Category

An original paper

Title

Trends in insurance claims for dental gold-silver-palladium alloy in private dental clinics from 2006 to 2020 in Japan

Running title

Trends in insurance claims for dental alloy

Authors

Yukihiro SATO[1], Kakuhiro FUKAI[2], Yuki KUNORI[1], Eiji YOSHIOKA[1], Yasuaki SAIJO[1]

Affiliations

1. Division of Public Health and Epidemiology, Department of Social Medicine, Asahikawa Medical University, 1-1-1, Midorigaoka higashi 2-jo, Asahikawa, Hokkaido, 078-8510, Japan

2. Fukai Institute of Health Science, 3-86, Hikonari, Misato, Saitama, 341-0003, Japan

Keywords: Dental materials; Health insurance claims data; Trend analysis; Gold-silver-palladium alloy; Repeated cross-sectional data

Numbers of reprints: 0

Corresponding Author

Yukihiro Sato

E-mail address: ys@epid.work

TEL: +81 166-68-2404

FAX: +81 166-68-2409

Abstract (148/150)

This study aimed to describe the trend in insurance claims for dental gold-silver-palladium alloy in private dental clinics from 2006 to 2020 and examine the association between the trend and the increasing price. We calculated the proportions of dental gold-silver-palladium alloy in inlays and crowns and performed a segmented regression analysis for the annual trend changes in the proportions. In inlays and fillings, the proportion of dental gold-silver-palladium alloy decreased from 13.2% in 2006 to 7.0% in 2020. However, there was no significant downwards trend during the periods with the increasing price. In crowns, the proportion of dental gold-silver-palladium alloy decreased from 93.9% in 2006 to 75.8% in 2020, and a significant trend change occurred during the periods with the increasing price. Since 2006, the proportions of the insurance claims for dental gold-silver-palladium alloy have trended downwards. The increased price might have partially contributed to the downwards trend.

INTRODUCTION

Changes in treatment patterns and detection of associated factors can facilitate planning future needs for treatment in healthcare services[1]. In dentistry, previous studies reported that treatment trends could be affected by the distribution of dental diseases, other health conditions, the age structure of populations, the age of dentists, and the evolution of dental materials[2–5]. In Japan, however, health services research on the trend change in the pattern of dental services is scarce.

Japan's universal health insurance system provides comprehensive dental coverage to every resident[6–8]. The insurance benefits cover general restorative and surgical treatments, and partially include orthodontic and implant treatments with conditions. The fees for dental procedures are standardised nationwide, most of which are lower than the prices in other countries[7].

Japan's health insurance system covers the costs of dental materials. In Japan, gold-silver-palladium alloy is one of the most commonly used dental materials[9]. However, the prices of gold and palladium have been increasing[10]. The increasing price of dental gold-silver-palladium alloy potentially might cause two problems. First, the rising expenses of the insurance fees for dental gold-silver-palladium alloy might become a barrier to patients[11]. Therefore, patients may not receive adequate restorative treatment. The second is an imbalance between the insurance fee and the market price for dental gold-silver-palladium alloy. In Japan, dentists in private clinics predominantly provide general dental care. In 2018, among a total of 104,908 dentists, 85.9% worked in private dental clinics[12]. Private dental clinics operate primarily on fees derived from insurance services, accounting for 76.3% of the annual revenue in 2021[13]. The Ministry of Health, Labour and Welfare reviews the insurance fee for dental metal materials two to four times per year. However, using dental metal materials might cause deficits due to the imbalance between the insurance fee and market

price. Owing to the above reasons, the increasing price of dental gold-silver-palladium alloy might affect the number of insurance claims for dental materials.

Generally, clinical decision-making is determined based on doctor-patient partnerships, considering patients' experiences, perceptions, and expectations[14]. For patients, esthetics are essential for satisfaction with dental appearance[15]. Because patients prefer natural tooth colour, insurance claims for dental metal materials might have been decreasing. For dentists, the composite resin is one of the primary options for dental caries treatment because the material can be easily manipulated[2]. However, trend changes in dental metal materials are rarely reported in Japan. It is crucial to describe whether inlays using metal materials were sufficiently replaced with fillings using non-metal materials. Thus, the first aim of this study was to describe the trend in the insurance claims for dental gold-silver-palladium alloys for inlays and crowns used in private dental clinics from 2006 to 2020 in Japan. Next, the increasing price of dental gold-silver-palladium alloys might decrease the insurance claims due to the two possible factors we mentioned above. Therefore, the second aim was to examine the association of the price and the trend in the insurance claims for dental gold-silver-palladium alloys.

METHODS

Study design

This was a before-and-after observational study using nationwide, annually, and cross-sectional insurance claims data. This study used publicly published datasets that did not contain any personal information; therefore, ethical approval was not required.

