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Co-Payments and Inequality in Gingival Bleeding and Dental Visits

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ABSTRACT

Objectives: Japan's universal health insurance covers a wide range of dental treatments, and the co-payment rates differ by age. We investigated whether the inequality in gingival bleeding and dental visits was smaller amongst those with lower co-payment rates.

Methods: This cross-sectional study used data from the 2019 Japan Gerontological Evaluation Study. The participants were functionally independent adults aged 65 years or older. The dependent variables were current gingival bleeding as a symptom of periodontal diseases and dental nonattendance for treatment in the past year. The independent variables were ridit scores of equivalent income and educational status. For covariates, we used age, sex, and the number of remaining teeth. To evaluate the inequalities, we used the slope index of inequality (SII) and the relative index of inequality (RII). We also conducted stratified analyses by co-payment rates (30%, 20%, and 10%) to clarify the difference in inequalities by co-payment rate.

Results: A total of 15,389 participants were included in the analysis; their mean age was 71.8 (SD = 4.1) and 51.8% were women. There were significant absolute and relative inequalities in gingival bleeding and dental visits by equivalent income and education. With regards to educational status, inequalities were lower with a decrease in the co-payment rate. In particular, relative inequality by education in gingival bleeding was the largest amongst the 30% co-payment group (RII, 1.918; 95% confidence interval [CI], 1.386 to 2.656). For gingival bleeding, the absolute and relative inequality by equivalent income were not significant amongst the 10% co-payment group (SII, −0.003; 95% CI, −0.003 to 0.028; RII, 1.006; 95% CI = 0.676 to 1.498).

Conclusions: A low co-payment rate was associated with smaller inequalities in gingival bleeding and dental visits by equivalent income and educational status.

Introduction

The importance of oral health inequalities was highlighted in the resolution on oral health that was adopted in the 74th World Health Assembly in 2021.[1] Previous studies have reported inequality in periodontal disease associated with socioeconomic status such as low education status and low income.[2–6] Periodontal disease is one of the main causes of

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tooth loss[7–10] related to all-cause mortality.[11–13] The inequality in periodontal disease can lead to inequality in tooth loss and consequently to general health inequalities. Additionally, there were studies that reported inequality of dental attendance and dental service use caused by socioeconomic status.[14,15]

Universal health coverage (UHC) is an important measure to improve access to health care.[16] UHC is crucial for achieving health and well-being in the Sustainable Development Goals, which many countries have been working towards.[17] Oral health is an important area that should be covered in UHC.[16,18] The prevalence of oral disease worldwide is very high, and it is a critical public health issue.[19] However, oral health has been neglected as part of UHC.[16,20] In a meeting in 2019, the United Nations highlighted the need to strengthen oral health in UHC.[21]

Japan has achieved UHC to a great extent; as a previous study reports, almost everyone was insured in 1961.[22] Japanese health care insurance plans are roughly divided into 2 types: employee and national health insurance plans.[22] Both plans cover the same types of medical services, including dentistry. This universal health insurance system covers most basic dental treatments.[23] The co-payment for medical and dental care decreases with age, with the rates being 30% until 69 years, 20% for those between 70 and 74 years, and 10% for those 75 years or older.[24]

Japan has the most accessible dental treatment when considering their universal health insurance system. In a study examining the per capita co-payment rate of dental treatment and the frequency of dental visits amongst countries of the Organisation for Economic Co-operation and Development, the co-payment rate for dental treatment is low in Japan and the frequency of dental visits per capita is high.[20]

Co-payment rates are important because they affect access to dental care. A previous study reported that amongst older adults, the proportion of people who attended dental visits varied depending on the co-payment rate.[25] However, they did not mention whether the difference in the co-payment rate reduced inequalities in dental visits. Additionally, another study investigated inequalities of denture use by income or education status, and researchers found inequalities of denture use by co-payment rate; the inequality appeared higher when the co-payment rate was higher.[26] These results may be attributed to a decrease in the inequality in dental visits due to the decrease in co-payments; however, the authors did not report the association with dental visits.

