Original Article

Low billing rates for additional fees for pediatric sedation during MRI imaging

Running title: Additional fee for pediatric MRI sedation

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Number of text pages: 13

Number of reference pages: 2

Word count: abstract, 249 words; main text, 2398 words

Number of references: 13

Number of tables: 1

Number of figures: 2

ABSTRACT

Background: Sedating children for magnetic resonance imaging (MRI) requires special consideration. The 2018 revision of social insurance allows additional fees to be calculated for pediatric MRIs performed under sedation in Japan. The number of claims since this addition was established and its trend are unknown.

Methods: To analyze the claims of additional fees for pediatric sedated MRI imaging after fiscal year (FY) 2018, the actual claims of the addition in inpatient and outpatient practice was analyzed using publicly-available data from the Ministry of Health, Labour and Welfare (MHLW). We analyzed the calculation rate for all MRI scans. Annual changes in the actual number and calculation rate were analyzed. The ratio of the number of additional fees to the overall number of pediatric radiological procedures was used to examine the geographic disparity.

Results: The number of calculations from FY 2018 to FY 2020 was available; in FY 2020, only 1347 additions were calculated, corresponding to 0.35% of the total number of MRI scans. The number of fees showed a decreasing trend. Most cases were in the 0–4 years age group: however, there were a few cases in the 10–14 years age group without such a decrease. The relative number of calculations by prefecture showed a disparity of up to 14 times.

Conclusions: The requirements for the addition of pediatric MRI sedation are strict and not fully utilized in pediatric sedation for MRI. Measures such as relaxing the requirements for the fee are needed to make MRI-related sedation safer. (249/250words)

Key words: deep sedation, intravenous anesthesia, pediatrics, magnetic resonance imaging, social insurance

List of abbreviations

FY: fiscal year

MHLW: Ministry of Health Labor and Welfare

MRI: magnetic resonance imaging

NDB: The National Database of Health Insurance Claims and Specific Health Checkups

Background

Magnetic resonance imaging (MRI) examinations is the most frequent indication for pediatric sedation.(1) Deep sedation is often required for pediatric MRI to suppress artifacts from body motion; however, sedation in the MRI room requires special attention due to its environment that is poorly adapted for observation and the effects of the sedation on respiratory or cardiovascular function. In an institutional survey conducted by the Japan Pediatric Society, 35% of institutions experienced sedation-related complications.(2) Although adverse event rates have improved,(3) the National Institute for Health Care Functional Evaluation's domestic database confirms that there are still scattered serious medical accidents related to deep sedation in children.(4)

The Japan Pediatric Society and two other academic societies first proposed recommendations on sedation for pediatric MRI imaging in 2013, and its latest version was published in 2020.(5) Based on the development of these academic recommendations, the Japanese medical insurance system began to levy additional fees on pediatric sedation for MRI in 2018 for children below the age of 15 years. Additional fees for pediatric MRI sedation (medical practice code: 170036170) are now applicable for MRI in pediatric cases with multiple areas of study.(6) The new extra fee allows 80% of the total imaging fee to be charged as a technical fee. However, it is unclear how much of the Japanese

government's subsidy for high-risk MRI scans is actually being used and how much it is contributing to the safety of MRI scans.

The National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB) Open Data is a public database of medical practices of the Ministry of Health, Labour and Welfare (MHLW). It is an anonymized source of medical information from the original NDB dataset that registers >90% of medical insurance claims in Japan. Data from 2014 onward can be accessed freely by everyone. Given that these data cover nearly all medical practices, they are an essential tool for analyzing real-world practice behaviors in Japan.(7, 8)

In this paper, to determine what additional fees are used for, we analyzed the number of claims for the fee and its regional differences using the NDB Open Data tables on diagnostic imaging.

Methods

Scope of data

Inpatient and outpatient diagnostic imaging summaries in the three years of NDB Open Data released by the MHLW from April 2018 to March 2021 were used to tabulate the

additions.(9)

Calculation of the total number of additions

The numbers of calculations by sex and age group were combined to calculate the total number of the extra fee nationwide (medical practice code 170036170).

