Regional disparities in primary cesarean delivery rates in Japan: the role of obstetrician availability

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BACKGROUND: The prevalence of cesarean section procedures is on the rise worldwide, necessitating a deeper understanding of the factors driving this trend to mitigate potential adverse consequences associated with unnecessary cesarean section deliveries.

OBJECTIVES: This study aims to investigate the rate of primary cesarean deliveries (PCD), a potential key indicator of obstetric care quality.

STUDY DESIGN: A national retrospective cohort study was conducted utilizing extensive data from the National Database of Health Insurance Claims and Specific Health Checkups of Japan spanning the years 2012 to 2018. The study examined the temporal trends in PCD rates and the indications for these procedures across different prefectures. Additionally, the study employed the obstetrician disproportionality index, as published by the Ministry of Health, Labour, and Welfare, to assess the influence of obstetrician availability on PCD rates.

RESULTS: Throughout the study period from 2012 to 2018, the rate of PCD in Japan remained relatively stable at approximately 14%. The primary indications for PCD in 2018 included labor arrest (18.3%), malpresentation (16.5%), nonreassuring fetal status (6.5%), and macrosomia (6.0%). Substantial regional disparities in PCD rates were observed, ranging from 8.9% to 20.4% among prefectures in 2018. Notably, prefectures categorized in the bottom 10 of the obstetrician disproportionality index exhibited significantly higher PCD rates compared to the top 10 prefectures (P=.0232), with a similar trend noted for PCD due to labor arrest (P=.0288). Furthermore, a negative correlation was identified between the obstetrician disproportionality index and PCD rates at the prefectural level (r=−0.3119, P=.0328).

CONCLUSIONS: Our study presents a comprehensive analysis of PCD rates in Japan, shedding light on regional disparities and highlighting the notable influence of obstetrician availability on clinical decision-making. This study contributes to the ongoing discourse on the escalating global trend in cesarean sections and the importance of healthcare resource allocation in maternal care.

Key words: cesarean sections, obstetric care quality, obstetrician availability, primary cesarean deliveries, regional disparities

Introduction

The prevalence of cesarean sections has been steadily increasing worldwide,[1] with Japan not exempt from this trend, where the rate now surpasses 20%.[2] While cesarean sections play a pivotal role in safeguarding the health of both mother and child, it has come to attention that not all cesarean deliveries (CD) are medically warranted. The World Health Organization has underscored the potential adverse effects of unnecessary cesarean sections.[1]

Understanding the drivers behind high cesarean section rates is of paramount importance, given their significant variation from one country to another and even within different regions of the same country. Japan's universal health insurance system endeavors to provide equitable healthcare services to all citizens. However, there exists an uneven distribution of obstetricians responsible for delivering obstetric care across prefectures.[3] This disparity in healthcare providers may be contributing to variations in cesarean section rates among different prefectures. Remarkably, there is a paucity of prior research investigating the plausible relationship between the distribution of obstetricians and the choice of delivery mode in Japan.

The National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB) stands as an invaluable resource in our pursuit of understanding

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None.

A comprehensive analysis using the national database reveals trends in primary cesarean deliveries in Japan (2012−2018), highlighting regional disparities and the significant impact of obstetrician availability on clinical decision-making.

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Why was this study conducted?

To determine the trends in the incidence and indication of primary cesarean deliveries (PCD) in Japan and its regional disparities among different prefectures.

Key findings

The study shows that PCD rates in Japan remained relatively stable at approximately 14% from 2012 to 2018. The main indications for PCD in 2018 included labor arrest (18.3%), malpresentation (16.5%), nonreassuring fetal status (6.5%), and macrosomia (6.0%). There were regional differences in PCD rates, and prefectures with lower obstetrician availability had significantly higher PCD rates, especially for cases with labor arrest.

What does this add to what is known?

This study highlights the influence of obstetrician availability on PCD rates and emphasizes the need for policies and programs to alleviate the adverse effects of obstetrician shortages on maternal health.

this issue. As the largest insured patient database in Japan, operated by the Ministry of Health, Labour, and Welfare (MHLW) since 2008, the NDB contains comprehensive information on diagnoses, treatments, and procedures. Owing to Japan's universal coverage health insurance system, almost all residents, except welfare recipients, are covered by public medical insurance. Our group has utilized the NDB to clarify the prevalence of postpartum hemorrhage and hypertensive disorders of pregnancy (HDP)-related hemorrhagic stroke in Japan.[4,5] The present study focused on primary cesarean delivery (PCD) within this vast dataset, as it is recognized as one of the potential key obstetric care quality indicators.[6]

This research aims to shed light on the current state of PCD in Japan and investigate the potential relationship between the sufficiency of obstetricians and PCD rates across different prefectures. By providing valuable insights into the factors impacting PCD rates, this study aspires to influence policy-making and contribute to the advancement of the perinatal care system in Japan.

