Title: Primary Cesarean Delivery Among Low-Risk First Births in South Jersey (2020 to 2024): Regional Benchmarking, Disparities, and Practice Variation

By Induben Prabhakar

The Cooperative - Family Health Initiatives

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1. INTRODUCTION

1.1 Background and Significance

Despite decades of quality improvement efforts, cesarean delivery rates in the United States remain high, with 32.3% of all births delivered surgically in 2023, according to national vital statistics data (Osterman et al., 2025). Nulliparous, term, singleton, vertex (NTSV) births represent low-risk first births at 37 or more weeks with a single fetus in head-first presentation, as defined in section 1.2.1. Among this population, the cesarean delivery rate increased to 26.6% in 2023 and then declined modestly to 25.3% in 2024, based on hospital-reported maternity care data respectively (Osterman et al., 2025; Leapfrog Group, 2025). Although this recent decrease represents progress, the NTSV cesarean rate remains 1.7 percentage points above the Healthy People 2030 target of 23.6%, a benchmark established to reduce unnecessary primary cesarean deliveries among low-risk women (Office of Disease Prevention and Health Promotion, 2020). Because the NTSV population represents the group with the lowest expected clinical need for surgical delivery, persistently elevated rates continue to signal opportunities for improvement in labor management practices, adherence to evidence-based guidelines, and equitable delivery of obstetric care (The Joint Commission, 2024).

This sustained elevation relative to historical patterns reflects a substantial departure from earlier cesarean delivery patterns and has prompted longstanding concern among maternal health stakeholders, policymakers, and quality improvement organizations. While cesarean delivery is lifesaving when medically indicated, mounting evidence demonstrates that cesarean rates substantially exceed clinical necessity in many settings, exposing mothers and newborns to avoidable risks and complications, as documented in the ACOG–SMFM Obstetric Care Consensus on safe prevention of primary cesarean delivery (2014).

Among nulliparous, term, singleton, vertex (NTSV) births, cesarean delivery rates are therefore widely recognized as a critical quality indicator. The NTSV population represents the most variable and provider-dependent component of primary cesarean births, with substantial opportunity for quality improvement and limited evidence that higher surgical rates improve maternal or neonatal outcomes (The Joint Commission, 2024). The NTSV measure specifically excludes multiple gestations, preterm births, and women with prior cesarean deliveries, factors that appropriately increase the likelihood of surgical delivery. By focusing exclusively on this low-risk population, the NTSV cesarean rate provides an unbiased assessment of obstetric practice patterns and institutional culture regarding surgical intervention, as summarized by Caughey and colleagues (2014).

The clinical and public health significance of reducing unnecessary primary cesarean deliveries is substantial. Compared with vaginal birth, cesarean delivery is associated with increased maternal risks, including postoperative infection, hemorrhage, venous thromboembolism, and prolonged recovery, as documented in systematic reviews and observational studies (Keag, Norman, & Stock, 2018; Blondon, 2016). For neonates, cesarean delivery without labor increases the risk of respiratory complications, including transient tachypnea of the newborn and other respiratory morbidity, compared with vaginal birth (Tefera et al., 2020). Moreover, primary cesarean delivery initiates a cascade of risks that extend to subsequent pregnancies, including increased likelihood of repeat cesarean, placenta previa, placenta accreta spectrum disorders, and uterine rupture complications described by Silver et al. (2006) and Clark et al. (2008) as being associated with substantial maternal morbidity and mortality. Each avoided primary cesarean delivery therefore represents both immediate benefits and prevention of cumulative risks across a woman's reproductive lifespan.

Beyond individual patient impacts, cesarean delivery carries significant economic implications. Cesarean delivery is substantially more expensive than vaginal delivery, with average hospital costs for cesarean births exceeding those for vaginal births by several thousand dollars per case, contributing to increased healthcare expenditures nationally when potentially unnecessary procedures are considered (Kozhimannil, Law, & Virnig, 2013; Health

System Tracker, 2025). These costs include not only the index delivery, but also downstream expenses related to longer hospital stays, readmissions, and management of complications in subsequent pregnancies.

Recognizing the importance of reducing unnecessary cesarean deliveries, the U.S. Department of Health and Human Services Healthy People 2030 initiative established a national target NTSV cesarean rate of 23.6%, as set forth by the Office of Disease Prevention and Health Promotion (2020). This target, designated as objective MICH-06, represents a modest reduction from the 2018 baseline of 25.9% and reflects achievable improvement based on current best-performing institutions and regions.

Despite a clear national benchmark and widespread recognition of the need to reduce unnecessary cesarean deliveries, the United States has not achieved the Healthy People 2030 target for low-risk (NTSV) cesarean births. Contemporary national data indicate that low-risk cesarean rates remain above the evidence-based target of 23.6%. National vital statistics documented a period of modest improvement through 2018, during which overall cesarean delivery rates declined following earlier peaks, suggesting some progress in obstetric practice patterns. However, more recent data indicate that these gains were not sustained, underscoring the ongoing challenge of reducing unnecessary primary cesarean deliveries at the population level (Martin, Hamilton, Osterman, & Driscoll, 2019). Moreover, recent stagnation and modest upticks in cesarean delivery rates have raised concerns that evolving obstetric practice patterns including expanded use of elective labor induction following the ARRIVE trial described by Grobman et al. (2018), which demonstrated lower cesarean rates under controlled trial conditions may not have translated into expected reductions in cesarean rates in routine clinical practice. Real-world analyses suggest that although induction rates increased after the trial's publication, overall cesarean birth rates did not decline uniformly, highlighting challenges in implementation fidelity outside the trial setting (Nethery et al., 2023).

Reducing primary cesarean deliveries has been identified as a national patient safety priority by multiple organizations, including The Joint Commission, the American College of Obstetricians and Gynecologists, and the Society for Maternal-Fetal Medicine, as articulated through multidisciplinary consensus efforts summarized by

(Spong and colleagues, 2012). The Joint Commission designates the nulliparous, term, singleton, vertex (NTSV) cesarean rate as Perinatal Care Core Measure PC-02, a quality metric that hospitals track and analyze to identify variation and opportunities for improvement in cesarean delivery practices. This designation reflects consensus that the NTSV cesarean rate is widely regarded as a valid, reliable, and actionable indicator of obstetric quality suitable for driving practice improvement.

The public health imperative to reduce unnecessary cesarean deliveries is further amplified by persistent and troubling racial and ethnic disparities in cesarean rates. National analyses demonstrate that non-Hispanic Black women experience higher NTSV cesarean rates than non-Hispanic White women, a disparity that persists even after controlling for maternal age, clinical and social covariates underscoring persistent racial inequities in obstetric care (McCloskey et al., 2025). This pattern suggests that factors beyond individual patient characteristics including structural racism, implicit bias in clinical decision-making, differential application of clinical protocols, and systemic inequities in healthcare access and quality, contribute to observed disparities, as argued by Crear-Perry and colleagues (2021). Addressing these inequities is not only a matter of quality improvement but also a fundamental issue of healthcare justice and human rights.

In summary, NTSV cesarean delivery rates serve as a critical barometer of maternity care quality, patient safety, healthcare value, and health equity. Elevated rates signal opportunities for evidence-based practice improvement that can simultaneously improve maternal and neonatal outcomes, reduce healthcare costs, and advance equity in maternal health, goals of paramount importance to healthcare systems, payers, policymakers, and most importantly, the women and families served by maternity care systems.

1.2 NTSV Cesarean Delivery as a National Quality Measure

Nulliparous, term, singleton, vertex (NTSV) births represent a standardized, nationally endorsed population used to evaluate cesarean delivery practices across hospitals and health systems.

1.2.1 Definition of the NTSV Population

NTSV is defined as:

- **Nulliparous** - first-time mothers
- **Term gestational age ≥ 37 weeks**
- **Singleton** - one fetus (not multiples)
- **Vertex** - fetus in head-down presentation

These criteria isolate a population with the lowest expected clinical necessity for cesarean delivery. As a result, the NTSV group represents the most appropriate denominator for monitoring potentially preventable primary cesarean births, as defined by The Joint Commission's Perinatal Care Core Measure PC- 02.

1.3 National and Statewide Performance

As noted, national NTSV cesarean rates remain above the Healthy People 2030 target of 23.6%. New Jersey's performance mirrors this challenge. Statewide NTSV cesarean rates fluctuated between 24.3% and 25.4% from 2021 to 2023, with no sustained downward trend (New Jersey Department of Health, 2024). This pattern suggests that despite statewide quality initiatives, cesarean reduction efforts have not achieved consistent progress.

Importantly, state-level data may mask substantially within state variation. Counties and hospitals within New Jersey demonstrate heterogeneous cesarean rates, induction practices, and patient populations, indicating that aggregate statistics alone provide an incomplete understanding of regional practice patterns. This variability underscores the rationale for focused regional analyses capable of identifying local drivers of elevated cesarean rates and opportunities for targeted intervention.

1.4 South Jersey Context and Study Rationale

South Jersey encompasses seven counties (Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Salem) with 1.8 million residents served by diverse hospitals ranging from high volume regional centers to smaller community facilities. The Cooperative, 2025, has documented regional perinatal trends through annual Achievement Reports, tracking birth outcomes, healthcare utilization, and emerging concerns that inform quality monitoring and system level improvement.

The region faces significant healthcare access variability. Statewide evaluations indicate that hospitals with fewer supportive services such as midwives, doulas, and lactation consultants disproportionately serve Hispanic and other historically marginalized populations, suggesting potential pathways through which access to supportive care may influence labor management and delivery practices Rutgers School of Public Health report, 2025. County-level variation exists in prenatal care access and social risk factor concentrations, which prior research associates with increased cesarean likelihood South Jersey Achievement, 2024.

Simultaneously, statewide initiatives including Nurture NJ Strategic Plan, 2021 and the New Jersey Maternal Health Hospital Report Card, 2025 have established frameworks for transparency and equity-focused improvement that South Jersey hospitals can leverage. Recent evaluations of New Jersey's maternity care landscape highlight ongoing efforts to enhance service availability and reduce disparities, providing infrastructure for regional quality improvement (Rutgers University, 2025).

Although New Jersey publicly reports NTSV cesarean rates at hospital and county levels, these data have not been synthesized into a focused, multi-year regional assessment examining temporal trends, intra-regional variation, and facility-level versus population-level characteristics compared with state and national benchmarks. This analysis therefore provides regionally specific evidence to inform targeted quality improvement tailored to local population needs.