To tabulate the total number of MRI scans, we counted the MRI scans aged 0–14 years old. The number of all MRI scans (medical practice codes 170015210, 170020110, 170033510, 170035010, 170039510, 170039610, and 170039710) were tabulated and the rate of the addition to the total number of MRI scan was calculated.

Estimation of regional differences

A prefecture-by-prefecture table was used to tabulate regional differences in the calculation of the additions. However, the number of MRI scans performed on pediatric patients by prefecture is not available in the original table from MHLW. Therefore, instead of the actual number of imaging examinations, the total number of pediatric additional fees for imaging examinations other than X-rays (practice codes 170039870, 170039970, and 170040070) was tabulated and used as the population number to determine the calculation rate of the additional fee. Only the number of inpatient calculations was used

in this study because of the large number of actual additions and the smaller effect of masking. Additionally, the relative calculation rate of the per capita addition was separately calculated and compared using the government-provided recent pediatric population.(10)

Processing of minority values

Columns containing minority cases are masked and hyphenated in the NDB Open Data database to protect people's personal information; however, these were read as 0 and counted. For those masked values that could be back-calculated from other values, the real values were determined by subtracting the total of the values in each column from the total number of cases.

Statistical analysis

The chi-square test was used to compare the application of additional fees between the different age groups, and the Cochran–Armitage test was used to analyze the difference in the application of additional fees in time trends. P-values of <0.05 were considered significant. We used GraphPad Prism version 5 (GraphPad Software, San Diego, CA, USA) for our statistical analyses.

Ethical considerations

This study is a secondary bibliometric analysis of public statistical information that has been anonymized and made available on the Internet. Therefore, ethical approval was waived by the Juntendo University School of Medicine Ethics Review Committee.

Note

The Social Insurance Committee members of Japan Pediatric Society (EI, AE, YN, and SO [observer]), including the chair (AE), former chair (YN), vice chair (EI), director in charge of the Social Insurance Committee of the Japanese Society of Pediatric Nutrition, Gastroenterology and Hepatology (II), the Social Insurance Committee member of the Japanese Society of Pediatric Anesthesiology (YS), and the chair of the Pediatric Committee of the Social Insurance Union of Societies Related to Internal Medicine (SO) were the authors of this article. However, the views expressed in this paper are those of the authors as individuals and do not reflect the views of the three abovementioned organizations.

Results

Number of additions for pediatric MRI sedation

Table 1 shows the actual number of additions, the rate of calculation per total MRI scan, and the annual trend for the three years starting from the 2018 fiscal year (FY).

In FY 2020, 262 outpatient cases and 1085 inpatient cases of additional fees were calculated. **The total number of MRI scans during the same period was 317478 for outpatients and 67578 for inpatients. As a result,** these numbers represented only 0.08% of the number of MRI scans performed on children in outpatient settings and only 1.61% of those performed in inpatient settings. The total number of inpatient and outpatient additional fees was 1347, or 0.35% of the total number of MRIs **(385056 scans)** performed on patients aged below 14 years. Similarly, the total number of additional fees was only 1769 (0.42%) in FY 2018 and 1230 (0.30%) in 2019.

The number of calculations by age group in FY 2018-20 shows that there were 3304 cases (76% of all additional fees) in the 0–4 age group, which decreased with age. The relative calculation rate decreased with age with a significant difference in the three age groups ($P < 0.01$) using the chi-square test. However, there were still 169 cases in the 10–14 years age group (3.9% of all additional fees).

Chronological changes in additional fees

Figure 1 shows the relative calculation rate of additions and their annual trends. The rate of additional fees calculated for all imaging examinations showed a significant downward trend during the three-year period **(P < 0.01, Cochran–Armitage test)**. We compared the calculation of additional fees between the three age groups. Of these, the number of fees calculated for inpatient cases neither increased nor decreased significantly (P = 0.15) (A), whereas fees calculated for outpatient cases showed a significant downward trend (P < 0.01) (B). Totally, there was a significant decrease (P < 0.01) (C)

The analysis of the total number of calculations by age group showed a significant decrease in the 0–4 years age group and the 5–9 years age group (P < 0.01 and P = 0.03, respectively). However, these decreasing trends were not observed in the 10–14 years age group **(not significant)** (A).

