education.²³ Therefore, it is likely that the selection bias does not matter
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8 319 in terms of age, sex and education. We are not able to discuss selection bias precisely
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10 320 because we do not have other information among non-responders, such as smoking
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12 321 habit, income and so on. Thirdly, the data used in this study was cross-sectional, not
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14 322 longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral
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16 323 health; but the reverse is also possible, i.e. it is well described that poor dental status
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18 324 can lead to social stigma and adversely impact people's chances of employment and
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20 325 success in life.⁴³ Attention should be given to the positive association between current
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22 326 poor SROH and economic disadvantage in childhood, because the assessments of
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24 327 economic disadvantage in childhood were based on the participants' recall (recall bias).
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27 328 Fourth, we did not gather data on brushing frequency or use of interdental brush/dental
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29 329 flossing³⁰, and we could not include these factors in the analysis. Some studies reported
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31 330 that people with lower educational attainment or low income use interdental
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33 331 brush/dental flossing less, and this might explain the association between SEPs and
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35 332 poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at
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37 333 workplace were not validated. However, both have been used in practice in Japan, and
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39 334 the internal consistency of the scale in the present participants was acceptably high:
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41 335 Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6
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43 336 items for social support. Future studies should employ well-validated questions on job
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45 337 stress and social support.
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339 Conclusion

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52 340 We found oral health disparities across various SEPs, and that work-related
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54 341 factors could account for more than half the association between occupation and SROH.
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56 342 Improving workplace environments may present a viable solution to reduce oral health
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6 343 disparities. Future studies on the effect of workplace-related factors on oral health
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8 344 should use longitudinal data to elucidate the causal association between the
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10 345 workplace-related factors and oral health.
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17
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19
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30
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32
33 356 design of the study. TT drafted the manuscript and JA, IK, KK, and KO revised it
34
35 357 critically for important intellectual content. TT, JA, IK, KK, and KO approved the final
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37 358 version of the manuscript.
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54 366 Institute). These sponsors were not involved in study design and the collection, analysis,
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56 367 and interpretation of data and the writing of the article and the decision to submit it for
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10 370 **Data sharing:** No additional data are available.
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Table 1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH ^a		<i>p</i> -value ^b
	n	(%)	
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 ^c	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) ^d	226	(32.3)	0.0012
5-7.5 million JPY (Approximately GBP 29,400-44,100) ^d	179	(26.6)	
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)	<.0001
3-5 million JPY (Approximately GBP 17,600-29,400) ^d	169	(30.2)	
More than 5 million JPY (Approximately GBP 29,400) ^d	173	(22.9)	
Education			
High school or less	263	(36.3)	<.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	<.0001
Normal	502	(25.7)	
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	<.0001
Normal	467	(24.8)	
Well-off, very well-off	180	(25.9)	

1	Job stress			
2	1st tertile(least stressful)	289	(25.2)	
3	2nd tertile	272	(25.2)	0.0017
4	3rd tertile(most stressful)	300	(31.3)	
5	Social support in workplace			
6	1st tertile(most supportive)	266	(23.4)	
7	2nd tertile	278	(29.1)	0.0014
8	3rd tertile(least supportive)	295	(29.8)	
9	Working hours per week			
10	<40	360	(26.7)	
11	40-50	162	(23.5)	
12	50-60	81	(26.3)	0.027
13	>60	67	(34.2)	
14	Type of employment			
15	Permanent	526	(25.3)	
16	Precarious	272	(30.9)	0.0083
17	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).

Table 2. 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	<i>p</i> -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".

Table 3. 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	<i>p</i> -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".

Table 4. 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	<i>p</i> -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

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5 a. SROH was assessed by the following question. “Overall, how would you rate the health of your
6 teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or
7 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good
8 SROH”, and “4.not so good and 5.poor” as “Poor SROH”.
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12 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	<i>p-value</i>
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						<i>p-value</i> ^b
		0	1	2	3	4	More than 4	
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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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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1 **Abstract**

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

5 Design: Cross-sectional study

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

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

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

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

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

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27 **Strengths and limitations of this study**

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

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

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

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

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44 **Background**

45 Oral health problems, such as dental caries, periodontal disease, and
46 edentulism, afflict more than half of the population of the planet (3.9 billion people) and
47 untreated dental caries is the most prevalent condition (35% across all ages) among the
48 291 conditions listed in the Global Burden of Disease 2010.^{1,2} Using disability-adjusted
49 life years (DALYs), which is an index of measuring disease burden in society, and is
50 calculated as sum of years of life lost due to premature mortality and years lived with
51 disability, Marcenes et al estimated that the global burden of oral conditions would
52 increase by approximately 20% from 1990 to 2010.^{1,2} In addition to their high
53 prevalence, oral health conditions are a major contributor to socioeconomic disparities
54 in health.^{3,4}

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

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6 69 workers reported less social impact, measured by the 14-item Oral Health Impact
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8 70 Profile, than did workers in lower white-collar or blue-collar occupations.¹⁸ Morita et al.
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10 71 examined the association of occupations with oral conditions, based on approximately
11
12 72 16,000 Japanese workers; they reported that professionals had better oral conditions
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14 73 than office workers and blue collar workers in Japan.^{15 16} Tsakos et al. reported
15
16 74 significant social gradients in oral health, based on a sample of 6,600
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18 75 community-dwelling English people aged 50 years and older.¹⁷ However, none of these
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20 76 considered workplace-related factors, such as social support, working hours, type of
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22 77 employment or job stress, as potential mediators of the association between occupations
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24 78 and oral health. Psychological stress is associated with the workplace-related factors as
25
26 79 well as occupations, and, on the other hand, oral diseases, such as periodontitis and
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28 80 gingivitis, are also associated with psychological stress.¹⁹⁻²² Therefore,
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30 81 workplace-related factors may be candidates for mitigating oral health disparities. and,
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32 82 we hypothesized that job stress (including work hours) – as well as stress-buffering
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34 83 factors such as workplace social support – would mediate the association between
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36 84 occupational class and oral health.

