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Research paper

Regional Inequality in Dental Care Utilization in Japan: An Ecological Study Using the National Database of Health Insurance Claims

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ABSTRACT

Background: This study examined regional inequalities in dental care utilization in Japan and the association of dental care utilization with socioeconomic factors.

Methods: Using the Fourth National Database of Health Insurance Claims and Specific Health Checkups of Japan Open data, this ecological study analyzed 216 million pieces of aggregated data from April 2017 to March 2018. Nine indicators of dental care utilization were used: outpatient visits, outreach services, cavity fillings, pulpectomies, dental calculus removals, periodontal surgeries, tooth extractions, dental bridges, and dentures. Standardized claim ratios (SCRs) for these indicators were calculated for Japan's 47 prefectures, which were divided into three groups based on the number of dental clinics per population, average income per capita, and the proportion of university enrollments. Associations of the dental care utilization with dental supply and regional socioeconomic factors were examined.

Findings: The ratios of maximum to minimum of SCRs were 1·4 for outpatient visits, 19·3 for outreach services, and 17·6 for periodontal surgeries. Dental supply was positively associated with outpatient visits, outreach services, dental calculus removal, and periodontal surgeries. Regional average income and educational level were positively associated with dental calculus removals, and negatively associated with pulpectomies, tooth extractions, dental bridges, and dentures.

Interpretation: In Japan, regional inequalities in dental care utilization exist for periodontal care and outreach services but are smaller for urgent and substantial dental care. Regional income and educational levels appear to have influence on dental care utilization.

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1. Background

Oral health inequalities still exist around the world [1]: they have been reported in the United States [2–4], Europe [5–9], Asia [10–12], Oceania [3], and other countries and regions [13]. These reports highlight the fact that inequalities in oral health and dental care have been neglected worldwide [14]. Previous studies, including those mentioned above, have identified socioeconomic factors such as income and education and the number of dentists, and others as the causes of such inequalities [15]. In the Global Goals for Oral Health 2020, the World Health Organization aimed to reduce oral health inequalities among different socioeconomic groups within countries and inequalities in oral health across countries [16]. The former goal is consistent with the Second Phase of the Healthy Japan 21 plan that was published in 2013,

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in which the Japanese government acknowledged regional and social inequalities in dental and oral health and emphasized the need for health promotion policies to reduce these inequalities [17].

In Japan, previous studies have examined the associations of inequalities in dental visits, number of treated teeth and missing teeth, and dental prosthesis use with socioeconomic factors by analyzing health survey data or healthcare insurance claims data in one region. These studies revealed a linear association between income level and dental visits [18,19]. Additionally, lower-income groups are less likely to use dental prostheses than are higher-income groups [20]. A previous study showed that individuals with fewer years of education had a higher number of treated teeth and a lower number of remaining teeth as compared to their counterparts [21]. These Japanese results are consistent with those in other Organisation for Economic Co-operation and Development (OECD)-member countries [3,8]. The studies mentioned above are, however, small-scale studies conducted in one region. To the best of the authors' knowledge, no national-level analysis regarding regional inequality in dental care utilization has been conducted in Japan, mainly owing to challenges in data collection. Understanding the current status of regional inequality in dental care utilization at the national level is necessary for planning future dental and oral health policies in Japan. This study, for the first time, examined regional inequality in dental care utilization in Japan using a national-level healthcare claims dataset recently made available to the public. This study also examined the associations of dental care utilization and dental care supply with socioeconomic factors, such as economic and educational levels, in each region.

2. Methods

2.1. Dental care supply system in Japan

In Japan, the universal public healthcare insurance system covers both medical and dental care. Treatment of dental caries, periodontal disease, and oral surgery and provision of dental prostheses are covered by insurance with a 30% copayment for adults younger than 75 years and 10–20% for adults older than 75 years [22]. Dental care services for the total population are provided by approximately 100,500 dentists at 68,500 dental facilities. In 2017, the total public dental expenditure was approximately 26·5 billion USD (i.e., 2·9 trillion JPY at the 2017 exchange rate) [23]; therefore, expenditure per capita on dental care was approximately 209 USD (23,000 JPY). This figure accounted for 6·9% of total healthcare expenditures [24]. The number of dentists per 100,000 people was 79·6 in 2017, ranking Japan ninth among 28 OECD countries [25] and ensuring an adequate dental service supply system.

2.2. Study design

An ecological study design at the prefectural level was adopted. The annual data (April 2017–March 2018) of dental care practices, aggregated at the prefectural level from dental care claims of public medical insurance for nearly the entire Japanese population, was used to examine regional differences in access to dental care and treatment. Additionally, the influence of the supply of dental care (number of dental clinics per 100,000 population) and socioeconomic factors (average income and university enrollment rate) in the prefectures were examined. Forty-seven prefectures in the administrative regions of Japan were divided into three groups according to the supply of dental care in the region (the number of dental clinics per 100,000 population) or socioeconomic factors (the average income per person and the proportion of university or college enrollment) to examine national differences in access to dental services and treatment.