Information on the insurance claims for dental materials

We obtained national health insurance claims data in June each year from the Survey on Economic Conditions in Health Care[16]. The codes and definitions of the insurance services

used in this study follow the definitions by the Ministry of Health, Labour and Welfare (MHLW). We used the datasets obtained from private dental clinics from 2006 to 2020 because the age-stratified datasets are available from 2005, and the insurance system was reviewed in 2006. Until 2014, the number of dental insurance claims was estimated using stratified two-stage random sampling. After 2015, the results include the actual number of insurance claims obtained from the national database of health insurance claims. After 2015, the data covered more than 95% of insurance fee receipts in dentistry.

We summarised the codes of the insurance services in **Supplemental Table 1**. We extracted the number of insurance claims for dental gold-silver-palladium alloys for inlays and crowns, respectively. The crown category included complete and resin-veneered crowns. Other insurance claims, such as one for partial-coverage crowns, were excluded in this study because they were infrequently selected by dentists and were unstable due to a small number of the insurance claims. We also excluded the insurance claims for materials for pontics because there was no non-metal material for dental bridges before 2017. In addition, the insurance claims for cast clasps using dental gold-silver-palladium alloy were also excluded because they were strongly affected by the number of insurance claims for removable partial dentures.

As a comparison group to the alloy for inlays, we extracted the number of insurance claims for filling materials defined as including composite resin, resin-modified glass ionomer cement, glass ionomer cement, and so on (**Supplemental Table 1**). This category also included insurance claims for the materials of composite resin and resin-modified glass ionomer cement inlays because, until 2017, these inlay materials were categorised as filling materials. As a comparison group to the alloy for crowns, we also extracted insurance claims for non-metal dental crown materials, defined as including insurance claims for material costs of resin jacket crowns, hard resin jacket crowns, and computer-aided design/computer-aided

manufacturing (CAD/CAM) crowns. In July 2016, resin jacket crowns were excluded from insurance. Since April 2014, CAD/CAM crowns have been covered by insurance. Insurance claims for dental silver alloy and nickel-chromium alloy for inlay and crown were also included as a comparison group.

To cancel out the reduction in the insurance claims related to the decreasing dental caries levels, we calculated the proportions of each dental material in the inlay and filling category and the crown category. At first, the age-standardised number of the insurance claims was calculated. The Japanese population in June 2020 was used as the standard population, which was obtained from the Statistics Bureau of Japan[17]. Then, we defined two categories: materials for inlays and fillings, and materials for crowns. The inlay and filling category consisted of the insurance claims for dental gold-silver-palladium alloy for inlays, dental silver alloy and nickel-chromium alloy for inlays, and filling materials. The crown category consisted of the insurance claims for dental gold-silver-palladium alloy for crowns, dental silver alloy and nickel-chromium alloy for crowns, and non-metal dental crown materials. In each group, the proportions of each material were calculated.

The price of dental gold-silver-palladium alloy

The price of dental gold-silver-palladium alloy posted by the MHLW was included in this study. The purchase price of a private company was also included as a proxy of the market selling price. Information on the mean purchase prices of GC CASTWELL M.C. 12%GOLD in each month from 2005 to 2021 was collected from the website of FUJIDENTAL[18]. The prices were inflation-adjusted using the consumer price index (CPI) in Japan in 2020[19]. In addition, to assess the imbalance price between the insurance fee and market selling price, we calculated the difference in inflation-adjusted Japanese yen per 1 g in each month by the posted price minus the purchase price. Therefore, a minus value means a deficit, and a plus value means a profit.

Statistical analyses

First, the correlations between the price of dental gold-silver-palladium alloy and the proportions of the age-standardised number of the insurance claims for dental gold-silver-palladium alloy were assessed using Pearson's correlation test. For Pearson's correlation test, we used the mean price and mean imbalance price for the 12 months before the relevant month (June each year). The imbalance price between the insurance fee and the market selling price was calculated by the posted price minus the market selling price. Therefore, a minus value means a deficit, and a plus value means a profit.

Second, we detected a multiple change point of the imbalance between the posted and purchase prices, and the purchase price of dental gold-silver-palladium alloy using the segment neighbourhood method, the R package "changepoint"[20], for the change in mean. Then, we defined periods based on the trend changes in the prices. Using the periods detected by the change point analyses, we performed a segmented regression analysis to estimate coefficients with 95% confidence intervals (CIs) for the trend changes in the proportions of the age-standardised number of the insurance claims for inlay and crown[21].

Two-tailed P values of <.05 were considered statistically significant. All analyses were performed using R software (version 4.1.2; R Foundation for Statistical Computing, Vienna, Austria) on macOS.