2. METHODS

2.1 Study Objectives

The overarching objective of this study is to evaluate patterns, predictors, and disparities in nulliparous, term, singleton, vertex (NTSV) cesarean delivery in South Jersey from 2020 to 2024. Building on national quality benchmarks and recent state level maternal health initiatives, this analysis aims to provide regionally specific evidence to inform quality improvement and equity-focused interventions.

The specific objectives of this study are to:

- Benchmark South Jersey NTSV cesarean rates against New Jersey statewide averages, U.S. national rates, and the Healthy People 2030 target
- Describe variation in NTSV cesarean delivery across key clinical and demographic characteristics, including induction status, body mass index (BMI), race/ethnicity, and insurance type
- Assess temporal trends in NTSV cesarean rates from 2020 through 2024, including potential changes during and after the COVID-19 pandemic
- Identify independent predictors of NTSV cesarean delivery using multivariable logistic regression
- Examine racial, ethnic, and payer-based disparities in NTSV cesarean delivery and determine whether these disparities persist after adjustment for clinical factors
- Generate actionable insights to support hospital-level quality improvement, regional planning, and alignment with New Jersey's maternal health equity initiatives

By achieving these objectives, this analysis not only complements statewide evaluations (such as Nurture NJ progress reports and the Maternal Health Hospital Report Card but also provides regionally specific insights that healthcare systems, policymakers, and community stakeholders can use to tailor interventions for populations with the greatest need.

2.2. Study Design and Setting

This study is a retrospective observational analysis of nulliparous, term, singleton, vertex (NTSV) births occurring during calendar years 2020 through 2024 among residents of the seven South Jersey counties (Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Salem). The analysis includes deliveries captured in hospital based NTSV birth records for facilities serving the South Jersey region.

2.3 Data Sources

This study uses a de-identified NTSV birth dataset for calendar years 2020 - 2024, derived from hospital delivery records from the New Jersey Department of Health, Office of Vital Statistics and Registry for South Jersey, including birth certificate data from VIP (2020-2021) and VERI-NJ (2022-2024) (New Jersey Department of Health, Office of Vita Statistics and Registry, 2025). The analytic dataset includes 29,247 NTSV births and contains aggregated information regarding selected maternal demographics, clinical risk factors, labor and delivery characteristics, and delivery outcomes.

For benchmarking and interpretation, South Jersey results were compared with:

- New Jersey statewide NTSV cesarean rates (New Jersey Maternal Data Center),
- U.S. national NTSV cesarean rates (CDC/MICH-06), and
- Healthy People 2030 NTSV target (23.6%; MICH-06).

These external sources were used for contextual comparison only; all statistical testing was performed using the South Jersey analytic dataset.

2.4 Sample Selection and Cohort Construction

The initial dataset comprised 87,332 delivery records from South Jersey hospitals for calendar years 2020 through 2024. From this full dataset, an analytic cohort was constructed by applying standardized criteria for nulliparous, term, singleton, vertex (NTSV) births, consistent with national definitions used for obstetric quality measurement.

To identify the NTSV population, records were retained if they met the following criteria:

- Nulliparous status, defined as no prior live births. To ensure comprehensive capture, both records coded as zero prior live births and records with missing values in the prior live birth field were included, recognizing the potential for underreporting.
- Term gestation (≥ 37 weeks)
- Singleton pregnancy.
- Vertex (cephalic) fetal presentation, identified using standardized coding indicating non-vertex status as "No."

Records that did not meet these criteria, including multiple gestations, preterm births, non-vertex presentations, and known prior live births were excluded from the analytic cohort.

After application of these inclusion and exclusion criteria, the final NTSV analytic cohort consisted of 29,247 records, representing 33.49% of the total delivery dataset across the five-year study period.

For calculation of NTSV cesarean delivery rates, the numerator was defined as the number of cesarean deliveries among NTSV births, and the denominator as the total number of NTSV births, inclusive of all delivery routes (cesarean, spontaneous vaginal, vacuum-assisted, forceps assisted and other).

2.5 Study Variables

Variables included in the analysis were selected based on clinical relevance and prior literature on factors associated with primary cesarean delivery. The primary outcome was mode of delivery, categorized as cesarean versus vaginal delivery.

Key exposure variables included labor induction status (induced, not induced, unknown), pre-pregnancy body mass index (BMI; underweight, normal, overweight, obesity classes I, II, III), maternal race and ethnicity, insurance type at delivery and pregnancy-related comorbidities (gestational diabetes, gestational hypertension, and eclampsia).

Sociodemographic variables included maternal race and ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, other race, and unknown) and insurance type (Medicaid, private, other government, self-pay, and unknown).

Geographic and institutional variables include county residence and delivery facility code. These variables were used to examine regional and facility-level variation in NTSV cesarean delivery rates and induction practices.

Records with missing BMI values were excluded from BMI-specific analyses but retained in all other analyses.

2.6 Statistical Analyses

Analyses were conducted using Microsoft Excel and RStudio.

- Descriptive statistics were used to summarize population characteristics and cesarean rates.
- Chi-square tests assessed associations between cesarean delivery and categorical predictors.
- Standardized residuals were examined to identify cells contributing most to observed associations.
- Crude odds ratios were calculated for selected bivariate comparisons.
- Trend analysis evaluated changes in NTSV cesarean rates over time.
- Multivariable logistic regression identified independent predictors of NTSV cesarean delivery, with adjusted odds ratios and 95% confidence intervals reported.

3. RESULTS

This section presents results in eight parts: (1) study population and overall NTSV cesarean rates; (2) benchmarking against state and national standards; (3) population characteristics of the NTSV cohort; (4) bivariate associations between NTSV cesarean delivery and key predictors using chi-square analyses; (5) stratified analyses examining interactions between key risk factors; (6) geographic variation at county and facility levels; (7) temporal

trends from 2020 to 2024; and (8) multivariable logistic regression identifying independent predictors of NTSV cesarean delivery.

3.1 Study Population and Overall NTSV Rate

This section summarizes the overall size and composition of the nulliparous, term, singleton, vertex (NTSV) cohort and presents overall NTSV cesarean delivery rates in South Jersey from 2020 to 2024. **Table 1** and **Figure 1** summarize the composition of South Jersey deliveries.

Between calendar years 2020 and 2024, a total of 87,332 delivery records were identified from South Jersey hospitals. After applying standard inclusion and exclusion criteria to isolate NTSV births, the final analytic cohort consisted of 29,247 NTSV deliveries, representing 33% of all deliveries during the five-year study period. The remaining 58,085 deliveries (67%) did not meet NTSV criteria and were excluded from subsequent analyses.

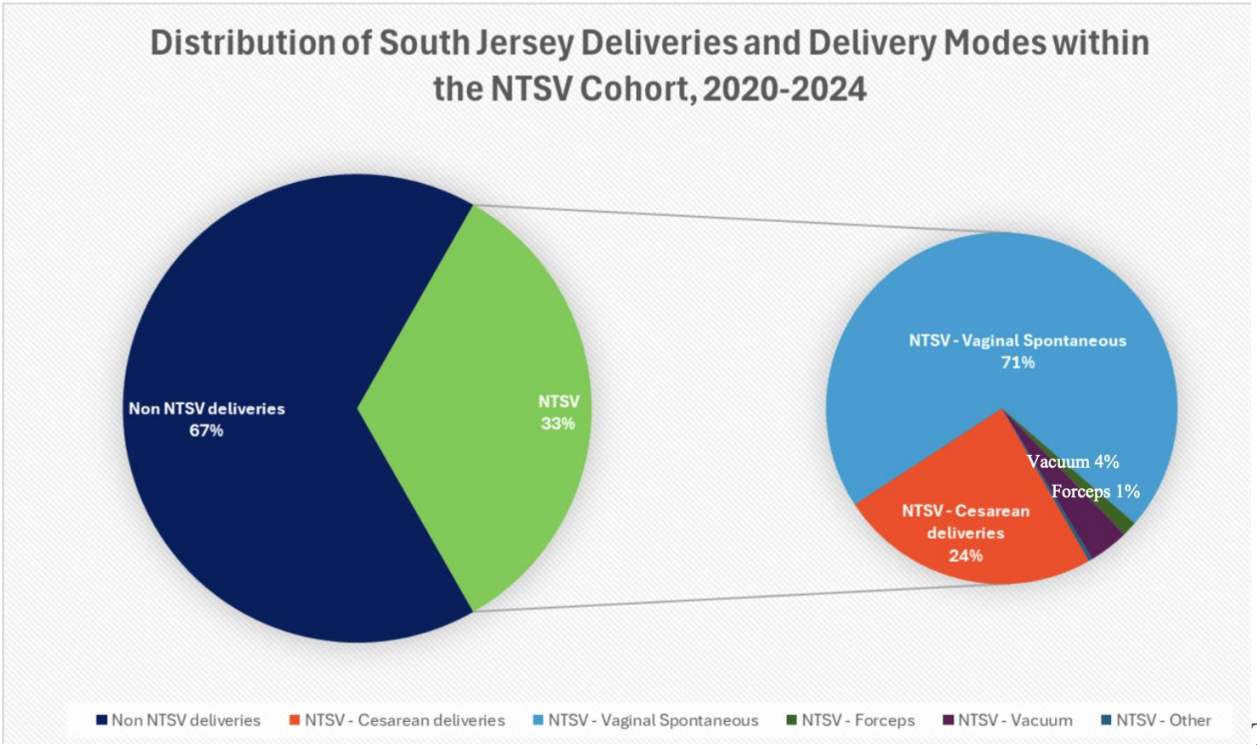
Within the NTSV cohort (N = 29,247), 7,034 deliveries were completed by cesarean delivery, resulting in an overall five-year NTSV cesarean delivery rate of 24%. The remaining 22,213 NTSV deliveries (76%) were delivered vaginally, including spontaneous vaginal, vacuum-assisted, and forceps-assisted births.

Table 1: Distribution of NTSV and Non-NTSV Deliveries and Delivery routes, South Jersey (2020-2024)

Category	Subcategory	Number of Births (n)	% of Total Cohort	% of NTSV Cohort
Total Birth Deliveries		87332	100%	-
Non NTSV Deliveries		58085	67%	-
NTSV deliveries		29247	33%	100%

	NTSV - Cesarean deliveries	7034	8%	24%
	NTSV - Vaginal Spontaneous	20636	24%	71%
	NTSV - Forceps	403	0%	1%
	NTSV - Vacuum	1072	1%	4%
	NTSV - Other	102	0%	0%

Figure 1. Distribution of Delivery Routes within the NTSV Cohort, South Jersey (2020 -2024



The pie chart presents the distribution of delivery routes within the NTSV cohort. Spontaneous vaginal delivery accounted for

the majority of births, followed by cesarean delivery, with smaller proportions of vacuum assisted and forceps assisted deliveries.

