ABSTRACT

Background: Costs for obstetrical care may be increasing for both patients and insurers.
Objective: To examine predictors of and trends in the cost of medical care during pregnancy.
Study design: We performed a study of pregnancies from 2009 to 2019 covered by commercial insurance resulting in term, singleton delivery hospitalizations and included in the MarketScan database. The analysis categorized pregnancies based on whether delivery occurred via cesarean versus vaginal delivery and whether pre-gestational diabetes or chronic hypertension was present. We estimated inflation-adjusted total medical costs from 273 days before through 42 days after delivery hospitalization discharge. The analysis evaluated costs for inpatient services, outpatient services, and outpatient drugs separately and trended these costs over the study period. The analysis dichotomized total medical costs into insurer liability versus out-of-pocket patient costs. The study used quantile regression models fit separately to evaluate costs for vaginal and cesarean delivery including demographic and medical characteristics.
Results: The analysis included 1,952,432 pregnancies covered by commercial insurance. From 2009 to 2019, median total medical costs increased from $14,091 (IQR $11,122–$18,417) to $19,645 (IQR $14,676–$27,959) with median inpatient costs increasing 36% and median outpatient costs increasing 43%. Out-of-pocket costs rose 65% for inpatient services and 120% for outpatient services. Median total pregnancy costs were higher for women with chronic hypertension (median $22,268, IQR $16,809–$30,901, p < .01), pregestational diabetes (median $20,786, IQR $15,702–$28,714, p < .01), and cesarean delivery (median $20,098, IQR $15,748–$26,889 versus median $14,904, IQR $11,728–$19,785 for vaginal delivery, p < .01). In adjusted analyses, chronic hypertension, diabetes, and cesarean delivery were associated with increased median total costs.
Conclusion: Total and out-of-pocket medical costs for maternity care are increasing among commercially insured patients. Chronic hypertension, pregestational diabetes, and cesarean delivery are important predictors of costs.

Introduction

Pregnancy is a major contributor to overall healthcare costs in the United States. In 2017, four of the 20 most expensive conditions during hospital stays billed to Medicaid and three of the 20 most expensive conditions during hospital stays billed to private insurance were related to pregnancy and childbirth [1]. Older studies have shown that payments for maternal care are rising with one study of payer data finding overall costs for maternal care increased more than 50% from 2004 to 2010 with a nearly fourfold increase in out-of-pocket costs [2].

It is possible that with rising maternal comorbidity and overall health care costs increasing faster than inflation [3], care costs during pregnancy are also increasing [4–6]. Up-to-date characterization of healthcare costs during pregnancy may be important for health policy, clinical leadership, and clinicians as well as pregnant women and their families. Because charges may not be an accurate reflection of costs, this analysis sought to analyze actual expenditures. Additionally, we sought to (i) disaggregate inpatient costs from outpatient costs, (ii) determine to what degree patient out-of-pocket costs versus insurance liability...
accounted for costs, (iii) determine predictors associated with increased costs, and (iv) detail trends in costs.

Methods

Database and inclusion criteria

We used the IBM Watson Health MarketScan Research Databases for this retrospective cohort analysis evaluating costs. MarketScan includes approximately 350 payers and captures inpatient, outpatient, and prescription drug claims from more than 50 million privately insured patients and 6 million Medicaid enrollees from 12 states annually [7]. Data were de-identified and, as such, the university institutional review board deemed the analysis exempt.

We identified delivery hospitalizations of commercially insured women using the International Classification of Diseases, 9th and 10th Revision, Clinical Modification (ICD-9-CM and ICD-10-CM) codes with approaches that ascertain more than 95% of deliveries [8,9]. Women aged 15–54 who underwent hospitalized for a term, singleton delivery from January 2009 through October 2019 were included. Preterm births were not included because of the need to test a range of assumptions related to pregnancy duration and hospitalization costs. Duration of pregnancy was estimated as 39 weeks (273 days) before delivery hospitalization based on a validated approach [10]. We analyzed costs through 42 days after delivery hospitalization discharge as this is a commonly estimated duration of the postpartum period. To ensure full ascertainment of pregnancy-related costs, we limited our sample to women who were continuously insured from 273 days prior to and 42 days after the delivery hospitalization. Data from 2008 to 2009 deliveries and November and December data following September and October 2019 delivery hospitalizations were included. Patients under capitated plans for inpatient and outpatient services or outpatient drugs were also excluded (Figure 1). Other exclusion criteria included: (i) the extreme end of hospital length of stay (>99.99th percentile) to exclude outliers, and (ii) a second delivery hospitalization code ≤42 days after the initial delivery to exclude scenarios with an unclear delivery billing date.