RESULTS

Table 1 and **Fig. 1** show the proportions of the age-standardised number of insurance claims for each material. In the inlay and filling category, the proportion of dental gold-silver-palladium alloy was 13.2% in 2006 and decreased to 7.0% in 2020. The proportion of filling materials was 85.6% in 2006 and increased to 92.3%. The proportion of dental silver alloy and nickel-chromium alloy was stable at less than 2%. In the crown category, dental gold-

139 silver-palladium alloy occupied 93.9% in 2006, but the proportion decreased to 75.8% in
140 2020. The proportion of non-metal dental crown materials increased to 19.3% in 2020 from
141 5.1% in 2006. Dental silver alloy and nickel-chromium alloy for crowns mostly occupied less
142 than 5%.

143 **Fig. 2A** shows the trends in the posted and purchase prices. In the purchase price of
144 dental gold-silver-palladium alloy, four change points were detected: October 2010,
145 December 2016, January 2019, and December 2019. **Fig. 2B** shows the trend in the imbalance
146 between the posted and purchase prices, and four change points were detected: June 2015,
147 September 2016, January 2019, and September 2021. A growing deficit was observed during
148 the period from January 2019 to September 2021, and we defined this period as an imbalance
149 price period. For convenience, we defined four periods: the first period (January 2005 to
150 October 2010), the second period (November 2010 to December 2016), the third period
151 (January 2017 to December 2018), and the fourth period (January 2019 to September 2021).

152 **Fig. 3** shows the results from Pearson's correlation test to assess the correlations
153 between the price and the insurance claims for dental gold-silver-palladium alloy. Although
154 the price of dental gold-silver-palladium alloy was strongly correlated with the proportions of
155 dental gold-silver-palladium alloy for inlays (Pearson correlation coefficient: -0.8577) and
156 crowns (-0.9599), the imbalance price was weakly or moderately correlated (0.3743 and
157 0.5683).

158 **Table 2** shows the trend changes in the proportions of each material from a
159 segmented regression analysis. There was no significant trend change in dental gold-silver-
160 palladium alloy for inlays in each period (first period: unstandardised coefficient = -0.793,
161 95% CI = -1.928, 0.343; second period: -0.377, 95% CI = -1.321, 0.568; third period: -0.191,
162 95% CI = -0.474, 0.092; fourth period: -0.348, 95% CI = -0.801, 0.106). In the crown
163 category, the proportion of dental gold-silver-palladium alloy significantly decreased since

the second period (first period: unstandardised coefficient = 0.126, 95% CI = -0.455, 0.707; second period: -0.929, 95% CI = -1.291, -0.568; third period: -1.269, 95% CI = -2.478, -0.060; fourth period: -4.410, 95% CI = -5.863, -2.958).

DISCUSSION

In inlays and fillings, the proportion of the insurance claims for dental gold-silver-palladium alloy for inlays was 13.2% in 2006 and decreased to 7.0% in 2020. There was no significant downwards trend during the periods with the rising price. In inlays and fillings, the filling materials occupied 85.6% to 92.3%. In crowns, the proportion of the insurance claims for dental gold-silver-palladium alloy was higher than 90% in 2006, but in 2020, the proportion decreased to 75.8%. The significant trend change occurred during the periods with the increasing price. In crowns, the proportion of the insurance claims for non-metal dental crown materials increased from 5.1% in 2006 to 19.3% in 2020. Since 2006, the proportions of the insurance claims for dental gold-silver-palladium alloy trended downwards. The increased price might have partially contributed to the downwards trend.

Dental gold-silver-palladium alloy for inlays decreased but was not significant during the periods with the increasing price. This might be because the filling materials already occupied more than 80% in 2006. However, the metal materials for inlays have been still gradually replaced with filling materials. Dental gold-silver-palladium alloy for crowns significantly decreased after the second period. Because treatments using non-metallic dental materials, such as CAD/CAM crowns, were applied to insurance services during the study period in response to the increasing price of dental gold-silver-palladium alloy, this introduction may have led dentists to select non-metallic dental materials for insurance treatment. In the future, non-metal dental materials can become more common in insured dental care in Japan.

The price of dental gold-silver-palladium alloy was strongly correlated with the proportions of dental gold-silver-palladium alloy for inlay and crown, whereas the imbalance price was weakly correlated. The deficit is irrelevant to patients and might have less impact on dentists' treatment selection in private clinics; therefore, the impact of the imbalance price might have been relatively small. However, the increasing price might have facilitated substituting metal dental materials with non-metal materials.

This study had major limitations. First, the trends in dental treatments and materials can change through other factors, such as patterns of dental diseases and the age structure of the population[2–5]. In this study, although we used the age-standardised proportions, these factors could not be fully adjusted. Second, it was difficult to determine when a clear deficit began because the price of dental gold-silver-palladium alloy has been gradually increasing. In addition, we used purchase price as a proxy for the market selling price; therefore, we could not obtain the actual deficit in dental clinics. Probably because the market selling price is expected to be higher than the purchase price, the deficit might be larger than that shown in **Fig. 2B.** Third, the dataset used in this study was limited to data from June and not annual data. This limitation can lead to random errors in the number of insurance claims. Furthermore, as the sampling method has changed since 2015, the earlier data may also have increased random errors.