Materials and methods

National Database of Health Insurance Claims (NDB)

The NDB from January 2012 to December 2018 was used to identify all women who underwent cesarean section. The NDB includes the following data of each patient: age, sex, primary and secondary diagnoses, and medications. Diagnoses and complications are recorded using the International Classification of Diseases Tenth Revision (ICD-10) codes and corresponding MHLW disease codes. The database contains no laboratory data or obstetric information such as gestational age. In the NDB data, hospitals are classified into two categories based on participation in the diagnosis procedure combination (DPC), a prospective payment system to control health care costs. DPC facilities contain approximately 1200 large referral hospitals, including all 82 academic hospitals in Japan, whereas non-DPC facilities contain relatively small-scale hospitals.[7] The study was approved by the advisory committee of MHLW and the ethics committee of Kyoto University (R1677), which exempted the need for patient informed consent due to the anonymous nature of the data.

Extraction of target women and clinical information

Women who underwent cesarean section and who had no ICD-10 codes of repeat cesarean (O34.2) were defined as women who performed primary CD. To identify major indication for primary CD, we determined ICD-10 code lists as shown in Supplementary Table S1. The major indications for PCD were specified according to the priority order of the indication categories described in the table at cases where multiple ICD-10 codes were registered. The priority indications for PCD were determined based on the order described in Supplementary Table S1. Placenta previa accreta were diagnosed when both placenta previa and placenta accreta were present. Placenta previa was defined as placenta previa without placenta accreta, and placenta accreta was defined as placenta accreta without placenta previa. Cases in which a PCD was performed but no ICD-10 codes matched the disease codes listed in Supplementary Table S1 were defined as having an "unknown" indication.

We collected clinical information including maternal age, peripartum interventions, including emergency cesarean section, and hospital types (DPC or non-DPC facilities).

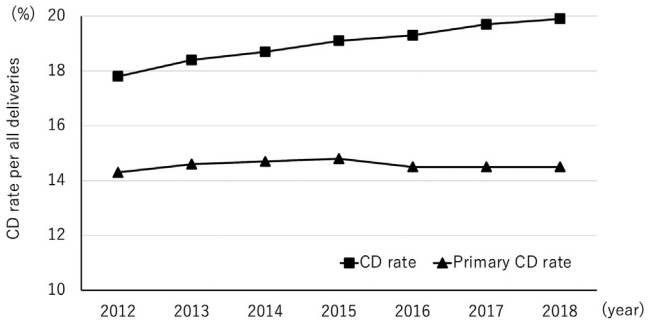
Geographical distribution index of obstetricians

In this study, the term "obstetrician" refers to physicians in Japan who manage deliveries, specifically those board-certified by the Japan Society of Obstetrics and Gynecology. There is no difference in seniority or experience between obstetricians working in DPC and non-DPC facilities. While both obstetricians and trained midwives can manage vaginal deliveries, only obstetricians are authorized to decide upon and conduct cesarean sections. Consequently, any facility that performs cesarean sections must have an obstetrician available to make and execute these decisions. The obstetrician disproportionality index[3] was used to investigate the relationship between the availability of obstetricians and PCD. The obstetrician disproportionality index was computed by MHLW utilizing national data from 2017 regarding obstetricians and gynecologists, with the 2017 PCD frequency employed in the statistical analysis.

Statistical method

All analyses were performed using GraphPad Prism 9.0 (GraphPad Software, La Jolla, CA, USA). Data were compiled by year and maternal age, and

FIGURE 1
Trends in cesarean delivery rates in Japan



Annual change in cesarean delivery rates and primary cesarean delivery rates per total number of deliveries from 2012 to 2018. *CD*, cesarean delivery.

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the incidence of PCD was calculated from the total number of deliveries obtained from the Vital Statistics Survey by MHLW.[8] We present the categorical variables as numbers and percentages; comparisons were made by Fisher's exact test. Continuous variables were shown as means and standard deviations. Geographic heatmap diagrams for the prefectural distribution were created using the Excel function. Correlation between obstetrician disproportionality Index and incidence of PCD or its indications was calculated using Spearman's rank correlation coefficient.