The actual number of fees decreased in FY 2019 for both inpatient and outpatient services and recovered in FY 2020, reaching numbers close to those of FY 2018 (Table 1).

Regional disparities in the calculation of additions

Figure 2 shows the claim rate of the addition of pediatric MRI sedation imaging per pediatric imaging other than X-rays (additional fee) by prefecture. Data for the areas with

a calculation rate of 0 include lost data masked by the NDB description rule due to the small number of cases. However, 94% of the total number of additions were captured by this statistic.

Even among the 20 prefectures for which actual figures could be calculated, there were clear regional disparities in the actual rates, with Saga Prefecture, which had the highest rate, having a rate that was 14 times higher than that of Osaka Prefecture, which had the lowest rate.

The same large regional disparity existed in the number of additions calculated per capita for the pediatric population by prefecture, which was calculated for confirmation **(see Supplementary Figure 1)**. and the correlation between the two series was extremely strong. (R = **0.93**, **see Supplementary Figure 2**).

Discussion

This study revealed the extremely low rate of use of the novel addition for sedation in pediatric MRI scanning and the decrease in the claim number. Also, there was a significant difference in the rate of use of additional fees by prefectures.

We used the domestic reimbursement database to examine the actual calculation of the additions for pediatric MRI sedation imaging in the three years following its

establishment. The registration rate of domestic reimbursement to the NDB Open Data exceeds 90%; thus, the data are highly reliable.(11) The estimates in this study are considered close to the actual number of calculations nationwide.

The addition for pediatric sedation for high-risk MRI, launched in Japan in 2018, is expected to supplement the human and material resources needed for pediatric MRI; however, unfortunately, it was used in only 0.35% of all pediatric cases. Even in the 0–4 years age group in which most cases require sedation, it was only 1.62% of all cases. The same trend was observed in inpatient care (where resources are usually more abundant than in outpatient care), although the rate of addition was higher than in outpatient care. This calculation rate is significantly lower than the actual eight-year calculation of pediatric MRI sedation in the previous report, although a direct comparison is difficult to perform.(12)

The requirement for the calculation of this addition is to have two physicians dedicated specifically to sedation as well as to perform imaging of two body areas at the same time.(6) However, in practice, due to a shortage of anesthesiologists, the majority of MRI sedation is performed by pediatricians rather than anesthesiologists,(5) and it takes much effort just to secure one physician dedicated to this task. It is probably impossible for many Japanese pediatric facilities to routinely meet the requirements for this addition.

The decrease in the actual calculation, mainly in the outpatient setting, may also reflect the disappointment of Japanese clinicians in the fee. **The real solution to this problem will require not only improved reimbursement but also better management by multi-disciplinary teams that integrate various medical professions, such as nurse practitioners who can perform specific medical procedures including intravenous injection, to compensate for the scarce human resources of specialist physicians.**

It is important to note that there is a small number of children aged 10–15 years for whom this addition is calculated and that they do not show the same downward trend as younger patients. The increasing trend of pediatric sedation at older ages was reported by an American group.(13) Additionally, accident reports of deep sedation in older children are not infrequent in the domestic accident database in Japan.(4) Currently, the additional pediatric fee for deep sedation (intravenous anesthesia) in Japan applies to children aged under 6 years; however, one idea for improvement might be to reform the system in the form of the addition of background comorbidities with higher age limits.

The large regional disparity also reflects the fact that special human and material resources must be secured to use this addition, and that it requires much effort to claim it. In other words, based on the study, the goal of equalizing medical care (the goal of Japan's public insurance system) is not being achieved. **Lack of human resources alone could**

not explain this disparity. It might also be due to regional disparities in physician sedation preferences and payment checking in reimbursement.

Sedation for pediatric MRI is a risky procedure, and it is appropriate to secure sufficient human and material resources through public financial support. However, the scientific rationale for requiring two full-time physicians for this addition is unclear, and it will be necessary to reconsider this issue in the future, including the relaxation of the requirement.