CONCLUSION

Since 2006, the proportion of insurance claims for dental gold-silver-palladium alloy trended downwards. The increased price might have partially contributed to the downwards trend. The increase in the price of dental alloys can be a source of healthcare costs. Moreover, recent modifications of Japan's health insurance system expanded the applications of non-metal dental materials in response to the increasing price of precious metals. Describing the trend in substituting metal dental materials with non-metal materials can assess the success of the

214 application enlargement of materials. Further studies should monitor the trends in insurance

215 claims for dental materials.

ACKNOWLEDGMENTS

We would like to thank the Ministry of Health, Labour and Welfare for access to data.

Data Availability

The insurance claims data in this study are available in e-Stat at https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00450048&tstat=000001029602.

Funding Sources

The authors received no financial support.

Conflict of Interest

The authors declared no conflicts of interest.

Authors' contributions

YuS was a major contributor in the conception of the study, analysing the data, the interpretation of the results, and writing the manuscript. All the other authors made substantive contributions to the interpretation of the results, and critically reviewed the draft. All authors read and approved the final draft of the manuscript.

REFERENCES

1) Brennan D. Dental Health Services Epidemiology. *Oral Epidemiology: A Textbook on Oral Health Conditions, Research Topics and Methods* 2021; 395–407.

2) Bayne SC, Ferracane JL, Marshall GW, et al. The Evolution of Dental Materials over the Past Century: Silver and Gold to Tooth Color and Beyond. *J Dent Res* 2019; 98: 257–265.

3) Eklund SA. Trends in dental treatment, 1992 to 2007. *J Am Dent Assoc* 2010; 141: 391–399.

4) Brennan DS, Ryan P, Spencer AJ, et al. Dental service rates: age, period, and cohort effects. *Community Dent Health* 2000; 17: 70–78.

5) Brennan DS, Balasubramanian M, Spencer AJ. Trends in dental service provision in Australia: 1983–1984 to 2009–2010. *Int Dent J* 2015; 65: 39–44.

6) Ikegami N, Yoo B-K, Hashimoto H, et al. Japanese universal health coverage: evolution, achievements, and challenges. *The Lancet* 2011; 378: 1106–1115.

7) Zaitsu T, Saito T, Kawaguchi Y. The Oral Healthcare System in Japan. *Healthcare* 2018; 6: 79.

8) Sakamoto H, Rahman M, Nomura S, et al. *Japan health system review*. New Delhi: World Health Organization. Regional Office for South-East Asia, https://apps.who.int/iris/handle/10665/259941 (2018).

9) Nakai M, Niinomi M. Chapter 12 Dental Metallic Materials. In: *Advances in metallic biomaterials : processing and applications*. Heidelberg: Springer, 2015. Epub ahead of

print 2015. DOI: 10.1007/978-3-662-46842-5.

10) The World Bank. Commodity Markets, https://www.worldbank.org/en/research/commodity-markets (2022, accessed 31 January 2022).

11) Manning WG, Bailit HL, Benjamin Bernadette, et al. The demand for dental care: evidence from a randomized trial in health insurance. *J Am Dent Assoc* 1985; 110: 895–902.

12) Ministry of Health, Labour and Welfare. Statistics of Physicians, Dentists and Pharmacists (in Japanese), https://www.mhlw.go.jp/toukei/list/33-20c.html (2021, accessed 27 December 2021).

13) Ministry of Health, Labour and Welfare. Survey on Economic Conditions in Health Care (Survey on Health Care Facilities) (in Japanese), https://www.mhlw.go.jp/bunya/iryouhoken/database/zenpan/iryoukikan.html (2021, accessed 24 December 2021).

14) Reissmann DR, Bellows JC, Kasper J. Patient Preferred and Perceived Control in Dental Care Decision Making. *JDR Clin Transl Res* 2019; 4: 151–159.

15) Samorodnitzky-Naveh GR, Geiger SB, Levin L. Patients' satisfaction with dental esthetics. *J Am Dent Assoc* 2007; 138: 805–808.

16) Ministry of Health, Labour and Welfare. Statistics of Medical Care Activities in Public Health Insurance (in Japanese), https://www.mhlw.go.jp/toukei/list/26-19.html (2020,

accessed 25 April 2022).

17) Statistics Bureau of Japan. Population estimates in Japan, https://www.stat.go.jp/data/jinsui/2.html (2022, accessed 25 February 2022).

18) FUJIDENTAL (in Japanese). *FUJIDENTAL*, https://fujidental.co.jp/ (2022, accessed 16 February 2022).