2.3. Data sources

2.3.1. Demographics, dental supply, and socioeconomic data

As regional factors for the utilization of dental care, the number of dental clinics per 100,000 population, which indicates the supply of dental care, and the average income and college enrollment rate, which indicate socioeconomic factors, were studied in each prefecture in Japan, with reference to previous literature. To calculate these regional factors, the official data of the population, the number of dental clinics, the average income per person, and the proportion of universities or colleges (including junior colleges, that is, 2- or 3-year programs) in each prefecture were used.

The following datasets were also used: Vital Statistics in 2017 [26] for population data, Survey of Medical Institutions in 2017 [27] for the number of dental clinics, ESRI Statistics Annual Report on Prefectural Accounts for average income [28], and School Basic Survey in 2017 [29] for the proportion of universities or colleges.

2.3.2. Health data

The Fourth National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB) Open data [30,31], which contain information on medical claims over the course of one year (April 2017 to March 2018) for nearly the entire population (approximately 126·2 million people) of Japan was used. The dental treatment codes on 216 million medical claims for dental treatment, excluding hospitalization treatment, were analyzed using data aggregated at the prefectural level. Since 2009, the Japanese Ministry of Health, Labour and Welfare has promoted the development of the NDB, and it aggregates all medical, dental, and pharmaceutical claims (covered primary, secondary, and tertiary care). Since 2016, the main aggregated data from the NDB have been published online as NDB Open Data. The NDB includes virtually all relevant information, such as patients' sex and age, inpatient and outpatient appointments, diagnoses, medical/dental treatments, procedures, and prescribed medications provided through healthcare insurance.

2.4. Dental care indicators

The nine chosen indicators representing dental care utilization are as follows: outpatient visits, outreach services (dental care at home or in a nursing home for people who have difficulty visiting a dental clinic, such as older people receiving nursing care) representing access to dental services, cavity fillings, pulpectomies representing caries treatments, dental calculus removal, periodontal surgeries representing periodontal treatments, tooth extractions (with the exception of deciduous or impacted teeth) representing terminal treatment of teeth, dental bridges, and dentures representing occlusal restorative treatments (see Supplementary Table 2 for more details).

2.5. Standardized claim ratio (SCR)

Each indicator was standardized using an indirect method stratified by age, and sex, as described below. The standardized claim ratios (SCRs) of the nine indicators were then calculated in each of the 47 prefectures.

As an index to show the level of a target prefecture of the medical claims relative to the whole Japan, standardized claim ratio (SCR) has been developed[32] as adjusting both sex ratio and age distribution, which was defined as:

$$\text{Standardized claim ratio (SCR)} = \frac{\text{Observed number of claims}}{\text{Expected number of claims}} \times 100$$

Table 1
Standardized claim ratios of the nine indicators representing dental care utilizations

name of indicator	number of prefectures	number of dental care records	median	mean	standard deviation	maximum (prefecture)	minimum (prefecture)	ratio of maximum to minimum
outpatient visits	47	36,51,37,593	96·5	96·2	7·5	113·4 (Tokyo)	80·3 (Aomori)	1·4
outreach services	47	1,13,70,509	56·8	68·5	52·4	281·5 (Osaka)	14·6 (Fukui)	19·3
cavity fillings	47	9,39,33,045	94·3	95·6	9·9	118·7 (Tokyo)	77·2 (Aomori)	1·5
pulpectomies	47	69,13,988	101·9	102·7	8·0	119·3 (Wakayama)	86·1 (Kanagawa)	1·4
dental calculus removals	47	7,29,73,523	86·1	87·2	20·8	146·8 (Aichi)	47·2 (Kagoshima)	3·1
periodontal surgeries	47	28,37,871	55·6	72·7	54·0	263·4 (Osaka)	15·0 (Shiga)	17·6
tooth extractions	47	1,14,23,369	102·0	103·1	6·9	116·9 (Oita)	90·1 (Kanagawa)	1·3
dental bridges	47	25,84,669	99·1	102·1	12·5	147·4 (Hokkaido)	86·3 (Saitama)	1·7
dentures	47	74,18,055	99·8	100·8	7·5	117·5 (Hokkaido)	88·4 (Shizuoka)	1·3

Here observed claims are the total number of claims in a target prefecture in a year, and expected claims are the number of claims in a year if the situation of submitting claims (sex and age specific claims rate) of whole Japan was assumed for the population in the target prefecture. Expected number of claims is calculated as,

$$\text{Expected number of claims} = \sum_{\substack{sex,\ age \\ age\ groups}} (\text{population of a sex and age group in a target prefecture} \times \text{sex and age specific claim rate of the sex and age group in whole Japan})$$

where the standard population of 2017 is applied for whole Japan, and sex- and age-specific groups were the total 2 × 18=36 groups of the combinations of (males, females) × (0-4,5-9,….,85 and over). Here, sex- and age- specific claim rate is, sex- and age- specific claim rate = (total claims for each sex and age group in a year) / (population for the sex and age group in a year).