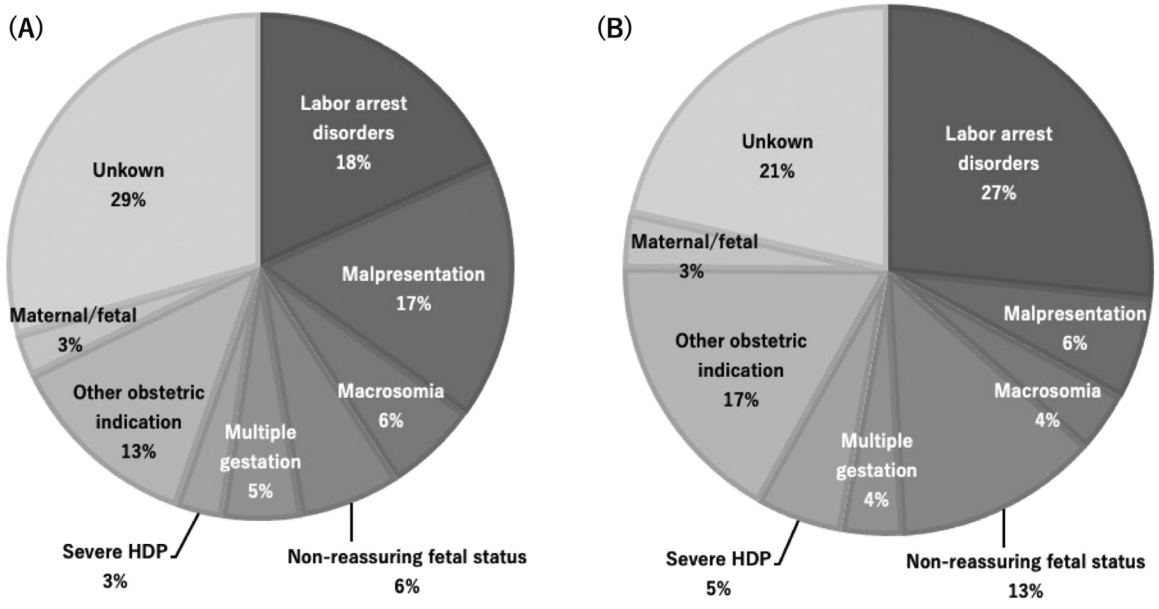
Results

Trend in PCD

Over the study period, the total number of deliveries exhibited a gradual decline, decreasing from 1037,231 in 2012 to 918,397 in 2018 (Supplementary Table S2). Despite this trend, the proportion of CD among total deliveries demonstrated a slight but consistent increase, rising from 17.8% in 2012 to 19.9% in 2018 (Figure 1, Supplementary Table S2). Throughout the same period, the prevalence of PCD remained relatively stable, hovering around 14% (Figure 1, Supplementary Table S2). The prevalence of emergent PCD exhibited a consistent upward trend, escalating from 6.1% in 2012 to 7.2% in 2018. When evaluating PCD rates per age group, a significant association with increasing maternal age was observed. For instance, in the 2018 dataset, the proportion of PCD more than doubled, increasing from 10.8% among 20 to 24-year-olds to 23.7% among 40 to 44-year-olds.

Next, we explored the trends of CD rates in hospitals participating in DPC system and non-DPC facilities, aiming to identify potential hospital-level differences in PCD rates. In DPC hospitals, both CD per total delivery and PCD per total delivery increased year on year (Supplementary Table S3). Specifically, CD rates rose from 8.8% in 2012 to 10.7% in 2018, while PCD rates increased from 6.1% in 2012 to 6.7% in 2018. In contrast, non-DPC facilities exhibited either stable or decreasing trends in both CD per total delivery

FIGURE 2
Indications for primary cesarean delivery



Indications for (A) primary cesarean delivery and (B) emergent primary cesarean delivery.

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(from 9.0% in 2012 to 9.2% in 2018) and PCD rates (from 8.2% in 2012 to 7.8% in 2018).

Indications for PCD

The analysis of PCD indications revealed labor arrest disorders as the most prevalent indication, accounting for 18.3% of cases, followed by malpresentation (16.5%), nonreassuring fetal status (NRFS) (6.5%), and macrosomia (6.0%) in 2018 (Figure 2, A). Further examination of labor arrest disorders indicated that obstructed labor accounted for 6.4% of cases, while uterine inertia contributed to 11.9%. Among "other obstetric indications," the main contributors were placenta previa (4.1%), intrauterine infection (3.1%), and PROM (2.4%), collectively accounting for 12.5% of cases (Supplementary Table S4).