Demographics and clinical characteristics

Demographic characteristics included a year of delivery, maternal age in years (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, and 50–54), geographic region (Northeast, North Central, South, West, and unknown), and metropolitan statistical area (metropolitan statistical area, non-metropolitan statistical area, unknown). Clinical characteristics included delivery type (vaginal or cesarean) and diagnoses of chronic hypertension and pregestational diabetes. We analyzed cesarean delivery as it may be an important determinant of costs. Similarly, we chose to analyze chronic hypertension and pregestational diabetes as they are common medical conditions that may be associated with increased costs. Pregestational diabetes and chronic hypertension are two chronic medical conditions most likely to result in adverse maternal and neonatal outcomes during pregnancy and they require more intensive medical care. Women with chronic hypertension and pre-gestational
diabetes were identified based on the presence of \( \geq 2 \) diagnostic codes for these conditions \( \geq 30 \) days apart during the study period for each pregnancy (273 days before to 42 days after each delivery hospitalization) (Supplemental Figure 1).

**Outcomes**

Total health care costs were calculated as the sum of all payments from all sources for inpatient services, outpatient services, and outpatient prescription drugs that were incurred from 273 days preceding the delivery hospitalization through 42 days after delivery hospitalization discharge. The sources of payments included patient out-of-pocket costs and insurance liability [11]. Out-of-pocket costs were calculated as the sum of the copayments, deductibles, and coinsurance paid by patients. The insurance liability was the total after deducting the out-of-pocket costs. An additional potential source of out-of-pocket costs comes from “surprise bills” defined as out-of-network charges from providers and care at in-network hospitals – these bills were not assessed in this analysis. Patients who did not receive any services or drugs were assigned a value of $0. In addition to analyzing total costs by year, outpatient services costs, inpatient services costs, and outpatient drug costs were separately analyzed by year. All the costs were adjusted for inflation to 2019 dollars using the Bureau of Labor Statistics Consumer Price Index [12].

**Statistical analysis**

Demographic and clinical characteristics are reported as proportions. Total costs are reported as medians with interquartile ranges (IQRs). The costs for inpatient services, outpatient services, and outpatient drugs are reported similarly and compared using Wilcoxon rank sums and the Kruskal-Wallis test. We fit quantile regression models to the median of total costs individually for vaginal and cesarean delivery that included as predictors year of delivery, maternal age, region, metropolitan statistical area, pregestational diabetes, chronic hypertension, and length of stay using an interior point algorithm with a resampling method (number of repeats = 200) for the confidence intervals (CIs). The changes in the median of the total medical costs and the 95% confidence interval by each covariate included in the models were also reported. All the analyses were performed using SAS (version 9.4; SAS Institute Inc, Cary, NC).

**Results**

After applying exclusion criteria to 3,893,802 eligible delivery hospitalizations, 1,952,432 pregnancies to 1,723,245 women with commercial insurance were included in the primary analysis (Figure 1, Table 1). Median total costs per pregnancy were $16,335 (IQR $12,594, $22,128) with median inpatient service costs $11,676 (IQR $9,104, $15,359), median outpatient service costs $3,613 (IQR $2,064, $6,340), and median drug costs $128 (IQR $26, $448) (Table 2).

Over the study period from 2009 to 2019, median total pregnancy costs increased from $14,091 (IQR $11,122–$18,417) to $19,645 (IQR $14,676–$27,959). Median inpatient service costs increased 36% from $10,097 to $13,710 (p-value <.01) with out-of-pocket costs rising 65% and insurance liability rising 30% (Figure 2A, Supplemental Table 2). Similarly, median outpatient service costs per pregnancy increased 43% from $3,089 (IQR $1,795, $5,272) in 2009 to $4,431 (IQR $2,484, $8,020) in 2019 (p < .01, Figure 2B). For outpatient services, out-of-pocket costs increased by 120% while insurance liability increased by 22%. In comparison median outpatient pharmacy costs decreased 43% from $157 (IQR $33, $439) in 2009 to $90 (IQR $16, $426) in 2019 (p < .01, Figure 2C).