The SCR is an index of the level of dental care utilization relative to whole Japan (100 for whole Japan) adjusted by sex ratio and age distribution of target prefecture with indirect method, which is similar to standardized mortality ratio.

SCR of 100 indicates the number of sex- and age- adjusted claims in a prefecture are equal to the whole Japan, which means the prefecture is the same level as the whole Japan for dental care utilization. SCR of higher(smaller) than 100 means the more(less) frequent level in dental care utilization relative to whole Japan.

The SCR can provide an objective and relative understanding of the nationwide status of medical care provision in Japan, and it can also be used to compare the status of medical care provision among regions. Therefore, it is used in research on regional differences in medical care [32]. Additionally, since it can be quickly calculated from the aggregated data, it is also used as an indicator for policymakers of national and prefectural governments to formulate medical plans.

As seen in the definition of SCR, the easiness to access to dental clinics (the concentration of dental clinics) is not adjusted. So, for examining regional difference in dental supply. we defined the supply-adjusted SCR (supply-adjusted SCR) as, supply adjusted SCR in a target prefecture = SCR / the number of dental clinics per 100,000 population

2.7. Statistical analysis

Dental care supply (i.e., the number of dental clinics per 100,000 population) and socioeconomic factors (economic level: average income per capita, educational level: the proportion of university enrollments) were configured to show regional inequality (differences) in Japan.

Regional differences in dental care utilization (outpatient visits, outreach services, cavity fillings, pulpectomies, dental calculus removals, periodontal surgeries, tooth extractions, dental bridges, dentures) were configured and tabulated using SCR.

We divided the 47 prefectures into three groups by tertile based on the number of dental clinics per 100,000 population, average income per person, and proportion of university or college enrollments. The associations of dental care utilization (nine SCRs) with dental care supply were then explored by the differences among the three groups (a) the number of dental clinics. Next, the associations of dental care utilization (nine supply-adjusted standardized claim ratios) with socioeconomic factors (economic or educational) were explored among the three groups based on (b) average income per person and (c) the proportion of university or college enrollments (Figures 1b and 1c, Supplementary Table 1).

Each difference among the three levels of groups was explored using rank statistics (Mann-Whitney test) with no adjustment for pairwise comparisons [33]. A two-sided p-value of less than 0·05 was considered significant. Statistical analyses were performed using Stata/16·0 (Stata-Corp LLC, 4905 Lakeway Drive, College Station, Texas 77845 USA).

2.8. Ethical considerations

This study was approved by the Research Ethics Committee of the University of Tsukuba (No. 1446). There was no direct patient involvement in this study. The NDB Open Data are anonymized medical claims data compiled and released by the Japanese Ministry of Health, Labour and Welfare; thus, the data do not identify individual patients and do not constitute personal information. Therefore, informed consent was waived.

2.9. Role of the funding source

This work was supported by a Health and Labour Sciences Research Grant from the Ministry of Health, Labour and Welfare of Japan (multidisciplinary research project on measures against