Therefore, this study aimed to evaluate whether the inequality in gingival bleeding as one of the symptoms of periodontal disease and dental attendance would be smaller with a decrease in co-payment rate. We hypothesised that the inequalities in gingival bleeding and dental attendance were smaller amongst those with lower co-payment rates.

Methods

Study settings and participants

This cross-sectional study was based on self-reported questionnaires. Data from the 2019 survey of the Japan Gerontological Evaluation Study (JAGES) were used. The JAGES is an ongoing large cohort study investigating health-related factors and targeting functionally independent older adults aged 65 years or older in Japan.[27] The questionnaires were distributed by mail to residents living in 63 municipalities between November 2019 and January 2020. The questionnaire consists of a core questionnaire and 8 versions (A to H) of supplemental questionnaires. Version D included dental-related questions, and our study targeted those who answered this supplemental questionnaire. The eligibility criteria of the analysed population are as follows: (1) those who have at least 1 tooth, (2) those who did not receive public assistance, (3) those who reported being functionally independent, and (4) those aged 69 to 79 years old, to align with the co-payment rate–age bands, given that the co-payment rate changes in 5-year increments in Japan's universal health insurance system. No third-party data were used.

Dependent variables

We used the following 2 dependent variables: gingival bleeding (as an indicator of periodontal disease) and dental nonattendance. Gingival bleeding is one of the major symptoms of periodontal disease, and it was determined using the following yes/no question: "I got blood from my gums recently."[28,29] Dental visits were assessed using the question, "When did you last visit the dental clinic for 'treatment' (including adjustment of dentures)?" and the possible responses were "during the past 6 months," "6 months to 1 year ago," "1 to 3 years ago," "more than 3 years ago," and "I've never seen a dentist." Those who had not visited a dental clinic in the past year were classified as not having dental attendance, and those who had visited were classified as having dental attendance.

Independent variables (socioeconomic indicators)

As socioeconomic indicators, we used equivalent household income and educational status. Equivalent household income was calculated by dividing annual household income by the square root of the family members. Equivalent household income (in Japanese yen [JPY], where 1 USD $\approx$ 109 JPY) was categorised as follows: (1) less than 1.00 million, (2) 1.00 to 1.99 million, (3) 2.00 to 2.99 million, (4) 3.00 to 3.99 million, and (5) 4 million or more. Educational status was categorised as 9 years or fewer, 10 to 12 years, and 13 years or more. Nine years of education is equivalent to junior high school; 12 years, to higher school; and 13 or more years, to a university or vocational school. Each education and income category was converted to a modified ridit score, which was calculated by the midpoint of the range of the cumulative distribution of the population of participants in each category.

Covariates

For covariates, we used age, sex, and the number of remaining teeth. The analysis was conducted by each co-payment group. Each co-payment group included a different age range. Therefore, we used the age of people who are applicable to each group as a continuous variable. Additionally, in this study, the target population comprised people who had at

least 1 tooth. Therefore, we used the number of remaining teeth (1–4, 5–9, 10–19, and ≥20) as categorical variables.

Statistical analysis

To evaluate the absolute and relative inequality in gingival bleeding and dental visits, we employed the slope index of inequality (SII) and the relative index of inequality (RII).[30] The SII and RII were used to estimate the absolute differences and relative ratio, respectively, of the prevalence of self-reported gingival bleeding and the dental nonattendance for treatment by socioeconomic inequality. If the SII is closer to 0 and the RII is closer to 1, there is less inequality in the absolute and relative scales, respectively. In Japan, whilst the geographic inequality of dental services has been decreasing, as of 2010, 21.4% of municipalities with a population of fewer than 5000 did not have dental clinics.[31] Therefore, the ease of access to dental clinics may vary by region. Consequently, we used generalised estimating equations, considering municipalities as clusters, as well as fitted models with binomial distribution and the identity link function for SII and the logarithmic link function for RII. Before the analyses, we conducted multiple imputations to reduce selection bias. The missing values were imputed by using multiple imputation by chained equations (MICE). We constructed 50 multiple imputed data sets and combined the estimates using Rubin's rule.[32,33] For multiple imputation, we used all variables (age, sex, the number of teeth, equivalent income, education status, gingival bleeding, and dental attendance for treatment).