3.2 Benchmarking of South Jersey NTSV Cesarean Rates

The overall NTSV cesarean delivery rate in South Jersey was benchmarked against New Jersey statewide rates, national rates, and the Healthy People 2030 target for the period 2020 to 2024. Across the five-year study period, South Jersey NTSV cesarean rates ranged from 23.5% to 25%, with annual rates of 24.1% in 2020, 23.5% in both 2021 and 2022, an increase to 25% in 2023, and a decline to 24.3% in 2024. In comparison, New Jersey statewide NTSV cesarean rates ranged from 24.3% to 25.9% over the same period, with rates of 25.9% in 2020, 24.9% in 2021, 24.3% in 2022, and 25.4% in 2023. Nationally, NTSV cesarean rates remained consistently higher, ranging from 25.9% in 2020 to a peak of 26.6% in 2023, before declining modestly to 25.3% in 2024.

Table 2 presents annual benchmarking comparisons, and **Figure 2** displays temporal trends in South Jersey relative to state and national benchmarks.

Table 2: Benchmarking of NTSV Cesarean Delivery Rates (%) In South Jersey Compared with New Jersey, U.S National Rates, and Healthy People 2030 Targets, 2020-2024

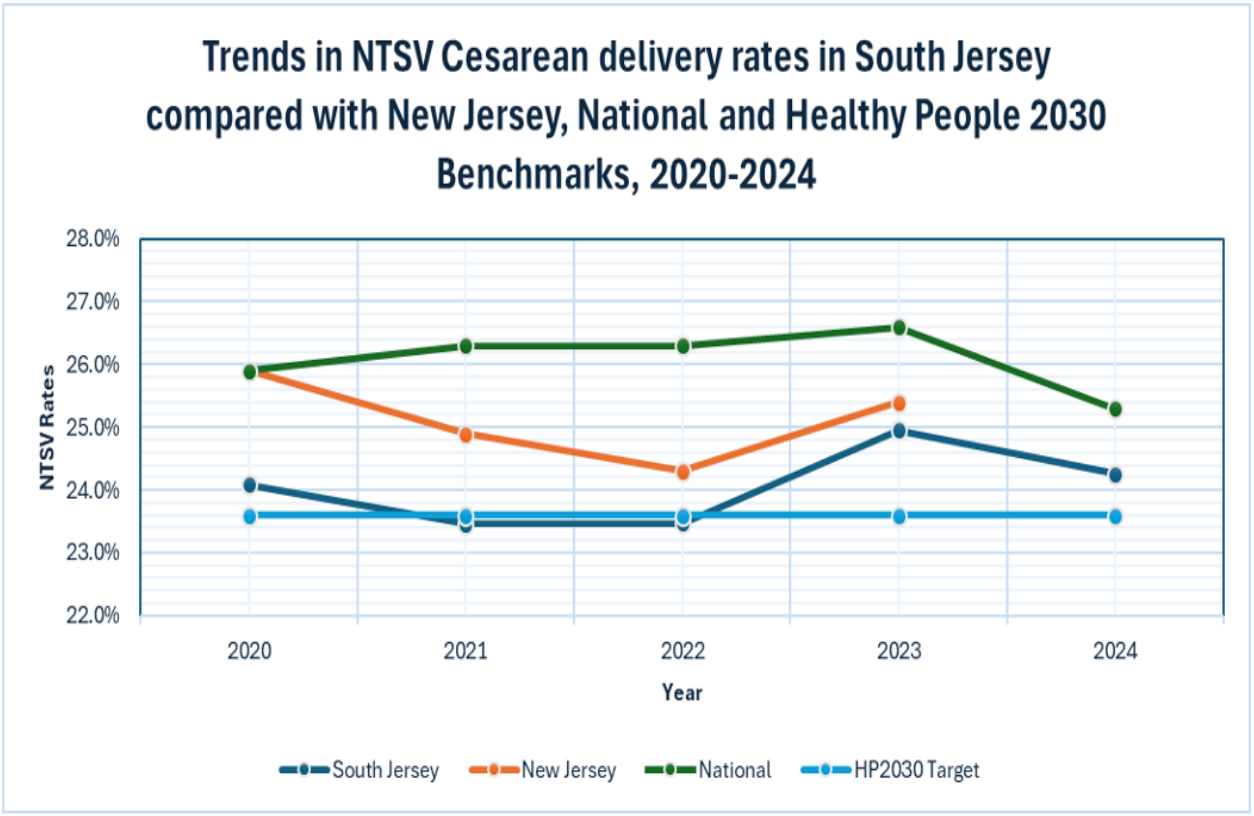
Region	2020	2021	2022	2023	2024
South Jersey	24.1%	23.5%	23.5%	25.0%	24.3%
New Jersey	25.9%	24.9%	24.3%	25.4%	
National	25.9%	26.3%	26.3%	26.6%	25.3%
HP2030 Target	23.6%	23.6%	23.6%	23.6%	23.6%

Note: Rate represents the percentage of NTSV births delivered by cesarean section within each region and year. South Jersey estimates are based on the analytic NTSV cohort; New Jersey and U.S. estimates are drawn from publicly reported benchmarks. Healthy People 2030 target reflects the national goal for NTSV cesarean delivery (23.6%).

The early years of the study period coincided with the COVID-19 pandemic, which has been associated nationally with temporary changes in obstetric care delivery. Despite these disruptions, South Jersey NTSV cesarean rates remained relatively stable and generally lower than both state and national averages throughout the study period.

Although South Jersey's performance approached the Healthy People 2030 target NTSV cesarean rate of 23.6% in multiple years, the target was not consistently achieved across the study period. These findings suggest that, while South Jersey compares favorably with broader state and national benchmarks, opportunities remain for continued improvement to meet established national quality goals.

Figure 2. NTSV Cesarean Delivery Rates in South Jersey Compared with New Jersey, National, and Healthy People 2030 Benchmarks, 2020–2024.



3.3 Population Characteristics of the NTSV Cohort

The nulliparous, term, singleton, vertex (NTSV) cohort included 29,247 births occurring in South Jersey between 2020 and 2024. The population was heterogeneous with respect to maternal body mass index (BMI), race and ethnicity, insurance coverage, labor induction status, and selected pregnancy-related comorbidities.

3.3.1 Maternal Body Mass Index

Pre-pregnancy maternal BMI varied across the cohort. Normal-weight individuals constituted the largest BMI category, followed by overweight and obese individuals. A substantial proportion of the cohort fell within obesity categories, including Obesity Classes I, II, and III. Underweight individuals represented a smaller proportion of NTSV births. Records with missing or unknown BMI accounted for approximately 4% of the cohort and were retained in overall analyses but excluded from BMI-specific summaries.

3.3.2 Race and Ethnicity

The NTSV cohort was racially and ethnically diverse. Non-Hispanic White individuals represented the largest racial and ethnic group, followed by Hispanic and non-Hispanic Black individuals. Asian non-Hispanic individuals and other racial and ethnic groups comprised smaller proportions of the cohort. A small percentage of records had race or ethnicity coded as unknown or refused.

3.3.3 Labor Induction Status

Labor induction was common within the NTSV cohort. A substantial proportion of births involved induction of labor, while others occurred without induction or had induction status recorded as unknown. Induction prevalence varied across maternal and clinical subgroups and is examined in subsequent analyses.

3.3.4 Insurance Coverage

Insurance type at delivery varied across the cohort. Medicaid and private insurance accounted for the majority of NTSV births, with smaller proportions covered by other government insurance, self-pay, or unknown insurance categories.

3.3.5 Pregnancy-Related Comorbidities

Selected pregnancy-related comorbidities were present among a subset of the cohort. Gestational diabetes and gestational hypertension were observed in a proportion of NTSV births, while eclampsia occurred infrequently. These conditions were examined in subsequent analyses as potential contributors to delivery outcomes.

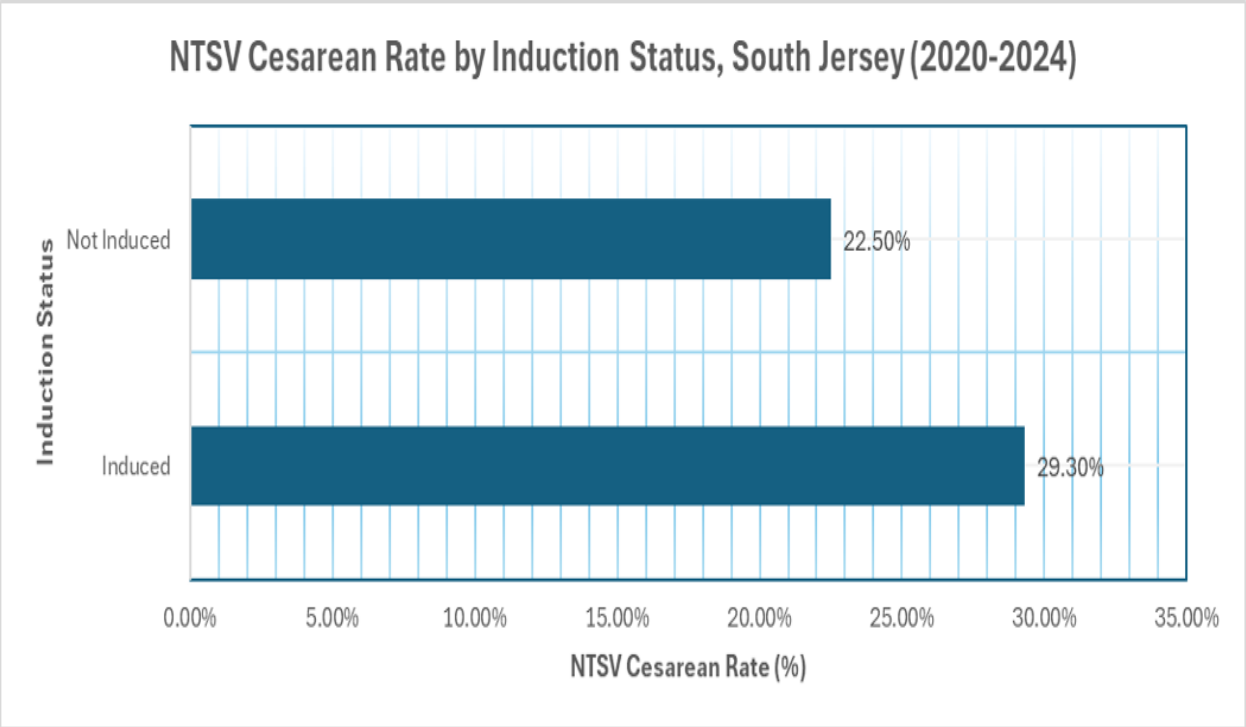
3.4 Bivariate Associations (Chi-Square Analyses)

Chi-square tests of independence were used to examine unadjusted associations between NTSV cesarean delivery and key clinical and demographic factors. All tests were two-sided, and statistical significance was assessed at $\alpha = 0.05$.