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39 85 In this study, we first examined data of 3,201 workers aged 25-50 years old in
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41 86 Japan to elucidate the associations between indicators of SEP (occupation, income
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43 87 wealth, education and SEP in childhood) and oral health. We then examined the
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45 88 mediation of socioeconomic disparities by workplace-related factors (social support in
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47 89 workplace, job stress, working hours and type of employment).

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52 **METHODS**

54 **Participants**

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56 93 We conducted the present study by using data from the J-SHINE (Japanese
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6 94 study of Stratification, Health, Income, and Neighborhood), the details of which have
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8 95 been previously described.²³ In brief, between October 2010 and February 2011, 13,920
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10 96 community-dwelling residents aged 25 to 50 years were probabilistically and randomly
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12 97 selected from four municipalities in and around Tokyo, Japan, with using the Basic
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14 98 Resident Registration System. Independent survey agencies were contracted to conduct
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16 99 the surveys, and the professional surveyors who had more than three years of
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18 100 experience in conducting interview-based social surveys made contacts with the eligible
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20 101 individuals after attending training sessions to conduct the J-SHINE study. The main
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22 102 reasons the surveyors were not able to receive responses from the eligible participants
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24 103 were as follows: “inaccessible contact (n=4371)” and “refusal of invitation (n=3677)”. Of
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26 104 those who were invited, 4,385 men and women responded (31.6%) to the invitation;
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28 105 these individuals formed the baseline of the J-SHINE study. A questionnaire was
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30 106 self-administered using a computer-assisted personal interview format, unless the
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32 107 participants requested a face-to-face interview. We excluded participants who did not
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34 108 answer the question about self-rated oral health, or who responded that they were not
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36 109 active in the labor market (including homemakers and students); this result in 3,201
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38 110 eligible participants.
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44 112 Measurements

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46 113 All measures in this study were obtained by self-report. Basic demographic
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48 114 variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and
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50 115 45-50 years old), and marital status (categorized as married/not married). Self-rated
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52 116 oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that
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54 117 can evaluate needs of dental care among people, especially those who do not usually
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56 118 visit dentists, and its validity and high internal consistency have been confirmed.^{24 25}
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6 119 SROH was assessed by the following question. *“Overall, how would you rate the health*
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8 *of your teeth and gums?”* Potential responses ranged from *“1.excellent, 2.good, 3.fair,*
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10 *4.not so good or 5.poor”*. In the analysis, the outcome was dichotomized:”1.excellent and
11
12 122 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

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14 As indicators of SEP, we used annual household income, wealth, educational
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16 124 attainment, occupation, and economic situations during childhood. Annual household
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18 125 income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400),
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20 126 JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100).
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23 127 Wealth was based on household financial and other assets (e.g. stock, bond, and so on)
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25 128 and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million
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27 129 (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment
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29 130 was divided into three categories; high school or less, vocational/junior college, and
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31 131 university or more. Occupational class was divided into three categories; professionals,
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33 132 office workers or blue collar workers. Occupations were self-reported, but, in addition, a
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35 133 sociologist on the team (K.K.) examined each response to determine the correct
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37 134 classification based on the detailed job description provided by the participants. Our
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39 135 method of occupational classification was previously used in “The national survey of
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41 136 Social Stratification and social Mobility”, which has been conducted in Japan every ten
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43 137 years since 1955 and is regarded as the most valid classification of occupations in
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45 138 Japan.²⁶ Economic conditions in childhood were evaluated through the following
46
47 139 questions. *“How would you rate the economic conditions in your household at age five?”*
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49 140 and *“How would you rate the economic conditions in your household at age fifteen?”*The
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51 141 answers were selected from *“1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well*
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53 142 *off”*. In the analysis, the answers were divided into three groups: “1.very difficult, 2.
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55 143 difficult”, “3.normal” and “4. well off 5. very well off”. This question was derived from
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6 144 the Comprehensive Survey of Living Conditions, which is annually conducted by the
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8 145 Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate
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10 146 subjective economic situation in Japan.

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13 147 With regard to workplace-related factors, job stress, social support in
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15 148 workplace, working hours, and type of employment were used. Job stress was evaluated
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17 149 by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ).
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19 150 BJSQ has been validated for use with Japanese workers, and consists of lists the 84
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21 151 questions which assesses job stress, social support in workplace and subjective
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23 152 physical/mental symptoms.²⁷ BJSQ has been used in workplaces in Japan and was used
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25 153 in previous research in Japan.²⁷²⁸ One example of the seven questions on the job stress
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27 154 was *"I have to deal with a lot of tasks"*, and the answer was chosen from *"1.yes, 2.rather*
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29 155 *yes 3.rather no, 4.no"*. Aggregated scores for the seven questions were divided into
30
31 156 tertiles. Social support in workplace consisted of six questions, which were also taken
32
33 157 from BJSQ. One example of six questions was *"How reliable is your boss when you are*
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35 158 *in trouble?"*, and the answer was chosen from *"1.very, 2.fairly 3.to some extent, 4.not"*.
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37 159 Aggregated scores for the six questions were divided into tertiles. Working hours were
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39 160 divided into four groups: less than 40 hours per week, 40 to 50 hours per week, 50 to 60
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41 161 hours per week, or more than 60 hours per week. Type of employment was divided into
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43 162 three groups: permanent, precarious or self-employment.
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48 164 Statistical analysis

