

Scientific Research Report

Trends in Self-Rated Poor Oral Health Among all Age Populations in Korea from 2007 to 2015: Monitoring Expansion of Dental Insurance

Song-Yi Kim^a, Nam-Hee Kim^{b*}^a Department of Dental Hygiene, The Graduate School, Yonsei University, Seoul, South Korea^b Department of Dental Hygiene, Wonju College of Medicine, Yonsei University, Wonju, South Korea

ARTICLE INFO

Article history:

Available online 18 September 2020

Key words:

Age-sex standardised prevalence rate

KNHANES

Older adults

Self-rated oral health

Socioeconomic status

Trends

ABSTRACT

Objectives: This study explored trends in self-rated poor oral health (SRPOH) from 2007 to 2015 among all age groups to monitor changes after the expansion of dental insurance.**Methods:** Repeated cross-sectional data from 2007 to 2015 Korea National Health and Nutrition Examination Surveys were collected and analysed. The respondents ($n = 20,199$) were categorised into four age groups: 0–19, 20–44, 45–64, and ≥ 65 years. The outcome variable was SRPOH, with independent variables being socioeconomic factors, sex, household income, and education. The age–sex standardised prevalence rate was calculated to determine trends, and complex samples logistic regression analysis was performed to confirm the factors affecting SRPOH.**Results:** Self-rated poor oral health prevalence decreased significantly from 2007 to 2009 (25%) to 2013 to 2015 (14%) in the age groups of 0–19 and 20–44 years ($P < 0.05$), whereas the SRPOH prevalence in the age groups of 45–64 and ≥ 65 years did not undergo any significant changes. Although the prevalence decreased by 6% among older adults, over 40% older women still experienced SRPOH. A sex gap increased with age but did not change over time. SRPOH was strongly associated with sex, income, and education across all age groups; the association did not notably change from 2007 to 2015.**Conclusions:** Self-rated poor oral health improved among younger people in Korea. The gender gap in the prevalence increased with age and persisted over time. However, income was the strongest determinant of SRPOH among all age groups, regardless of dental insurance expansion. Further studies should aim to draw causal inferences to explore the policy impact of dental insurance benefits.

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Introduction

The Universal Health Coverage (UHC) aims to consistently provide health services to the population according to its needs without financially burdening people.¹ The Republic of Korea has achieved UHC of the entire population since 1989. However, despite the rapid development of UHC, dental care insurance has only been initiated recently, with limited coverage benefits.

Oral health is an integral part of overall health that is affected by social determinants such as health insurance for dental care.² However, the introduced health insurance had little consideration of coverage for dental care due to lack of funds and a lower priority than systemic health.^{3,4} Recently, the Korean government initiated expansion of health insurance coverage for dental care to improve dental care access and reduce inequalities in oral health. As part of the expansion, insurance coverage was extended to pit and fissure sealing for preventing dental caries since 2009, denture treatment for declining chewing ability since 2012, and dental scaling for prevention of periodontal diseases since 2013. The entire aged population could be eligible for the extended dental insurance benefits as per the UHC. Therefore, expansion of

* Corresponding author. Nam-Hee Kim, Department of Dental Hygiene, Wonju College of Medicine, Yonsei University, 20 Ilsan-ro, Wonju, Gangwondo 26426, Korea.

E-mail address: nami71@yonsei.ac.kr (N.-H. Kim).

<https://doi.org/10.1111/idj.12608>

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dental insurance is expected to contribute to improved access to dental care and oral health services.

Previous literature includes reports on the availability, accessibility, acceptability, and quality of dental services to verify the efficiency, effect, and equity of dental insurance coverage in many countries.^{5–12} These outcomes were determined for the purpose of this study. However, it is clear that health insurance should be extended to benefit vulnerable people who need such coverage the most.^{3,9} For instance, although dental service accessibility increased after dental health insurance expansion,^{10,12,13} the oral health inequalities remained and/or even widened.^{12,14} Therefore, monitoring the changes after the expansion and finding the appropriate target is crucial for filling the evidence gap.

Self-rated oral health enables a combined assessment of an individual's oral health needs and oral health status, including their quality of life.^{15,16} It is highly correlated with clinical dental diseases and can even predict tooth loss,¹⁷ as demonstrated in large population surveys.^{18–20} A few studies have found no association between socioeconomic status and oral health outcomes.^{17,19,21–24} Low socioeconomic status is thought to be related to poor oral health outcomes. Therefore, it is important to examine whether those socioeconomic factors that have been affecting self-rated oral health would be improved by the expansion of dental insurance.

When it comes to methodological aspects in dental research, a counterfactual framework must be considered to find the policy impact and draw a causal inference.^{25,26} To assess the impact of the policy before drawing a causal inference, the trends in changes post its implementation need to be monitored, and it needs to be determined whether the benefits have reached the vulnerable people who are most in need of such services. However, there is little data regarding the impact of the expansion of dental health insurance and explore the trends in oral health outcomes for all populations. Therefore, this study aimed to verify the trends in self-rated poor oral health (SRPOH) across all ages.

Methods

Repeated cross-sectional secondary data from the fourth through the sixth Korea National Health and Nutrition Examination Surveys (KNHANES-IV, -V, -VI; 2007–2015)²⁷ performed by the Korea Centers for Disease Control and Prevention was collected and analysed. A systematic sampling technique was used with proportional allocation as per multistage stratification by age, sex, and region. The average response rate was over 95% every year in the representative Korean population.²⁷

The participants of the current study consisted of respondents of KNHANES-IV, V, and VI ($n = 68,431$; men = 30,817, 45.0%; women = 37,614, 55.0%). Participants were classified by age, as per the norms of the National Health Insurance coverage in Korea (0–19 years: children/adolescents; 20–44 years: young adults; 45–64 years: middle-aged adults; and 65 years or older: older adults).