19) Statistics Bureau, Ministry of Internal Affairs and Communications. Consumer Price Index. *Consumer Price Index*, https://www.stat.go.jp/data/cpi/ (2022, accessed 14 June 2022).

20) Killick R, Eckley IA. changepoint: An R Package for Changepoint Analysis. *J Stat Softw* 2014; 58: 1–19.

21) Muggeo VM. Segmented: an R package to fit regression models with broken-line relationships. *R News* 2008; 8: 20–25.

Fig. 1. Proportions of the age-standardised number of the insurance claims for dental gold-silver-palladium alloy from 2006 to2020. **A:** Proportions of each material for inlay and filling. **B:** Proportions of each material for crown.

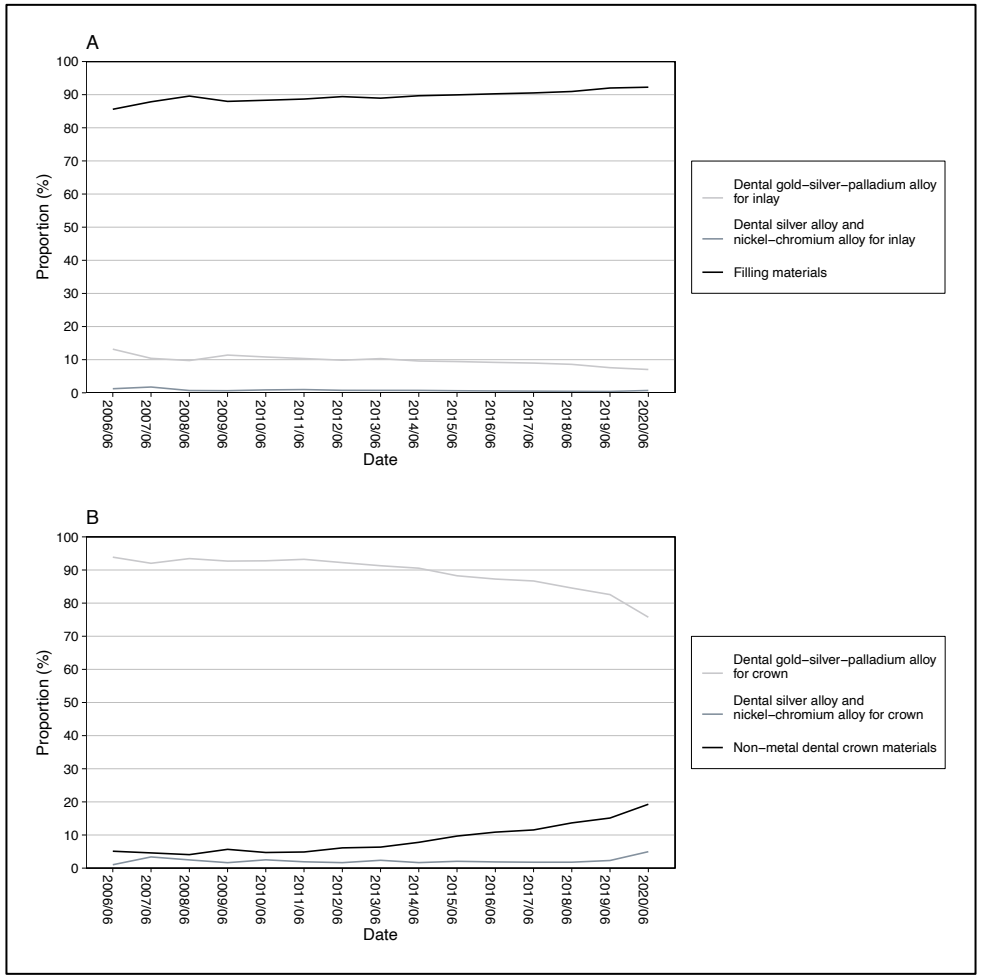

Fig. 2. Trend in the price of dental gold-silver-palladium alloy from 2006 to2020. **A:** The trend in the posted price and the purchase prices of dental gold-silver-palladium alloy. **B:** The trend in the posted price minus the purchase price of dental gold-silver-palladium alloy in each month.