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50 165 Differences in background characteristics according to SROH (good or poor)
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52 166 were compared using the chi-square test (Table1). We estimated logistic regression
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54 167 models for the association between poor SROH and SEP. We computed sex- and age-
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56 168 adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office
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6 169 workers and blue collar workers, compared with professionals. We also calculated the
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8 170 ORs between each SEP and SROH (Table2), and the ORs between work-related factors
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10 171 and SROH (Table3). Additionally, we estimated the multivariate ORs for the association
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12 172 between occupations and SROH, adjusting for work-related factors, such as job stress
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14 173 social support in workplace, working hours, and type of employment (Table4). With
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16 174 regard to missing data on explanatory variables, we carried out 2 separate analyses. In
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18 175 the first analysis, dummy variables were used for missing data, with creation of a
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20 176 categorical indicator for missing responses (missing category) (Appendix Table1). In the
21
22 177 second analysis, we conducted multiple imputations for the missing data, included all
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24 178 variables shown in Table1. Interactions between sex and the other variables
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26 179 (age/marital status/job stress/social support in the workplace/working hour/type of
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28 180 employment) were tested by entering multiplicative interaction terms into the
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30 181 multivariate adjusted model, because employment situation in Japan is highly different
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32 182 in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical
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34 183 analyses, and “Proc MI” and “Proc MIANALYZE” were used for the multiple
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36 184 imputations
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186 Ethics

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

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

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6 194 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table
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8 195 1 describes the basic characteristics of the study participants according to level of SROH.
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10 196 All of the characteristics except marital status were significantly associated with SROH.
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12 197 Poor SROH was more prevalent in men, older age-groups, blue collar workers,
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14 198 precarious workers, as well as those with lower income, lower wealth, lower educational
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16 199 attainment, higher childhood poverty, lower social support, higher stress and longer
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18 200 working hours.

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

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

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

230

231 Discussion

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

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6 244 disparities across occupations as well as other indicators of SEP, including income,
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8 245 wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation,
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10 246 income, wealth and parental occupation, among older individuals in England.¹⁷

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13 247 One reason why people with higher SEP had better SROH may be related to
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15 248 preventive practices – e.g. dental flossing or use of interdental brush (interproximal
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17 249 brush). Neamatol et al. reported that students with doctorate or masters degrees flossed
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19 250 more than those with bachelor degree or less³⁰, while Tseveenjav et al. reported that
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21 251 people with higher educational attainment performed cleaning more than the others.³¹
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23 252 Another reason people in higher SEP had better SROH might be utilization of
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25 253 preventive dentistry. People with lower incomes tend to use preventive dental service
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27 254 less frequently^{32 33}, and the difference of use in preventive service might explain the
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29 255 social gradient of SROH. In fact, in the present study, approximately one in three
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31 256 participants (32.3%) among the richest group made a preventive dental clinic visit in
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33 257 the past year, whereas only one in four participants (24.7%) among the poorest group
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35 258 did so. On the other hand, we did not observe a big difference among rich and poor
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37 259 participants in the use of dental services for treatment; 42.3% for the richest group
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39 260 versus 41.4% for the poorest group. Thus, the pathway from lower household income to
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41 261 poor SROH might be through preventive dental service utilization.

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44 262 Another explanation for the relationship between SEP and SROH might be
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46 263 through psychosocial factors. Baker et al reported that greater sense of coherence and
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48 264 higher self-esteem were linked to better oral health perceptions.³⁴ Therefore, these
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50 265 factors might be mediators between SEP and SROH because those who are in higher
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52 266 SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

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55 267 Our findings add to the previous literature by suggesting that occupational
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57 268 inequalities in oral health can be substantially explained by work-based factors, such as,

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6 269 social support in the workplace, job stress, working hours, and type of employment
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8 270 (precarious vs. permanent). These workplace-related factors might be targets for
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10 271 interventions to mitigate oral health disparities, i.e. in addition to intervening to
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12 272 improve socioeconomic conditions, it may be possible focus on working conditions to
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14 273 reduce oral health disparities.

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16 274 Social support has been reported to have a “stress-buffering effect” on
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18 275 cardiovascular diseases.³⁵⁻³⁷ Stress has been reported as one of the exacerbating factors
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20 276 for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk
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22 277 factor for gingivitis²¹, and Krejci CB, et al. suggested that stress may hasten the
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24 278 development and progression of periodontitis through the suppression of T-cell activity
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26 279 or a reduction in salivary IgA.^{19 20} Precarious employment was also significantly
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28 280 associated with poor SROH in the multivariate model. Previous studies on precarious
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30 281 employment showed that this form of work is associated with job insecurity and
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32 282 psychological distress^{38 39}, and, therefore, being in a precarious employment might also
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34 283 a risk factor of developing periodontitis or gingivitis via stress. The number of
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36 284 precarious employees has been increasing all over the world as well as in Japan. In
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38 285 Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in
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40 286 1985.⁴⁰

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43 287 Previous studies have suggested a consistent link between early life-course
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45 288 socioeconomic circumstances and health status in adulthood.^{3 5 41 42} Our study is
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47 289 consistent with previous research in showing an association between childhood SEP and
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49 290 oral health. Poulton R et al. examined 1,000 children in New Zealand and found that
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51 291 there was a significant social gradient of dental health (tooth cleanliness, gingival
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53 292 bleeding, periodontal disease, and tooth decay) across childhood SEP.³ Thomson et al.
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55 293 examined 789 individuals and revealed that those who were in low socioeconomic status
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6 294 at age 5 years were more likely to have lost a tooth in adulthood because of caries and
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8 295 had greater prevalence and extent of periodontitis.⁵ In our study, when poverty during
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10 296 the childhood at age five or fifteen was added to the multivariate model, both poverty
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12 297 during childhood at age five and at age fifteen were associated with poorer SROH (OR:
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14 298 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen,
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16 299 respectively, not shown in tables). These two factors seemed to be independently
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18 300 associated with SROH, because coefficients of the other covariates in the multivariate
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20 301 model hardly changed before and after adding the childhood poverty variables to the
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22 302 multivariate model. Therefore, poverty during childhood appears to affect SROH in
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24 303 adulthood separately from sex, age, and the current workplace-related factors. In Japan,
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26 304 school children do receive oral checkups for free, however, they do not receive free dental
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28 305 care. Therefore, economic difficulties during childhood might result in oral health
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30 306 disparities during childhood, leading to oral health disparities during adults.
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308 · Limitations