The dependent variable was SRPOH, whereas the independent variables were sex, household income, and education, which are representative of socioeconomic status (SES).

SRPOH was surveyed with the question: “In your opinion, how do you rate your oral health, including your teeth and gums?” Participants responded by rating it as 1 (*very good*), 2 (*good*), 3 (*average*), 4 (*bad*), or 5 (*very bad*). Parents responded for children under the age of 12 years. SRPOH was defined as a rating of bad or very bad.

Average monthly household income was adjusted for household size and then categorised into four groups by standardised quantile. In the 2013–2015 data, the low-income group was defined as having a monthly household income of <644.00 USD, the low-middle income group as having a monthly household income of ≥ 644.00 to <1,330.00 USD, the middle-high income as having a monthly household income of $\geq 1,330.00$ to <2,279.00 USD, and the high-income group as having a monthly household income of $\geq 2,279$ USD. Data on education were determined by the participants' highest level of education attained at the time of the survey, categorised as elementary school (<6 years of education), middle school (6–9 years of education), high school (10–12 years of education), or college or higher (>12 years of education).

For statistical analyses, the data were weighted with the sample to enhance validity and representability for the population as per KNHANES guidelines.²⁷ To verify trends, the age–sex standardised prevalence rate was calculated using the KNHANES data as the standard population. A Stata command (*dstdize*) was used to split each age group into males and females, consecutively, to provide age- and sex-wise standardisation for the reference population in each study wave, and age- and sex-specific population sizes for the index population. Pearson's correlation coefficient and P-value were computed for trend analysis, with expanding weight for each age group. Differences in prevalence of SRPOH in the years studied were tested using interaction terms between study year and each age group. A complex samples adjusted logistic regression analysis was performed, considering covariates, to investigate the factors affecting SRPOH (*svy*: logistic). All statistical analyses were conducted in Stata statistical software (version 15.1; Stata Corp LP, College Station, TX), and graphical depiction of results was done using R (version 3.5.1; SNU General Public License, Korea, foundation for Statistical Computing, Vienna, Austria; <https://www.R-project.org/>).

The KNHANES has been reviewed and approved annually since 2007 by the Research Ethics Committee of the Korea Centers for Disease Control and Prevention. Every participant voluntarily provided informed consent for the in-person interview. This study was exempted from ethical review by the Institutional Review Board at Yonsei University Wonju Severance Christian Hospital (CR318339). The research was conducted in accordance with the 2008 Medical Association Declaration of Helsinki and its later amendments.

Results

The prevalence of SRPOH decreased among all age groups over time. Remarkable changes were found between the KNHANES-V (2010–2012) and KNHANES-VI (2013–2015) data, whereas there were no changes between the KNHANES-IV (2007–2009) and KNHANES-V (2010–2012) data (Figure).

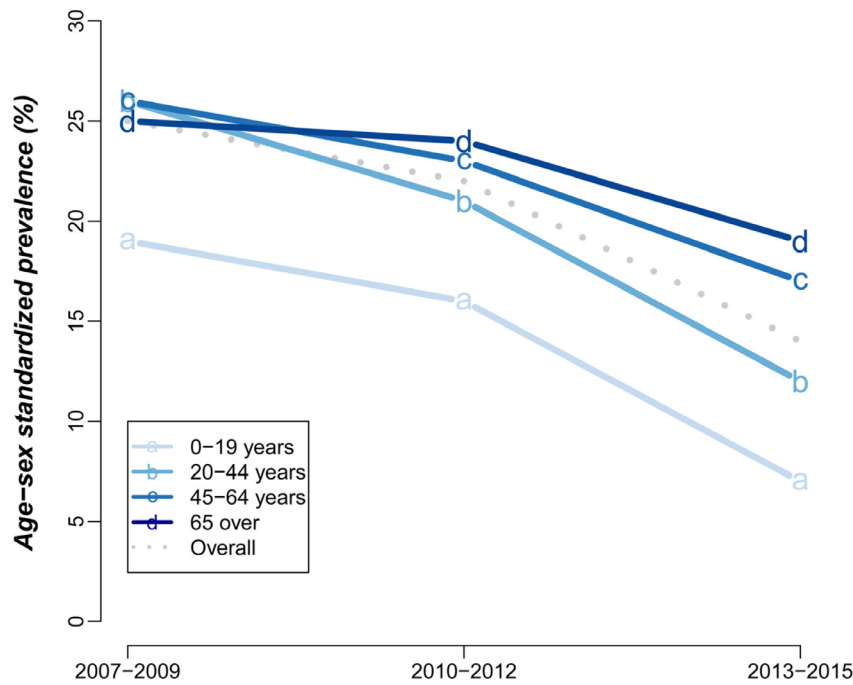


Fig. – Trends in age–sex standardised prevalence rates of self-rated poor oral health over 9 years by age group.

Table 1 shows socio-demographic data and SRPOH by age group in each year. All differences were statistically significant with P-values <0.05. Crude and adjusted prevalence rates are included for data comparison between years. The prevalence of SRPOH in the entire sample decreased by 11% from 2007–2009 (25%) to 2013–2015 (14%). The decreases were significant among the age groups of 0–19 years ($P=0.003$) and 20–44 years ($P=0.038$); there were no significant changes among the age groups of 45–64 years ($P=0.057$) or 65 years or older ($P=0.305$). Although the prevalence of SRPOH decreased by 6% among older adults in general (from 25% respondents between 2007 and 2009 to 19% respondents between 2013 and 2015), over 40% older women still experienced SRPOH, which was ~15% higher than that of older men. A sex gap was found among participants aged 20 years or older, which increased with age but did not change over time (Figure A1).