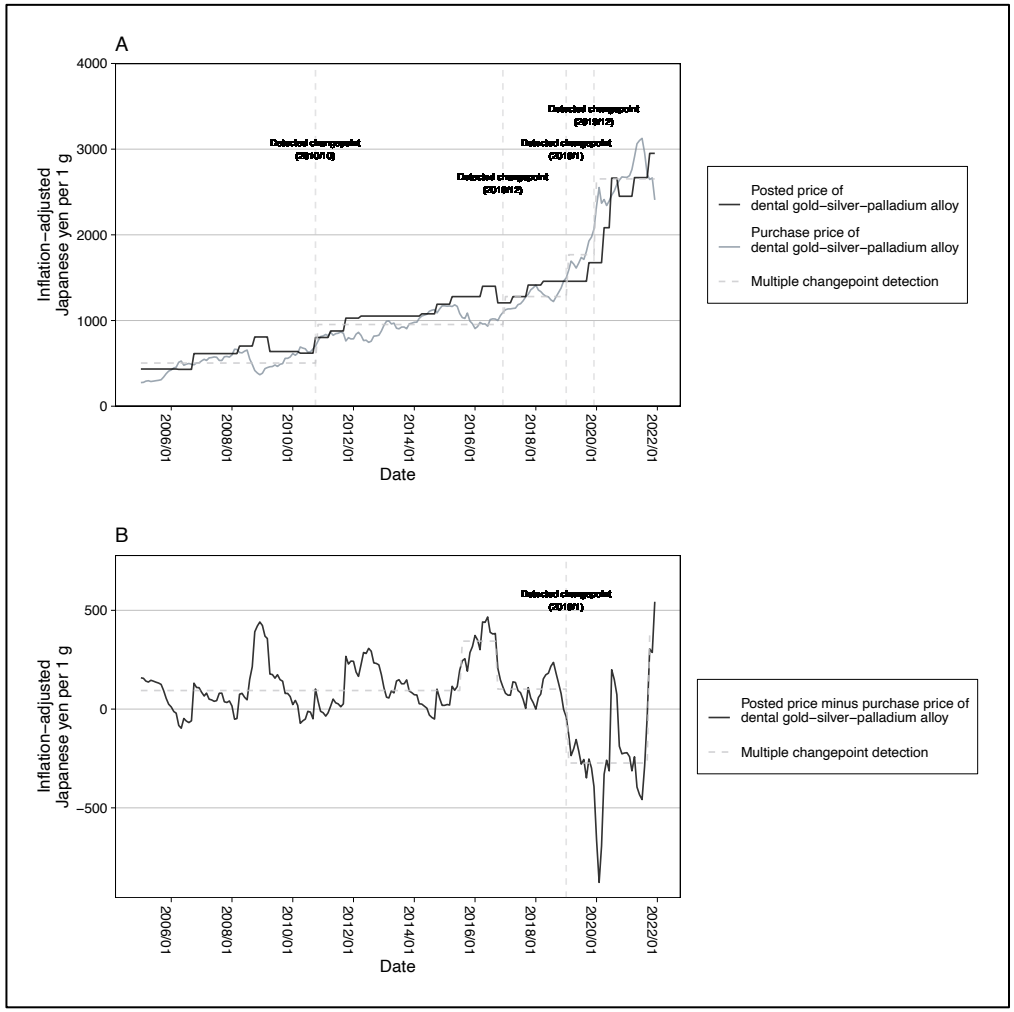

Fig. 3. Correlations between the price of dental gold-silver-palladium alloy and the proportions of the age-standardised number of the insurance claims for dental gold-silver-palladium alloy for inlay and crown. **A:** Correlations between the mean price and the proportions of dental gold-silver-palladium alloy for inlay. **B:** Correlations between the imbalance price and the proportions of dental gold-silver-palladium alloy for inlay. **C:** Correlations between the mean price and the proportions of dental gold-silver-palladium alloy for crown. **D:** Correlations between the imbalance price and the proportions of dental gold-silver-palladium alloy for crown.