Evaluating the mode of delivery, median total costs were higher for cesarean than vaginal delivery (median $20,098, IQR $15,748–$26,889 versus median $14,904, IQR $11,728–$19,785, p < .01, Table 1) with cesarean median inpatient service costs $4,179 higher and cesarean median outpatient service costs $631 higher (Table 2). Chronic hypertension was associated with higher median total costs (median $22,268, IQR $16,809–$30,901 versus median $16,137, IQR $12,485–$21,741, p < .01) including median inpatients service costs $2,157 higher and outpatient service costs $3,257 higher. Pregestational diabetes was associated with higher median total costs (median $20,786, IQR $15,702–$28,714 versus median $16,043, IQR $12,424–$21,581, p < .01) with $1,367 higher mean inpatient service costs and $2,573 higher outpatient service costs.

In the quantile regression model for vaginal delivery, chronic hypertension ($3,680, 95% CI $3,587–$3,773), pre-gestational diabetes ($2,725, 95% CI $2,671–$2,778), later study year, maternal 40–44 years, delivery in the Northeast, the longer length of stay, and metropolitan statistical area were all associated with increased estimates for total costs (Table 3). In the model for cesarean deliveries, these characteristics were also associated with increased estimates for total costs.
Discussion

Main findings

Over the study period, costs for both outpatient and inpatient care during pregnancy rose including an increase in both out-of-pocket costs and insurance liability. Increased costs were present for pregnancies resulting in cesarean compared to vaginal birth and for pregnancies with underlying diagnoses of chronic hypertension and diabetes.

Interpretation

These findings suggest that pregnancy likely represents a significant financial burden to many patients with commercial insurance with increasing overall out-of-pocket costs. A 2013 literature review of pregnancy-related costs observed underlying comorbidities such as diabetes and hypertension to be important contributors to costs which aligned with our findings [13]. A prior MarketScan analysis that compared cost estimates between 2004 and 2010 found similarly increasing costs with rising out-of-pocket costs [2]. A recent study examining pregnancy-related out-of-pocket costs for women enrolled in employer-based insurance found that mean total out-of-pocket spending for maternity care for all modes of delivery increased from $3,069 in 2008 to $4,569 in 2015, with an even larger increase in expenses reported for mothers who underwent cesarean birth. Cesarean birth is an expensive surgical procedure that in our analysis was associated with inpatient costs nearly 40% higher than vaginal delivery.

How to best address rising costs for maternal care is a complex question that involves public policy, clinical management, and resource utilization. Costs rose

Table 1. Demographics and clinical characteristics of patients with commercial insurance.