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

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6 319 English, and the present study was conducted in Japanese. As far as we know, no
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8 320 previous studies have validated the scale in Japanese yet. However, we have confirmed
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10 321 that poor SROH was significantly associated with number of removed tooth in the
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12 322 sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of
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14 323 remaining teeth and clinical examination in Japanese.⁴³ Therefore, this might support
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16 324 that the scale in Japanese is also valid. Future studies are needed to clarify the validity
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18 325 of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al.
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20 326 compared the collected sample with the vital statistics in Census 2010 of the target
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22 327 population and reported that the obtained sample was properly equivalent with respect
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24 328 to age, sex, and education.²³ Therefore, it is likely that the selection bias does not matter
25
26 329 in terms of age, sex and education. We are not able to discuss selection bias precisely
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28 330 because we do not have other information among non-responders, such as smoking
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30 331 habit, income and so on. Thirdly, the data used in this study was cross-sectional, not
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32 332 longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral
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34 333 health; but the reverse is also possible, i.e. it is well described that poor dental status
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36 334 can lead to social stigma and adversely impact people's chances of employment and
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38 335 success in life.⁴⁴ Attention should be given to the positive association between current
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40 336 poor SROH and economic disadvantage in childhood, because the assessments of
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42 337 economic disadvantage in childhood were based on the participants' recall (recall bias).
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44 338 Fourth, we did not gather data on brushing frequency or use of interdental brush/dental
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46 339 flossing³¹, and we could not include these factors in the analysis. Some studies reported
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48 340 that people with lower educational attainment or low income use interdental
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50 341 brush/dental flossing less, and this might explain the association between SEPs and
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52 342 poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at
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54 343 workplace were not validated. However, both have been used in practice in Japan, and
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6 344 the internal consistency of the scale in the present participants was acceptably high:
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8 345 Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6
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10 346 items for social support. Future studies should employ well-validated questions on job
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12 347 stress and social support.
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16 349 **Conclusion**

18 350 We found oral health disparities across various SEPs, and that work-related
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20 351 factors could account for more than half the association between occupation and SROH .
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22 352 Improving workplace environments may present a viable solution to reduce oral health
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24 353 disparities. Future studies on the effect of workplace-related factors on oral health
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26 354 should use longitudinal data to elucidate the causal association between the
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28 355 workplace-related factors and oral health.
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381

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383

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392 **Data sharing:** No additional data are available.

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Table 1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH ^a		<i>p</i> -value ^b
	n	(%)	
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 ^c	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) ^d	226	(32.3)	0.0012
5-7.5 million JPY (Approximately GBP 29,400-44,100) ^d	179	(26.6)	
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)	<.0001
3-5 million JPY (Approximately GBP 17,600-29,400) ^d	169	(30.2)	
More than 5 million JPY (Approximately GBP 29,400) ^d	173	(22.9)	
Education			
High school or less	263	(36.3)	<.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	<.0001
Normal	502	(25.7)	
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	<.0001
Normal	467	(24.8)	
Well-off, very well-off	180	(25.9)	

1	Job stress			
2	1st tertile(least stressful)	289	(25.2)	
3	2nd tertile	272	(25.2)	0.0017
4	3rd tertile(most stressful)	300	(31.3)	
5	Social support in workplace			
6	1st tertile(most supportive)	266	(23.4)	
7	2nd tertile	278	(29.1)	0.0014
8	3rd tertile(least supportive)	295	(29.8)	
9	Working hours per week			
10	<40	360	(26.7)	
11	40-50	162	(23.5)	
12	50-60	81	(26.3)	0.027
13	>60	67	(34.2)	
14	Type of employment			
15	Permanent	526	(25.3)	
16	Precarious	272	(30.9)	0.0083
17	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).

Table 2. 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	<i>p</i> -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".

Table 3. 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	<i>p</i> -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".

Table 4. 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	<i>p</i> -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

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5 a. SROH was assessed by the following question. "Overall, how would you rate the health of your
6 teeth and gums?" Potential responses ranged from "1.excellent, 2.good, 3.fair, 4.not so good or
7 5.poor". In the analysis, the outcome was dichotomized:"1.excellent and 2.good, 3.fair" as "Good
8 SROH", and "4.not so good and 5.poor" as "Poor SROH".
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12 b. Divorced/separated and widow people were classified into "not married".
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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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1 **Abstract**

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

5 Design: Cross-sectional study

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

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

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

23 Conclusions: We found oral health disparity across SEP among workers in Japan.

24 Approximately 60% of the association between occupation and SROH was explained by
25 job-related factors. Economic difficulties during childhood appear to affect SROH in