Regarding emergent PCD indications, labor arrest disorders remained the leading cause at 26.6%, with obstructed labor accounting for 11.9% and uterine inertia contributing 14.7%. Subsequently, NRFS (12.6%), malpresentation (6.2%), and macrosomia (3.7%) were also observed as common indications (Figure 2, B). Among emergent PCD cases with "other obstetric indications," intrauterine infection constituted the primary indication (5.6%), while PROM played a contributory role (4.7%) (Supplementary Table S4).

Moreover, the indications for PCD were analyzed in facilities participating in the DPC system and non-DPC centers. In DPC facilities, the main indications were malpresentation (17.7%), NRFS (13.9%), labor arrest disorders (12.4%), multiple gestation (10.1%), placenta previa (7.2%), and severe HDP (5.2%) (Table). Conversely, non-DPC facilities reported labor arrest disorders as the most common indication (23.3%), followed by malpresentation (15.6%), and macrosomia (6.9%) (Table).

Regional variation by prefecture in cesarean delivery rate

The analysis of PCD rates in Japan unveiled substantial regional disparities, with rates ranging from 8.9% to 20.4% among prefectures in 2018 (Figure 3, A). Particularly noteworthy was the significant variation in frequency observed among prefectures for cases with labor arrest disorders, macrosomia, NRFS, and severe HDP, with corresponding coefficient of variation rates of 35.6%, 41.8%, 52.1%, and 30.0%, respectively, in 2018 (Figure 3, B–E). In contrast, the coefficient of variation rates for malpresentation and multiple births were relatively lower, at 13.6% and 20.9%, respectively.

To further explore the potential relationship between the availability of obstetricians and PCD rates, we employed the obstetrician disproportionality index published by MHLW. A comparative analysis of PCD rates between the top 10 prefectures in the obstetrician disproportionality index (Top 10 group) and the bottom 10 prefectures in the index (Bottom 10 group) highlighted significantly higher PCD rates in the Bottom 10 group (P=.0232, Figure 4, A). Moreover, a comparison of PCD rates between the two groups for CD indications, for which the coefficient of variation was large between prefectures, revealed significantly higher PCD rates in the Bottom 10 group for labor arrest disorders

TABLE
Primary indications of primary cesarean delivery in DPC and non-DPC facilities

	2012	2013	2014	2015	2016	2017	2018
Indications in DPC facilities, *n* (% per primary CD in DPC facilities)							
Labor arrest disorders	6644 (10.47)	6757 (10.63)	6880 (10.90)	7099 (11.20)	7588 (12.09)	7463 (12.22)	7622 (12.45)
Malpresentation	10,481 (16.52)	10,698 (16.83)	10,796 (17.11)	10,978 (17.32)	10,949 (17.44)	10,611 (17.38)	10,809 (17.65)
Macrosomia	3806 (6.00)	3729 (5.87)	3529 (5.59)	3480 (5.49)	3237 (5.16)	3172 (5.20)	3042 (4.97)
Nonreassuring fetal status	7891 (12.44)	7966 (12.53)	8294 (13.14)	8322 (13.13)	8575 (13.66)	8492 (13.91)	8538 (13.94)
Multiple gestation	5159 (8.13)	5409 (8.51)	5414 (8.58)	5584 (8.81)	5877 (9.36)	6031 (9.88)	6185 (10.1)
Indications in non-DPC facilities, *n* (% per primary CD in non-DPC facilities)							
Labor arrest disorders	17,317 (20.31)	18,370 (21.29)	18,939 (22.43)	19,259 (22.43)	17,868 (22.57)	17,564 (22.98)	16,782 (23.33)
Malpresentation	11,663 (13.68)	12,277 (14.23)	12,230 (14.48)	12,835 (14.95)	12,342 (15.59)	11,964 (15.65)	11,221 (15.60)
Macrosomia	6333 (7.43)	6606 (7.66)	6374 (7.55)	6496 (7.57)	5872 (7.42)	5461 (7.14)	4981 (6.92)
Nonreassuring fetal status	33 (0.04)	57 (0.07)	58 (0.07)	87 (0.10)	71 (0.09)	48 (0.06)	48 (0.07)
Multiple gestation	1266 (1.48)	1221 (1.42)	1137 (1.35)	1054 (1.23)	740 (0.93)	542 (0.71)	526 (0.73)

CD, cesarean delivery; *DPC*, diagnosis procedure combination.