Table 2 shows the result of logistic regression for crude and adjusted models. All the differences were statistically significant with P-values <0.05. There were no significant changes in socioeconomic factors such as sex, income, and education between 2007 and 2015. There was a strong association of SRPOH with sex, income, and education that persisted over time in all age groups. Although the odds ratios (OR) were not attenuated after further controlling for sex, income, and education covariates, they remained significant. In the overall sample, SRPOH was most strongly associated with income, although it was also associated with sex and education (model 2: OR=2.15, 95% confidence interval [CI]=1.84–2.51 in 2007–2009, OR=2.16, 95% CI=1.80–2.59 in 2010–2012, and OR=2.22, 95% CI=1.82–2.72 in 2013–2015). In the overall sample results, the crude OR from the univariate logistic analysis was smaller than most of the adjusted OR models, which further increased by controlling for covariates.

Similar findings were observed in all age groups except for those under the age of 20 (Table 2).

Discussion

This study investigated trends in SRPOH in all age groups from 2007 to 2015 to monitor the consequences of expansion of dental health insurance in Korea. Data analysis revealed four major findings.

First, younger generations (aged 0–19 and 20–44 years) significantly improved their SRPOH. However, no statistically significant improvement was found in middle-aged or older adults (aged 45–64 and 65 years and older). Second, most changes in all age groups occurred between the KNHANES-V (2010–2012) and KNHANES-VI (2013–2015). Third, a sex gap in SRPOH prevalence was found, which increased with age and persisted over time; older women experienced particularly high SRPOH. Fourth, there were no other significant changes in socioeconomic factors affecting SRPOH from 2007 to 2015.

The expected finding of the improvement in SRPOH among participants aged 19 years or younger aligns with recent literature, and it may have been due to the increase in pit and fissure sealing procedures and decrease in dental caries.^{22,24} Those aged 19 years and older have been eligible for insurance coverage of dental scaling services since 2012, which increased its accessibility¹² for not just dental treatment but also preventive dental care.¹³ Among the middle-aged and elderly adults, there was an increase in the use of dental scaling services, which is a service that was generally provided to young adults before the expansion of dental insurance.^{10,12,13} However, it is unclear if dental insurance coverage for dental scaling services affects oral health outcomes such as periodontal symptoms, prevalence of

Table 1 – Trends in age–sex standardised prevalence rates of self-rated poor oral health

