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RESEARCH

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Unpacking childbirth expenditures: what are the factors driving extreme costs in Serbia?

Radomir Markovic[1*†], Radomir Anicic[1†], Sladjana Benkovic[2] and Bojana Matejic[3]

Abstract

Background Maternity healthcare costs vary widely due to demographic, pregnancy-related, and clinical factors. Understanding the drivers of extreme costs is crucial for optimizing resource allocation and ensuring equitable access to quality maternal healthcare. This study aimed to identify factors associated with extreme hospital childbirth costs in a tertiary-level hospital in Belgrade, Serbia.

Methods A cross-sectional study was conducted on 6,949 women who gave birth in 2019. Maternal age, parity, pregnancy characteristics, delivery method, anesthesia type, perinatal interventions, and comorbidities were analyzed. Costs were categorized as expected or extreme, and multivariate logistic regression identified significant predictors of extreme costs.

Results In our study, 4.1% of mothers required extreme-cost hospitalization and treatment, and these extreme costs were significantly more prevalent among older women, first-time mothers, preterm births, and pregnancies ending in cesarean section. Mothers with extreme costs had a median hospital stay of 23 days compared to 5 days for those with expected costs ($p < 0.001$). The median total cost of maternity healthcare was 604.3 USD. Women undergoing cesarean delivery had four times higher odds of incurring extreme costs compared to those with spontaneous vaginal delivery.

Conclusions Identifying cost-driving factors in maternity healthcare can improve financial planning and resource distribution in tertiary healthcare settings. Strategies to reduce unnecessary interventions, improve prenatal risk assessment, and optimize hospital stays should be explored to balance cost efficiency with high-quality maternal healthcare.

Keywords Maternal health services, Pregnancy, Hospital costs, Obstetric surgical procedures

†Radomir Markovic and Radomir Anicic contributed equally to this work.

*Correspondence:
Radomir Markovic
dr.rade.markovic@gmail.com
[1]Clinic for Gynecology and Obstetrics "Narodni Front", Belgrade, Serbia
[2]Faculty of Organizational Sciences, University of Belgrade, Belgrade, Serbia
[3]Institute of Social Medicine, Faculty of Medicine, University of Belgrade, Belgrade, Serbia

Background

Access to sexual and reproductive health services is an integral component of women's healthcare. The continuous advancement of obstetric and postnatal healthcare has been among the crucial factors in improving maternal and infant health outcomes [1]. A key strategy in eliminating avoidable maternal and neonatal deaths is to ensure that childbirth occurs in medical facilities staffed by trained health professionals and equipped to manage obstetric emergencies [2]. Ensuring that all women receive adequate healthcare, including prevention and timely management of complications during and after pregnancy and childbirth, is recognized in the United Nations Sustainable Development Goals (SDGs). In that regard, the first target of SDG 3 (Good Health and Wellbeing) aims to reduce the global maternal mortality ratio to below 70 per 100,000 live births by 2030 [3].

However, the organization of maternity healthcare, which includes standard preventive, diagnostic, and therapeutic services related to pregnancy and childbirth, faces many challenges globally and requires a well-resourced healthcare system. Many regions worldwide lack competent healthcare providers, accessible health services, and resources like essential medicines and obstetric equipment, or they face other health system failures due to ongoing crises [4]. Additionally, inpatient childbirth can result in catastrophic health expenditures that may discourage women from seeking professional help, even in high-income countries [5].

Serbia has successfully met the United Nations maternal mortality ratio (MMR) target, and this value has remained nearly unchanged since 1990 [6]. The positive MMR figures can be attributed to a high proportion of childbirths in healthcare facilities. According to The United Nations Children's Fund and data from the 2019 Mixed Indicators Cluster Survey, only a small number of childbirths occurred outside healthcare facilities and were recorded among the vulnerable Roma population [7]. In 2023, the MMR stood at 9.8 per 100,000 live births, which remains higher than many European Union member states [6].

Some of the most prevalent causes of maternal mortality globally are associated with severe bleeding, infection, and pre-eclampsia. Successful treatment of these conditions often necessitates the collaboration of a multidisciplinary team of health professionals, extended hospital stays for the mother and child, blood products and medications, and other direct and indirect hospitalization costs. These complications lead to poorer health outcomes and significantly burden the healthcare system due to increased expenses and resource utilization [4, 8].

Ensuring that all women have access to adequate healthcare during and after pregnancy and childbirth requires effective management within the healthcare system, including planning expected childbirth costs [9]. Serbia has implemented diagnosis-related groups (DRGs) to standardize payment for hospital services, including obstetric care and childbirth, and optimize limited resource allocation. Women with similar clinical characteristics and patterns of health service/resource consumption are classified into the same DRG associated with an expected cost of hospitalization [10].