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6 26 adulthood separately from sex, age, and the current workplace-related factors.
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6 27 **Strengths and limitations of this study**
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8 · Previous studies have shown an association between socioeconomic positions
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10 (SEP) in adulthood and oral health, however few have examined the relation between
11
12 SEP in childhood and oral health in adulthood.
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14 · Using cross-sectional data of 3,201 workers aged 25-50 years old in Japan, we
15
16 found evidence that economic difficulties during childhood as well as SEP in adulthood
17
18 independently appeared to affect self-rated oral health (SROH) in adulthood among
19
20 working men and women.
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22 · Workplace-related factors (social support in the workplace, job stress, working
23
24 hours, and type of employment) substantially explained the association between
25
26 occupation and SROH.
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28 · The response rate was low, however, the obtained sample was properly
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30 equivalent with respect to age, sex, and education, compared with vital statistics in
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32 Census 2010 of the target population.
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44 **Background**

45 Oral health problems, such as dental caries, periodontal disease, and
46 edentulism, afflict more than half of the population of the planet (3.9 billion people) and
47 untreated dental caries is the most prevalent condition (35% across all ages) among the
48 291 conditions listed in the Global Burden of Disease 2010.^{1,2} Using disability-adjusted
49 life years (DALYs), which is an index of measuring disease burden in society, and is
50 calculated as sum of years of life lost due to premature mortality and years lived with
51 disability, Marcenes et al estimated that the global burden of oral conditions would
52 increase by approximately 20% from 1990 to 2010.^{1,2} In addition to their high
53 prevalence, oral health conditions are a major contributor to socioeconomic disparities
54 in health.^{3,4}

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

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6 69 workers reported less social impact, measured by the 14-item Oral Health Impact
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8 70 Profile, than did workers in lower white-collar or blue-collar occupations.¹⁸ Morita et al.
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10 71 examined the association of occupations with oral conditions, based on approximately
11
12 72 16,000 Japanese workers; they reported that professionals had better oral conditions
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14 73 than office workers and blue collar workers in Japan.^{15 16} Tsakos et al. reported
15
16 74 significant social gradients in oral health, based on a sample of 6,600
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18 75 community-dwelling English people aged 50 years and older.¹⁷ However, none of these
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20 76 considered workplace-related factors, such as social support, working hours, type of
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22 77 employment or job stress, as potential mediators of the association between occupations
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24 78 and oral health. Psychological stress is associated with the workplace-related factors as
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26 79 well as occupations, and, on the other hand, oral diseases, such as periodontitis and
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28 80 gingivitis, are also associated with psychological stress.¹⁹⁻²² Therefore,
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30 81 workplace-related factors may be candidates for mitigating oral health disparities. and,
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32 82 we hypothesized that job stress (including work hours) – as well as stress-buffering
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34 83 factors such as workplace social support – would mediate the association between
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36 84 occupational class and oral health.

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39 85 In this study, we first examined data of 3,201 workers aged 25-50 years old in
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41 86 Japan to elucidate the associations between indicators of SEP (occupation, income
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43 87 wealth, education and SEP in childhood) and oral health. We then examined the
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45 88 mediation of socioeconomic disparities by workplace-related factors (social support in
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47 89 workplace, job stress, working hours and type of employment).

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52 **METHODS**

53 **Participants**

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56 93 We conducted the present study by using data from the J-SHINE (Japanese
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6 94 study of Stratification, Health, Income, and Neighborhood), the details of which have
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8 95 been previously described.²³ In brief, between October 2010 and February 2011, 13,920
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10 96 community-dwelling residents aged 25 to 50 years were probabilistically and randomly
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12 97 selected from four municipalities in and around Tokyo, Japan, with using the Basic
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14 98 Resident Registration System. Independent survey agencies were contracted to conduct
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16 99 the surveys, and the professional surveyors who had more than three years of
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18 100 experience in conducting interview-based social surveys made contacts with the eligible
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20 101 individuals after attending training sessions to conduct the J-SHINE study. The main
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22 102 reasons the surveyors were not able to receive responses from the eligible participants
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24 103 were as follows: “inaccessible contact (n=4371)” and “refusal of invitation (n=3677)”. Of
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26 104 those who were invited, 4,385 men and women responded (31.6%) to the invitation;
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28 105 these individuals formed the baseline of the J-SHINE study. A questionnaire was
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30 106 self-administered using a computer-assisted personal interview format, unless the
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32 107 participants requested a face-to-face interview. We excluded participants who did not
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34 108 answer the question about self-rated oral health, or who responded that they were not
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36 109 active in the labor market (including homemakers and students); this result in 3,201
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38 110 eligible participants.
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44 112 Measurements

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46 113 All measures in this study were obtained by self-report. Basic demographic
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48 114 variables included sex (men/women), age (categorized as 25-29, 30-34, 35-39, 40-44, and
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50 115 45-50 years old), and marital status (categorized as married/not married). Self-rated
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52 116 oral health (SROH) was used to evaluate oral conditions. SROH is a screening tool that
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54 117 can evaluate needs of dental care among people, especially those who do not usually
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56 118 visit dentists, and its validity and high internal consistency have been confirmed.^{24 25}
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6 119 SROH was assessed by the following question. *“Overall, how would you rate the health*
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8 *of your teeth and gums?”* Potential responses ranged from *“1.excellent, 2.good, 3.fair,*
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10 *4.not so good or 5.poor”*. In the analysis, the outcome was dichotomized:”1.excellent and
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12 2.good, 3.fair” as “Good SROH”, and “4.not so good and 5.poor” as “Poor SROH”.