First, we conducted an analysis including the interaction term for overall participants to check the association between the co-payment rate and socioeconomic indicators. Because we could not obtain information from the government directly about the actual co-payment rate for individuals in the Japanese national health insurance system, the co-payment rate is determined by age.[24] The data used in our study included adults aged 65 or older, and the co-payment rate is 30% for those aged 65 to 69 years, 20% for those aged 70 to 74 years, and 10% for those aged 75 years and older.[24] Therefore, we used the population aged 75 to 79 years as the 10% co-payment group to align the age bands. Each age was used as a new 3-category variable indicating the co-payment rate (65–69 = 30%, 70–74 = 20%, and 75–79 = 10% co-payment rate). Second, the analyses were stratified by the co-payment rate. We created 3 models for each analysis. Model 1 was the univariate analysis, model 2 was adjusted for age and sex, and model 3 was adjusted for age, sex, and the number of remaining teeth. In model 2 and model 3, age was used as a continuous variable. We used Stata MP version 16.1 to perform all analyses.

Ethical issues

The JAGES survey was approved by the Ethics Committee on Research of Human Subjects at Nihon Fukushi University (No. 10–05). The additional 2019 survey used in this study was approved by the National Center for Geriatrics and Gerontology (No. 1274–2), Chiba University (No. 3442), and the Japan Agency for Gerontological Evaluation Study Organization (No. 2019–01).

Results

The Figure presents the flowchart of the participants included in this study. In the 2019 wave, 31,747 individuals answered the questionnaires, including questions related to gingival bleeding and dental visits (response rate, 69.1%). Subsequently, we excluded the individuals who disagreed with the use of data for research purposes (n = 7394) or did not fulfill the eligibility criteria (n = 8964) (the details of the eligibility criteria are shown in the Figure). Finally, the analysis included 15,389 participants; their mean age was 71.8 years (SD = 4.1), and 51.8% were women. The number of participants in the 30%, 20%, and 10% co-payment categories were 5025, 5800, and 4564, respectively. Missing values for 2574 participants were imputed by MICE (see Supplemental Table 1). Table 1 shows the prevalence of gingival bleeding and dental nonattendance for treatment stratified by each co-payment group. In each co-payment group, the prevalence of gingival bleeding was higher in both the lower equivalent income categories and educational status. The number of people reporting no dental visits for treatment in the past year was high in the lower-socioeconomic-status category for each co-payment rate. Before the analyses, we examined the interaction between the co-payment rate and each socioeconomic status for dependent variables. Although there were tendencies for the effect of the independent variables to differ by the co-payment rate, there was no significant interaction between the co-payment rate and socioeconomic status ($P \geq .05$), except for income and co-payment in absolute inequalities of gingival bleeding ($P < .05$; see Supplemental Table 2).

Gingival bleeding

Table 2 shows the inequalities in the prevalence of gingival bleeding in both absolute and relative scales. The result of model 3, which was adjusted for age, sex, and the number of remaining teeth, indicated significant absolute and relative inequalities by equivalent income and education in gingival bleeding in each co-payment group. Absolute inequalities (SII) by equivalent income were as follows: 30% co-payment group, 0.054 (95% confidence interval [CI], 0.020–0.087) and 20% co-payment group, 0.041 (95% CI, 0.013–0.069). Relative inequalities (RII) by equivalent income were as follows: 30% co-payment group, 1.583 (95% CI, 1.166–2.148) and 20% co-payment group, 1.588 (95% CI, 1.159–2.174). Moreover, the SIIs by educational status were as follows: 30% co-payment group, 0.073 (95% CI, 0.036–0.109); 20% co-payment group, 0.039 (95% CI, 0.010–0.068); and 10% co-payment group, 0.031 (95% CI, 0.002–0.059). The RIIs by educational status were as follows: 30% co-payment group, 1.918 (95% CI, 1.386–2.656); 20% co-payment group, 1.606 (95% CI, 1.164–2.216); and 10% co-payment group, 1.587 (95% CI, 1.074–2.345). However, amongst the 10% co-payment group, there were no significant inequalities of gingival bleeding by equivalent income. The inequalities by educational status were larger than those by equivalent income.