3.4.1 Induction Status and NTSV Cesarean Delivery

Cesarean delivery occurred more often among NTSV births in which labor was induced compared with those that were not induced. Among induced NTSV deliveries, 29.30% resulted in the Cesarean section, whereas 22.50% of non-induced deliveries were completed by the Cesarean section, representing around 7-percentage -point difference as shown in **Figure 3.**

Figure 3. Comparison of NTSV cesarean delivery rates among induced and non-induced births in South Jersey, 2020-2024



This difference was statistically significant (χ^2 test, $p < 0.001$), indicating that induction status was meaningfully associated with cesarean delivery in the NTSV population. In unadjusted analyses NTSV

patients whose labor was induced had higher odds of cesarean delivery compared with those who were not induced (OR = 1.43), corresponding to 43% higher odds of cesarean birth.

Similarly, the relative risk of cesarean delivery was higher among induced labors (RR = 1.31), indicating that induced patients were about 31% more likely to have a cesarean delivery compared with those who entered labor without induction.

3.4.2 Body Mass Index

The Pre-pregnancy maternal body mass index (BMI) varied across the NTSV cohort. Among NTSV cesarean births (N = 29247), cesarean delivery rate increased progressively with higher BMI categories, as shown in **Table 3**.

Women with normal BMI had an NTSV cesarean rate of 18%, while higher rates were observed among women classified as overweight (24%) and obese. Specifically cesarean rates were 30% among women with Obesity class I, 35% among those with Obesity class II, and 42% among those with Obesity class III. Underweight women had a comparatively lower NTSV cesarean rate (11%). Records with missing or unknown BMI values accounted for a small proportion of the cohort (4%) and were excluded from BMI specific interpretations.

Overall, overweight and obese women including Obesity classes (I - III) accounted for the majority of NTSV cesarean deliveries, reflecting both their higher cesarean rates and their larger representation within the NTSV population.

Table 3: NTSV Cesarean Deliveries and Cesarean Rates by Pre-pregnancy Maternal BMI Category, South Jersey, (2020-2024)

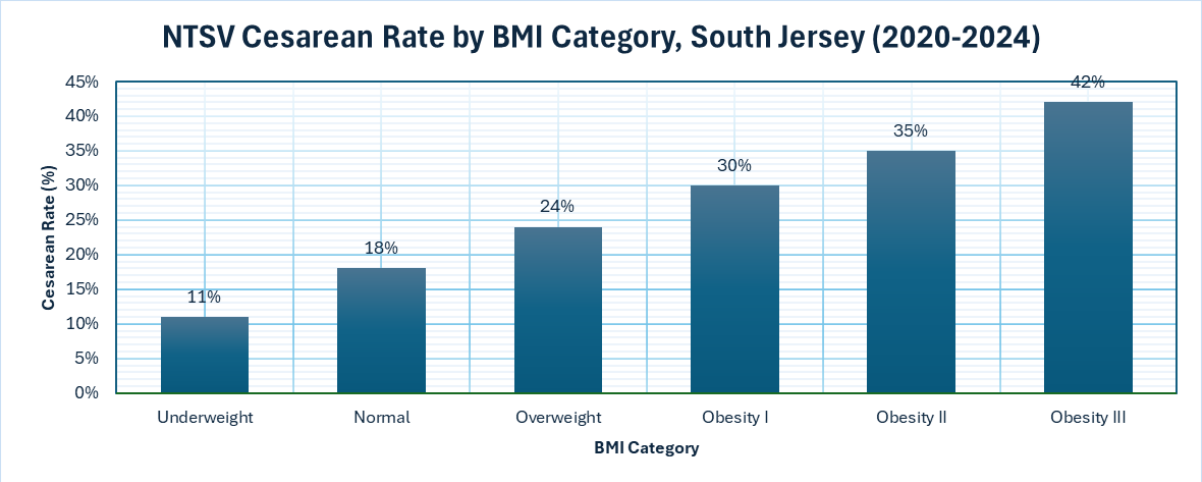
Row Labels	NSTV Cesarean deliveries	Total NTSV births	NTSV Cesarean Rate (%)

Normal	1988	11074	18%
Obesity I	1362	4524	30%
Obesity II	798	2265	35%
Obesity III	682	1611	42%
Overweight	1864	7811	24%
Underweight	88	784	11%
Unknown	252	1178	21%
Grand Total	**7034**	**29247**	24%

The pre-pregnancy maternal body mass index (BMI) was strongly associated with NTSV cesarean delivery. Chi-square testing demonstrated a statistically significant relationship between BMI category and mode of delivery (χ^2 test, $p < 0.001$), indicating that cesarean delivery rates varied substantially across BMI groups.

Cesarean delivery rates increased progressively with higher BMI categories **(Figure 4).** Underweight and normal BMI individuals experienced significantly fewer cesarean deliveries than expected based on their representation in the cohort. In contrast, individuals classified as Obesity I, Obesity II, and Obesity III experienced significantly higher cesarean delivery rates than expected. The magnitude of this deviation increased steadily across obesity classes, suggesting a clear dose response relationship between increasing BMI and cesarean risk.

Figure 4. Distribution of NTSV cesarean delivery rates by BMI category in South Jersey, 2020-2024



Odds ratio estimates further supported this pattern. Compared with normal BMI individuals, the odds of cesarean delivery increased monotonically with each higher BMI category, with the highest odds observed among individuals with Obesity Class III. These findings indicate that higher maternal BMI is associated with a substantially increased likelihood of cesarean delivery among low-risk NTSV births.

3.4.3 Race and Ethnicity

The NTSV cohort was racially and ethnically diverse as presented in **table 4** below. Among all NTSV births (N = 29,247), cesarean deliveries accounted for 7,034 cases. In absolute terms, the largest number of NTSV cesarean deliveries occurred among non-Hispanic White (n = 3,979), Hispanic (n = 1,558), and non-Hispanic Black individuals (n = 1,089), reflecting the underlying distribution of births within the cohort.

When examined as rates within racial and ethnic subgroups, non-Hispanic black individuals experienced a higher NTSV cesarean rate (26%) compared with non-Hispanic White individuals (24%) and Hispanic individuals (22%). Asian non-Hispanic individuals had an NTSV cesarean rate of 23% (Table 4). Smaller racial and ethnic groups showed greater variability in rates, likely to reflect limited sample sizes.

Across all groups, Vaginal - spontaneous delivery remained the predominant delivery route within the NTSV cohort, as evidenced by cesarean rates well below 50%.

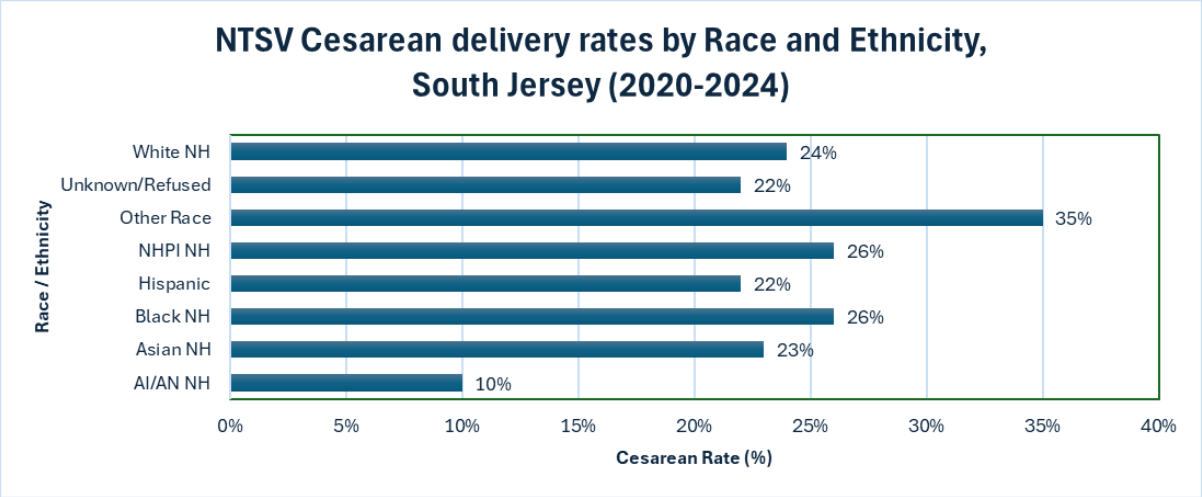
NTSV cesarean delivery rates differed significantly by race and ethnicity (χ^2 test, $p < 0.001$), indicating non-uniform distribution of delivery mode across racial and ethnic groups. In absolute terms, the largest number of NTSV cesarean deliveries occurred among non-Hispanic White individuals (n = 3,979), followed by Hispanic (n = 1,558) and non-Hispanic Black individuals (n = 1,089), reflecting underlying population distributions. However, standardized residual analysis demonstrated disparities beyond population size alone. Non-Hispanic Black individuals experienced significantly more cesarean deliveries than expected (standardized residual = +2.24), while Hispanic individuals experienced significantly fewer than expected (standardized residual = −3.98). Cesarean deliveries among non-Hispanic White individuals were slightly above expected levels but did not reach statistical significance.

Overall, these findings indicate meaningful racial and ethnic differences in unadjusted NTSV cesarean delivery rates across South Jersey. The extent to which these disparities persist after adjustment for clinical risk factors, induction status, BMI, and insurance type is examined in subsequent multivariable analyses.

Table 4: NTSV Cesarean Delivery Rates by Maternal Race and Ethnicity, South Jersey, 2020-2024

Race/Ethnicity	NTSV Cesarean deliveries	Total NTSV births	NTSV Cesarean Rate (%)
AI/AN NH	1	10	10%
Asian NH	349	1500	23%
Black NH	1089	4182	26%
Hispanic	1558	7118	22%
NHPI NH	5	19	26%
Other Race	38	110	35%
Unknown/Refused	14	64	22%
White NH	3979	16243	24%
Grand Total	**7034**	**29247**	**24%**

Figure 5: Distribution of NTSV cesarean delivery rates by Race and Ethnicity in South Jersey, 2020-2024



3.4.4 Maternal Comorbidities

Among NTSV births with documented clinical comorbidities, cesarean delivery accounted for approximately 32% of deliveries among those with gestational diabetes, 31% among those with gestational hypertension, and 29% among the small number of cases complicated by eclampsia (Table 5). These percentages describe cesarean delivery within each comorbidity subgroup and are presented descriptively.