Age group	K-IV (2007–2009)				K-V (2010–2012)				K-IV (2013–2015)				P for trend [†]
	n	Crude*	SPR [†]	95% CI	n	Crude*	SPR [†]	95% CI	n	Crude*	SPR [†]	95% CI	
Over all Total	8,144	0.61	0.25	0.24–0.25	7,231	0.60	0.22	0.21–0.22	4,824	0.59	0.14	0.14–0.15	0.095
Sex													
Men	3,277	0.62	0.25	0.24–0.25	2,991	0.61	0.22	0.22–0.23	1,943	0.62	0.15	0.14–0.15	
Women	4,867	0.60	0.25	0.24–0.25	4,240	0.60	0.21	0.21–0.22	2,881	0.58	0.14	0.13–0.14	
Income													
Low	1,701	0.66	0.26	0.25–0.27	1,396	0.67	0.23	0.22–0.24	999	0.66	0.15	0.14–0.16	
Middle-low	2,144	0.64	0.26	0.25–0.26	1,974	0.62	0.22	0.21–0.23	1,304	0.61	0.14	0.14–0.15	
Middle-high	2,319	0.59	0.24	0.23–0.24	2,024	0.58	0.21	0.20–0.22	1,313	0.57	0.14	0.13–0.14	
High	1,980	0.56	0.23	0.22–0.24	1,837	0.55	0.20	0.19–0.21	1,208	0.54	0.13	0.12–0.13	
Education													
Elementary	2,668	0.60	0.20	0.19–0.21	2,197	0.60	0.17	0.17–0.18	1,388	0.60	0.11	0.11–0.12	
Middle	1,119	0.63	0.23	0.22–0.24	923	0.62	0.19	0.18–0.20	616	0.64	0.12	0.11–0.13	
High	2,538	0.63	0.23	0.22–0.23	2,178	0.64	0.20	0.20–0.21	1,517	0.63	0.14	0.13–0.14	
College	1,819	0.58	0.18	0.18–0.19	1,933	0.56	0.16	0.16–0.17	1,303	0.53	0.11	0.10–0.11	
0–19 years Total	1,076	0.45	0.19	0.17–0.20	1,017	0.40	0.16	0.15–0.17	496	0.37	0.07	0.06–0.08	0.003
Sex													
Men	512	0.42	0.20	0.18–0.22	505	0.40	0.20	0.18–0.22	245	0.36	0.18	0.15–0.20	
Women	564	0.47	0.25	0.23–0.27	512	0.41	0.20	0.18–0.22	251	0.39	0.20	0.17–0.22	
Income													
Low	168	0.50	0.03	0.02–0.03	141	0.52	0.02	0.02–0.03	85	0.36	0.01	0.01–0.01	
Middle-low	280	0.46	0.02	0.02–0.03	310	0.43	0.02	0.02–0.02	144	0.41	0.01	0.01–0.01	
Middle-high	332	0.42	0.02	0.02–0.03	301	0.38	0.02	0.02–0.02	146	0.38	0.01	0.01–0.01	
High	296	0.42	0.02	0.02–0.03	265	0.34	0.02	0.01–0.02	121	0.31	0.01	0.01–0.01	
Education													
Elementary	689	0.39	0.02	0.02–0.02	683	0.34	0.01	0.01–0.02	299	0.29	0.01	0.01–0.01	
Middle	288	0.52	0.01	0.01–0.01	241	0.50	0.01	0.01–0.01	126	0.49	0.01	0.00–0.01	
High	99	0.63	0.01	0.01–0.01	93	0.58	0.01	0.01–0.01	71	0.51	0.00	0.00–0.00	
College													
20–44 years Total	3,248	0.60	0.26	0.25–0.26	2,695	0.59	0.21	0.20–0.22	1,627	0.57	0.12	0.12–0.13	0.038
Sex													
Men	1,265	0.62	0.24	0.23–0.25	1,063	0.63	0.25	0.24–0.26	635	0.62	0.24	0.23–0.26	
Women	1,983	0.58	0.36	0.34–0.37	1,632	0.56	0.34	0.33–0.36	992	0.54	0.33	0.31–0.35	
Income													
Low	265	0.65	0.11	0.10–0.11	181	0.60	0.08	0.07–0.09	114	0.68	0.05	0.05–0.05	
Middle-low	850	0.65	0.11	0.10–0.11	744	0.61	0.08	0.08–0.09	410	0.60	0.05	0.04–0.05	
Middle-high	1,153	0.59	0.10	0.09–0.10	974	0.60	0.08	0.08–0.08	571	0.56	0.05	0.04–0.05	
High	980	0.55	0.09	0.08–0.09	796	0.55	0.07	0.07–0.08	532	0.53	0.04	0.04–0.05	
Education													
Elementary	45	0.67	0.05	0.05–0.06	20	0.70	0.03	0.03–0.03	20	0.75	0.02	0.02–0.02	
Middle	155	0.63	0.10	0.09–0.11	71	0.63	0.07	0.07–0.08	36	0.69	0.02	0.02–0.03	
High	1,631	0.62	0.10	0.10–0.11	1,145	0.63	0.08	0.08–0.09	693	0.62	0.05	0.05–0.05	
College	1,417	0.57	0.09	0.09–0.10	1,459	0.56	0.08	0.07–0.08	878	0.52	0.04	0.04–0.04	
45–64 years Total	2,491	0.67	0.26	0.25–0.26	2,283	0.66	0.23	0.22–0.24	1,711	0.64	0.17	0.16–0.17	0.057
Sex													
Men	1,022	0.68	0.28	0.27–0.29	964	0.67	0.28	0.27–0.30	698	0.67	0.27	0.26–0.29	
Women	1,469	0.66	0.39	0.37–0.40	1,319	0.64	0.37	0.36–0.39	1,013	0.62	0.36	0.35–0.38	
Income													
Low	461	0.70	0.09	0.08–0.09	344	0.70	0.08	0.07–0.08	272	0.67	0.06	0.05–0.06	
Middle-low	725	0.69	0.09	0.08–0.09	629	0.68	0.08	0.07–0.08	484	0.67	0.06	0.05–0.06	
Middle-high	695	0.66	0.08	0.08–0.09	619	0.65	0.07	0.07–0.08	468	0.63	0.05	0.05–0.06	
High	610	0.62	0.08	0.07–0.08	691	0.62	0.07	0.07–0.07	487	0.61	0.05	0.05–0.06	
Education													
Elementary	891	0.69	0.08	0.08–0.09	648	0.72	0.08	0.08–0.09	404	0.67	0.05	0.05–0.05	
Middle	547	0.68	0.08	0.08–0.09	457	0.67	0.08	0.07–0.08	327	0.67	0.06	0.05–0.06	
High	704	0.65	0.08	0.08–0.09	768	0.65	0.07	0.07–0.08	618	0.65	0.06	0.05–0.06	
College	349	0.61	0.07	0.07–0.08	410	0.55	0.06	0.06–0.07	362	0.55	0.04	0.04–0.05	
≥65 years Total	1,329	0.66	0.25	0.24–0.26	1,236	0.70	0.24	0.23–0.25	990	0.68	0.19	0.18–0.20	0.305
Sex													
Men	478	0.68	0.24	0.23–0.26	459	0.68	0.25	0.24–0.27	365	0.70	0.26	0.24–0.27	
Women	851	0.65	0.42	0.40–0.44	777	0.71	0.45	0.43–0.47	625	0.66	0.42	0.40–0.44	

Age group	K-IV (2007–2009)				K-V (2010–2012)				K-IV (2013–2015)				P for trend [‡]
	n	Crude*	SPR [†]	95% CI	n	Crude*	SPR [†]	95% CI	n	Crude*	SPR [†]	95% CI	
Income													
Low	807	0.67	0.04	0.04–0.05	730	0.71	0.04	0.04–0.05	528	0.71	0.04	0.03–0.04	
Middle-low	289	0.66	0.04	0.04–0.05	291	0.70	0.04	0.04–0.04	266	0.64	0.03	0.03–0.03	
Middle-high	139	0.63	0.04	0.03–0.04	130	0.62	0.04	0.03–0.04	128	0.66	0.03	0.03–0.03	
High	94	0.61	0.04	0.04–0.04	85	0.72	0.04	0.04–0.04	68	0.63	0.03	0.02–0.03	
Education													
Elementary	1,043	0.66	0.04	0.04–0.05	846	0.72	0.04	0.04–0.05	665	0.69	0.03	0.03–0.04	
Middle	129	0.66	0.03	0.03–0.04	154	0.64	0.03	0.03–0.04	127	0.68	0.03	0.03–0.04	
High	104	0.68	0.03	0.03–0.04	172	0.69	0.04	0.04–0.04	135	0.63	0.03	0.02–0.03	
College	53	0.55	0.02	0.01–0.02	64	0.64	0.03	0.02–0.03	63	0.62	0.02	0.02–0.03	

K-IV, K-V and K-IV denote the 4th, 5th, and 6th Korea National Health and Nutrition Examination Surveys, respectively.