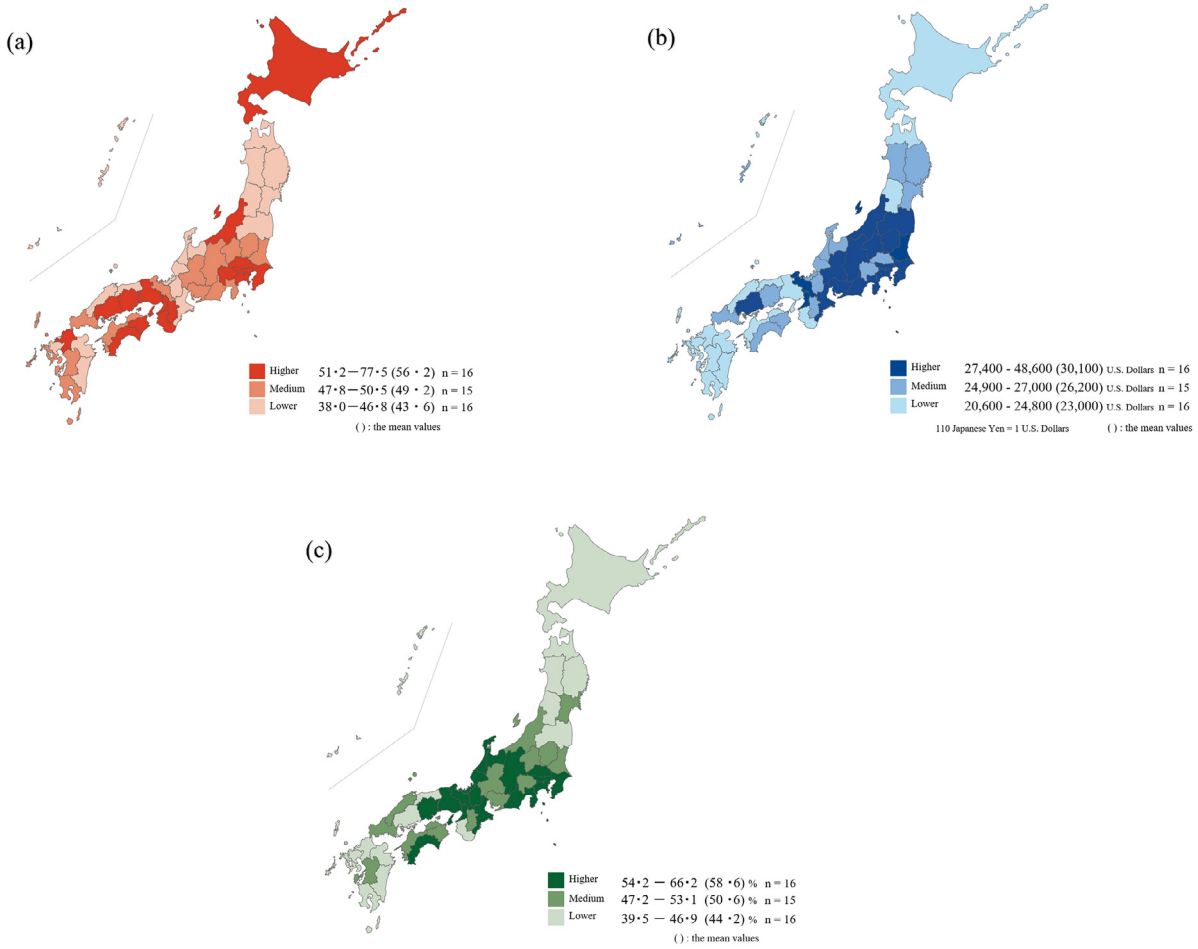

Figure 1. (a) Map of 47 prefectures categorized into three groups based on the number of dental clinics per 100,000 population
(b) Map of 47 prefectures categorized into three groups based on the average income per person
(c) Map of 47 prefectures categorized into three groups based on the proportion of university or college enrollment

lifestyle-related diseases such as cardiovascular diseases and diabetes mellitus). The research project aimed at the development of new evaluation indicators and methods for the preservation of dental and oral health: health services research to reduce health inequalities in Japan (no. H31-19FA1001, the principal investigator: Nanako Tamiya, MD). The funding source of this study had no role in study design, data collection, data analysis, data interpretation, or writing the manuscript.

3. Results

For the SCRs of the nine indicators, the median, mean, maximum, minimum, the ratios of maximum to minimum, and distribution are shown in Table 1 and Figure 2. The ratios of maximum to minimum of SCRs were 1·4 for outpatient visits and 19·3 for outreach services. For dental procedures, the ratios of maximum to minimum of SCRs were 1·5 for cavity fillings, 1·4 for pulpectomies, 3·1 for dental calculus removals, 17·6 for periodontal surgeries, 1·3 for tooth extractions, 1·7 for dental bridges, and 1·5 for dentures (see Supplementary Table 3-1 for the results in each prefecture).

The mean number of dental clinics per 100,000 people of the 47 prefectures was 49·8. In the higher, medium, and lower groups, the mean values were 56·2 (range: 51·2–77·5), 49·2 (range: 47·8–50·5), and 43·6 (range: 38·0–46·8), respectively. The mean prefectural average income per resident of the 47 prefectures was approximately 26,500 USD (2·91 million JPY). In the higher, medium, and lower groups, the mean values were 30,100(range: 27,400–48,600) USD (3·31 (range: 3·01–5·35) million JPY), 26,200 (24,900–27,000) USD (2·88 (2·74–2·97) million JPY), and 23,000 (20,600–24,800) USD (2·53 (2·27–2·73) million JPY), respectively. The mean percentage of university or college education attainment of all 47 prefectures was 51·2%. In the higher, medium, and lower groups, the mean values were 58·6% (range: 54·2–66·2), 50·6% (47·2–53·1), and 44·2% (39·5–46·9), respectively (Supplementary Table 1).

The number of dental clinics per 100,000 people was positively associated with outpatient visits ($p<0·001$ for both L–M and L–H), outreach services ($p<0·001$ both L–M and L–H), cavity fillings ($p=0·004$ L–M, $p=0·001$ L–H), dental calculus removals ($p=0·001$ L–M, $p=0·002$ L–H), and periodontal surgeries ($p=0·016$ L–H, $p=0·048$ M–H) but was negatively associated with tooth extractions ($p=0·022$ L–H) (Figure 3, Supplementary Table 4-1).