Literature indicates that childbirth costs vary significantly based on the delivery method and the services provided. Standard vaginal delivery (SVD) is typically regarded as the most economical childbirth method, requiring the least resources and resulting in minimal direct and indirect costs. In contrast, cesarean sections (CS) are linked to higher costs than other delivery methods [11–13].

In Serbia, the healthcare system is centralized, and childbirth is generally facilitated at higher levels of care. Providing healthcare services to pregnant women, including antenatal care, delivery, and postnatal care for mothers and children, is mandatory and publicly funded through the National Health Insurance Fund [14]. The National Health Insurance Fund contracts health institutions to provide care for nearly the entire population of Serbia, and all women are insured by the State during their pregnancies. The system is primarily based on compulsory health insurance, funded through payroll contributions that are proportional to individual income. The Clinic for Gynecology and Obstetrics „Narodni Front" is a major tertiary-level university hospital located in Belgrade, responsible for delivering standard childbirth services for women residing in the capital and managing complicated pregnancies for all referred women throughout Serbia.

Understanding which factors contribute the most to extreme childbirth costs is necessary for healthcare system planning and resource allocation. Identifying these drivers of extreme childbirth costs could enable better management of hospital expenditures and improved maternal healthcare, particularly in settings with limited workforce and resource capacity [15].

Our study aimed to identify the primary factors influencing extreme maternal healthcare costs in a tertiary-level university hospital, utilizing data that examined obstetric and clinical characteristics alongside total treatment costs and types of services provided.

Methods

Study design and patient population

In this study, we applied a single-centre, cross-sectional study design. We analysed the comprehensive database with information from the health records of all women admitted for childbirth at the Clinic for Gynecology and Obstetrics "Narodni Front" in Belgrade, Serbia, in 2019.

Women were excluded from the study if they experienced a stillbirth, gave birth in December 2018 but were discharged in January 2019, or were not insured by the National Health Insurance Fund of Serbia. A total of 6,949 women met the criteria to be included in the study. The Ethics Committee of the Clinic for Gynecology and Obstetrics "Narodni Front" (decision: 05006-2021-20698, December 6, 2021) reviewed and approved the study protocol, ensuring that all ethical and regulatory requirements met the standards.

Data collection and measurements

This study collected demographic data (women's age) and clinical variables, including obstetric characteristics before, during, and after childbirth. Additionally, data were gathered on the length of hospital stay. The study also included information on patients' classification into diagnosis-related groups (DRGs) and hospitalization costs. All data was gathered from the hospital's health information system, which keeps electronic health records of all admitted patients. Additionally, all data on the cost of provided health services were collected from the hospital's financial database. Serbia implements the Australian Refined Diagnosis Related Groups Version 6.0 classification system.

Obstetric characteristics were categorized into the following variables:

- Pregnancy and childbirth characteristics: parity (total number of childbirths), number of neonates at birth, gestational age at birth, and type of conception (natural vs. in vitro fertilization);
- Clinical complexity of pregnancy: Presence of complications before, during, and after childbirth, including severe maternal morbidity (SMM) emergence;
- Provided health services: Method of delivery, type, and duration of obstetric interventions (including assisted delivery), number of surgical procedures performed during hospitalization (including hysterectomy, cervical cerclage, exploratory laparotomy, anesthesia, sedation, oxygen therapy), blood transfusion or the use of other blood products, delivery outcome, length of hospitalization, and requirement for intensive care or ventilation support;

Total treatment cost calculations were based on pricing data obtained from the official price list of the National Health Insurance Fund and verified through insurance invoices for each patient included in the study. These prices encompassed the costs of medical services, including staff salaries, patient meals, and variable overheads, as well as the costs of medicines, blood products, and sanitary materials.

To distinguish between direct and indirect costs, we subtracted the expenses for medicines, blood products, sanitary materials, and the labor costs of medical teams working in the maternity ward (for vaginal deliveries) and the operating room (for C-sections and other postnatal surgeries) from the total treatment costs.

We applied the Time-Driven Activity-Based Costing (TDABC) method to estimate the cost of medical team labor during the main hospitalization activities (vaginal delivery, C-section, and postnatal surgeries). This method involves multiplying the time spent by the number of team members involved (specialists, nurses, or midwives) and their respective hourly labor rates [16]. Hourly labor rates were calculated by dividing the total annual wage costs for each type of medical team member by the average number of working hours per year.

All given costs are presented based on the average annual exchange rate of the national currency to USD (the United States dollar, USD) in 2019.