Technical limitations of this study include the following: inpatient examinations at medium-to-large hospitals with comprehensive care claims (Diagnosis Procedure Combination) could not be included; inpatient MRI scans at such hospitals were not captured in the statistics because MRI imaging fees and additional fees were included in the comprehensive care costs. The actual numbers of some minority columns were not available because their values were masked based on the rules of NDB Open Data. We were not able to examine the policy outcome we most wanted to know about (the reduction in incidents due to the calculation of this addition) because we did not use the main body of actual claim data or clinical records. Some of these limitations could be addressed by performing analyses using the main body of NDB data or studies using comprehensive reimbursement big data.

In conclusion, we have analyzed the calculation of the addition for pediatric MRI sedation imaging after its expansion for the first time by analyzing the public medical claims database of MHLW. This additional fee is only used in 0.35% of all pediatric MRI procedures due to strict requirements, and the number of procedures has been decreasing. To realize safer pediatric MRI examinations, a more accessible reimbursement system is needed.

Acknowledgments: We thank the members of the Social Insurance Committee of the Japan Pediatric Society for their participation in discussions on this issue.

Conflict of interest statement: The authors declare no conflict of interest.

Source of funding: This work was partly supported by JSPS KAKENHI (grant number JP 60749951).

Author contributions: E.I. and Y.T. conceived and designed the study; E.I., Y.T., M.M., and B.Y. collected and analyzed the data; E.I., Y.T., A.E., Y.N., S.Y., I.I., Y.S., Y.B., T.K., Y.O., and T.S. interpreted the data. E.I. and T.Y. wrote the manuscript, and Y.M., T.K., B.Y., Y.O., and T.S. reviewed and revised the paper. All authors read and approved the final manuscript.

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Table 1

Calculation of additional pediatric MRI sedation imaging (medical practice code: 170036170) for the three-year period beginning in FY 2018. The total number of pediatric MRI scans for the same age group is shown in the right part of the table.

	MRI sedation addition (outpatient)				Total MRI scan (outpatient)			
	0–4 YO	5–9 YO	10–14 YO	Total	0–4 YO	5–9 YO	10–14 YO	Total
FY2018	437	150	28	615	26880	67852	248586	343318
FY2019	215	96	16	327	26880	67852	248586	343318
FY2020	181	63	18	262	21185	63134	233159	317478
FY2018-20	833	309	62	1204	74945	198838	730331	1004114

	MRI sedation addition (inpatient)				Total MRI scan (inpatient)			
	0–4 YO	5–9 YO	10–14 YO	Total	0–4 YO	5–9 YO	10–14 YO	Total
FY2018	916	200	38	1154	44361	14139	14981	73481
FY2019	733	143	27	903	43401	14682	14605	72688
FY2020	822	216	42	1085	40881	12988	13709	67578
FY2018-20	2471	559	107	3142	128643	41809	43295	213747

	MRI sedation addition (total)				Total MRI scan (total)			
	0–4 YO	5–9 YO	10–14 YO	Total	0–4 YO	5–9 YO	10–14 YO	Total
FY2018	1353	350	66	1769	71241	81991	263567	416799
FY2019	948	239	43	1230	70281	82534	263191	416006
FY2020	1003	279	60	1347	62066	76122	246868	385056
FY2018-20	3304	868	169	4346	203588	240647	773626	1217861

MRI: magnetic resonance imaging, YO: year old, FY: fiscal year

Figure Legends

Figure 1

Chronological change in the relative calculation rate of the addition for pediatric MRI sedation. The population is the total number of MRIs in the same age group. A) Number of outpatient additions. B) Number of inpatient additions. C) Total number.

Figure 2

Regional disparities in the calculation rate of the addition for pediatric MRI sedation imaging by prefecture. The total number of additional pediatric charges for imaging other than X-rays was used as the population. The dotted line indicates the national average. **Prefectures where the number of calculations could not be detected are excluded from this figure because they are affected by the masking of minority data (see text).**