|                                | N  | %    | Median total expenditures (IQR) |
|--------------------------------|----|------|---------------------------------|
| All delivery hospitalizations  | 1,952,432 | –  | $16,335 ($12,594–22,128)        |
| Cesarean delivery              | No | 1,364,348 | 69.9 | $14,904 ($11,728–19,785)       |
|                                | Yes| 588,084 | 30.1 | $20,098 ($15,748–26,889)       |
| Chronic hypertension           | No | 1,869,950 | 95.8 | $16,137 ($12,485–21,741)       |
|                                | Yes| 82,482 | 4.2  | $22,268 ($16,809–30,901)       |
| Diabetes                        | No | 1,804,650 | 92.4 | $16,043 ($12,424–21,581)       |
|                                | Yes| 147,782 | 7.6  | $20,786 ($15,702–28,714)       |
| Year of delivery                | 2009 | 184,570 | 9.5  | $14,091 ($11,122–18,417)       |
|                                | 2010 | 191,297 | 9.8  | $14,540 ($11,428–19,107)       |
|                                | 2011 | 206,002 | 10.6 | $14,798 ($11,660–19,481)       |
|                                | 2012 | 224,038 | 11.5 | $15,211 ($12,745–21,534)       |
|                                | 2013 | 183,531 | 9.4  | $16,295 ($12,994–22,133)       |
|                                | 2014 | 164,757 | 8.4  | $17,247 ($13,361–23,222)       |
|                                | 2015 | 173,611 | 8.9  | $18,070 ($13,835–24,592)       |
|                                | 2016 | 153,138 | 7.8  | $18,411 ($14,054–26,133)       |
|                                | 2017 | 146,787 | 7.5  | $18,916 ($14,376–26,133)       |
|                                | 2018 | 131,836 | 6.8  | $19,645 ($14,676–27,959)       |
| Maternal age in years          | 15–19 | 50,490 | 2.6  | $15,074 ($11,543–20,317)       |
|                                | 20–24 | 227,595 | 11.7 | $15,510 ($11,978–20,877)       |
|                                | 25–29 | 546,156 | 28.0 | $15,266 ($11,990–20,241)       |
|                                | 30–34 | 710,884 | 36.4 | $16,326 ($12,666–21,949)       |
|                                | 35–39 | 343,655 | 17.6 | $18,394 ($14,016–25,078)       |
|                                | 40–44 | 67,911 | 3.5  | $20,714 ($15,343–28,840)       |
|                                | 45–49 | 4,848 | 0.3  | $22,239 ($13,963–33,137)       |
|                                | 50–54 | 893 | 0.1  | $10,624 ($4,099–28,735)        |
| Geographic region              | Northeast | 323,479 | 16.6 | $20,027 ($14,854–27,319)       |
|                                | North Central | 468,662 | 24.0 | $15,343 ($12,182–19,970)       |
|                                | South | 804,631 | 41.2 | $15,369 ($12,098–20,187)       |
|                                | West | 334,820 | 17.2 | $17,996 ($13,308–25,089)       |
|                                | Unknown | 20,840 | 1.1  | $14,951 ($12,028–19,281)       |
| Metropolitan statistical area  | Non-MSA | 246,486 | 12.6 | $14,535 ($11,336–19,430)       |
|                                | MSA | 1,639,754 | 84.0 | $16,613 ($12,795–22,480)       |
|                                | Unknown | 66,192 | 3.4  | $16,672 ($13,190–23,049)       |
| Length of stay in days         | 0 | 29,754 | 1.5  | $14,000 ($10,822–18,720)       |
|                                | 1 | 308,447 | 15.8 | $13,827 ($10,929–18,082)       |
|                                | 2 | 891,399 | 45.7 | $15,194 ($11,979–20,010)       |
|                                | >2 | 722,832 | 37.0 | $19,451 ($14,974–26,437)       |
| All patients                   | 1,723,245 | 100.0 | n/a                              |
| Number of deliveries by patient | 1 | 1,505,938 | 87.4 | n/a                             |
|                                | 2 | 199,102 | 11.6 | n/a                             |
|                                | 3 | 16,631 | 1.0  | n/a                             |
|                                | 4 | 1,417 | 0.1  | n/a                             |
|                                | 5–7 | 157 | 0.01 | n/a                             |