13
14 As indicators of SEP, we used annual household income, wealth, educational
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16 attainment, occupation, and economic situations during childhood. Annual household
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18 income was divided into tertiles; less than JPY 5 million (Approximately GBP 29,400),
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20 JPY 5 to 7.5 million (GBP 29,400-44,100), or more than JPY 7.5 million (GBP 44,100).
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23 Wealth was based on household financial and other assets (e.g. stock, bond, and so on)
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25 and was divided into tertiles; less than JPY 3 million (GBP 17,600), JPY 3 to 5 million
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27 (GBP 17,600-29,400), or more than JPY 5 million (GBP 29,400). Educational attainment
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29 was divided into three categories; high school or less, vocational/junior college, and
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31 university or more. Occupational class was divided into three categories; professionals,
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33 office workers or blue collar workers. Occupations were self-reported, but, in addition, a
34
35 sociologist on the team (K.K.) examined each response to determine the correct
36
37 classification based on the detailed job description provided by the participants. Our
38
39 method of occupational classification was previously used in “The national survey of
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41 Social Stratification and social Mobility”, which has been conducted in Japan every ten
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43 years since 1955 and is regarded as the most valid classification of occupations in
44
45 Japan.²⁶ Economic conditions in childhood were evaluated through the following
46
47 questions. *“How would you rate the economic conditions in your household at age five?”*
48
49 and *“How would you rate the economic conditions in your household at age fifteen?”*The
50
51 answers were selected from *“1.very difficult, 2. difficult, 3.normal, 4. well off 5. very well*
52
53 *off”*. In the analysis, the answers were divided into three groups: “1.very difficult, 2.
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55 difficult”, “3.normal” and “4. well off 5. very well off”. This question was derived from
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6 144 the Comprehensive Survey of Living Conditions, which is annually conducted by the
7
8 145 Ministry of Health, Labour, and Welfare, and is regarded as a standard way to evaluate
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10 146 subjective economic situation in Japan.

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13 147 With regard to workplace-related factors, job stress, social support in
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15 148 workplace, working hours, and type of employment were used. Job stress was evaluated
16
17 149 by seven questions, which were taken from the Brief Job Stress Questionnaire (BJSQ).
18
19 150 BJSQ has been validated for use with Japanese workers, and consists of lists the 84
20
21 151 questions which assesses job stress, social support in workplace and subjective
22
23 152 physical/mental symptoms.²⁷ BJSQ has been used in workplaces in Japan and was used
24
25 153 in previous research in Japan.^{27 28} One example of the seven questions on the job stress
26
27 154 was *“I have to deal with a lot of tasks”*, and the answer was chosen from *“1.yes, 2.rather*
28
29 155 *yes 3.rather no, 4.no”*. Aggregated scores for the seven questions were divided into
30
31 156 tertiles. Social support in workplace consisted of six questions, which were also taken
32
33 157 from BJSQ. One example of six questions was *“How reliable is your boss when you are*
34
35 158 *in trouble?”*, and the answer was chosen from *“1.very, 2.fairly 3.to some extent, 4.not”*.
36
37 159 Aggregated scores for the six questions were divided into tertiles. Working hours were
38
39 160 divided into four groups: less than 40 hours per week, 40 to 50 hours per week, 50 to 60
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41 161 hours per week, or more than 60 hours per week. Type of employment was divided into
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43 162 three groups: permanent, precarious or self-employment.
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48 164 Statistical analysis

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50 165 Differences in background characteristics according to SROH (good or poor)
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52 166 were compared using the chi-square test (Table1). We estimated logistic regression
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54 167 models for the association between poor SROH and SEP. We computed sex- and age-
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56 168 adjusted odds ratio (OR) and 95% confidence intervals (C.I.) for poor SROH among office
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6 169 workers and blue collar workers, compared with professionals. We also calculated the
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8 170 ORs between each SEP and SROH (Table2), and the ORs between work-related factors
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10 171 and SROH (Table3). Additionally, we estimated the multivariate ORs for the association
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12 172 between occupations and SROH, adjusting for work-related factors, such as job stress
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14 173 social support in workplace, working hours, and type of employment (Table4). With
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16 174 regard to missing data on explanatory variables, we carried out 2 separate analyses. In
17
18 175 the first analysis, dummy variables were used for missing data, with creation of a
19
20 176 categorical indicator for missing responses (missing category) (Appendix Table1). In the
21
22 177 second analysis, we conducted multiple imputations for the missing data, included all
23
24 178 variables shown in Table1. Interactions between sex and the other variables
25
26 179 (age/marital status/job stress/social support in the workplace/working hour/type of
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28 180 employment) were tested by entering multiplicative interaction terms into the
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30 181 multivariate adjusted model, because employment situation in Japan is highly different
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32 182 in men and women. SAS 9.3 (SAS Institute, Cary, NC) was used for all statistical
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34 183 analyses, and “Proc MI” and “Proc MIANALYZE” were used for the multiple
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36 184 imputations
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186 Ethics

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

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192 Results

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

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6 194 2.good (N of 772), 3.fair (N of 1155), 4.not so good (N of 738) and 5.poor (N of 129). Table
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8 195 1 describes the basic characteristics of the study participants according to level of SROH.
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10 196 All of the characteristics except marital status were significantly associated with SROH.
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12 197 Poor SROH was more prevalent in men, older age-groups, blue collar workers,
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14 198 precarious workers, as well as those with lower income, lower wealth, lower educational
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16 199 attainment, higher childhood poverty, lower social support, higher stress and longer
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18 200 working hours.