* Crude denotes prevalence rate of self-rated poor oral health.

[†] SPR denotes age-sex standardised prevalence rate of self-rated poor oral health. It was calculated using the KNHANES data as the standard population.

[‡] Pearson's correlation coefficient was used to explore P-value for trend analysis with expanding weight for each age group.

Table 2 – Logistic regression results of self-rated poor oral health

Model	K-IV (2007–2009) OR (95% CI)	K-V (2010–2012) OR (95% CI)	K-VI (2013–2015) OR (95% CI)
Overall			
Crude	1.61 (1.52–1.71)	1.57 (1.47–1.68)	1.45 (1.34–1.55)
Model 1	1.67 (1.53–1.83)	1.68 (1.52–1.86)	1.62 (1.45–1.80)
Model 2	2.15 (1.84–2.51)	2.16 (1.80–2.59)	2.22 (1.82–2.72)
Model 3	1.59 (1.41–1.79)	1.68 (1.45–1.95)	1.57 (1.33–1.86)
Model 4	1.94 (1.65–2.27)	2.03 (1.67–2.47)	1.96 (1.60–2.42)
0–19 years			
Crude	0.87 (0.76–1.00)	0.81 (0.69–0.94)	0.59 (0.49–0.71)
Model 1	0.76 (0.61–0.94)	0.78 (0.63–0.97)	0.55 (0.42–0.72)
Model 2	0.93 (0.62–1.40)	1.18 (0.79–1.79)	0.53 (0.32–0.87)
Model 3	0.58 (0.46–0.73)	0.63 (0.49–0.80)	0.40 (0.29–0.54)
Model 4	0.67 (0.44–1.01)	0.94 (0.60–1.47)	0.39 (0.23–0.65)
20–44 years			
Crude	1.62 (1.48–1.77)	1.54 (1.40–1.71)	1.35 (1.21–1.51)
Model 1	1.75 (1.52–2.01)	1.77 (1.51–2.06)	1.63 (1.37–1.94)
Model 2	2.34 (1.67–3.29)	1.86 (1.29–2.68)	3.27 (1.98–5.41)
Model 3	1.93 (0.93–4.04)	3.21 (1.05–9.84)	4.31 (1.24–14.96)
Model 4	2.12 (0.98–4.62)	3.01 (0.97–9.37)	6.93 (1.60–29.95)
45–64 years			
Crude	1.95 (1.76–2.15)	1.98 (1.77–2.22)	1.82 (1.62–2.06)
Model 1	2.12 (1.81–2.47)	2.15 (1.82–2.53)	1.96 (1.64–2.34)
Model 2	2.66 (2.01–3.63)	2.76 (1.96–3.90)	2.21 (1.57–3.10)
Model 3	2.56 (2.03–3.24)	2.99 (2.25–3.96)	2.47 (1.81–3.36)
Model 4	2.92 (2.12–4.01)	3.32 (2.26–4.87)	2.49 (1.70–3.65)
>65 years			
Crude	2.06 (1.77–2.40)	2.40 (2.04–2.84)	1.89 (1.61–2.23)
Model 1	2.11 (1.64–2.72)	2.08 (1.65–2.64)	2.32 (1.81–2.97)
Model 2	2.30 (1.75–3.03)	2.14 (1.62–2.84)	2.92 (2.14–3.97)
Model 3	2.41 (1.81–3.21)	2.22 (1.63–3.02)	2.53 (1.81–3.53)
Model 4	2.52 (1.87–3.40)	2.26 (1.63–3.14)	2.97 (2.08–4.25)

CI, confidence interval; OR, odds ratio.

Crude model denotes self-rated oral health of poor (1) vs. good/moderate (0) without covariates. Model 1: adjusted for sex. Model 2: adjusted for sex and income. Model 3: adjusted for sex and education. Model 4: adjusted for sex, income, and education. Logistic regression considering complex sampling. K-IV, K-V and K-IV denote the 4th, 5th, and 6th Korea National Health and Nutrition Examination Surveys, respectively.

periodontal diseases, and overall periodontal health. The lack of clear evidence thus far may be due to insufficient coverage benefits. Further research investigating the impact of dental insurance coverage on oral health outcomes is necessary.

Despite variations in the initiation of insurance expansion by age and coverage benefit, there was a more significant change in SRPOH for all age groups from KNHANES-V (2010–2012) to KNHANES-VI (2013–2015) as compared to the change from KNHANES-IV (2007–2009) to KNHANES-V (2010–2012; Figure). The age–sex standardised prevalence rate showed a clear trend of decreasing SRPOH among participants aged 45 years and younger. To evaluate the independent impact of insurance in the future, prevalence rates of SRPOH pre- and post-insurance need to be compared with a difference-in-difference design.²⁵

In Korea, the gender gap in public health, including dental health, is a major issue.^{23,28} For example, men benefit more from access to medical services.²⁹ On the other hand, women have more access to dental care services and engage in more favorable oral health behaviors than do men.^{30,31} However, it is hypothesised that expanding insurance coverage is an important means of reducing gender disparities in access to healthcare.³² Therefore, further research is needed to examine the gender gap to inform future policy developments.