Table 5 : NTSV Cesarean Delivery Rates by Maternal Comorbidities, South Jersey, 2020-2024

Maternal comorbidity	Total NTSV births	NTSV Cesarean	NTSV Cesarean (%)
Gestational Diabetes	2217	714	32%

Gestational Hypertension	2576	798	31%
Eclampsia	7	2	29%

3.4.5 Insurance Type and NTSV Cesarean delivery:

Between 2020 and 2024, a total of 29,247 NTSV births were recorded. Insurance coverage at delivery varied across the NTSV cohort. As shown in Table 6, Medicaid was the predominant payer type (55.4%, n = 16,215), followed by private insurance (41.4%, n = 12,110).

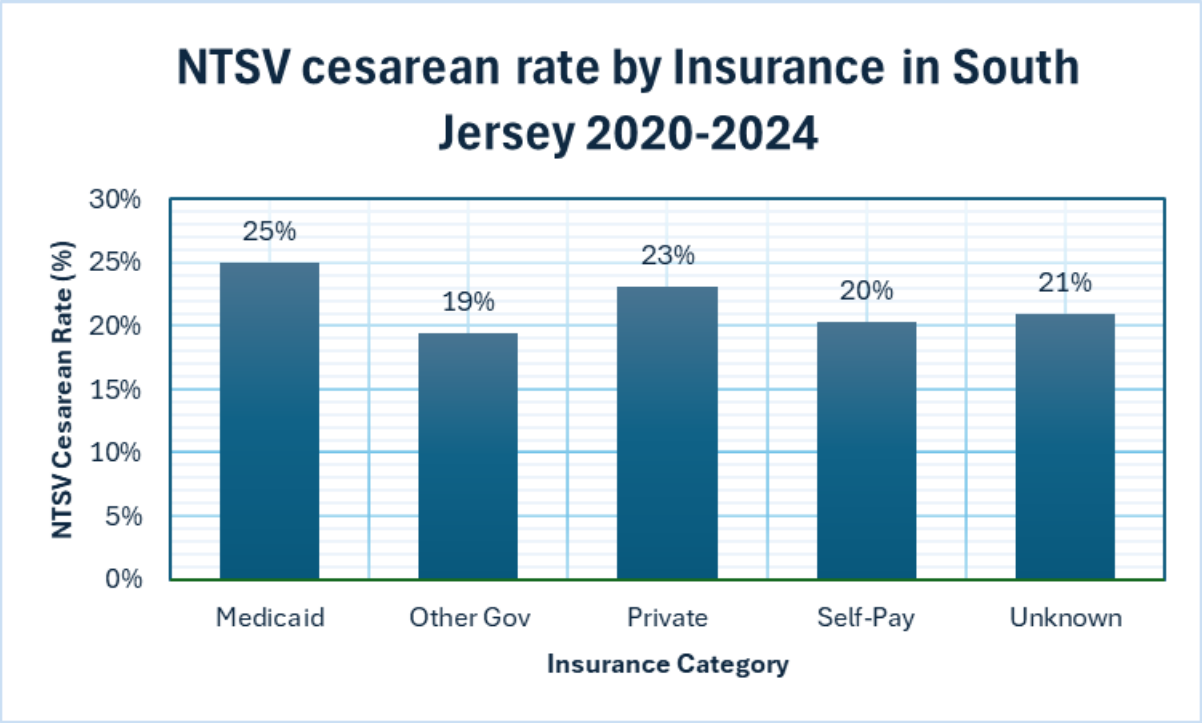
Table 6: NTSV Cesarean Delivery Rates by Insurance types, South Jersey, 2020-2024

Row Labels	**NSTV cesarean deliveries**	**Total NTSV births**	**NTSV Cesarean Rate (%)**
Medicaid	4053	16215	25%
Other Gov	48	247	19%
Private	2794	12110	23%
Self-Pay	74	365	20%
Unknown	65	310	21%
Grand Total	**7034**	**29247**	24%

- Medicaid: 4,053 cesareans out of 16,215 births (25%)
- Private Insurance: 2,794 cesareans out of 12,110 births (23%)
- Self-Pay: 74 cesareans out of 365 births (20%)

- Other Government Insurance: 48 cesareans out of 247 births (19%)
- Unknown Insurance: 65 cesareans out of 310 births (21%)

Figure 6: Distribution of NTSV cesarean delivery rates by Insurance category in South Jersey, 2020-2024



NTSV cesarean delivery rates differed significantly by insurance type (χ^2 test, $p < 0.001$). Medicaid-insured individuals experienced a cesarean rate of 25%, compared with 23% among privately insured individuals, a 2-percentage point difference. Self-pay patients had a cesarean rate of 20%, while those covered by other government insurance had the lowest rate at 19%.

Standardized residual analysis revealed that Medicaid-insured individuals experienced significantly more cesarean deliveries than expected (standardized residual = +2.46), while self-pay patients experienced significantly fewer

than expected (standardized residual = −2.20). These findings indicate that insurance type is associated with cesarean delivery among NTSV births in unadjusted comparisons. The extent to which this association persists after adjustment for clinical risk factors is examined in multivariable regression analyses (Section 3.8.3).

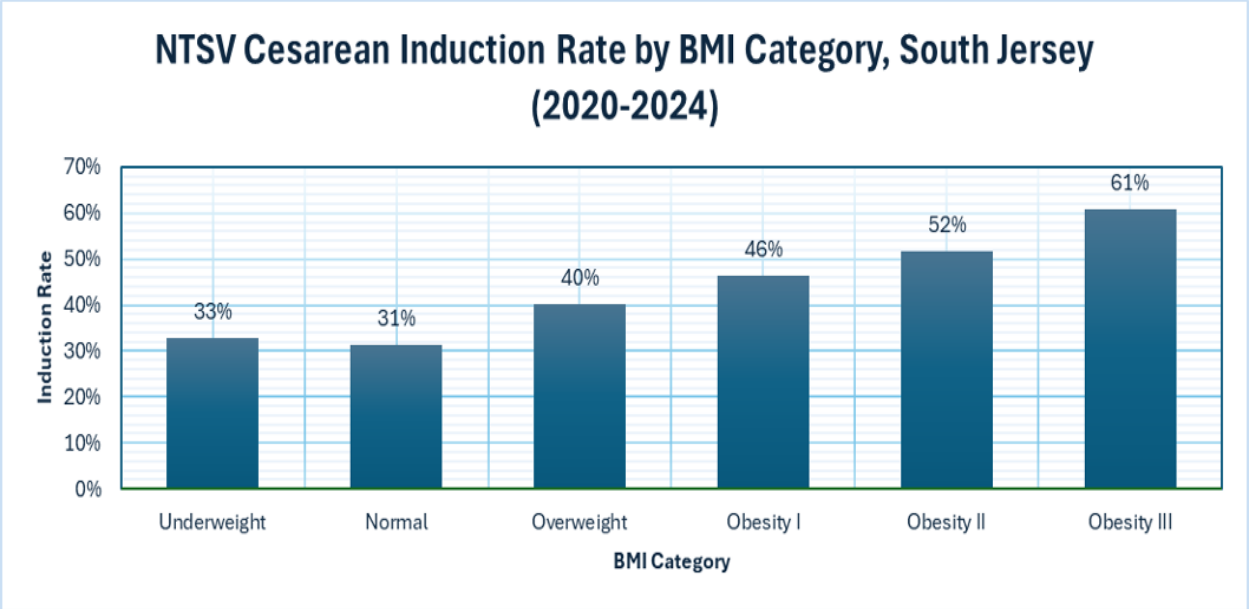
3.5 Stratified Analyses

3.5.1 BMI and Induction Status

Labor induction rates also differed significantly by BMI category (χ^2 test, $p < 0.001$). Induction rates increased steadily as BMI increased, demonstrating a clear gradient across BMI groups.

Normal and underweight individuals had the lowest induction rates, ranging from approximately 31% to 33%. Induction rates were higher among overweight individuals and increased further among those with obesity. The highest induction rate was observed among individuals with Obesity Class III, with nearly 61% of births involving labor induction.

Figure 6. Variation in NTSV cesarean delivery rates among induced births across maternal BMI categories in South Jersey, 2020-2024



Standardized residuals confirmed that individuals with higher BMI categories were significantly more likely to undergo labor induction than expected, while normal and underweight individuals were significantly less likely to be induced. These findings suggest that increasing BMI is associated not only with higher Cesarean delivery rates but also with greater use of labor induction, which may partially contribute to observed differences in Cesarean risk.

3.5.2 BMI and Insurance

BMI distribution differed significantly by insurance type (χ^2 test, $p < 0.001$). Medicaid-insured individuals had a significantly higher concentration of overweight and obese BMI categories than expected, while privately insured individuals had significantly fewer high-BMI cases than expected.