The average income per person was positively associated with dental calculus removals ($p=0·024$ L–H) but was negatively associated with pulpectomies ($p=0·022$ L–M), tooth extractions ($p=0·033$ L–M), dental bridges ($p=0·018$ L–M), and dentures ($p=0·010$ L–M, $p=0·042$ L–H) (Figure 4, Supplementary Table 4-2-1).

The proportion of university or college enrollments was positively associated with outreach services ($p=0·002$ L–H, $p=0·004$ M–H) and dental calculus removals ($p=0·001$ L–H, $p=0·024$ M–H), but was negatively associated with pulpectomies ($p=0·018$ L–H), tooth extractions ($p=0·011$ L–M, $p=0·004$ L–H), dental bridges ($p<0·001$ both L–M and, L–H), and dentures ($p=0·001$ L–M, $p=0·016$ L–H) (Figure 5, Supplementary Table 4-3-1).

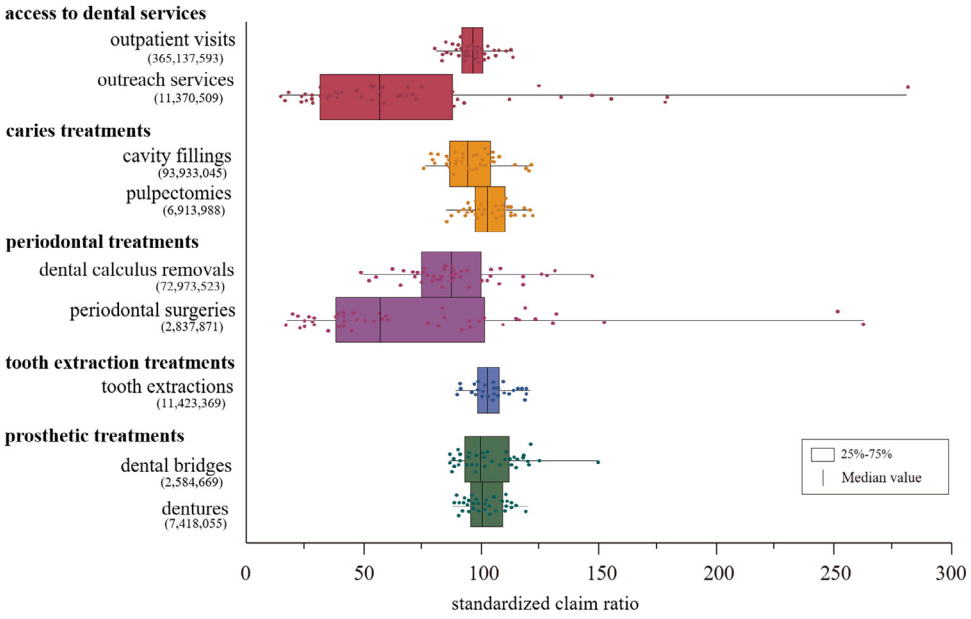

Figure 2. Standardized claim ratios of the nine indicators representing dental care utilization
The dots indicate the following: red for access to dental services, yellow for caries treatments, purple for periodontal treatments, blue for tooth extraction treatments, and green for prosthetic treatments. Bold text represents the category of the indicators. ( ) :number of dental care records.

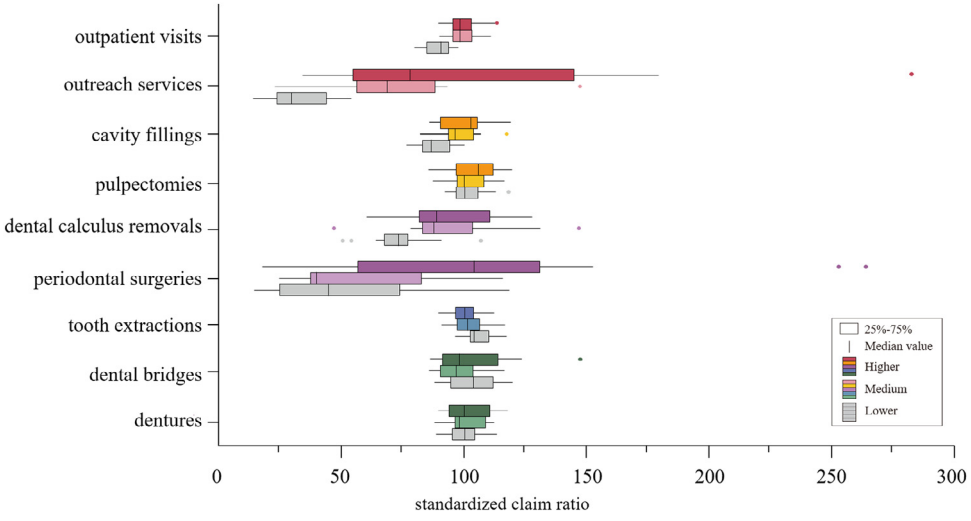

Figure 3. Comparison of standardized claim ratios of dental services among the three groups based on the number of dental clinics per 100,000 population
The dots indicate the following: red for access to dental services, yellow for caries treatments, purple for periodontal treatments blue for tooth extraction treatments, and green for prosthetic treatments. The 47 prefectures were divided into three groups by tertile (higher: 16, medium: 15, and lower:16) according to the number of dental clinics per 100,000 population. Each difference of the standardized claim ratio based on the nine indicators among three groups of the number of dental clinics per 100,000 population was explored using rank statistics (Mann-Whitney test) without adjustment for multiple comparisons.