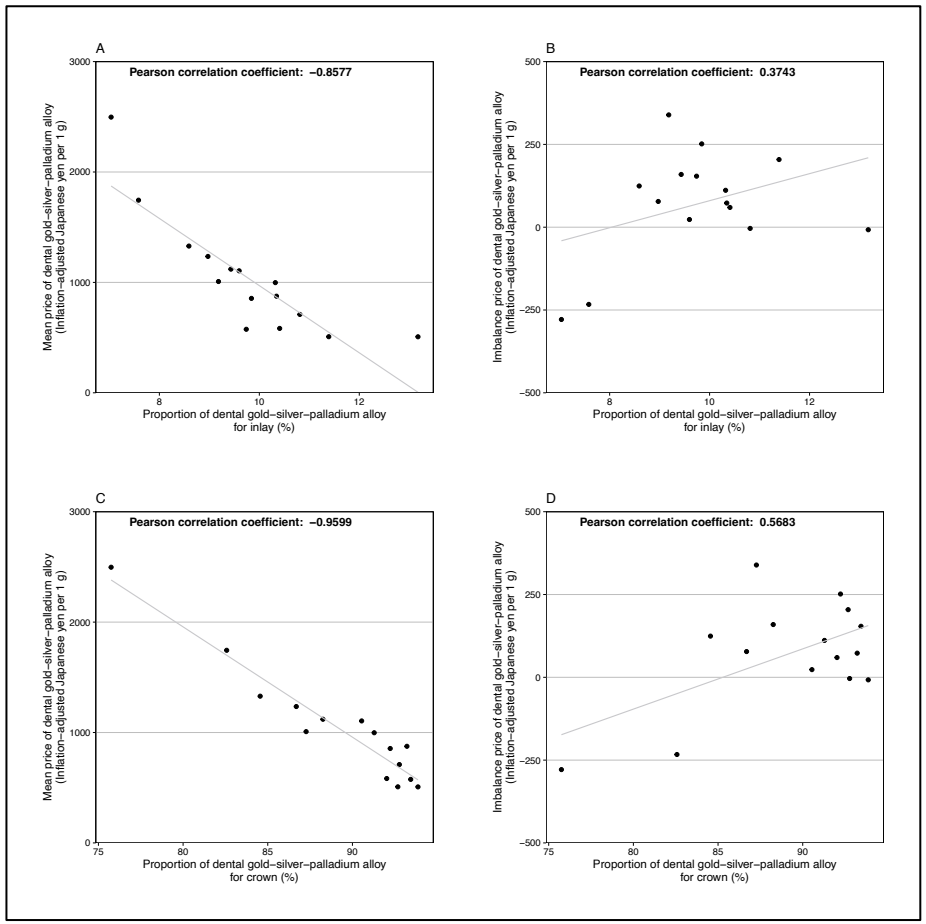

Table 1. Proportions of the age-standardised number of the insurance claims for dental gold-silver-palladium alloy from 2006 to2020.

Category	Material		June 2006	June 2007	June 2008	June 2009	June 2010	June 2011	June 2012	June 2013	June 2014	June 2015	June 2016	June 2017	June 2018	June 2019	June 2020
Materials for inlay and filling	Dental gold-silver-palladium alloy	Number of claims	967,711	865,094	765,204	744,158	682,080	706,860	796,943	779,988	758,032	774,207	756,905	771,074	718,940	604,394	467,768
		Age-standardised number of claims	891,252	786,322	716,965	718,838	660,231	662,683	765,313	753,327	737,165	755,348	740,162	758,246	711,282	601,031	467,768
		Proportion	**13.2**	**10.4**	**9.7**	**11.4**	**10.8**	**10.3**	**9.8**	**10.3**	**9.6**	**9.4**	**9.2**	**9.0**	**8.6**	**7.6**	**7.0**
	Dental silver alloy and nickel-chromium alloy	Number of claims	95,794	150,254	56,265	44,792	57,855	67,932	61,642	57,228	58,546	52,447	46,790	43,951	38,059	32,649	47,215
		Age-standardised number of claims	83,326	131,741	50,467	40,484	53,420	62,569	58,089	53,869	55,977	50,306	44,925	42,552	37,249	32,326	47,215
		Proportion	**1.2**	**1.7**	**0.7**	**0.6**	**0.9**	**1.0**	**0.7**	**0.7**	**0.7**	**0.6**	**0.6**	**0.5**	**0.4**	**0.4**	**0.7**
	Filling materials	Number of claims	6,066,771	6,938,971	6,799,881	5,667,206	5,538,855	5,866,479	7,095,564	6,620,436	6,977,340	7,312,401	7,371,967	7,729,536	7,580,646	7,321,005	6,134,383
		Age-standardised number of claims	5,790,257	6,637,428	6,594,407	5,552,020	5,393,143	5,681,395	6,952,441	6,492,173	6,888,444	7,203,050	7,275,427	7,650,304	7,530,732	7,292,776	6,134,383
		Proportion	**85.6**	**87.8**	**89.6**	**88.0**	**88.3**	**88.7**	**89.4**	**88.9**	**89.7**	**89.9**	**90.3**	**90.5**	**91.0**	**92.0**	**92.3**
Materials for crown	Dental gold-silver-palladium alloy	Number of claims	1,650,993	1,632,375	1,382,073	1,299,986	1,337,770	1,223,235	1,433,047	1,331,292	1,371,670	1,359,806	1,338,303	1,364,814	1,293,029	1,113,712	933,477
		Age-standardised number of claims	1,683,382	1,684,928	1,392,645	1,332,961	1,374,174	1,229,280	1,460,624	1,350,502	1,391,136	1,370,927	1,345,009	1,370,459	1,296,965	1,114,779	933,477
		Proportion	**93.9**	**92.0**	**93.4**	**92.7**	**92.8**	**93.2**	**92.2**	**91.3**	**90.5**	**88.3**	**87.3**	**86.7**	**84.6**	**82.6**	**75.8**
	Dental silver alloy and nickel-chromium alloy	Number of claims	19,953	56,303	35,805	22,396	36,540	24,786	26,159	33,288	25,258	31,879	28,858	28,206	27,420	31,067	61,197
		Age-standardised number of claims	18,371	61,865	37,029	23,666	37,172	25,194	26,222	35,007	25,609	31,980	28,817	28,233	27,465	31,090	61,197
		Proportion	**1.0**	**3.4**	**2.5**	**1.6**	**2.5**	**1.9**	**1.7**	**2.4**	**1.7**	**2.1**	**1.9**	**1.8**	**1.8**	**2.3**	**5.0**
	Non-metal dental crown materials	Number of claims	92,638	82,579	64,449	82,458	70,035	67,473	97,384	93,936	119,282	151,009	168,550	183,183	210,270	204,606	237,621
		Age-standardised number of claims	91,548	84,153	60,716	81,579	69,907	64,239	96,814	93,920	119,666	150,403	167,463	182,293	209,491	204,163	237,621
		Proportion	**5.1**	**4.6**	**4.1**	**5.7**	**4.7**	**4.9**	**6.1**	**6.3**	**7.8**	**9.7**	**10.9**	**11.5**	**13.7**	**15.1**	**19.3**