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

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

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6 219 Table 4 shows the multivariate ORs and 95% CI for poor SROH from the
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8 220 multiple imputation models. The associations between occupational class and poor
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10 221 SROH were substantially attenuated by work-related factors. Approximately 60% of the
11
12 222 association between occupations and poor SROH was explained by the work-related
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14 223 factors.²⁸ In the multivariate model, all of the workplace-related factors (social support,
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16 224 job stress, type of employment and working hours) were significantly associated with
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18 225 poor SROH. Compared with the analysis that employed dummy categories for missing
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20 226 values (Appendix Table1), we found similar results after accounting for missing values
21
22 227 using multiple imputations. None of the interactions were significant; occupation
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24 228 (p=0.19), age (p=0.74), marital status (p=0.44), job stress (p=0.25), job support (p=0.50),
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26 229 working hours (p=0.83), and type and employment (p=0.73).
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31 Discussion

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33 232 In the present study, we found oral health disparity across various indicators of
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35 233 SEP as well as childhood SEP among workers in Japan. Moreover, the association
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37 234 between occupations and SROH was substantially explained by job-related factors. Our
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39 235 finding is notable for demonstrating oral health disparities even in Japan. The
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41 236 Japanese universal health coverage includes most of dental service as well as medical
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43 237 services, and the citizens, including children and older adults, have access to dental
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45 238 services with relatively low out-of-pocket cost. For most of adult patients, 70 % of dental
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47 239 care payments are covered by the universal health care insurance. For people with 70 or
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49 240 older, 80% of the payments are covered.²⁹ Besides, the copayments among children are
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51 241 reimbursed in more than half of local governments, depending on their policies. Our
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53 242 findings are consistent with a previous study by Morita et al., which reported that there
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55 243 were significant oral health disparities across occupations.¹⁶ We found oral health
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6 244 disparities across occupations as well as other indicators of SEP, including income,
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8 245 wealth, and childhood SEP. Tsakos, et al. reported social gradients across occupation,
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10 246 income, wealth and parental occupation, among older individuals in England.¹⁷

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13 247 One reason why people with higher SEP had better SROH may be related to
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15 248 preventive practices – e.g. dental flossing or use of interdental brush (interproximal
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17 249 brush). Neamatol et al. reported that students with doctorate or masters degrees flossed
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19 250 more than those with bachelor degree or less³⁰, while Tseveenjav et al. reported that
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21 251 people with higher educational attainment performed cleaning more than the others.³¹
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23 252 Another reason people in higher SEP had better SROH might be utilization of
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25 253 preventive dentistry. People with lower incomes tend to use preventive dental service
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27 254 less frequently^{32 33}, and the difference of use in preventive service might explain the
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29 255 social gradient of SROH. In fact, in the present study, approximately one in three
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31 256 participants (32.3%) among the richest group made a preventive dental clinic visit in
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33 257 the past year, whereas only one in four participants (24.7%) among the poorest group
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35 258 did so. On the other hand, we did not observe a big difference among rich and poor
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37 259 participants in the use of dental services for treatment; 42.3% for the richest group
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39 260 versus 41.4% for the poorest group. Thus, the pathway from lower household income to
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41 261 poor SROH might be through preventive dental service utilization.

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44 262 Another explanation for the relationship between SEP and SROH might be
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46 263 through psychosocial factors. Baker et al reported that greater sense of coherence and
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48 264 higher self-esteem were linked to better oral health perceptions.³⁴ Therefore, these
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50 265 factors might be mediators between SEP and SROH because those who are in higher
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52 266 SEP, including occupations, have, in general, higher self-esteem and sense of coherence.

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55 267 Our findings add to the previous literature by suggesting that occupational
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57 268 inequalities in oral health can be substantially explained by work-based factors, such as,

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6 269 social support in the workplace, job stress, working hours, and type of employment
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8 270 (precarious vs. permanent). These workplace-related factors might be targets for
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10 271 interventions to mitigate oral health disparities, i.e. in addition to intervening to
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12 272 improve socioeconomic conditions, it may be possible focus on working conditions to
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14 273 reduce oral health disparities.

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16 274 Social support has been reported to have a “stress-buffering effect” on
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18 275 cardiovascular diseases.³⁵⁻³⁷ Stress has been reported as one of the exacerbating factors
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20 276 for periodontitis or gingivitis. Hugo FN et al. reported that stress was a significant risk
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22 277 factor for gingivitis²¹, and Krejci CB, et al. suggested that stress may hasten the
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24 278 development and progression of periodontitis through the suppression of T-cell activity
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26 279 or a reduction in salivary IgA.^{19 20} Precarious employment was also significantly
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28 280 associated with poor SROH in the multivariate model. Previous studies on precarious
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30 281 employment showed that this form of work is associated with job insecurity and
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32 282 psychological distress^{38 39}, and, therefore, being in a precarious employment might also
33
34 283 a risk factor of developing periodontitis or gingivitis via stress. The number of
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36 284 precarious employees has been increasing all over the world as well as in Japan. In
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38 285 Japan 35.2% of total workers in 2012 were precarious workers, while only 16.4% were in
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40 286 1985.⁴⁰

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44 287 Previous studies have suggested a consistent link between early life-course
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46 288 socioeconomic circumstances and health status in adulthood.^{3 5 41 42} Our study is
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48 289 consistent with previous research in showing an association between childhood SEP and
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50 290 oral health. Poulton R et al. examined 1,000 children in New Zealand and found that
51
52 291 there was a significant social gradient of dental health (tooth cleanliness, gingival
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54 292 bleeding, periodontal disease, and tooth decay) across childhood SEP.³ Thomson et al.
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56 293 examined 789 individuals and revealed that those who were in low socioeconomic status

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6 294 at age 5 years were more likely to have lost a tooth in adulthood because of caries and
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8 295 had greater prevalence and extent of periodontitis.⁵ In our study, when poverty during
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10 296 the childhood at age five or fifteen was added to the multivariate model, both poverty
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12 297 during childhood at age five and at age fifteen were associated with poorer SROH (OR:
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14 298 1.60, 95%CI: 1.23-2.08 at age five, and OR: 1.47, 95%CI: 1.15-1.87 at age fifteen,
15
16 299 respectively, not shown in tables). These two factors seemed to be independently
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18 300 associated with SROH, because coefficients of the other covariates in the multivariate
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20 301 model hardly changed before and after adding the childhood poverty variables to the
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22 302 multivariate model. Therefore, poverty during childhood appears to affect SROH in
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24 303 adulthood separately from sex, age, and the current workplace-related factors. In Japan,
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26 304 school children do receive oral checkups for free, however, they do not receive free dental
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28 305 care. Therefore, economic difficulties during childhood might result in oral health
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30 306 disparities during childhood, leading to oral health disparities during adults.
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308 · Limitations