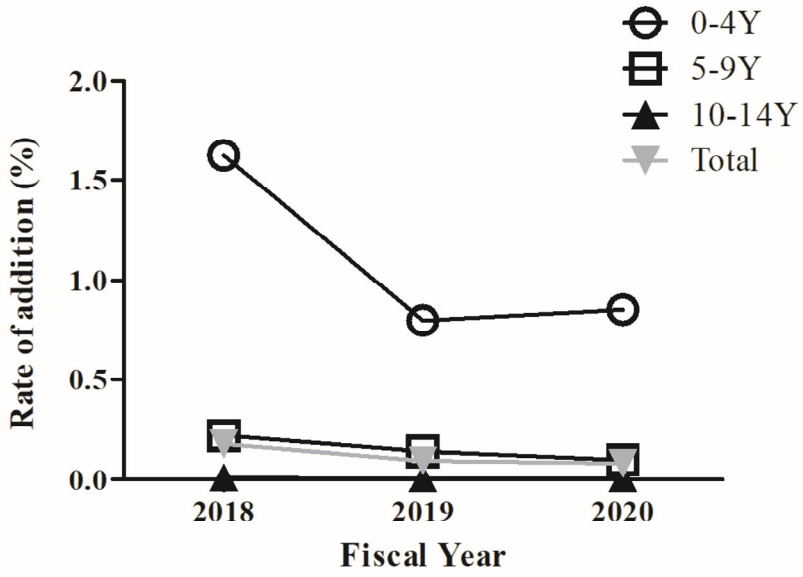
Supplementary Figure 1

Regional disparities in the calculation rate of the addition for pediatric MRI sedation imaging by prefecture *per capita*. Data from Reference 10 were used for the pediatric population. Dotted line indicates national averages. Masking was handled as in Figure 2.

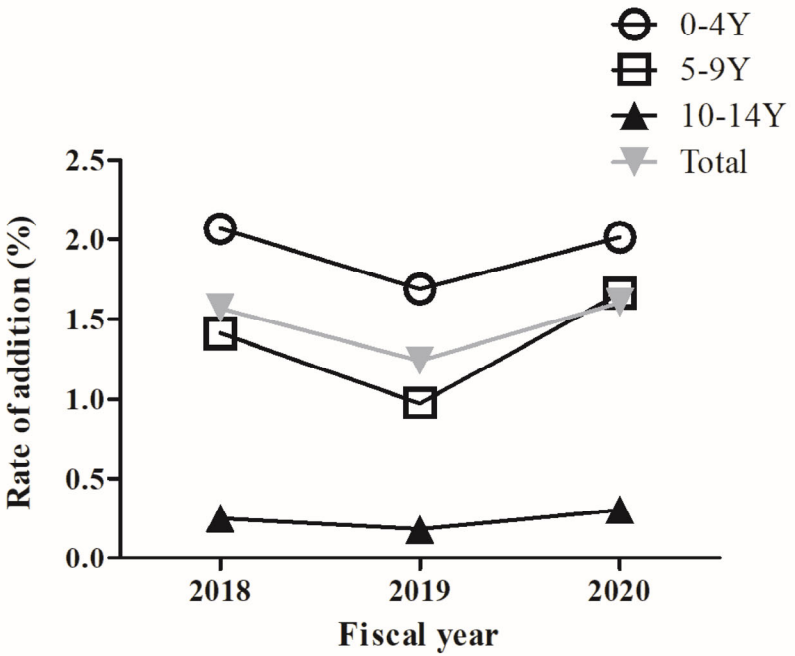
Supplementary Figure 2.

Correlation chart comparing the regional calculation rates of the addition for pediatric MRI sedation imaging calculated per number of pediatric imaging to the rates calculated per pediatric population (R = 0.93).