4. Discussion

Using the Fourth NDB Open Data, an ecological study was conducted to examine dental care utilization in Japan. Regional inequality in dental care utilization in Japan appears to be larger for outreach services and periodontal treatments and smaller for urgent and substantial dental care. When regional dental care supply was considered, regional income levels or educational levels appear to have an influence on dental care utilization.

The ratio of maximum to minimum of outpatient visits was 1·4, indicating a small regional inequality, while the ratio of maximum to minimum of SCRs of outreach services was 19·3, indicating considerable regional inequality. In Japan, outpatient dental visits decrease sharply after the age of 75 years [34]. To meet the older population's dental care needs, which have increased alongside a rapidly aging population, the government has taken measures to promote an increase in the provision of outreach services by giving dental care providers incentives in their medical fees [35]. Future measures to promote outreach services should also consider the perspective of correcting the difference in supply between regions. Considerable inequalities in periodontal treatment were found nationwide; the ratio of maximum to minimum of SCRs of periodontal treatment were 3·1 for dental calculus removal and 17·6 for periodontal surgery. These values were higher than those of other dental treatments. Dental calculus removal, which is an initial preventive treatment against periodontal disease, is greatly influenced by geographical and socioeconomic factors [36]. Further, periodontal surgery is a conservative treatment for severe periodontal disease and is typically performed by periodontal disease specialists [37]. A previous study reported regional inequalities in the num-

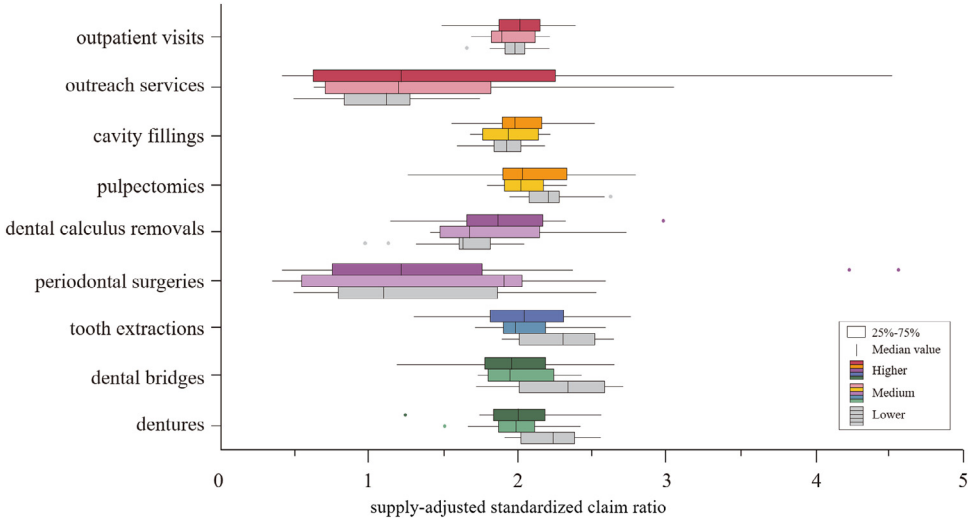

Figure 4. Comparison of supply-adjusted standardized claim ratios of dental services among the three groups based on the regional average income
The dots indicate the following: red for access to dental services, yellow for caries treatments, purple for periodontal treatments, blue for tooth extraction treatments, and green for prosthetic treatments. The 47 prefectures were divided into three groups by tertile (higher: 16, medium: 15, and lower:16) according to regional average income. Each difference of the supply-adjusted standardized claim ratios based on the nine indicators among the three groups of regional average income was explored using rank statistics (Mann-Whitney test) without adjustment for multiple comparisons.