Figure 7. Maternal BMI category distribution among NTSV cesarean deliveries stratified by Insurance type in South Jersey, 2020-2024

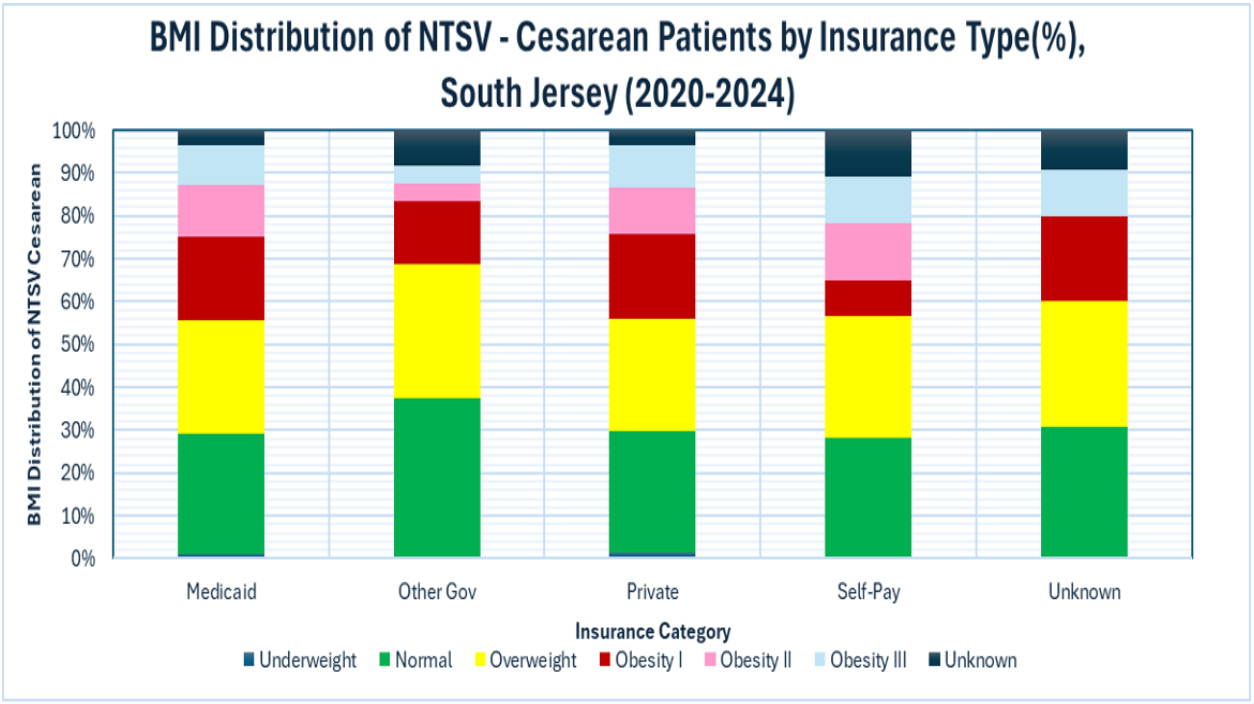


Table 7: BMI vs Insurance (Total NTSV - Cesarean patients)

Insurance	Underweight	Normal	Overweight	Obesity I	Obesity II	Obesity III	Unknown
Medicaid	47	1139	1072	791	481	385	138
Other Gov	0	18	15	7	2	2	4
Private	41	790	737	545	305	280	96
Self-Pay	0	21	21	6	10	8	8
Unknown	0	20	19	13	0	7	6

Standardized residuals indicated that elevated BMI categories were overrepresented among Medicaid-insured births, whereas normal BMI was more common among privately insured births. These findings highlight

socioeconomic patterning of maternal BMI within the NTSV cohort and suggest that insurance types may act as an important contextual factor in observed cesarean delivery disparities.

3.6 Geographic Variation:

Geographic variation was observed across South Jersey counties and facilities. County-level distributions demonstrated differences in delivery route composition and induction patterns, highlighting heterogeneity in obstetric practice across the region.

Overall, these descriptive findings characterize the NTSV population in South Jersey and provide the foundation for subsequent bivariate and multivariable analyses examining factors associated with cesarean delivery.

3.6.1 County-level Analysis

County-Level Variation in NTSV Cesarean Delivery by Induction Status

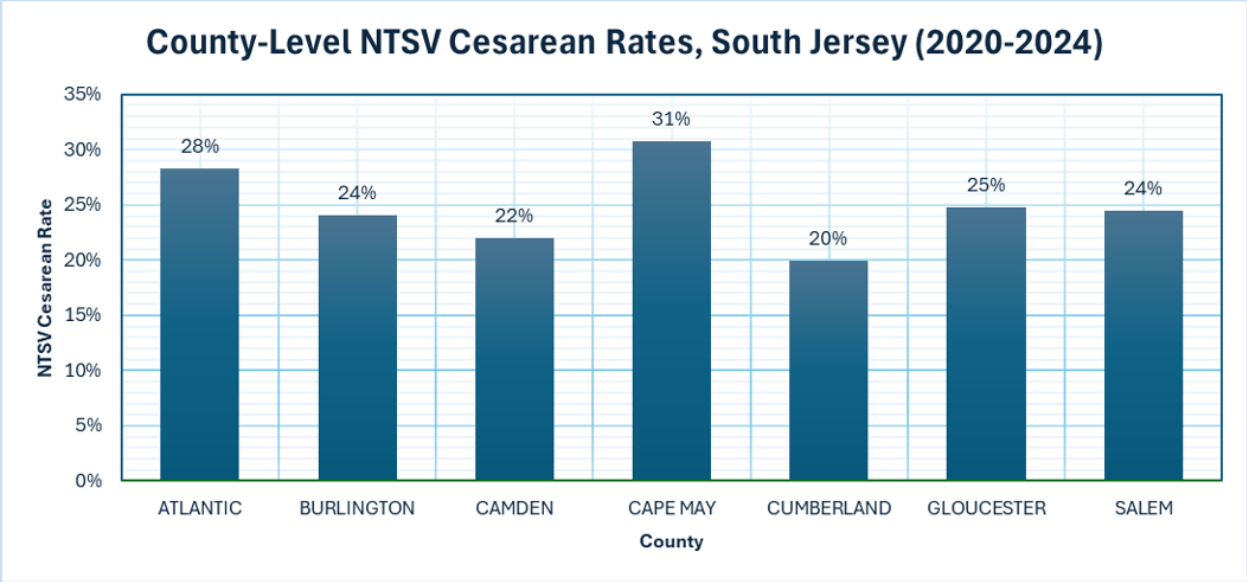
Significant geographic variation in NTSV cesarean delivery rates was observed across South Jersey counties, particularly when stratified by induction status.

Across all counties combined, 24% of NTSV deliveries resulted in cesarean birth, with 40% of all NTSV deliveries involving labor induction. Among induced NTSV patients, the cesarean rate was 28%, compared with 22% among non-induced patients, indicating a consistently higher likelihood of cesarean delivery among induced NTSV births across counties.

Table 8. County-level NTSV cesarean delivery and Induction patterns in South Jersey, 2020-2024

County	Number of NTSV cesarean deliveries (n)	NTSV Cesarean Rate (%)	Induction Rate among NTSV Births (%)	Cesarean rate among induced NTSV births (%)
ATLANTIC	1252	28%	36%	44%
BURLINGTON	1532	24%	41%	48%
CAMDEN	2016	22%	38%	44%
CAPE MAY	365	31%	34%	41%
CUMBERLAND	542	20%	42%	54%
GLOUCESTER	1107	25%	43%	45%
SALEM	220	24%	46%	55%
Grand Total	7034	24%	40%	46%

Figure 8. NTSV Cesarean delivery rates by county in South Jersey, 2020-2024



County-Level Patterns

Atlantic County demonstrated a relatively elevated overall NTSV cesarean rate (28%), with 36% of NTSV deliveries induced. Among induced patients, the cesarean rate was 34%, compared with 25% among non-induced patients, suggesting a meaningful induction-associated increase in cesarean risk.

Burlington County showed a lower overall NTSV cesarean rate (24%) but had one of the highest induction proportions (41%). Nearly 48% of cesarean deliveries in Burlington occurred following induction, reinforcing the role of induction practices in driving cesarean utilization despite a moderate overall rate.

Camden County had one of the lowest overall NTSV cesarean rates (22%), even though 38% of deliveries were induced. Cesarean rates among induced patients (25%) were only modestly higher than among non-induced patients (20%), suggesting more favorable outcomes associated with induction management in this county.

Cape May County exhibited a higher NTSV cesarean rate (31%) despite a lower induction proportion (34%). Among induced patients, cesarean rates reached 37%, indicating a particularly high cesarean risk when induction occurred.

Cumberland County showed the lowest overall cesarean rate (20%), even though 42% of NTSV deliveries were induced. The cesarean rate among induced patients (26%) remained lower than in several other counties, may indicate differences in practice patterns.

Gloucester County had a mid-range NTSV cesarean rate (25%) but one of the highest induction proportions (43%). Approximately 45% of cesarean deliveries occurred following induction, with induced patients experiencing higher cesarean rates than non-induced patients.

Salem County, while smaller in volume, demonstrated notable variability over time, with an overall NTSV cesarean rate of 24% and a high proportion of inductions (46%). In several years, more than half of cesarean deliveries followed induction, warrants further evaluation.

Summary of County Findings

Overall, county-level analysis revealed that:

- Induction of labor was consistently associated with higher NTSV cesarean rates across all counties.
- Counties varied substantially in both induction prevalence and cesarean risk following induction.
- Some counties (e.g., Camden, Cumberland) maintained lower cesarean rates despite high induction volumes, suggesting opportunities to identify and replicate best practices.
- Other counties (e.g., Cape May, Atlantic) demonstrated higher cesarean rates among induced patients, indicating potential areas for targeted clinical review and quality improvement initiatives.

These findings highlight meaningful geographic disparities in obstetric practice patterns within South Jersey and underscore the importance of county-specific strategies to reduce unnecessary primary cesarean deliveries.

3.6.2 Facility-Level Variation in NTSV Cesarean Delivery and Induction Practices

Facility-level analysis demonstrated substantial variation in NTSV cesarean delivery rates and induction-related patterns across South Jersey hospitals during the 2020 to 2024 study period. Overall NTSV cesarean rates ranged from approximately 16% to over 32%, with notable differences in both induction prevalence and cesarean outcomes among induced and non-induced patients.