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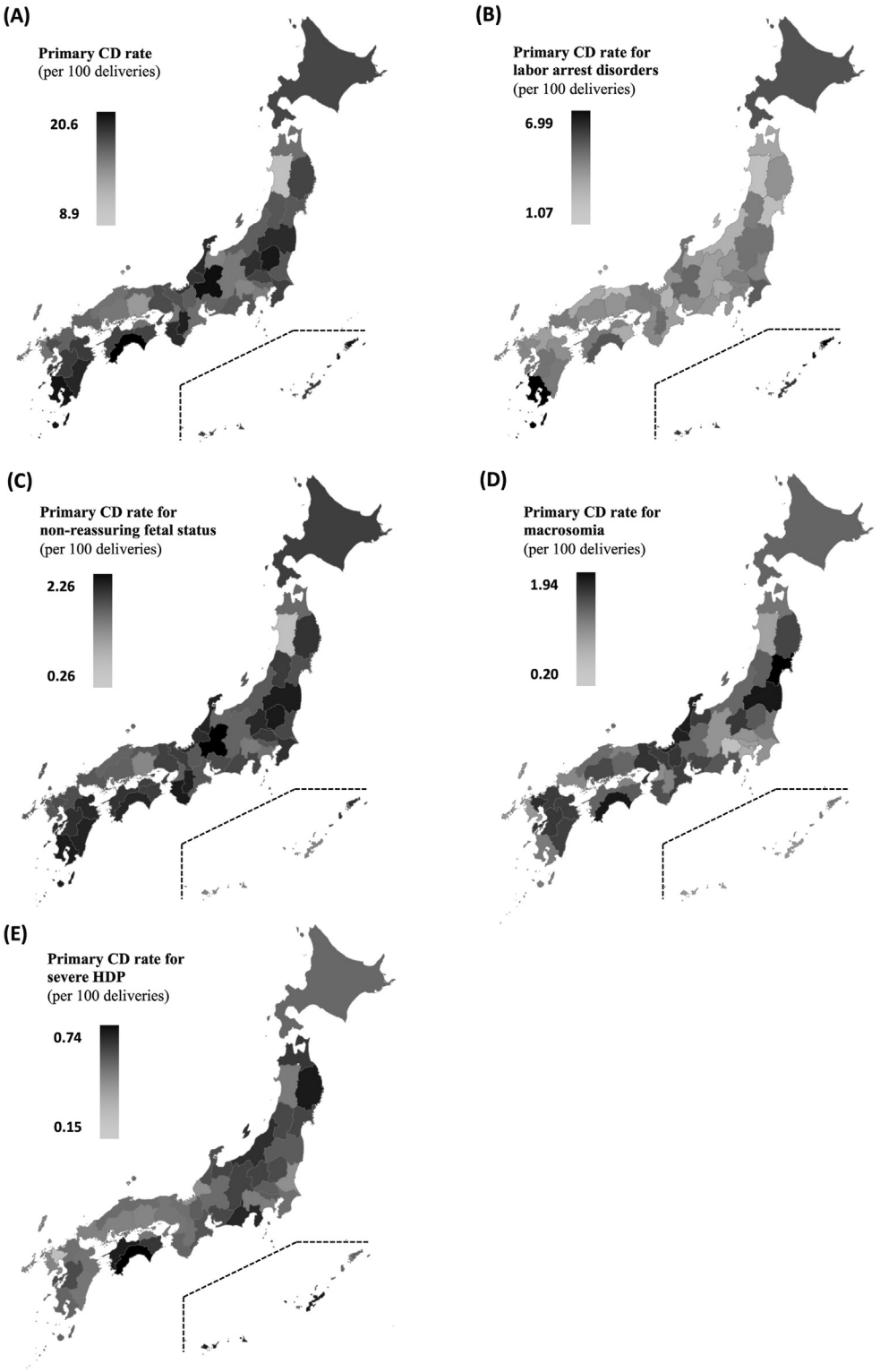
FIGURE 3
Geographic distribution of primary cesarean delivery rates and their indications



Geographic distribution of (A) primary CD rate, (B) primary CD rate for labor arrest disorders, (C) primary CD rate for nonreassuring fetal status, (D) primary CD rate for macrosomia, and (E) primary CD rate for severe HDP, across Japan. *CD*, cesarean delivery; *HDP*, hypertensive disorders of pregnancy.