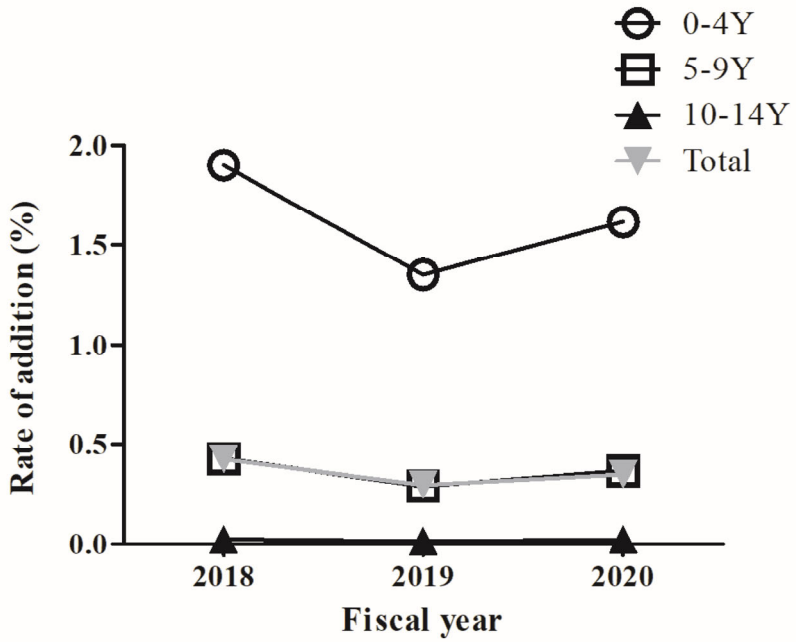
A. Outpatient fee

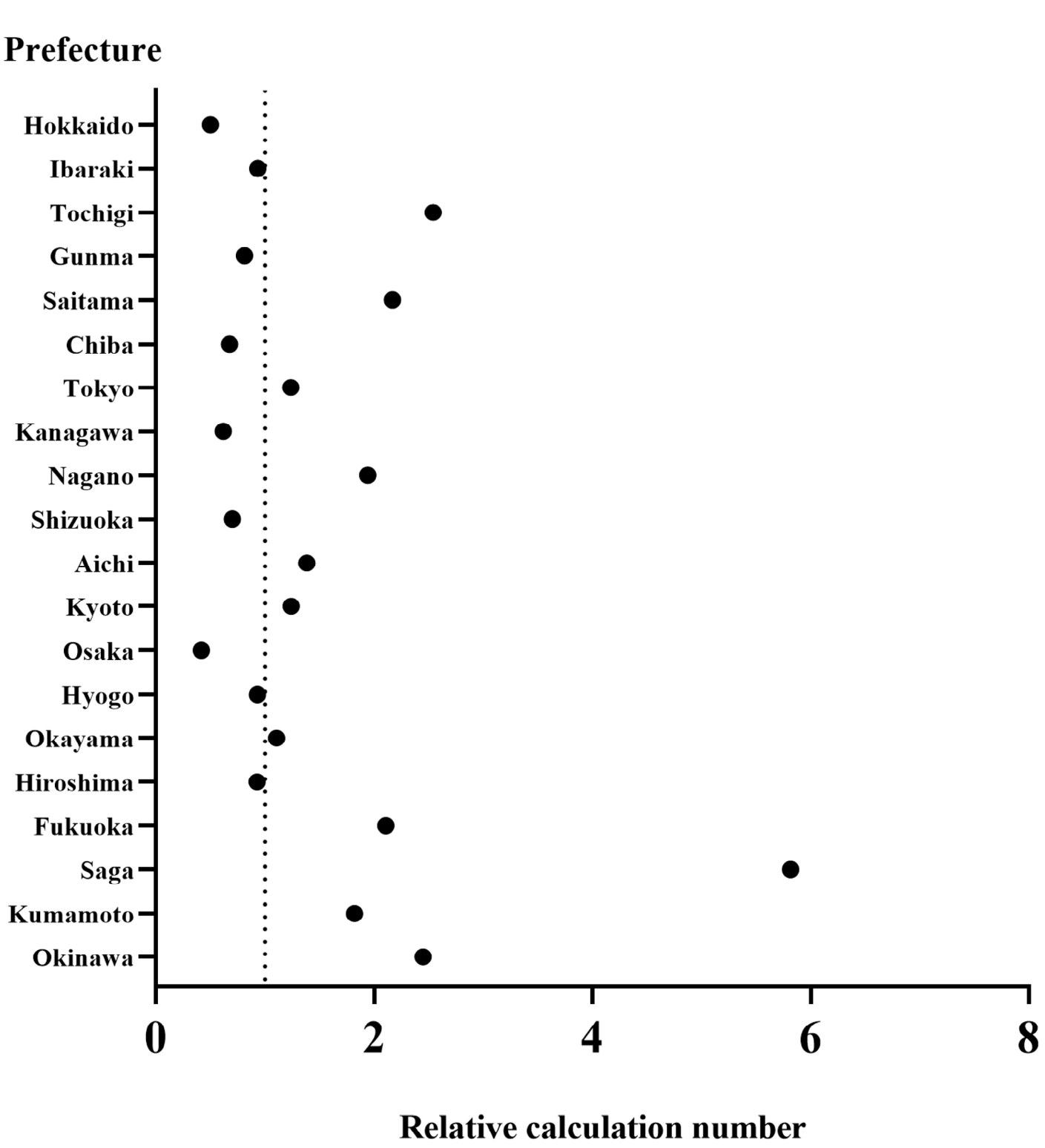


B. Inpatient fee



C. Total