IQR, interquartile range.
| Table 2. Median expenditures by mode of delivery and presence of chronic hypertension and pregestational diabetes with commercial insurance. |
|-------------------------------------------------------------------------------------------------|
| **Total expenditures** | **Insurance liability** | **Out-of-pocket** |
| **N** | **Median** | **IQR** | **Median** | **IQR** | **Median** | **IQR** |
| Cost, overall | | | | | | |
| Inpatient, overall | 1,952,432 | $11,676 | $9,104 | $15,359 | $9,888 | $7,381 | $13,539 | $1,433 | $549 | $2,425 |
| Outpatient, overall | 1,952,432 | $3,613 | $2,064 | $6,340 | $2,607 | $1,285 | $4,955 | $764 | $299 | $1,525 |
| Outpatient pharmacy, overall | 1,952,432 | $128 | $26 | $448 | $55 | $1 | $269 | $48 | $11 | $144 |
| Cesarean versus vaginal delivery | | | | | | |
| Inpatient | | | | | | |
| Vaginal | 1,364,348 | $10,602 | $8,421 | $13,462 | $8,915 | $6,783 | $11,781 | $1,369 | $539 | $2,319 |
| Cesarean | 588,084 | $14,781 | $11,760 | $19,038 | $12,803 | $9,762 | $17,092 | $1,602 | $582 | $2,686 |
| Outpatient pharmacy | | | | | | |
| Vaginal | 1,364,348 | $3,438 | $1,975 | $5,981 | $2,470 | $1,218 | $4,666 | $732 | $283 | $1,463 |
| Cesarean | 588,084 | $4,069 | $2,310 | $7,190 | $2,962 | $1,469 | $5,668 | $846 | $342 | $1,670 |
| Chronic hypertension, present versus absent | | | | | | |
| Inpatient | | | | | | |
| No hypertension | 1,869,950 | $11,602 | $9,059 | $15,220 | $9,809 | $7,331 | $13,390 | $1,438 | $557 | $2,430 |
| Chronic hypertension | 82,482 | $13,759 | $10,518 | $18,732 | $12,096 | $9,762 | $16,985 | $1,602 | $582 | $2,686 |
| Outpatient pharmacy | | | | | | |
| No hypertension | 1,869,950 | $3,516 | $2,020 | $6,128 | $2,529 | $1,252 | $4,784 | $747 | $291 | $1,490 |
| Chronic hypertension | 82,482 | $6,773 | $4,125 | $11,104 | $5,183 | $2,849 | $9,027 | $1,280 | $594 | $2,306 |
| Pregestational diabetes, present versus absent | | | | | | |
| Inpatient | | | | | | |
| No diabetes | 1,804,650 | $11,584 | $9,047 | $15,201 | $9,787 | $7,314 | $13,362 | $1,446 | $560 | $2,438 |
| Diabetes | 147,782 | $12,951 | $9,986 | $17,331 | $11,312 | $8,382 | $15,682 | $1,287 | $387 | $2,268 |
| Outpatient pharmacy | | | | | | |
| No diabetes | 1,804,650 | $3,464 | $1,992 | $6,032 | $2,489 | $1,233 | $4,705 | $738 | $286 | $1,473 |
| Diabetes | 147,782 | $6,037 | $3,635 | $10,016 | $4,573 | $2,467 | $8,069 | $1,165 | $527 | $2,162 |

THE JOURNAL OF MATERNAL-FETAL & NEONATAL MEDICINE

THE JOURNAL OF MATERNAL-FETAL & NEONATAL MEDICINE
Figure 2. (A) Median commercial insurance inpatient costs by year of delivery. (A–C) demonstrate median inpatient, outpatient, and pharmacy costs, respectively, and stratified by total, insurance, and out-of-pocket costs. Estimates were adjusted for inflation to 2019 dollars.
for healthcare on the whole, with total personal health care rising at 4.4% annually, hospital care at 5.1%, prescription drugs at 3.4%, physician services at 3.6%, and clinical services at 6.3% from 2008 to 2009 per a report by the American Medical Association analyzing Centers for Medicare & Medicaid Services data [14]. To some degree rising out-of-pocket costs for maternal care with employer coverage may be due to increased enrollment in high-deductible healthcare plans [4]. It is also likely that some factors driving rising medical costs such as rates of comorbid conditions, demographic trends, and related complications will continue to increase in the near future [15,16]. Other research has shown significant maternal and neonatal healthcare costs are associated with hypertensive disorders, diabetes, and increasing maternal age [17,18]; these conditions may be increasing on a population basis. Some drivers of cost, such as cesarean delivery, may be modifiable. Cesarean birth has increased more than 50% since the late nineties and is a contributor to the rising cost of pregnancy observed within the United States [19]. Quality improvement efforts to reduce the likelihood of a first cesarean delivery among nulliparous women have demonstrated modest improvements in vaginal delivery rates [20] and may also reduce cost.