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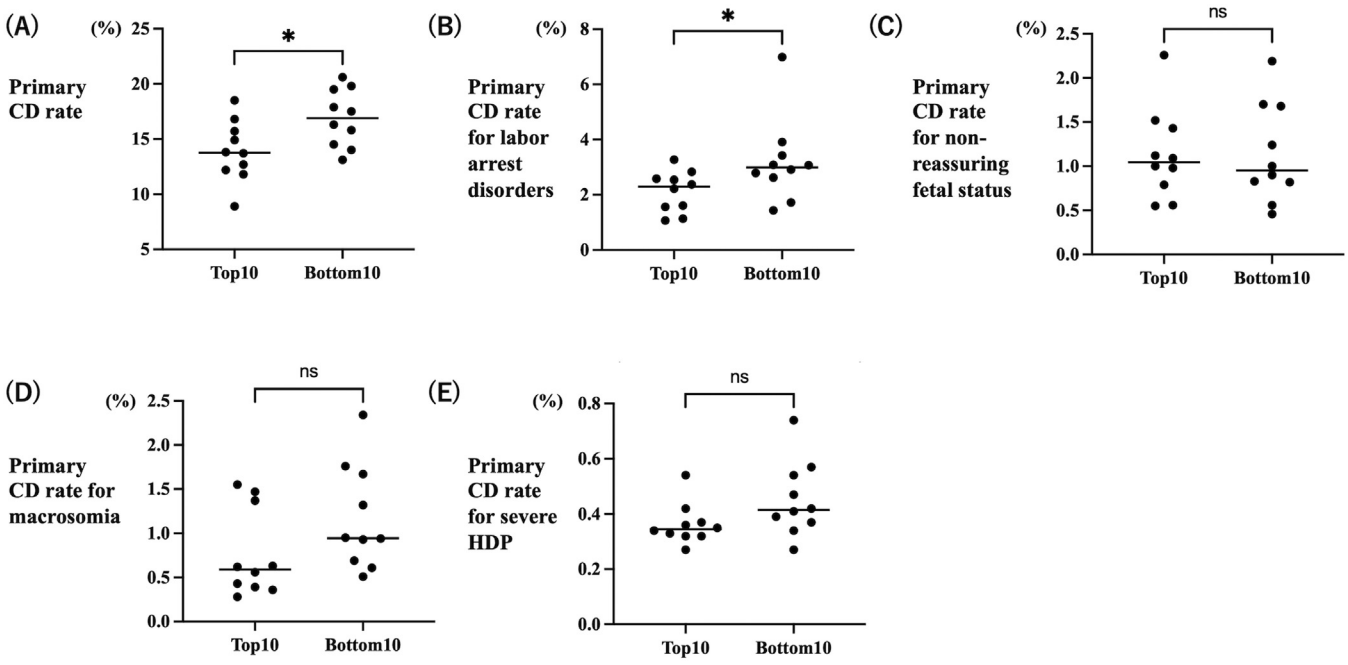
FIGURE 4
Comparison of primary cesarean delivery rates and their indications between Top 10 and Bottom 10 prefectures in the obstetrician disproportionality index



Comparison of (A) primary CD rate, (B) primary CD rate for labor arrest disorders, (C) primary CD rate for nonreassuring fetal status, (D) primary CD rate for macrosomia, and (E) primary CD rate for severe HDP, between top10 and bottom 10 prefectures in the obstetrician disproportionality index. *CD*, cesarean delivery; HDP, hypertensive disorders of pregnancy.

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(*P*=.0288, Figure 4, B), and also higher tendency for macrosomia and severe HDP (*P*=.0753 and .0537; Figure 4, C and D, respectively). Conversely, no difference was observed for cases involving NRFS (*P*=.9560, Figure 4, E). Subsequently, we extended our inquiry to investigate whether the disproportionate availability of obstetricians influenced the decision threshold of conducting emergent cesarean sections or primary cesarean sections due to maternal advanced age. For both elective and emergent cesarean sections, a trend toward increased PCD rates within the Bottom 10 group was discerned (*P*=.0718 and .1005, respectively; data not shown). Furthermore, significantly higher PCD rates were evident within the Bottom 10 group for both individuals aged <35 and ≥35 years (*P*=.0147 and .0411, respectively; data not shown).

Finally, we assessed the correlation between the obstetrician disproportionality index and the PCD rate in each prefecture, revealing a statistically significant negative correlation (*r*=−0.3119, *P*=.0328, Figure 5, A). While not statistically significant, a comparable pattern was observed in the context of labor arrest disorders (*r*=−0.2767, *P*=.0597, Figure 5, B). In contrast, there was a lack of substantial correlation in the case of NRFS (*r*=0.04348, *P*=.7717, Figure 5, C). Additionally, the PCD rates for both macrosomia and severe HDP exhibited a tendency toward negative correlation with the obstetrician disproportionality index (*r*=−0.1606 and −0.2599 and *P*=.2809 and 0.0777, respectively; Figure 5, D and E).