Dental nonattendance for treatment in the past year

Table 3 presents the results of inequalities of dental visits by socioeconomic indicators. The absolute and relative

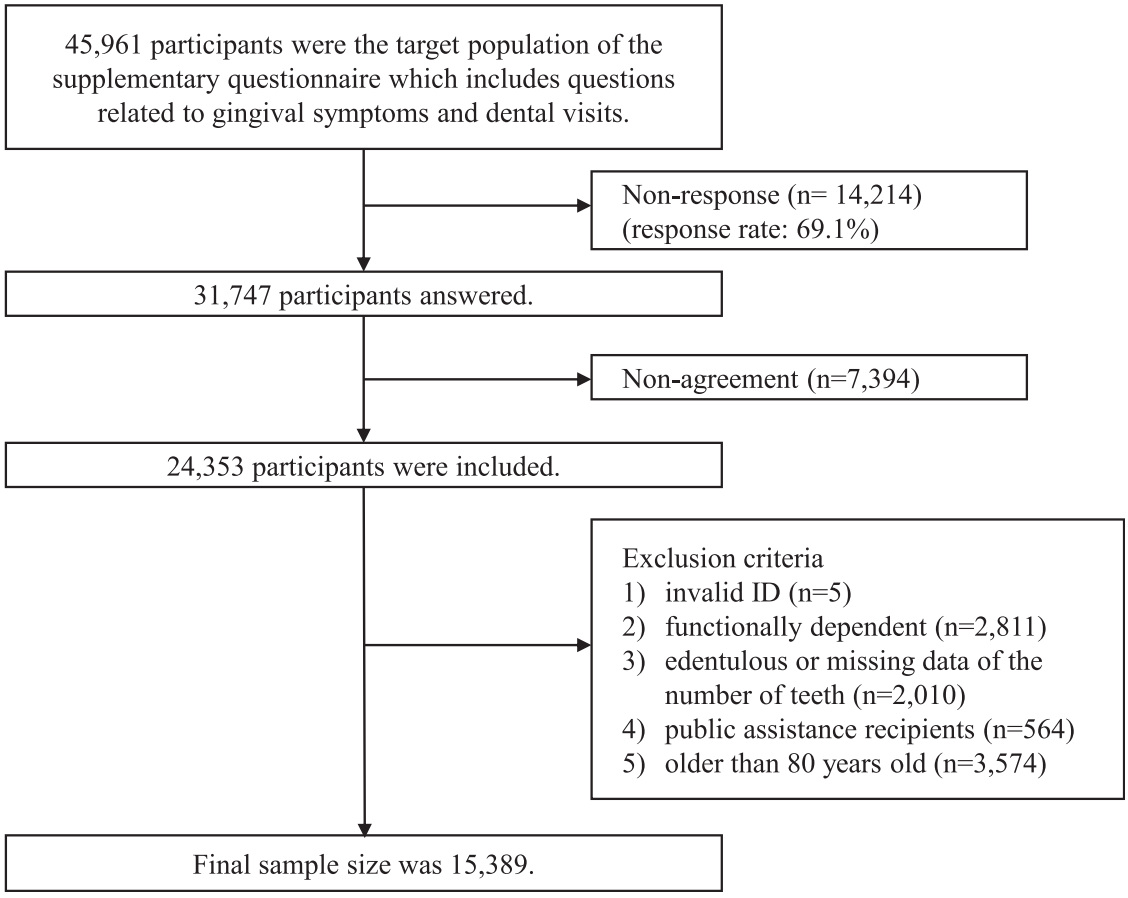

Fig – Flowchart of participants in this study.