Statistical analysis

Statistical analysis included descriptive statistics such as measures of central tendency and variability (standard deviation, 95% confidence interval [CI]). The normality of the distribution of continuous variables was tested using the Shapiro-Wilk test. Student's t-test, Mann-Whitney U-test, Chi-square test, and Fisher's exact test were applied to assess the significance of differences. All variables significant in univariate regression analysis were used in multivariate logistic regression analysis to identify factors associated with extreme costs, the main outcome variable, and analyze the relationship between outcomes related to extreme costs and potential associated factors. We defined extreme cost as a total healthcare cost higher than the 75th percentile plus 1.5 times the interquartile range – IQR. All statistical hypotheses were tested at a significance level of $p = 0.05$ using the Statistical Package for Social Sciences (SPSS), version 22.0 (IBM SPSS Statistics, Armonk, NY).

Results

Pregnancy and delivery characteristics

A total of 6,949 women who gave birth were included in the study. Of these, 4,638 (66.7%) had a spontaneous vaginal delivery (SVD). The average maternal age was 31.9 ± 5.4 years. Half of the women were primiparous, while the remaining had experienced at least one prior birth. The vast majority conceived naturally (94.5%) and had singleton pregnancies (94.2%). The mean gestational age at birth was 38.4 ± 2.2 weeks, ranging from 22 to 42 weeks. Based on gestational age, 11.4% of births were classified as preterm, while 88.6% were term deliveries. Among the total study population, 185 (2.7%) women experienced SMM, with severe preeclampsia being the

Table 1 Pregnancy details and delivery characteristics

***N* (%)**	
Age (M ± sd)	31.9 ± 5.4
Age group (years)	
< 20	65 (0.9)
20–34	4,653 (67.0)
> 35	2,231 (32.1)
Conception type	
Natural	6,567 (94.5)
Assisted Reproductive Technology	382 (5.5)
Pregnancy history	
Primipara	3,474 (50.0)
Higher ordered-pregnancy	3,475 (50.0)
Type of pregnancy	
Singleton	6,543 (94.2)
Multiples	406 (5.8)
Pregnancy term	
Preterm	785 (11.4)
Term	6,131 (88.6)
Delivery	
SVD	4,638 (66.7)
CS	2,311 (33.3)
Severe maternal morbidity	
No	6,754 (97.3)
Yes	185 (2.7)
Severe bleeding	56/185 (30.3)
Severe preeclampsia	63/185 (34.0)
Eclampsia	1/185 (0.5)
Sepsis	41/185 (22.2)
Uterine rupture	24/185 (13.0)
Other comorbidities	
Yes	2,162 (31.1)
No	4,787 (68.9)

most frequent complication (63/185, 34.0%). Detailed pregnancy and delivery characteristics are presented in Table 1.

Hospitalization details and performed interventions

The median length of hospitalization in the semi-intensive and standard care units was five days for women who had an SVD (range: 0–87 days). Mothers who underwent CS had a significantly more extended hospital stay, with a median of six days [U=3,122,268.5, p < 0.001] (Table 3). Most women included in the study required no additional perinatal interventions (42.8%) or had one intervention (40.0%). A total of 1,137 (16.4%) received oxygen therapy, while 330 (4.8%) required a blood transfusion. Most women did not undergo surgical procedures during hospitalization (66.7%), while 32.9% had one procedure. Among those who underwent surgery (N = 2,317), 72.6% required an urgent intervention. Epidural anesthesia was administered to 4,304 (61.9%) mothers, whereas 1,057 (15.2%) received general anesthesia.

Table 2 Type and number of healthcare services provided, DRG case classification, and healthcare costs grouping

***N* (%)**	
Supportive procedures	
Oxygen therapy	1,137 (16.4)
Blood transfusion	330 (4.8)
Interventions (number)	
0	2,970 (42.8)
1	2,778 (40.0)
2	1,013 (14.6)
3	153 (2.2)
4	33 (0.5)
5	2 (0.0)
Surgery procedures	
0	4,632 (66.7)
1	2,288 (32.9)
2	27 (0.4)
3	2 (0.0)
Urgent surgeries	
Yes	1,683 (72.6)
No	634 (27.4)
Anesthesia	
General anesthesia	1,057 (15.2)
Epidural anesthesia	4,304 (61.9)
Sedation	269 (3.9)
Puerperal DRGs*	
O01A	572 (8.2)
O01B	1,737 (25.0)
O02A	527 (7.6)
O02B	418 (6.0)
O60Z	3,695 (53.2)
Costs of treatment	
Expected	6,662 (95.9)
Extreme	287 (4.1)

*O01A – CS terminated delivery with major/severe complications; O01B - CS terminated delivery with no major/severe complications; O02A – Vaginal delivery with surgical procedures and major/severe complications; O02B – Vaginal delivery with surgical procedures and no major/severe complications; O60Z – SVD

DRGs and maternal inpatient healthcare costs

Based on DRG classification, most mothers in the study were categorized under O60Z (53.2%) or O01B (25.0%). A summary of these data is presented in Table 2. The median total cost of maternal inpatient healthcare in the maternity ward was 604.3 USD (range: 108.3–8040.6), with direct costs amounting to 98.6 USD (range: 14.6–3434.6) and indirect costs 497.1 USD (range: 92.3–5980.5). The highest costs were incurred by patients classified under DRG O01A, with a median of 1157.7 USD (range: 435.7–8040.6).