Discussions

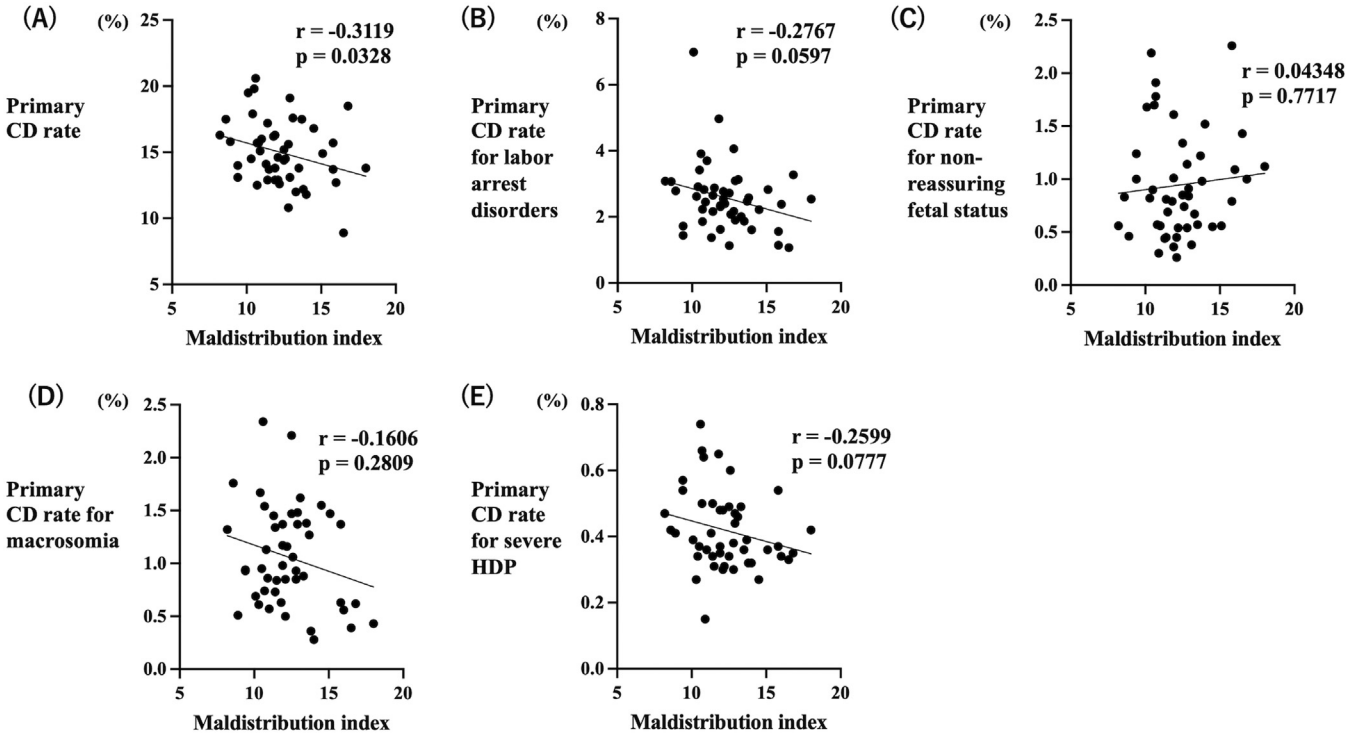
Principal findings

In this study, we present, for the first time, a comprehensive analysis of the national trend in PCD in Japan. Our report uncovers substantial regional variations in the PCD rate and its associated indications across different prefectures, shedding light on the impact of obstetrician availability. This study offers a novel perspective by suggesting that obstetrician availability may impact the decision threshold for performing PCD.