Poor oral health could be an indicator of lower socioeconomic class³³; however, the reverse could also be true. Researchers have explored socioeconomic factors (i.e., income and education) influencing oral health^{21,33,34} to verify which factors attenuated the change over the 9 years of the study period. If some factors did, in fact, attenuate the change from pre- to post-dental insurance time, it would be possible to identify the most vulnerable people who could be targeted for socioeconomic inequality reduction through expansion of dental insurance.^{35,36} However, the finding that there was no remarkable change in the factors influencing oral health implies that the effect size of education level is higher among middle-aged adults (20–44 and 45–64 years) and the effect size of income is higher among older adults (65 years and older; Tables 2

and A1). Health policies to reduce inequalities in health-care and health outcomes should be a priority, regardless of income level, education, and sex.³⁷ Therefore, this study aimed to monitor the consequences of expanding coverage for dental services to assess if it increases the access to dental care, improves oral health, and reduces oral health inequalities regardless of socio-demographic status. It is unclear whether the change in SRPOH was independent of the impacts of expansion of dental insurance. Although a trend of improved oral health over time was found, the maximum changes found between KNHANES-V (2010–2012) and KNHANES-VI (2013–2015) may not be related to the expansion of dental insurance. It is known that observational studies have fundamental methodological limitations such as information bias, unmeasured confounding, and reverse causations.^{25,26} Therefore, future studies need to evaluate causal effects with a counterfactual framework.

There are some of the limitations of this study and factors to be considered when interpreting the results. First, the study might have some bias derived from unobserved SES variables as covariates, because it only included the data available in the KNHANES. Future research needs to investigate SES in more detail to evaluate its impact on dental insurance. Second, there might be an influence of information bias according to age and education level.³⁸

Strengths of the study include the following. First, nationally representative data were used, which makes it possible to generalise the findings to the national population. In addition, age–sex standardised prevalence rates were calculated and interaction terms were considered for comparison between several years. Second, this study included participants from all life stages to compare age groups. Third, the repeated data showed overall changes in the factors contributing to oral health.

In conclusion, SRPOH has been improving among younger generations in Korea. The largest change for all age groups was found to have occurred from KNHANES-V (2010–2012) to KNHANES-VI (2013–2015). However, the gender gap increased with age and persisted. The influence of income on poor oral health among Koreans of all age groups did not undergo any remarkable change from 2007 to 2015, regardless of the expansion of dental insurance. Further studies should aim to explore causal inferences to identify policy implications of the expansion of dental insurance.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgements

The authors thank all examiners and participants of the KNHANES.

REFERENCES

1. World Health Organization. Health systems governance for universal health coverage: Action plan. Geneva, Switzerland: World Health Organization; 2019.
2. Marmot M, Bell R. Social determinants and dental health. *Adv Dent Res* 2011;23:201–6.
3. Choi MK. The impact of Medicaid insurance coverage on dental service use. *J Health Econ* 2011;30:1020–31.
4. Moore R. The Swedish national dental insurance and dental health care policy. *J Am Dent Assoc* 1981;102:627–30.
5. Manski RJ, Moeller JF, Chen HY. Dental care coverage and use: modeling limitations and opportunities. *Am J Public Health* 2014;104:2002–9.
6. Decker SL, Lipton BJ. Do Medicaid benefit expansions have teeth? The effect of Medicaid adult dental coverage on the use of dental services and oral health. *J Health Econ* 2015;44:212–25.
7. Zhang A, Nikoloski Z, Mossialos E. Does health insurance reduce out-of-pocket expenditure? Heterogeneity among China's middle-aged and elderly. *Soc Sci Med* 2017;190:11–9.
8. Baicker K, Allen H, Wright B, et al. The effect of Medicaid on dental care of poor adults: evidence from the Oregon health insurance experiment. *Health Serv Res* 2018;53:2147–64.
9. Damiano PC, Shugars DA, Johnson JD. Expanding health insurance coverage and the implications for dentistry. *J Public Health Dent* 1992;52:52–8.
10. Park HJ, Lee JH, Park S, et al. Trends in the utilization of dental outpatient services affected by the expansion of health care benefits in South Korea to include scaling: a 6-year interrupted time-series study. *J Periodontal Implant Sci* 2018;48:3–11.
11. Fuhmei W, Jung-Der W, Yu-Wen H. Universal health insurance, health inequality and oral cancer in Taiwan. *PLoS One* 2018;13:e0205731.
12. Jang YE, Kim CB, Kim NH. Utilization of preventive dental services before and after health insurance covered dental scaling in Korea: 2009 to 2014 Community Health Survey. *Asia Pac J Public Health* 2017;29:70–80.
13. Jang YE, Kim CB, Kim NH. Influence of dental insurance coverage on access to preventive periodontal care in middle-aged and elderly populations: analysis of representative Korean Community Health Survey Data (2011–2015). *Int Dent J* 2019;69:445–53.
14. Kim ES, Kim BI, Jung HI. Does the national dental scaling policy reduce inequalities in dental scaling usage? A population-based quasi-experimental study. *BMC Oral Health* 2019;19:185.
15. Benyamini Y, Leventhal H, Leventhal EA. Self-rated oral health as an independent predictor of self-rated general health, self-esteem and life satisfaction. *Soc Sci Med* 2004; 59:1109–16.
16. Vigu AL, Stanciu D, Lotrean LM, et al. Complex interrelations between self-reported oral health attitudes and behaviors, the oral health status, and oral health-related quality of life. *Patient Prefer Adherence* 2018;12:539–49.
17. Meisel P, Holtfreter B, Volzke H, et al. Self-reported oral health predicts tooth loss after five and ten years in a population-based study. *J Clin Periodontol* 2018;45:1164–72.
18. Blizniuk A, Ueno M, Zaitsu T, et al. Association between self-reported and clinical oral health status in Belarusian adults. *J Investig Clin Dent* 2017;8:e12206.
19. Kim SY, Kim JE, Kim HN, et al. Association of self-perceived oral health and function with clinically determined oral health status among adults aged 35–54 years: a cross-sectional study. *Int J Environ Res Public Health* 2018;15:1681.