inequalities of dental visits by equivalent income and education were observed in each co-payment group. Regarding absolute inequality by equivalent income, smaller inequalities were observed in the lower co-payment group. The SIIs by equivalent income were as follows: 30% co-payment group, 0.093 (95% CI, 0.041–0.145); 20% co-payment group, 0.084 (95% CI, 0.037–0.130); and 10% co-payment group, 0.071 (95% CI, 0.020–0.123). The trends of RII by income were not similar to the trends of the absolute inequalities that showed smaller inequalities in the lower co-payment groups. The RIIs by equivalent income were as follows: 30% co-payment group, 1.287 (95% CI, 1.128–1.469); 20% co-payment group, 1.270 (95% CI, 1.108–1.455); and 10% co-payment group, 1.304 (95% CI, 1.089–1.562). Whilst the same trend was not observed for the SII and RII by equivalent income, the inequalities by education were smaller for lower co-payment rate in both the absolute and relative scales. The SIIs by educational status were estimated as follows: 30% co-payment group, 0.108 (95% CI, 0.052–0.164); 20% co-payment group, 0.086 (95% CI, 0.038–0.135); and 10% co-payment group, 0.049 (95% CI, −0.002 to 0.100). In the 10% co-payment group, the SII by education was not significant. The RIIs by educational status were as follows: 30% co-payment group, 1.339 (95% CI, 1.165–1.540); 20% co-payment group, 1.282 (95% CI, 1.112 −1.477); and 10% co-payment group, 1.204 (95% CI, 1.011 −1.434).

Discussion

To the best of our knowledge, this is the first study investigating that the inequalities of self-reported gingival bleeding or access to dental by equivalent income or educational status are different for each co-payment rate. We also investigated the interactions between the co-payment rate and socioeconomic status; however, we did not find significant interactions, except for between the 10% co-payment rate and income in terms of the absolute inequality of gingival bleeding. Inequalities observed in gingival bleeding were smaller in the lower co-payment group, and in the 10% co-payment group, the inequalities of gingival bleeding by equivalent income were not significant. The inequalities in dental visits were also lower in those with a lower co-payment group, except for the relative inequality by equivalent income. Additionally, the absolute inequality by education was not significant in the 10% co-payment group.

Our findings that smaller inequalities of oral health and dental attendance were observed in lower co-payment groups are consistent with previous studies.[26,34] A study conducted in Japan showed that the inequality of denture use by income was smaller in the group with a lower co-payment.[26] Similarly, our results showed that amongst the low co-payment group, inequalities in gingival bleeding and dental visits by equivalent income were lower. However,

Table 1 – Rate of gingival bleeding and no dental visits for treatment amongst participants in each co-payment category (N = 15,389).

		65–69 years (n = 5025)			70–74 years (n = 5800)			75–79 years (n = 4564)		
		No.	Gingival bleeding (%)	No dental visit for treatment (%)	No.	Gingival bleeding (%)	No dental visit for treatment (%)	No.	Gingival bleeding (%)	No dental visit for treatment (%)
Sex	Men	2440	12.7	42.7	2813	9.9	35.7	2166	9.2	29.9
	Women	2585	9.8	35.1	2987	9.0	32.0	2398	6.4	27.6
Equivalent income (JPY)	<100	393	13.5	48.2	545	12.3	40.2	602	7.3	33.0
	≥100 to <200	1492	13.4	40.4	2096	10.3	35.2	1754	8.0	30.4
	≥200 to <300	1319	10.1	37.3	1353	9.1	32.8	1063	7.7	26.8
	≥300 to <400	1044	9.8	37.7	1035	8.1	31.7	656	7.7	25.3
	≥400	777	10.0	34.9	770	7.5	30.0	490	7.4	26.0
Education status	≤9	610	14.6	47.1	1071	13.2	38.8	1304	9.0	31.8
	10–12	2415	12.2	38.9	2696	8.7	33.8	1997	7.6	28.1
	≥13	2000	9.1	36.1	2033	8.5	31.2	1263	6.7	26.5
Number of teeth	1–4	169	6.7	58.8	285	8.7	48.6	316	6.8	40.6
	5–9	346	13.4	44.9	468	12.5	39.6	514	9.8	35.6
	10–19	1028	14.6	39.6	1292	13.4	32.9	1076	10.4	25.8
	≥20	3482	10.0	37.0	3755	7.7	32.3	2658	6.4	27.1