Clinical implications

The optimal PCD rate represents a multifaceted concern in contemporary obstetrics. This study reveals, for the first time, the recent stability of the PCD rate in Japan (2012−2018) at approximately 14%, which closely parallels the consistent trend observed in the United States (U.S.), where the PCD rate remained at around 22% from 2016 to 2021.[9,10] In Japan, the PCD rate exhibited an escalation in tandem with maternal age, mirroring a pattern observed in the U.S. The most prevalent indication for PCD in Japan was labor arrest, aligning with the situation in the U.S. However, the frequency of labor arrest displayed a remarkable divergence, with the U.S. reporting a higher incidence (34%) compared to Japan

FIGURE 5
Correlation between geographical maldistribution index of obstetricians and primary cesarean delivery rates and their indications



Geographical maldistribution index was negatively correlated to (A) primary CD rate and (B) primary CD rate for labor arrest disorders, while there was a lack of substantial correlation in the case of (C) nonreassuring fetal status. There were tendencies toward negative correlation between maldistribution index and (D) primary CD rate for macrosomia and (E) primary CD rate for macrosomia HDP. CD, cesarean delivery; *HDP*, hypertensive disorders of pregnancy.

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(18%).[10] This discrepancy may stem from variations in the prevalence of obesity among pregnant women or the influence of continuous education, which has directed clinical practices toward the prudent utilization of cesarean sections. Another conspicuous distinction between Japan and the U.S. pertains to the incidence of NRFS as an indication for PCD. In Japan, this incidence was notably lower at 6%, in stark contrast to the 23% recorded in the U.S.[10] This variance may, at least in part, be ascribed to the presence of 29% of PCD with an unknown indication in this study, possibly encompassing cesarean sections where NRFS was the underlying cause. Notably, the disparities in the frequency of labor arrest and NRFS observed between Japan and the U.S. were also evident when comparing facilities categorized as DPC and non-DPC facilities. These variations may reflect differences in healthcare provider density and patient risk profiles. The determination of the ideal PCD rate hinges upon a multifarious interplay of factors, encompassing medical necessity, healthcare resource availability, and healthcare provider practices. The findings of this study, which indicate relatively low rates of PCD in Japan, coupled with Japan's consistent ranking among countries with the lowest maternal and infant mortality rates globally,[11] may suggest that perinatal care in Japan has adeptly struck a balance between restraining unwarranted cesarean sections while ensuring their accessibility when medically warranted.

The shortage of obstetricians in rural areas in Japan presents a significant healthcare concern with potential clinical implications. This study is the first to empirically demonstrate the impact of obstetrician maldistribution on the PCD rate. Specifically, our findings reveal an elevated cesarean section rate in prefectures with a relative shortage of obstetricians, particularly in cases of labor arrest, presumed macrosomia, and severe HDP. This reflects the tendency of obstetricians to opt for cesarean sections when they anticipate challenges in managing vaginal deliveries due to insufficient healthcare provider support, potentially contributing to higher cesarean section rates. Conversely, our investigation reveals that the cesarean section rate for NRFS remains unaffected by the obstetrician disproportionality index. This intriguing finding may be attributable to the dedication and adherence of obstetricians to standardized clinical guidelines, prioritizing the health and safety of the infant. It underscores the importance of adhering to established protocols and best practices in situations involving

NRFS, mitigating the influence of obstetrician shortages on cesarean section rates.

Research implications

It's crucial to conduct further research to quantify the clinical impact of the shortage of obstetricians in rural areas and implement policies and programs to mitigate its adverse effects on maternal and neonatal health in rural Japan.

Strengths and limitations

Strengths of this paper include its comprehensive analysis of the national trends in PCD in Japan, spanning a substantial study period (2012−2018) and involving a large dataset. Furthermore, it successfully identifies significant regional disparities in PCD rates and associated indications, shedding light on regional healthcare disparities. The study's innovative perspective on the impact of obstetrician availability on clinical decision-making enriches our understanding of healthcare provider distribution effects on patient care. However, the paper has limitations, primarily related to potential issues with data quality and completeness. Additionally, while the paper discusses associations between obstetrician availability and PCD rates, it does not establish causality. The presence of a significant proportion of PCD cases with unknown indications introduces uncertainty into the analysis, potentially affecting result accuracy and conclusions.

Conclusions

This study highlights substantial regional disparities in PCD rates among different prefectures in Japan, partially attributable to a relative shortage of obstetricians. It underscores the need for policies and programs to alleviate the adverse effects of obstetrician shortages on maternal health. ■

CRediT authorship contribution statement

Akihiko Ueda: Conceptualization, Methodology, Formal analysis, Writing − original draft. **Baku Nakakita:** Conceptualization, Methodology. **Yoshitsugu Chigusa:** Writing − review & editing. **Haruta Mogami:** Writing − review & editing. **Genta Kato:** Resources, Supervision. **Hiroaki Ueshima:** Resources. **Masaki Mandai:** Supervision. **Eiji Kondoh:** Conceptualization, Data curation, Writing − original draft, Project administration. ■

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.xagr.2024.100366.

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