20. Guevara-Canales JO, Morales-Vadillo R, Sacsquispe-Contreras SJ, et al. Association between self-perceived oral health and clinical indicators. *Oral Health Prev Dent* 2018;16:33–41.
21. Shin HS. Social gradients in oral health status in Korea population. *Arch Oral Biol* 2018;95:89–94.
22. Choi JS, Park DY. The impact of national health insurance coverage on pit and fissure sealing experience. *Rural Remote Health* 2018;18:4804.
23. Lee SY, Kim SJ, Yoo KB, et al. Gender gap in self-rated health in South Korea compared with the United States. *Int J Clin Health Psychol* 2016;16:11–20.
24. Kim HN, Han DH, Jun EJ, et al. The decline in dental caries among Korean children aged 8 and 12 years from 2000 to 2012 focusing SiC Index and DMFT. *BMC Oral Health* 2016;16:38.
25. Listl S, Jürges H, Watt RG. Causal inference from observational data. *Community Dent Oral Epidemiol* 2016;44:409–15.
26. Grytten J. The impact of education on dental health – ways to measure causal effects. *Community Dent Oral Epidemiol* 2017;45:485–95.
27. KCDC. Korea National Health and Nutrition Examination Survey. Osong, Korea: Korea Centers for Disease Control and Prevention; 2018.
28. Kim YJ, Kim CB, Ahn YH, et al. Gender differences in chewing discomfort in older South Koreans. *Int J Dent Hyg* 2015;13:273–82.
29. Asiskovitch S. Gender and health outcomes: the impact of healthcare systems and their financing on life expectancies of women and men. *Soc Sci Med* 2010;70:886–95.
30. Ahn ES, Shin MS, Hwang JM. Dental utilization associated factors among elderly. *J Dent Hyg Sci* 2015;15:60–6.
31. Silva AE, Langlois Cde O, Feldens CA. Use of dental services and associated factors among elderly in southern Brazil. *Rev Bras Epidemiol* 2013;16:1005–16.
32. Merzel C. Gender differences in health care access indicators in an urban, low-income community. *Am J Public Health* 2000;90:909–16.
33. Sabbah W, Tsakos G, Chandola T, et al. Social gradients in oral and general health. *J Dent Res* 2007;86:992–6.
34. Hakeberg M, Wide Boman U. Self-reported oral and general health in relation to socioeconomic position. *BMC Public Health* 2017;18:63.
35. Sullivan JA. The Medicare Part D donut hole and healthcare reform: will the coverage gap be closed? *Health Care Law Mon* 2010;2010:2–6.
36. Kaestner R, Lubotsky D. Health insurance and income inequality. *J Econ Perspect* 2016;30:53–78.
37. Khang YH, Lee SI. Health inequalities policy in Korea: current status and future challenges. *J Korean Med Sci* 2012;27:S33–40.
38. Shepperd J, Malone W, Sweeny K. Exploring causes of the self-serving bias. *Soc Personal Psychol Compas* 2008;2:895–908.

Appendix A

Table A1, Figure A1

Table A1 – Logistic regression of self-rated poor oral health

Age group	K-IV (2007–2009)		K-V (2010–2012)		K-VI (2013–2015)	
	Adjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Overall						
Sex (ref. men)	0.92 (0.82–1.03)	0.158	0.88 (0.77–0.99)	0.038	0.81 (0.70–0.93)	0.003
Income (ref. low income)						
Low-middle	0.87 (0.72–1.03)	0.113	0.84 (1.02–0.69)	0.69	0.77 (0.61–0.98)	0.031
Middle-high	0.68 (0.56–0.82)	0.000	0.71 (0.87–0.58)	0.58	0.66 (0.52–0.83)	0.000
High	0.64 (0.53–0.77)	0.000	0.66 (0.81–0.54)	0.54	0.61 (0.47–0.79)	0.000
Education (ref. elementary)						
Middle school	1.16 (0.97–1.38)	0.101	1.05 (0.87–1.28)	0.593	1.30 (1.01–1.68)	0.043
High school	1.34 (1.16–1.54)	0.000	1.23 (1.03–1.46)	0.021	1.38 (1.13–1.69)	0.002
College or higher	1.06 (0.90–1.25)	0.516	0.99 (0.83–1.18)	0.905	0.98 (0.80–1.20)	0.813
0–19 years						
Sex	1.31 (0.95–1.81)	0.097	1.04 (0.76–1.43)	0.797	1.05 (0.72–1.53)	0.793
Income						
Low-middle	0.84 (0.53–1.32)	0.444	0.71 (0.43–1.19)	0.195	1.17 (0.66–2.07)	0.583
Middle-high	0.76 (0.48–1.19)	0.234	0.63 (0.38–1.05)	0.074	1.11 (0.63–1.96)	0.719
High	0.94 (0.61–1.45)	0.781	0.48 (0.29–0.80)	0.005	0.79 (0.44–1.45)	0.450
Education						
Middle school	1.61 (1.19–2.18)	0.002	1.48 (1.04–2.12)	0.030	2.40 (1.55–3.70)	0.000
High school	2.68 (1.71–4.20)	0.000	2.01 (1.24–3.27)	0.005	2.50 (1.47–4.26)	0.001
20–44 years						
Sex	0.85 (0.72–1.00)	0.052	0.77 (0.64–0.94)	0.010	0.71 (0.56–0.91)	0.006
Income						
Low-middle	0.99 (0.68–1.43)	0.937	1.11 (0.77–1.61)	0.580	0.59 (0.34–1.01)	0.054
Middle-high	0.73 (0.52–1.03)	0.072	1.03 (0.70–1.50)	0.890	0.51 (0.30–0.86)	0.012
High	0.67 (0.47–0.95)	0.026	0.88 (0.59–1.30)	0.522	0.52 (0.30–0.88)	0.016
Education						
Middle school	1.26 (0.55–2.89)	0.580	0.69 (0.20–2.38)	0.560	0.44 (0.09–2.11)	0.306
High school	1.19 (0.57–2.48)	0.644	0.64 (0.21–2.00)	0.446	0.51 (0.13–1.96)	0.328
College or higher	0.91 (0.44–1.91)	0.812	0.52 (0.17–1.61)	0.257	0.35 (0.10–1.31)	0.121
45–64 years						
Sex	0.80 (0.64–1.00)	0.046	0.77 (0.63–0.95)	0.013	0.80 (0.64–1.02)	0.069
Income						
Low-middle	0.89 (0.67–1.19)	0.428	1.00 (0.69–1.45)	0.985	1.05 (0.72–1.51)	0.811
Middle-high	0.81 (0.59–1.13)	0.214	0.75 (0.52–1.10)	0.145	0.95 (0.65–1.40)	0.808
High	0.73 (0.53–1.01)	0.058	0.83 (0.57–1.22)	0.341	0.85 (0.56–1.27)	0.425
Education						
Middle school	0.92 (0.70–1.22)	0.561	0.85 (0.60–1.19)	0.343	1.07 (0.71–1.60)	0.744
High school	0.87 (1.14–0.77)	0.316	0.77 (0.57–1.04)	0.083	0.92 (0.65–1.30)	0.623
College or higher	0.73 (0.51–1.06)	0.096	0.54 (0.38–0.76)	0.001	0.59 (0.41–0.85)	0.004
>65 years						
Sex	0.86 (0.63–1.19)	0.369	1.20 (0.87–1.64)	0.272	0.68 (0.29–0.94)	0.021
Income						
Low-middle	0.87 (0.64–1.20)	0.394	1.05 (0.72–1.52)	0.808	0.69 (0.48–0.98)	0.038
Middle-high	0.81 (0.49–1.35)	0.416	0.64 (0.39–1.03)	0.068	0.69 (0.42–1.14)	0.149
High	1.02 (0.57–1.81)	0.959	1.43 (0.76–2.69)	0.264	0.59 (0.31–1.10)	0.095
Education						
Middle school	0.91 (0.57–1.44)	0.688	0.79 (0.20–1.23)	0.293	1.01 (0.62–1.65)	0.956
High school	0.79 (0.47–1.30)	0.349	1.02 (0.64–1.62)	0.934	0.87 (0.55–1.37)	0.550
College or higher	0.57 (0.29–1.16)	0.120	0.82 (0.39–)	0.591	1.11 (0.59–2.10)	0.745