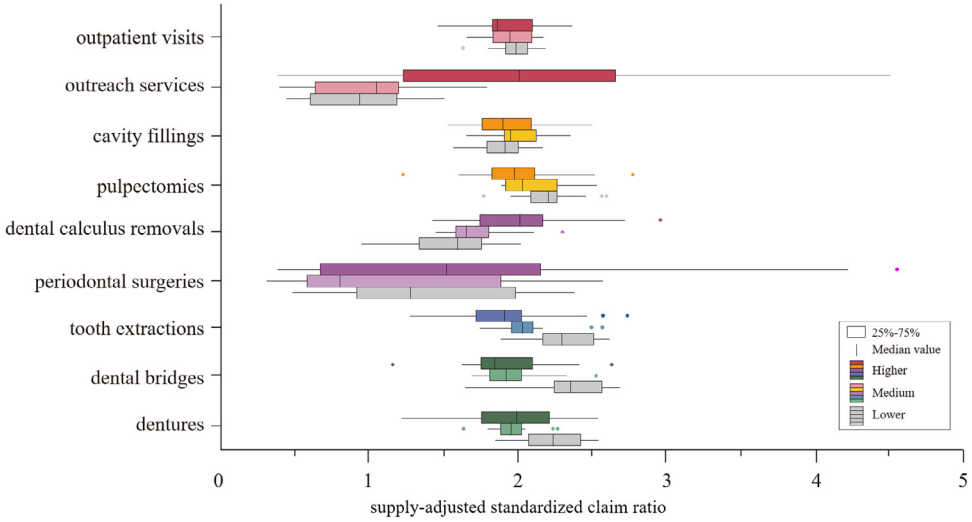

Figure 5. Comparison of supply-adjusted standardized claim ratios of dental services among the three groups based on the proportion of university or college enrollment
The dots indicate the following: red for access to dental services, yellow for caries treatments, purple for periodontal treatments, blue for tooth extraction treatments, and green for prosthetic treatments. The 47 prefectures were divided into three groups by tertile (higher: 16, medium: 15, and lower:16) according to the proportions of university or college enrollment. Each difference of the supply-adjusted standardized claim ratios based on the nine indicators among the three groups of the proportion of university or college enrollment was explored using by rank statistics (Mann-Whitney test) without adjustment for multiple comparisons.

ber of periodontists compared to that of general dentists [38]. Periodontal surgery is often performed by periodontists and since there are regional differences in the number of periodontists, there may be regional differences depending on the supply of dental care [39]. Older individuals now retain more of their teeth than in the past, and the percentage of adults with periodontal disease has consequently been increasing. To respond to the expected increase in periodontal disease among older adults, it may be necessary to introduce incentives to promote the prevention and treatment of periodontal disease according to the actual situation of dental care in different regions. This can be done with reference to approaches taken in European countries, such as requiring health checkups and visits to the dental clinic at least once a year as a condition for prosthetic treatment coverage [40], and by eliminating the uneven distribution of dentists involved in the treatment of periodontal disease.

The results show that outpatient visits, outreach services, cavity fillings, dental calculus removals, and periodontal surgeries were associated with the supply of dental care. In contrast, pulpectomies or tooth extractions to treat acute symptoms accompanying intense pain or inflammation and dental bridges or dentures to restore occlusal function were not associated with the supply of dental care. These results seem to suggest that dental care services for acute symptoms and occlusal recovery have been well established and are available across Japan.

The initial phase of dental caries treatment and periodontal treatment showed regional inequalities owing to differences in the number of dental clinics per region. Previous studies indicated that in areas with more (vs. less) medical facilities, visits for mild cases and recurrent visits are more common, as patients' healthcare costs are lower and they have better access to services [41,42]. Additionally, in such areas, there is more physician-induced de-

mand as a result of competition and information asymmetry. In areas with more dental clinics, there may potentially be excessive initial dental caries and periodontal treatments. In contrast, in areas with few dental clinics, dentists might spend most of their time providing first aid treatment or treating severe diseases; they might not have time to treat mild or moderate diseases.

Concerning the associations between the indicators of dental care utilization with regional socioeconomic factors (i.e., average income per capita) and the proportion of university enrollments, in lower areas, initial or preventive treatments such as dental calculus removals were lower, and urgent or substantial treatments such as pulpectomies and tooth extractions were higher. These results are consistent with those of a previous study in which groups with higher levels of income had higher preventive dental care [36], groups with higher levels of education had higher preventive dental care, and groups with lower levels of education had more extractions [21]. In contrast, this study showed a greater use of dental bridges or dentures in lower-income areas as compared to higher-income areas. These results were inconsistent with a previous study [20]. Several reasons can be considered. First, this study only included prosthetic treatments covered by universal healthcare insurance and not those outside of it such as ceramic bridges, metal dentures, and dental implants. Therefore, the prosthetic treatments not covered by universal healthcare insurance for typical high-income patients may have been underestimated. Second, this study was based on the data of those who received dental care, while the previous study was based on a questionnaire survey of older adult residents in the community [20]. The previous study showed that 30% of older adults with 19 or fewer teeth did not use dental bridges or dentures, indicating an unmet need for dental care among those who did not visit dental clinics. Finally, this was an ecological study, whereas the previous study was performed on an individual basis. Prosthetic treatments were significantly more often provided in areas with lower income levels. This suggests that the need for occlusal restorative treatment may be higher in low-income areas [43] and that, under Japan's universal healthcare system, occlusal restorative treatment is provided even in low-income areas.