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

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6 319 English, and the present study was conducted in Japanese. As far as we know, no
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8 320 previous studies have validated the scale in Japanese yet. However, we have confirmed
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10 321 that poor SROH was significantly associated with number of removed tooth in the
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12 322 sample (Appendix Table2). Ando et al confirmed the validity of self-reported number of
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14 323 remaining teeth and clinical examination in Japanese.⁴³ Therefore, this might support
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16 324 that the scale in Japanese is also valid. Future studies are needed to clarify the validity
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18 325 of the scale in Japanese. Secondly, the response rate was low. However, Takada et. al.
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20 326 compared the collected sample with the vital statistics in Census 2010 of the target
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22 327 population and reported that the obtained sample was properly equivalent with respect
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24 328 to age, sex, and education.²³ Therefore, it is likely that the selection bias does not matter
25
26 329 in terms of age, sex and education. We are not able to discuss selection bias precisely
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28 330 because we do not have other information among non-responders, such as smoking
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30 331 habit, income and so on. Thirdly, the data used in this study was cross-sectional, not
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32 332 longitudinal, therefore, we cannot infer causality. Thus, low SEP could cause worse oral
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34 333 health; but the reverse is also possible, i.e. it is well described that poor dental status
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36 334 can lead to social stigma and adversely impact people's chances of employment and
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38 335 success in life.⁴⁴ Attention should be given to the positive association between current
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40 336 poor SROH and economic disadvantage in childhood, because the assessments of
41
42 337 economic disadvantage in childhood were based on the participants' recall (recall bias).
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44 338 Fourth, we did not gather data on brushing frequency or use of interdental brush/dental
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46 339 flossing³¹, and we could not include these factors in the analysis. Some studies reported
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48 340 that people with lower educational attainment or low income use interdental
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50 341 brush/dental flossing less, and this might explain the association between SEPs and
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52 342 poorer SROH. Finally, the 7 items for job stress and the 6 items for social support at
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54 343 workplace were not validated. However, both have been used in practice in Japan, and
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6 344 the internal consistency of the scale in the present participants was acceptably high:
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8 345 Cronbach's alpha coefficient was 0.90 for the 7 items for job stress, and 0.91 for the 6
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10 346 items for social support. Future studies should employ well-validated questions on job
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12 347 stress and social support.
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16 349 **Conclusion**

18 350 We found oral health disparities across various SEPs, and that work-related
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20 351 factors could account for more than half the association between occupation and SROH .
21
22 352 Improving workplace environments may present a viable solution to reduce oral health
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24 353 disparities. Future studies on the effect of workplace-related factors on oral health
25
26 354 should use longitudinal data to elucidate the causal association between the
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28 355 workplace-related factors and oral health.
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42
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50
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52
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55 368 version of the manuscript.
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371

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Table 1. Characteristics of participants by status of self-rated oral health (SROH) among 3,201 men and women aged 25-50 years old in Japan during 2010-2011

Characteristic	Poor SROH ^a		<i>p</i> -value ^b
	n	(%)	
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 ^c	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) ^d	226	(32.3)	0.0012
5-7.5 million JPY (Approximately GBP 29,400-44,100) ^d	179	(26.6)	
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)	<.0001
3-5 million JPY (Approximately GBP 17,600-29,400) ^d	169	(30.2)	
More than 5 million JPY (Approximately GBP 29,400) ^d	173	(22.9)	
Education			
High school or less	263	(36.3)	<.0001
Vocational/junior college	262	(26.9)	
University or more	333	(22.7)	
Economic situation at home when respondents were five years old			
Poor, very poor	226	(34.8)	<.0001
Normal	502	(25.7)	
Well-off, very well-off	133	(23.5)	
Economic situation at home when respondents were fifteen years old			
Poor, very poor	216	(35.9)	<.0001
Normal	467	(24.8)	
Well-off, very well-off	180	(25.9)	

1	Job stress			
2	1st tertile(least stressful)	289	(25.2)	
3	2nd tertile	272	(25.2)	0.0017
4	3rd tertile(most stressful)	300	(31.3)	
5	Social support in workplace			
6	1st tertile(most supportive)	266	(23.4)	
7	2nd tertile	278	(29.1)	0.0014
8	3rd tertile(least supportive)	295	(29.8)	
9	Working hours per week			
10	<40	360	(26.7)	
11	40-50	162	(23.5)	
12	50-60	81	(26.3)	0.027
13	>60	67	(34.2)	
14	Type of employment			
15	Permanent	526	(25.3)	
16	Precarious	272	(30.9)	0.0083
17	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).

Table 2. 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	<i>p</i> -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".

Table 3. 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	<i>p</i> -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".

Table 4. 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	<i>p</i> -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

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5 a. SROH was assessed by the following question. “Overall, how would you rate the health of your
6 teeth and gums?” Potential responses ranged from “1.excellent, 2.good, 3.fair, 4.not so good or
7 5.poor”. In the analysis, the outcome was dichotomized:”1.excellent and 2.good, 3.fair” as “Good
8 SROH”, and “4.not so good and 5.poor” as “Poor SROH”.
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12 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	<i>p-value</i>
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						<i>p-value</i> ^b
		0	1	2	3	4	More than 4	
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.