Table 9: Facility Level C-Section Rates

Across facilities, the proportion of NTSV deliveries that were induced varied widely, ranging from approximately

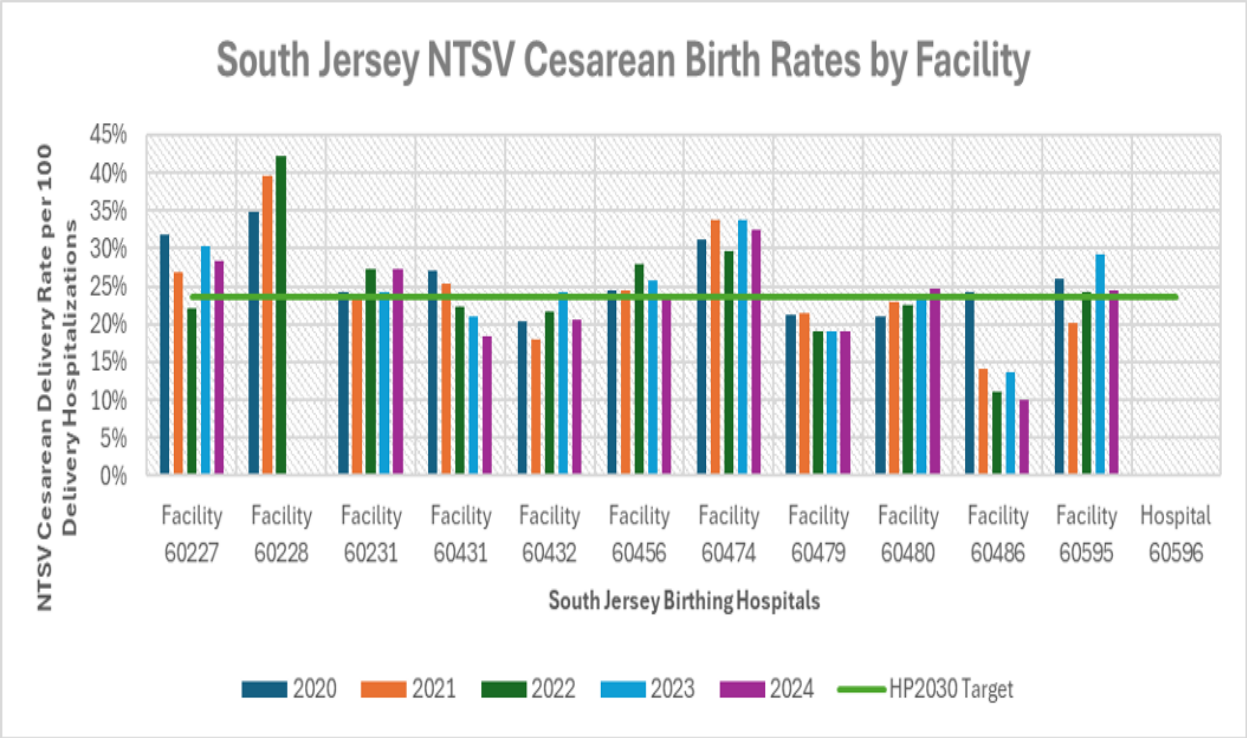
Year	Facility 60227	Facility 60228	Facility 60431	Facility 60432	Facility 60456	Facility 60474	Facility 60479	Facility 60480	Facility 60486	Facility 60595	Hospital 60596
2020	32%	35%	27%	20%	24%	31%	21%	21%	24%	26%	0%
2021	27%	39%	25%	18%	24%	34%	21%	23%	14%	20%	0%
2022	22%	42%	22%	22%	28%	30%	19%	22%	11%	24%	0%
2023	30%		21%	24%	26%	34%	19%	23%	14%	29%	0%
2024	28%		18%	21%	24%	33%	19%	25%	10%	24%	0%
HP2030 Target	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%	23.6%

19% to nearly 51% between 2020 to 2024. Facilities with higher induction prevalence generally exhibited higher cesarean delivery rates among induced patients, with induction-specific cesarean rates ranging from approximately 23% to over 62%. In contrast, cesarean rates among non-induced NTSV deliveries were consistently lower across facilities, typically ranging between 15% and 34%.

Temporal patterns within facilities were generally stable across the five-year period, with some facilities showing modest year-to-year fluctuations, particularly during the early COVID-19 period. However, relative differences between facilities persisted over time, suggesting sustained institutional practice variation rather than random annual fluctuation.

These findings highlight significant inter-facility variation in NTSV cesarean delivery and induction practices, underscoring opportunities for targeted quality improvement and benchmarking initiatives at the hospital level.

Figure 9. Facility level NTSV cesarean delivery rates in South jersey, 2020-2024



3.7 Temporal Trends in NTSV Cesarean Delivery (2020–2024)

Annual NTSV cesarean delivery rates in South Jersey remained stable throughout the study period, ranging from 23% to 25%. Trend analysis demonstrated no statistically significant change over time (slope = 0.0018; p = 0.99), indicating that NTSV cesarean rates did not meaningfully increase or decrease between 2020 and 2024.

3.8 Multivariable Logistic Regression Analysis

To identify independent predictors of NTSV cesarean delivery after adjustment for potential confounders, a multivariable logistic regression model was fitted with cesarean delivery as the binary outcome. The model included induction status, maternal BMI category, insurance type, race and ethnicity, and selected pregnancy-related comorbidities (gestational hypertension and gestational diabetes).

3.8.1 Labor Induction

After adjustment for maternal clinical and demographic factors, labor induction remained a statistically significant independent predictor of NTSV cesarean delivery. Induced labor was associated with higher odds of cesarean delivery compared with non-induced labor ($\beta = 0.21$, $p < 0.001$). This finding indicates that, even after accounting for BMI, race and ethnicity, insurance status, and comorbidity, induction of labor independently increased the likelihood of cesarean delivery within the low-risk NTSV population.

3.8.2 Maternal Body Mass Index

Maternal BMI demonstrated a strong and graded association with cesarean delivery. Compared with individuals with normal BMI (reference group), the odds of cesarean delivery increased progressively across higher BMI categories. Overweight individuals had significantly higher odds of cesarean delivery ($\beta = 0.34$, $p < 0.001$), with further increases observed among those with Obesity Class I ($\beta = 0.63$, $p < 0.001$), Obesity Class II ($\beta = 0.85$, $p < 0.001$), and Obesity Class III ($\beta = 1.10$, $p < 0.001$). This pattern reflects a clear dose–response relationship between increasing BMI and cesarean risk.

In contrast, underweight individuals had significantly lower odds of cesarean delivery compared with those of normal BMI ($\beta = -0.55$, $p < 0.001$). Records with unknown BMI were associated with modestly higher odds of cesarean delivery ($\beta = 0.22$, $p = 0.004$), suggesting potential residual confounding or documentation differences in this subgroup.

3.8.3 Insurance Type

After multivariable adjustment, insurance status showed a modest but statistically significant association with cesarean delivery. Medicaid-insured individuals had slightly higher odds of cesarean delivery compared with those with private insurance ($\beta = 0.07$, $p = 0.012$), corresponding to 7% higher adjusted odds.

No statistically significant differences were observed for self-pay, other government insurance, or unknown insurance categories relative to private insurance. These findings suggest that payer-related differences in cesarean risk persist after accounting for clinical risk factors, though the magnitude of the association is smaller than that observed for BMI or induction status.

The persistence of insurance-related differences after adjustment for maternal BMI, race/ethnicity, and pregnancy complications suggests that insurance type may serve as a marker for unmeasured socioeconomic factors or differences in healthcare access that influence cesarean delivery outcomes.

3.8.4 Race and Ethnicity

After multivariable adjustment, most racial and ethnic differences observed in unadjusted analyses were attenuated and no longer statistically significant. Non-Hispanic Black individuals did not have significantly different odds of cesarean delivery compared with non-Hispanic White individuals after adjustment. Hispanic individuals, however, retained significantly lower odds of cesarean delivery relative to non-Hispanic White individuals ($\beta = -0.13$, $p < 0.001$), indicating that the lower cesarean rates observed among Hispanic patients were not fully explained by measured clinical and socioeconomic factors.

Individuals classified as "Other Race" had higher odds of cesarean delivery ($\beta = 0.61$, $p = 0.003$), though this category represents a heterogeneous group and should be interpreted cautiously. No significant associations were observed for Asian non-Hispanic, AI/AN, NHPI, or unknown/refused race and ethnicity categories.

3.8.5 Pregnancy-Related Comorbidities

Both gestational hypertension and gestational diabetes were independently associated with higher odds of cesarean delivery. Gestational hypertension was associated with increased odds of cesarean delivery ($\beta = 0.16$, $p < 0.001$), as was gestational diabetes ($\beta = 0.26$, $p < 0.001$). These findings confirm that even within a low-risk NTSV cohort, the presence of pregnancy-related comorbidities significantly increases the likelihood of cesarean delivery.

3.8.6 Model Fit and Interpretation

The multivariable model demonstrated improvement over the null model, as reflected by a reduction in deviance. These results indicate that induction status, maternal BMI, and pregnancy-related comorbidities are the strongest independent predictors of NTSV cesarean delivery in South Jersey, while many unadjusted racial and insurance-based differences are partially explained by underlying clinical factors.

Overall, the regression findings suggest that variation in cesarean delivery within the NTSV population is driven primarily by modifiable clinical practices and maternal risk profiles rather than demographic characteristics alone, reinforcing the importance of targeted, evidence-based labor management strategies.

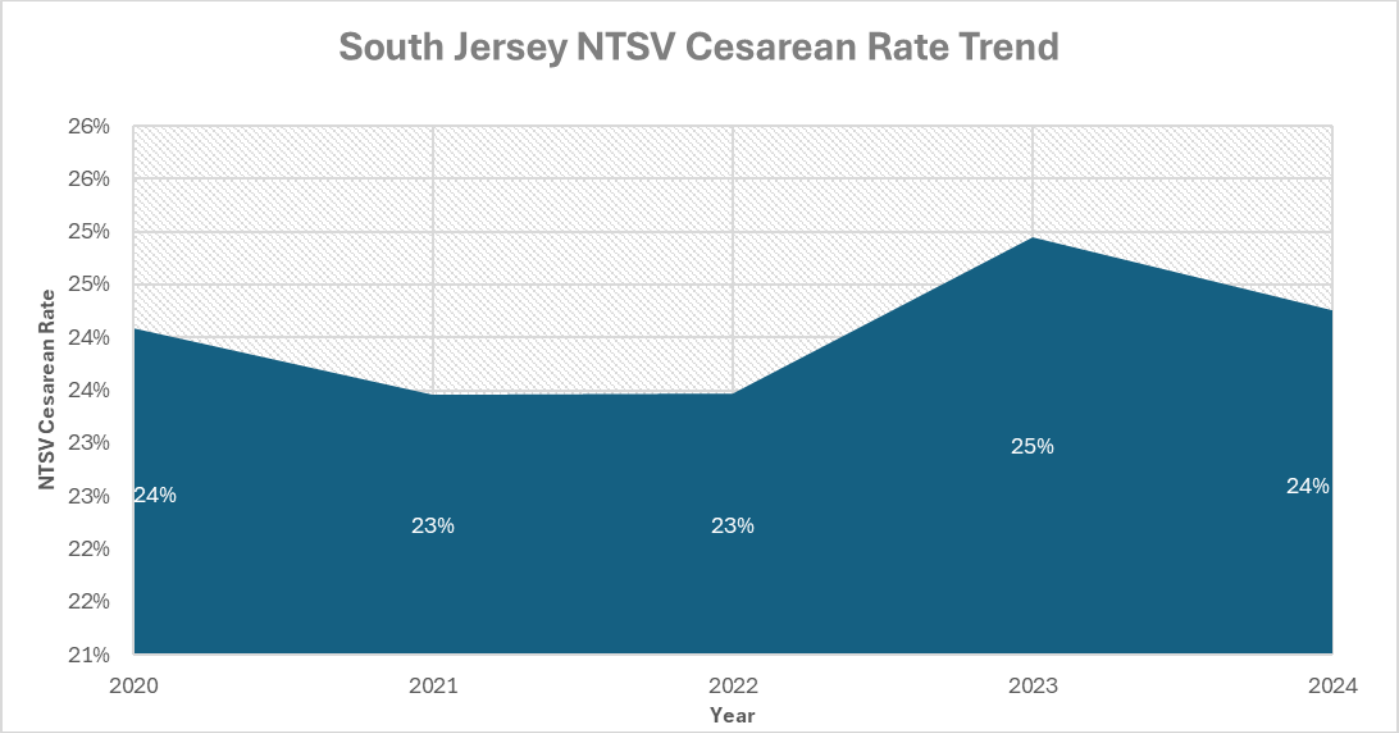
4. DISCUSSION

4.1 Interpretation of Key Findings

This study provides a comprehensive regional assessment of nulliparous, term, singleton, vertex (NTSV) cesarean delivery patterns in South Jersey from 2020 through 2024. Several key findings emerge.