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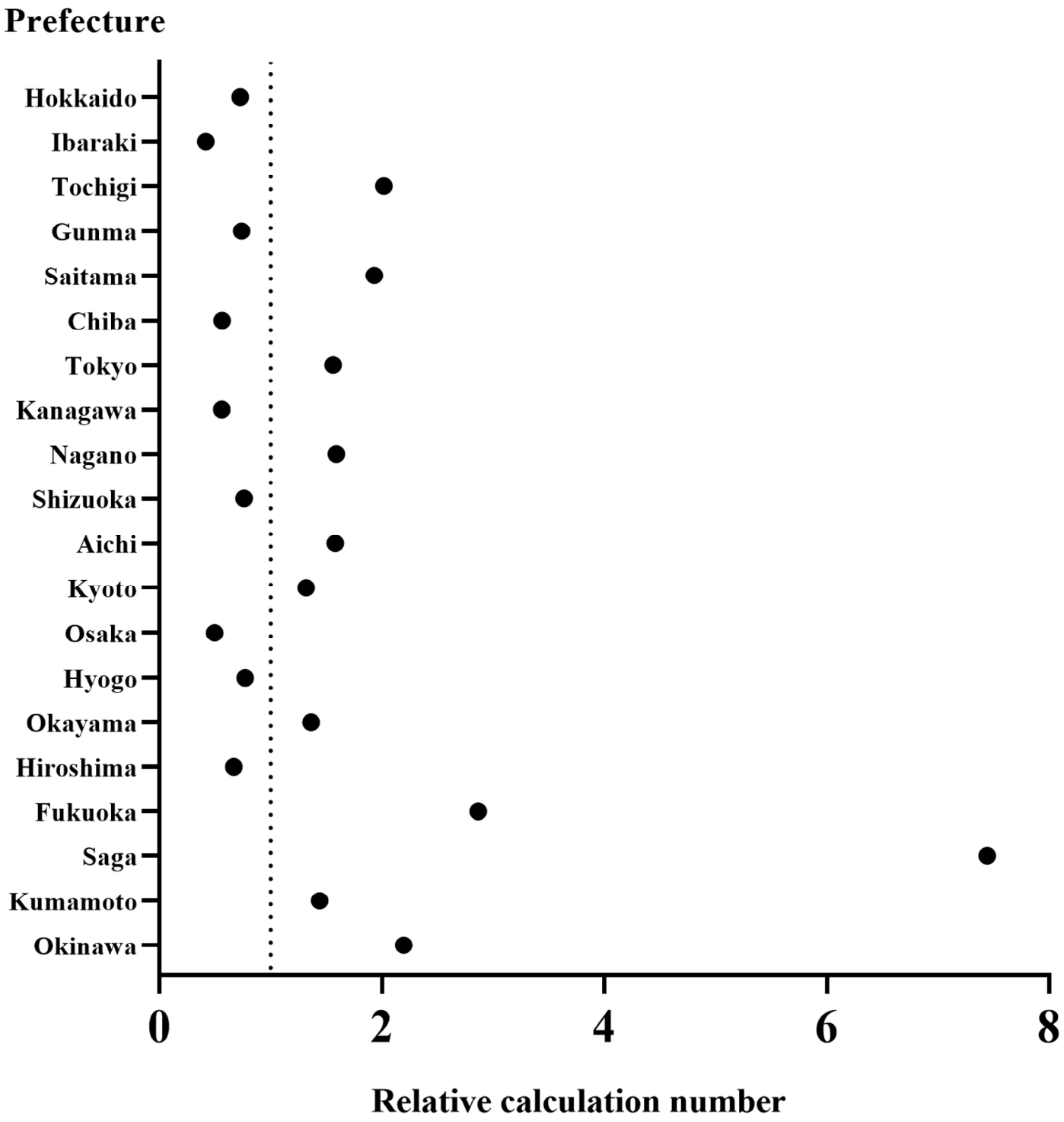
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