Filling materials mainly included the claims for composite resin, resin-modified glass ionomer cement, glass ionomer cement, and composite resin and resin-modified glass ionomer cement inlay.
The crown category included complete crown and resin-veneered crown.
Non-metal dental crown materials included the claims for materials of resin jacket crown, hard resin jacket crown, and CAD/CAM crown.

Table 2. Trend changes from 2006 to 2020 in the proportions of the age-standardised number of insurance claims for each dental material from a segmented regression analysis.

Category	Material		Trends in each period	
			Unstandardised coefficient	95% confidence interval
Materials for inlay and filling	Dental gold-silver-palladium alloy	First period (2006 to 2010)	-0.793	-1.928, 0.343
		Second period (2010 to 2016)	-0.377	-1.321, 0.568
		Third period (2017 to 2018)	-0.191	-0.474, 0.092
		Fourth period (2019 to 2020)	-0.348	-0.801, 0.106
	Dental silver alloy and nickel-chromium alloy	First period (2006 to 2010)	-0.140	-0.288, 0.008
		Second period (2010 to 2016)	-0.029	-0.121, 0.063
		Third period (2017 to 2018)	-0.115	-0.424, 0.193
		Fourth period (2019 to 2020)	0.131	-0.240, 0.501
	Filling materials	First period (2006 to 2010)	**0.488**	**0.032, 0.944**
		Second period (2010 to 2016)	0.220	-0.064, 0.504
		Third period (2017 to 2018)	0.492	-0.458, 1.441
		Fourth period (2019 to 2020)	0.662	-0.480, 1.803
Materials for crown	Dental gold-silver-palladium alloy	First period (2006 to 2010)	0.126	-0.455, 0.707

	Second period (2010 to 2016)	**-0.929**	**-1.291, -0.568**
	Third period (2017 to 2018)	**-1.269**	**-2.478, -0.060**
	Fourth period (2019 to 2020)	**-4.410**	**-5.863, -2.958**
Dental silver alloy and nickel-chromium alloy	First period (2006 to 2010)	0.044	-0.357, 0.444
	Second period (2010 to 2016)	-0.062	-0.312, 0.187
	Third period (2017 to 2018)	-0.180	-1.013, 0.654
	Fourth period (2019 to 2020)	**1.557**	**0.555, 2.559**
Non-metal dental crown materials	First period (2006 to 2010)	-0.170	-0.597, 0.258
	Second period (2010 to 2016)	**0.992**	**0.725, 1.258**
	Third period (2017 to 2018)	**1.448**	**0.558, 2.339**
	Fourth period (2019 to 2020)	**2.853**	**1.783, 3.924**

Filling materials mainly included the claims for composite resin, resin-modified glass ionomer cement, glass ionomer cement, and composite resin and resin-modified glass ionomer cement inlay.
The crown category included complete crown and resin-veneered crown.
Non-metal dental crown materials included the claims for materials of resin jacket crown, hard resin jacket crown, and CAD/CAM crown.

Supplemental Table 1. Summary of the definitions of insurance services with codes.

Category	Code
Dental gold-silver-palladium alloy for inlay	DM021, DM022, DM025, and DM026
Dental silver alloy and nickel-chromium alloy for inlay	DM030, DM031, DM034, DM035, DM039, DM040, DM043, and DM044
Filling materials	DM014, DM015, DM016, DM017, DM018, DM093, DM094, DM095, DM096, DM19, DM120, DM121, DM122, DM123, and DM124
Dental gold-silver-palladium alloy for crown	DM024, DM029, and DM048
Dental silver alloy and nickel-chromium alloy for crown	DM033, DM038, DM042, DM047, DM049, and DM050
Non-metal dental crown materials	DM051, DM052, DM053, DM097, and DM114