CI, confidence interval; OR, odds ratio.

Logistic regression considering complex sampling. Adjusted for sex, income, and education in each age group and every study wave. Reference: sex (ref. men) income (ref. low income) and education (ref. elementary). K-IV, K-V and K-IV denote the 4th, 5th, and 6th Korea National Health and Nutrition Examination Surveys, respectively.

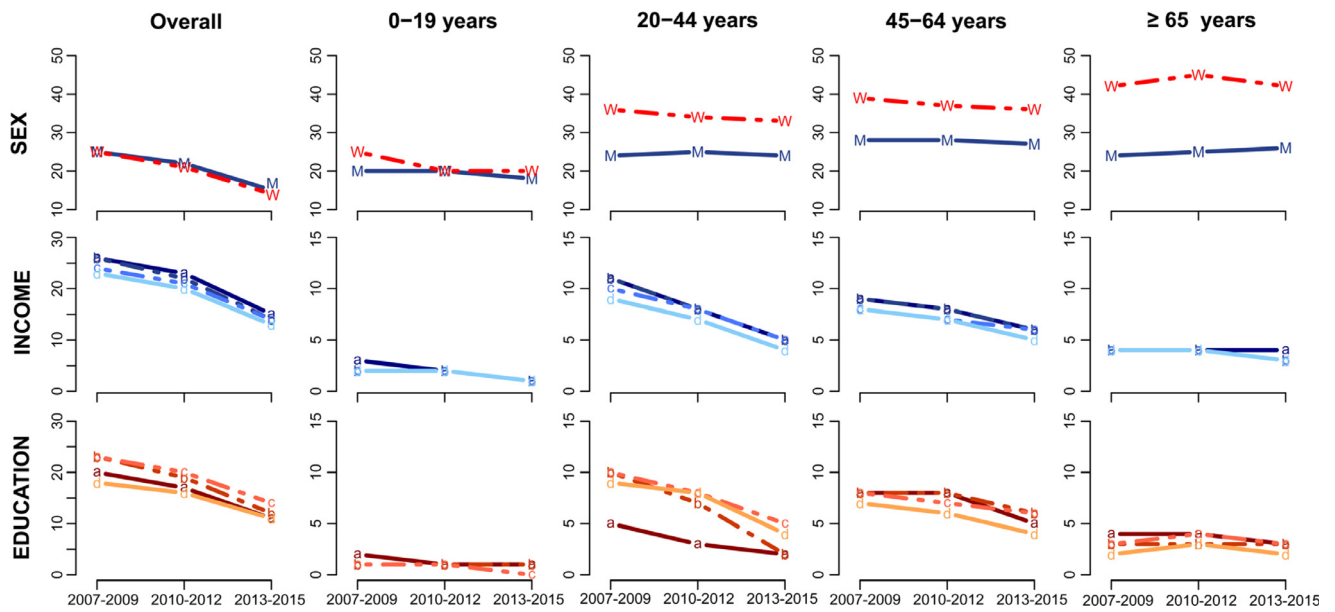


Fig. A1 – Age–sex standardised prevalence rates of self-rated poor oral health over 9 years by sex, income, and education