only the relative inequality in dental visits by equivalent income was not small amongst the lower co-payment group. It has been reported that absolute and relative inequalities do not always evaluate the same aspects of inequalities.[35] In our study, the proportion of higher-income groups who reported dental nonattendance in the past year was also smaller, along with the co-payment rate. This may be why the relative inequality in dental visits by equivalent income was not smaller in the lower co-payment group. Previous studies have observed dental health inequalities by education level.[15,36] The inequalities by education level reflect effects from childhood because one's education level is typically decided in a relatively early life stage.[15,37] Our study extends this finding by showing that low co-payment rates may decrease the inequalities in gingival bleeding and dental visits by educational status.

The reduction in inequalities in gingival bleeding with the low co-payment rate by equivalent income may be explained by the reduction in inequalities in dental visits. A previous study reported that the reduction in co-payment will increase the number of dental visits and improve self-rated oral health.[38] The reduction in the co-payment rate would have made it simpler for people to obtain dental care, thereby improving access and leading to more people receiving dental care; this includes periodontal disease treatment, which relieves periodontal symptoms like gingival bleeding. Moreover, there were inequalities in gingival bleeding and dental visits by education, which may be explained as follows. Educational attainment determines income, occupation, lifestyle, and health behaviour. Therefore, the inequalities by education may have accumulated throughout the life course. However, because the inequalities were small amongst the lower co-payment groups, especially in the 10% co-payment group, significant absolute inequality was not observed. This may suggest that the small co-payment may make dental visits more accessible.

The present study has several strengths. First, the data used in this study were obtained from Japan, where the majority of the population benefits from UHC. Our results suggested the possibility that the decline in the co-payment rate could reduce socioeconomic inequality even under UHC. Second, we used 2 different indicators of inequalities (SII and RII), enabling us to assess the different aspects of inequalities. Third, the sample size was relatively large (N = 15,389), covering 63 municipalities nationwide. This study also has several limitations. First, our study design was cross-sectional and could not infer the temporality between socioeconomic inequality and gingival bleeding or dental visits. However, gingival bleeding or dental attendance is less likely to affect the individual socioeconomic status. The second is that the effect of age, for example, in inflammatory dysregulation,[39] could not be completely excluded. Future studies should be conducted amongst same-age people with different co-payment rates. The third is that the information on the co-payment rate was not obtained from the local goverment. In Japan, the co-payment rate is generally determined by age amongst older adults; however, for some high-income individuals, the co-payment rate is high regardless of age. Due to a lack of data from the local government, we could not consider these cases in our analysis. The fourth limitation is information bias. We employed self-reported gingivitis and dental visits, leading to nondifferential misclassification and biased estimates. Because the gingival bleeding question was binary, nondifferential misclassification may have biased the estimates towards null. However, future studies employing measurements with less misclassification are required for dental visits.

Conclusions

The present study revealed the socioeconomic inequalities in the prevalence of gingival bleeding and dental visits amongst functionally independent older adults residing in Japan, where UHC strategies have been implemented. However, these inequalities were attenuated by lower co-payment rates. The reduction in co-payments is

Table 2 – The absolute and relative inequalities of gingival bleeding in each co-payment by socioeconomic indicators.