### Strengths and limitations

There are several strengths and limitations that are important to consider in interpreting the results of this study. A strength of this study is that as opposed to charges which may not be a true reflection of costs and are present in commonly used databases such as the National Inpatient Sample, insurance liability and out-of-pocket costs were analyzed. A second strength is that we were able to analyze a large sample of women with commercial insurance over a relatively long study period and disaggregate inpatient, outpatient, and pharmacy costs. A third strength is that

---

Table 3. Quantile regression for commercial insurance total expenditures for vaginal versus cesarean delivery.

| Chronic hypertension | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|----------------------|------------------------------------------|------------------------------------------|
| No                   | Referent                                  | Referent                                  |
| Yes                  | $3,680 ($3,587 to $3,773)*                 | $4,488 ($4,374 to $4,602)*                |

| Pre-gestational diabetes | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|--------------------------|------------------------------------------|------------------------------------------|
| No                       | Referent                                  | Referent                                  |
| Yes                      | $2,725 ($2,671 to $2,778)*                | $3,500 ($3,411 to $3,590)*                |

| Year of delivery | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|------------------|------------------------------------------|------------------------------------------|
| 2009             | Referent                                  | Referent                                  |
| 2010             | $266 ($221 to $311)*                      | $260 ($170 to $349)*                      |
| 2011             | $484 ($445 to $524)*                      | $630 ($543 to $716)*                      |
| 2012             | $845 ($802 to $887)*                      | $1,306 ($1,229 to $1,384)*                |
| 2013             | $1,786 ($1,745 to $1,826)*               | $2,457 ($2,371 to $2,543)*                |
| 2014             | $2,102 ($2,057 to $2,146)*               | $2,799 ($2,709 to $2,889)*                |
| 2015             | $2,614 ($2,567 to $2,662)*               | $3,448 ($3,356 to $3,540)*                |
| 2016             | $3,201 ($3,149 to $3,253)*               | $4,317 ($4,210 to $4,425)*                |
| 2017             | $3,554 ($3,506 to $3,603)*               | $4,977 ($4,870 to $5,083)*                |
| 2018             | $3,910 ($3,854 to $3,965)*               | $5,651 ($5,537 to $5,765)*                |
| 2019             | $4,440 ($4,370 to $4,510)*               | $6,590 ($6,468 to $6,713)*                |

| Maternal age in years | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|-----------------------|------------------------------------------|------------------------------------------|
| 15–19                 | Referent                                  | Referent                                  |
| 20–24                 | −$187 (−$258 to −$117)*                   | −$279 (−$475 to −$83)*                    |
| 25–29                 | −$395 (−$460 to −$333)*                   | −$668 (−$872 to −$446)*                   |
| 30–34                 | $48 (−$17 to $112)*                       | −$427 (−$627 to −$228)*                   |
| 35–39                 | $1,252 ($1,183 to $1,321)*               | $861 ($562 to $1,016)*                    |
| 40–44                 | $2,466 ($2,357 to $2,574)*               | $2,670 ($2,431 to $2,908)*                |
| 45–49                 | $512 ($562 to $562)                       | $5,488 ($4,944 to $6,031)*                |
| 50–54                 | −$8,768 (−$9,466 to −$8,069)*            | $9,466 ($6,725 to $12,208)*               |

| Geographic region     | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|-----------------------|------------------------------------------|------------------------------------------|
| Northeast             | Referent                                  | Referent                                  |
| North central         | $3,731 ($3,767 to $3,695)*               | −$4,856 (−$4,933 to −$4,779)*            |
| South                 | −$3,980 (−$4,014 to −$3,946)*            | −$5,594 (−$5,668 to −$5,520)*            |
| Unknown               | −$2,416 (−$2,526 to −$2,305)*            | −$4,051 (−$4,268 to −$3,834)*            |
| West                  | −$1,557 (−$1,602 to −$1,513)*            | −$842 (−$940 to −$744)*                   |

| Metropolitan statistical area (MSA) | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|-------------------------------------|------------------------------------------|------------------------------------------|
| Non-MSA                             | Referent                                  | Referent                                  |
| MSA                                 | $1,211 ($1,182 to $1,240)*               | $1,096 ($1,029 to $1,162)*               |
| Unknown                             | −$283 (−$357 to −$209)*                   | −$384 (−$560 to −$209)*                   |