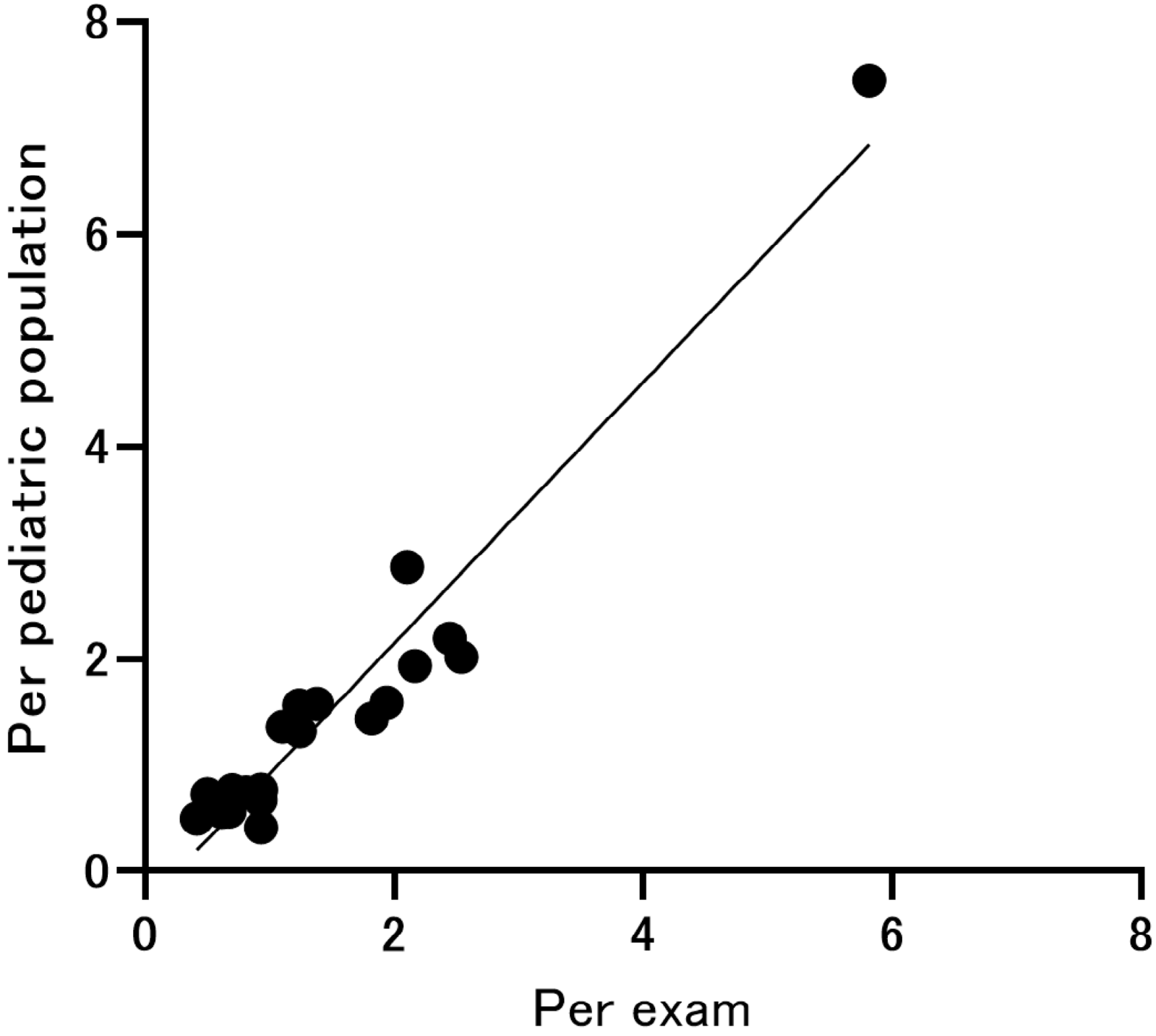
Per pediatric population
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