Socioeconomic indicators			No.	Slope index of inequality			Relative index of inequality		
				Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income	Co-payment	30%	5025	0.052 (0.018 to 0.086)**	0.056 (0.022 to 0.090)**	0.054 (0.020 to 0.087)**	1.611 (1.189 to 2.182)**	1.666 (1.230 to 2.257)**	1.583 (1.166 to 2.148)**
		20%	5800	0.048 (0.019 to 0.076)**	0.050 (0.022 to 0.078)***	0.041 (0.013 to 0.069)**	1.680 (1.229 to 2.298)**	1.734 (1.266 to 2.375)***	1.588 (1.159 to 2.174)**
		10%	4564	0.002 (−0.029 to 0.032)	0.003 (−0.027 to 0.034)	−0.003 (−0.033 to 0.028)	1.021 (0.687 to 1.518)	1.069 (0.717 to 1.592)	1.006 (0.676 to 1.498)
Education	Co-payment	30%	5025	0.076 (0.039 to 0.112)***	0.079 (0.042 to 0.115)***	0.073 (0.036 to 0.109)***	1.946 (1.411 to 2.684)***	2.041 (1.480 to 2.815)***	1.918 (1.386 to 2.656)***
		20%	5800	0.046 (0.016 to 0.075)**	0.049 (0.019 to 0.078)**	0.039 (0.010 to 0.068)**	1.707 (1.246 to 2.339)***	1.801 (1.311 to 2.475)***	1.606 (1.164 to 2.216)**
		10%	4564	0.031 (0.002 to 0.061)*	0.037 (0.008 to 0.065)*	0.031 (0.002 to 0.059)*	1.523 (1.030 to 2.251)*	1.665 (1.128 to 2.458)*	1.587 (1.074 to 2.345)*

Model 1: crude; model 2: adjusted for sex and age; model 3: adjusted for sex, age, and the number of teeth.

* $P < .05$;
** $P < .01$;
*** $P < .001$.

Table 3 – The absolute and relative inequalities of dental visits for treatment in each co-payment by socioeconomic indicators.

Socioeconomic indicators			No.	Slope index of inequality			Relative index of inequality		
				Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income	Co-payment	30%	5025	0.097 (0.045 to 0.148)***	0.105 (0.054 to 0.157)***	0.093 (0.041 to 0.145)***	1.287 (1.128 to 1.468)***	1.329 (1.165 to 1.516)***	1.287 (1.128 to 1.469)***
		20%	5800	0.088 (0.042 to 0.134)***	0.094 (0.048 to 0.140)***	0.084 (0.037 to 0.130)***	1.291 (1.128 to 1.477)***	1.319 (1.153 to 1.510)***	1.270 (1.108 to 1.455)***
		10%	4564	0.082 (0.030 to 0.133)**	0.085 (0.034 to 0.136)**	0.071 (0.020 to 0.123)**	1.325 (1.109 to 1.585)**	1.340 (1.120 to 1.603)**	1.304 (1.089 to 1.562)**
Education	Co-payment	30%	5025	0.113 (0.057 to 0.168)***	0.124 (0.069 to 0.179)***	0.108 (0.052 to 0.164)***	1.344 (1.169 to 1.545)***	1.397 (1.216 to 1.606)***	1.339 (1.165 to 1.540)***
		20%	5800	0.087 (0.038 to 0.135)***	0.099 (0.051 to 0.148)***	0.086 (0.038 to 0.135)***	1.288 (1.120 to 1.481)***	1.330 (1.156 to 1.530)***	1.282 (1.112 to 1.477)***
		10%	4564	0.058 (0.007 to 0.109)*	0.063 (0.012 to 0.114)*	0.049 (−0.002 to 0.100)	1.220 (1.026 to 1.450)*	1.252 (1.052 to 1.490)*	1.204 (1.011 to 1.434)*

Model 1: crude; model 2: adjusted for sex and age; model 3: adjusted for sex, age, and the number of teeth.

* $P < .05$;
** $P < .01$;
*** $P < .001$.

considered an effective policy to eliminate oral health inequalities even in a nation where UHC has already been implemented.

Author contributions

N.N. and J.A. conceived of the study and wrote the first draft. The analysis, data gathering, debate, and writing of the second and succeeding revisions were done by all writers. The paper has been evaluated and reviewed by all authors, who have also given their consent for submission.

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Conflict of interest

None disclosed.

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Supplementary materials

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