| Length of stay in days | Vaginal delivery model, estimate (95% CI) | Cesarean delivery model, estimate (95% CI) |
|-----------------------|------------------------------------------|------------------------------------------|
| 0                     | Referent                                  | Referent                                  |
| 1                     | $501 ($418 to $585)*                      | −$1,612 (−$1,974 to −$1,249)*            |
| 2                     | $1,697 ($1,616 to $1,777)*               | −$1,561 (−$1,916 to −$1,207)*            |
| >2                    | $4,005 ($3,920 to $4,090)*               | $1,032 ($678 to $1,387)*                 |
while administrative data have known limitations, they are generated for billing purposes and analyzing costs is an appropriate use of this type of data. In terms of limitations, an important consideration is that the convenience sample of billing information was not specifically designed to be representative of the entire US population or to analyze trends. However, this database is frequently used in trends analyses [21–24] and our findings align with other analyses of payer data demonstrating similar trends in costs [2,4]. Third, this study cannot fully account for additional costs associated with ‘surprise medical bills.’ Fourth, compared to other recent studies, we did not evaluate ‘catastrophic’ medical bills [25]. Finally, as this study was intended as a broad overview of trends, it did not disaggregate costs for the wide range of conditions, procedures, and interventions contributing to increased costs. It is possible that other chronic and obstetric conditions may be important drivers of costs. Additionally, the costs of newborn hospitalizations were not evaluated; these costs have also been demonstrated to represent a significant financial burden [5]. Fourth, we did not disaggregate and trend costs for individual procedures and services over the study period. It is possible that costs could be rising because care is becoming more intensive, prices are increasing, or both. Future research is indicated to determine the primary drivers of increasing costs which may be important for informing policy.

Conclusion

In summary, inpatient and outpatient costs during pregnancy rose over the study period. Increasing insurance liability and out-of-pocket costs were noted with costs higher in the setting of diabetes, chronic hypertension, and cesarean delivery. For many patients, pregnancy costs may represent a significant financial burden with implications for accessing and utilizing care.

Disclosure statement

Dr. D’Alton had a senior leadership role in ACOG II’s Safe Motherhood Initiative which received unrestricted funding from Merck for Mothers. Dr. Wright has served as a consultant for Clovis Oncology and received research funding from Merck. The other authors did not report any potential conflicts of interest.

Funding

The author(s) reported there is no funding associated with the work featured in this article.

References

[1] Liang L, Moore B. (IBM Watson Health), Soni A (AHRQ). National Inpatient Hospital Costs: The Most Expensive Conditions by Payer, 2017. HCUP Statistical Brief #261. Month (AHRQ); 2020. Agency for Healthcare Research and Quality, Rockville, MD. [cited 2021 Sept 18]. Available from: www.hcup-us.ahrq.gov/reports/statbriefs/sb261-Most-Expensive-Hospital-Conditions-2017.pdf.

[2] Truven Health Analytics. The cost of having a baby in the United States. Greenwood Village (CO). [cited 2021 Sept 16]. Available from: https://www.catalyze.org/wp-content/uploads/2017/04/2013-The-Cost-of-Having-a-Baby-in-the-United-States.pdf.

[3] Kamal R, McDermott D, Ramirez G, et al. How has U.S. spending on healthcare changed over time? The Peterson Center on Healthcare and Kaiser Family Foundation. [cited 2021 Sept 16]. Available from: https://www.healthsystemtracker.org/chart-collection/u-s-spending-healthcare-changed-time/#item-start.

[4] Moniz MH, Fendrick AM, Kolenic GE, et al. Out-of-Pocket spending for maternity care among women with employer-based insurance, 2008–15. Health Aff. 2020;39(1):18–23.

[5] Chua KP, Fendrick AM, Conti RM, et al. Out-of-Pocket spending for deliveries and newborn hospitalizations among the privately insured. Pediatrics. 2021;148(1): e2021050552.

[6] Johnson W, Milewski A, Martin K. Health Care Cost Institute. Understanding Variation in Spending on Childbirth Among the Commercially Insured. HCCI Brief May;2020. [cited 2022 March 15]. Available from: https://healthcostinstitute.org/images/pdfs/HCCI_2020_Childbirth.pdf.