These findings suggest that access to preventive dental care may be limited in the lower income or educational areas, and thus there may be fewer dentist visits for early-stage treatments such as dental calculus removal. In these areas, dental diseases may have already reached an advanced stage by the time the patient visits a dental clinic. As a result, tooth preservation becomes more difficult or even impossible, requiring subsequent occlusal rehabilitation. The tendency to visit a dental clinic after an advanced illness was observed in areas with lower average income levels or lower educational levels after adjusting for the number of dental clinics in each region.

This study has several limitations. First, as this is an ecological study, the results might not be suitable for extrapolation to an individual level owing to the risk of ecological fallacy. Second, since the NDB data were a collection of requests for reimbursement of medical fees paid for medical services provided through universal healthcare insurance, the data do not include treatments such as dental implants, ceramic bridges, or orthodontic treatments, as these are excluded from the insurance coverage. Thus, dental prosthetic treatment was likely to have been underestimated in urban areas where medical treatments not covered by insurance are performed more often. Third, the differences in oral health (e.g., number of remaining teeth) and the relative incidences of oral diseases in the regions were not considered. The number of remaining teeth in members of a community may be affected by the frequency of prosthetic treatments, and the percentage of edentulous people may affect the practice of periodontal disease treatment. Fourth, the validation of the data published by the NDB is ongoing [44]. In recent years, research focusing on validation in medical and pharmacy claims has been conducted on data published using the NDB [45,46]. Thus, the validity of the published dental claims data needs to be verified in the future.

Despite these limitations, this study has a notable strength: It is the first national-level study to clarify regional inequality in dental care utilization including caries treatments, periodontal treatments, extractions, and prosthodontic treatments in Japan using NDB Open Data, which comprises comprehensive health insurance claims for nearly the entire population. Additionally, the associations between inequalities in dental care utilization with regional dental care supply and socioeconomic factors were examined. This study is a first important step in demonstrating regional inequalities in dental care utilization in Japan; thus, such inequalities can be appropriately addressed.

5. Conclusions

Regional inequalities in dental care utilization in Japan appear to be greatest for periodontal care and outreach services. Regional inequalities appear to be smaller for urgent and substantial dental care, such as alleviating pain and treatments for maintaining basic occlusal function. In areas with more dental clinics, higher income levels, or higher educational levels, patients are more likely to be examined at the initial stages of dental diseases, while in areas with lower income levels or educational levels, patients are more likely to be examined after dental diseases have progressed. Regional income levels or educational levels appear to have an influence on dental care utilization.

This study provides essential information for health policymakers to decrease regional inequality in dental care utilization in Japan.

Consent for publication

Not applicable.

Availability of data and materials

The datasets for the current study are available in the NDB Open Data repository of Japanese Ministry of Health, Labour and Welfare: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000177221_00003.html

Authors' contributions

KT designed the study, analyzed data, and wrote the initial draft of the manuscript. TM contributed to the analysis and interpretation of data and extensively assisted in the preparation of the manuscript. MII, MAI, NS, TW, HT, and NT contributed to the interpretation of the data and critically reviewed the manuscript. All authors approve the final version of the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Research in context

Evidence before this study

Previous studies to examine the associations of inequalities in dental care utilization with socioeconomic factors in Japan were small-scale studies conducted in one region. These studies found that there is a linear relationship between income level and dental visit, low-income groups are less likely to use dental prosthetics than high income groups,

and people with fewer years of education have more treated teeth and fewer remaining teeth than those with more years of education. These results are consistent with those in other OECD countries.

Added value of this study

We used the NDB Open data, which comprise comprehensive health insurance claims for almost the entire population. To the best of our knowledge, this is the first national level study to clarify regional inequality in dental care utilization, including caries treatment, periodontal treatment, extraction, and prosthodontic treatment in Japan. We also examined the associations of dental care utilization with regional dental care supply and socioeconomic factors. Our study is a first important step in demonstrating regional inequalities in dental care utilization in Japan, so that such inequalities can be appropriately addressed.

Implications of all the available evidence

In Japan, there may be regional inequalities in the treatment of periodontal disease and in access to dental care. Regional income and educational levels appear to have influence on dental care utilization. Our study provides essential information to tackle regional inequality in dental care utilization in Japan and worldwide.

Declaration of Competing Interest

Takahiro Mori's appointment as an associate professor at the University of Tsukuba was sponsored by JMDC Inc. in the financial year 2018 (i.e., April 2018–March 2019), by SMS CO., LTD. in the financial year 2019 (i.e., April 2019–March 2020), and by FAST DOCTOR CO., LTD in the financial year 2020 (i.e., April 2020–March 2021). JMDC Inc., SMS CO., LTD, and FAST DOCTOR CO., LTD did not play any role in the conception, designing, conducting, or reporting of this study.

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The other authors declare that they have no competing interests.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2021.100170.

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