First, the overall NTSV cesarean delivery rate in South Jersey ranged from 23% to 25% across the five-year period, with year-specific rates of 24% (2020), 23% (2021 to 2022), 25% (2023), and 24% (2024). These rates were consistently lower than national averages and generally comparable to or slightly lower than New Jersey statewide rates, although the Healthy People 2030 target of 23.6% was not consistently achieved. This suggests that, at an aggregate level, South Jersey performs relatively favorably compared with broader benchmarks, while still leaving room for improvement to meet national quality goals.

Figure 10. Five-year trend in NTSV cesarean delivery rates in South Jersey, 2020-2024



Second, labor induction emerged as a strong unadjusted predictor of cesarean delivery within the NTSV population. Cesarean delivery occurred in 29.3% of induced NTSV births compared with 22.5% of non-induced births, representing a clinically meaningful absolute difference of approximately seven percentage points. Induction was associated with a 43% increase in the odds of cesarean delivery (OR = 1.43) and a 31% higher relative risk (RR = 1.31). These findings indicate that, within a low-risk population, induction practices are closely linked to cesarean outcomes and represent an important area for clinical review.

Third, substantial variation in NTSV cesarean delivery was observed across maternal demographic and clinical characteristics. Cesarean rates differed significantly by race and ethnicity, with non-Hispanic Black individuals experiencing significantly more cesarean deliveries than expected and Hispanic individuals experiencing fewer than expected in unadjusted analyses. Body mass index (BMI) demonstrated a clear dose response relationship

with cesarean delivery, with rates increasing progressively across overweight and obesity categories and the highest risk observed among individuals with Obesity Class III. Importantly, higher BMI was also associated with greater use of labor induction, suggesting potential interaction between maternal risk factors and labor management decisions.

Fourth, insurance-based disparities emerged as a significant factor in NTSV cesarean delivery. Insurance type was significantly associated with cesarean delivery ($\chi^2 = 23.84$, $p < 0.001$). Medicaid-insured individuals experienced significantly more cesarean deliveries than expected (standardized residual = +2.46), while privately insured individuals experienced significantly fewer than expected (standardized residual = –1.48). In absolute terms, cesarean rates were 25% among Medicaid-insured births compared with 23% among privately insured births.

Stratified analyses revealed that Medicaid-insured births had significantly higher concentrations of elevated BMI categories (χ^2 test, $p < 0.001$), suggesting insurance type serves as a marker for underlying socioeconomic and clinical risk profiles. However, multivariable regression showed that Medicaid insurance retained a modest but significant association with cesarean delivery even after adjustment for BMI, race/ethnicity, and pregnancy complications ($\beta = 0.07$, $p = 0.012$), indicating that clinical factors alone do not fully explain payer-related disparities. These findings suggest that insurance status may reflect broader social determinants of health, including access to prenatal care, nutritional resources, and supportive services that influence maternal health status and labor outcomes.

Finally, meaningful geographic and institutional variation was identified. County-level analyses revealed differences in both induction prevalence and cesarean risk following induction. Some counties (e.g., Camden and Cumberland) maintained lower cesarean rates despite relatively high induction volumes, while others (e.g., Cape May and Atlantic) demonstrated markedly higher cesarean rates among induced patients. Facility-level analyses similarly showed wide variation in overall NTSV cesarean rates, induction prevalence, and the proportion of

cesarean deliveries following induction. The persistence of these differences across years suggests stable practice pattern variation rather than random fluctuation.

4.2 Clinical and Operational Significance

The findings of this study have important clinical and operational implications for maternity care delivery in South Jersey.

The strong association between labor induction and cesarean delivery within the NTSV population underscores the need for careful evaluation of induction practices. While induction is clinically appropriate in many circumstances, the observed differences suggest that variation in patient selection, timing, cervical readiness assessment, and labor management protocols may influence outcomes. Counties and facilities that achieved lower cesarean rates despite high induction prevalence may offer valuable insights into effective induction management strategies that could be shared across the region.

The progressive increase in cesarean risk with higher BMI highlights the importance of tailored obstetric care for individuals with overweight and obesity, even within a low-risk NTSV population. These findings support the need for evidence-based labor management approaches that account for maternal body habitus while avoiding unnecessary escalation to surgical delivery. The observed clustering of higher BMI categories among Medicaid-insured individuals underscores that cesarean disparities reflect both clinical and socioeconomic factors. Healthcare systems serving predominantly Medicaid populations may benefit from enhanced prenatal obesity management programs and labor support services to address these intersecting risks.

Racial and ethnic disparities in unadjusted cesarean delivery rates raise important concerns about equity in obstetric care. The finding that non-Hispanic Black individuals experienced more cesarean deliveries than expected, while Hispanic individuals experienced fewer, suggests that factors beyond clinical risk alone may

influence delivery decisions. These patterns warrant further evaluation in adjusted analyses and highlight the importance of monitoring NTSV cesarean rates as both a quality and equity indicator.

From an operational perspective, the substantial county and facility-level variation identified in this study suggests opportunities for benchmarking and peer learning. Facilities with consistently lower NTSV cesarean rates, particularly among induced patients, may serve as models for best practices in labor management, staffing, and protocol implementation. Conversely, facilities with higher rates may benefit from targeted review of induction criteria, labor support resources, and clinical decision-making pathways.

4.3 Comparison with Statewide and National Context

When placed in the context of statewide and national trends, South Jersey's NTSV cesarean delivery patterns reflect both progress and persistent challenges.

Nationally, NTSV cesarean rates increased from 25.9% in 2020 to a peak of 26.6% in 2023 before declining modestly to 25.3% in 2024. New Jersey statewide rates followed a similar pattern, remaining in the mid 20% range throughout the study period. In contrast, South Jersey consistently demonstrated slightly lower rates than both state and national averages, even during the COVID-19 pandemic period, when obstetric care delivery experienced widespread disruption.

Despite this relatively favorable performance, South Jersey did not consistently meet the Healthy People 2030 target of 23.6%. The persistence of rates above this benchmark particularly in certain counties and facilities suggests that regional averages may mask meaningful internal variation. This reinforces the importance of subregional and facility-level analyses rather than reliance on aggregate statistics alone.

Importantly, the patterns observed in South Jersey align with broader national findings regarding the role of induction, BMI, and sociodemographic factors in shaping cesarean delivery risk. However, the identification of counties and facilities that achieved lower cesarean rates under similar conditions indicates that improvement is

achievable within existing clinical and policy frameworks. South Jersey's performance relative to state and national benchmarks therefore highlights both the feasibility of meeting national targets and the need for targeted, data-driven quality improvement initiatives tailored to local practice environments.

5. Limitations

This study has several limitations that should be considered:

Data Quality: Hospital records and birth certificates were used for this analysis and may contain inaccuracies or incomplete information. Some mothers may have been misclassified as first-time mothers if their previous births weren't fully documented in source records. In addition, about 4% of records lacked race/ethnicity information, which may have affected subgroup analyses.

Limited Scope: We only studied low-risk first-time mothers with full-term, single, head-down babies (NTSV births). Our findings may not apply to higher-risk pregnancies where C-sections are more medically necessary, such as twins, premature births, or breech babies.

Missing Information: Our dataset didn't include important details like how ready the cervix was for labor (Bishop score), how long labor lasted, or whether the baby showed signs of distress. We also couldn't measure provider decision-making styles or whether mothers had continuous labor support. These factors are likely to influence C-section decisions but couldn't be studied.

Not Cause and Effect: This study shows connections between factors (like BMI and C-sections) but cannot prove one causes the other. Other unmeasured factors may explain some of the patterns we observed.

Hospital Comparisons: When comparing hospitals, we didn't account for differences in patient populations, staffing, or hospital policies. Therefore, these comparisons should be viewed as identifying areas for further investigation rather than definitive hospital rankings.

COVID-19 Period: Our data covers 2020-2024, which includes the pandemic. We did not separate out how COVID-19 specifically affected C-section rates.

Despite these limitations, this study analyzed a large, comprehensive dataset using nationally recognized standards. The findings provide valuable insights into C-section patterns, disparities, and potential areas for improvement in South Jersey maternal care.

6. Conclusion & Recommendations

Between 2020 and 2024, South Jersey's cesarean delivery rate for low-risk first-time mothers consistently exceeded the national Healthy People 2030 target of 23.6%. This analysis identified several modifiable factors driving these elevated rates: labor induction practices, maternal obesity, medical complications such as gestational diabetes, persistent racial and ethnic disparities, and significant variation across counties and hospitals.

These findings reveal clear opportunities for improvement. Labor induction rates increased dramatically with rising BMI from 33% in normal-weight mothers to 61% in those with severe obesity, suggesting that obesity itself may be used as an induction indication despite limited evidence supporting this practice. Nearly half (46%) of all cesarean deliveries occurred following induction, highlighting the need for more selective use of this intervention, particularly in first-time mothers.

Racial disparities persisted even after accounting for BMI and other clinical factors. Black and Hispanic mothers experienced disproportionately higher cesarean rates, pointing to potential differences in clinical decision-making, implicit bias, or access to supportive care practices.

To reduce unnecessary cesareans and improve maternal outcomes in South Jersey, we recommend:

- Adopting standardized protocols for labor induction that emphasize cervical readiness and medical necessity

- Implementing obesity management programs in prenatal care
- Providing implicit bias training and promoting equitable care practices across all facilities
- Establishing regional quality improvement collaboratives to share best practices among hospitals
- Enhancing continuous monitoring and facility-level feedback on NTSV cesarean rates

With coordinated, data-driven efforts, South Jersey can align cesarean delivery practices with evidence-based standards and achieve better, more equitable maternal health outcomes.

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