[7] The Truven Health MarketScan databases for life sciences researchers. [cited 2020 Feb 15]. Available from: https://truvenhealth.com/Portals/0/Assets/2017-MarketScan-Databases-Life-Sciences-Researchers-WP.pdf.

[8] Kuklina E, Whiteman M, Hillis S, et al. An enhanced method for identifying obstetric deliveries: implications for estimating maternal morbidity. Matern Child Health J. 2008;12(4):469–477.

[9] Clapp MA, James KE, Friedman AM. Identification of delivery encounters using international classification of diseases, tenth revision, diagnosis and procedure codes. Obstet Gynecol. 2020;136(4):765–767.

[10] Margulis AV, Setoguchi S, Mittleman MA, et al. Algorithms to estimate the beginning of pregnancy in administrative databases. Pharmacoepidemiol Drug Saf. 2013;22(1):16–24.

[11] Berrow AS, Chen L, Chatterjee S, et al. Cost of care for the initial management of ovarian cancer. Obstet Gynecol. 2017;130(6):1269–1275.

[12] Bureau of labor statistics consumer price index; 2019. [cited 2021 July 30]. Available from: https://www.bls.gov/cpi/data.htm.

[13] Huynh L, McCoy M, Law A, et al. Systematic literature review of the costs of pregnancy in the US. Pharmacoeconomics. 2013;31(11):1005–1030.

[14] Rama A. The American Medical Association. Policy Research Perspectives. National Health Expenditures,
2018. Spending Growth Remains Steady Even with Increases in Private Health Insurance and Medicare Spending. May 2020. [cited 2022 March 15]. Available from: https://www.ama-assn.org/system/files/2020-08/prp-annual-spending-2018.pdf.

[15] Ananth CV, Keyes KM, Wapner RJ. Pre-eclampsia rates in the United States, 1980-2010: age-period-cohort analysis. BMJ. 2013;347:f6564.

[16] Booker WA, Ananth CV, Wright JD, et al. Trends in comorbidity, acuity, and maternal risk associated with preeclampsia across obstetric volume settings. J Matern Fetal Neonatal Med. 2019;32(16):2680–2687.

[17] Mischkot BF, Hersh AR, Greiner KS, et al. Maternal and infant hospitalization costs associated with maternal pre-pregnancy body mass index in California, 2007-2011. J Matern Fetal Neonatal Med. 2020;12:1–10.

[18] Kolu P, Raitanen J, Rissanen P, et al. Health care costs associated with gestational diabetes mellitus among high-risk women—results from a randomised trial. BMC Pregnancy Childbirth. 2012;12(1):71.

[19] Martin JA, Hamilton BE, Osterman MJK, et al. Births: final data for 2016. Natl Vital Stat Rep. 2018;67(8):1–50.

[20] Rosenstein MG, Chang SC, Sakowski C, et al. Hospital quality improvement interventions, statewide policy initiatives, and rates of cesarean delivery for nulliparous, term, singleton, vertex births in California. JAMA. 2021;325(16):1631–1639.

[21] Varshneya K, MedressZA, Jensen M, et al. Trends in anterior lumbar interbody fusion in the United States: a MarketScan study from 2007 to 2014. Clin Spine Surg. 2020;33(5):E226–E230.

[22] Bonazza NA, Smuin DM, Joshi R, et al. Surgical trends in articular cartilage injuries of the knee, analysis of the Truven Health MarketScan commercial claims database from 2005-2014. Arthrosc Sports Med Rehabil. 2019;1(2):e101–e7.

[23] Wren AA, Bensen R, Sceats L, et al. Starting young: trends in opioid therapy among US adolescents and young adults with inflammatory bowel disease in the Truven MarketScan database between 2007 and 2015. Inflamm Bowel Dis. 2018;24(10):2093–2103.

[24] Hu J, Ugiliweneza B, Meyer K, et al. Trend and geographic analysis for traumatic brain injury mortality and cost based on MarketScan database. J Neurotrauma. 2013;30(20):1755–1761.

[25] Peterson JA, Albright BB, Moss HA, et al. Catastrophic health expenditures with pregnancy and delivery in the United States. Obstet Gynecol. 2022;139(4):509–520.