Among mothers who incurred extreme costs, 49.1% were classified as O01A, whereas 55.2% of those with expected costs belonged to O60Z. A statistically significant difference was observed in DRG distribution based on maternal healthcare costs (χ^2 = 779.519, p < 0.001).

The median length of hospitalization for mothers incurring extreme costs was 23 days (range: 4–137), compared to 5 days (range: 1–72) for those with expected costs, demonstrating a statistically significant difference (U = 89,855.5; $p < 0.001$).

Among the total study population, 287 (4.1%) mothers required extreme-cost hospitalization and treatment, with significantly higher representation among older mothers (t = 2.743, $p = 0.006$), first-time mothers (χ^2 = 8.043, $p = 0.005$), preterm births (gestational age < 37 weeks, χ^2 = 665.892, $p < 0.001$), naturally conceived pregnancies (χ^2 = 77.220, $p < 0.001$), singleton pregnancies (χ^2 = 239.679, $p < 0.001$), and pregnancies ending in cesarean section (χ^2 = 427.349, $p < 0.001$). Additionally, 29.6% of mothers with extreme costs had an SMM diagnosis, compared to only 1.4% among those with expected costs (χ^2 = 889.561, $p < 0.001$).

Regarding anesthesia type, mothers incurring extreme costs were significantly more likely to receive general anesthesia (59.9% vs. 13.3%, $p < 0.001$) and significantly less likely to receive epidural anesthesia (49.1% vs. 62.5%, $p < 0.001$). Pregnancy and clinical characteristics of cases with extreme and expected costs are detailed in Table 3.

Extreme inpatient healthcare cost predictors

The multivariate logistic regression model included predictors of extreme maternal healthcare costs statistically significant at $p = 0.05$ in the univariate logistic regression

Table 3 Pregnancy and clinical characteristics of cases incurring extreme and expected costs of healthcare

Variable	Extreme costs (*n* = 287)	Expected costs (*n* = 6662)	*p*-value
Age (years)	32.8 ± 6.4	31.8 + 5.3	t = 2,743, $p = 0.006$
Age groups, n (%)			
< 20	4 (1.4)	61 (0.9)	
20–34	162 (56.4)	4,491 (67.4)	U = 859772.0, $p < 0.001$
>35	121 (42.2)	2,110 (31.7)	
Parity, n (%)			
Primiparous	167 (58.2)	3,307 (49.6)	$\chi^2 = 8.043$, $p = 0.005$
Multiparous	120 (41.8)	3,355 (50.4)	
Pregnancy type, n (%)			
Singleton	210 (73.2)	6,333 (95.1)	$\chi^2 = 239.679$, $p < 0.001$
Multiple	77 (26.8)	329 (4.9)	
Gestational age (weeks), n (%)			
< 37	168 (58.7)	617 (9.3)	$\chi^2 = 665.892$, $p < 0.001$
37+	118 (41.3)	6,013 (90.7)	
Conception method, n (%)			
Natural	238 (82.9)	6,329 (95.0)	$\chi^2 = 77.220$, $p < 0.001$
Assisted Reproduction Technology	49 (17.1)	333 (5.0)	
Delivery method, n (%)			
SVD	30 (10.5)	4,608 (69.2)	$\chi^2 = 427.349$, $p < 0.001$
CS	257 (89.5)	2,054 (30.8)	
Lenght of hospital stay [(days): median (range)]	23 (4-137)	5 (1–72)	U = 89855,5; $p < 0.001$
Standard and semi-intensive care unit	21 (0-134)	5 (0–71)	U = 259482.5; $p < 0.001$
Intensive care unit	1 (0–39)	0 (0–10)	U = 325945.0; $p < 0.001$
SMMs, (%)	91 (31.7)	94 (1.4)	χ2 = 889.561, p < 0,001
Severe bleeding	34 (11.8)	22 (0.3)	$p < 0.001$
Severe preeclampsia	34 (11.8)	29 (0.4)	$p < 0.001$
Eclampsia	0 (0.0)	1 (0.0)	$p < 1.000$
Sepsis	18 (6.3)	23 (0.3)	$p < 0.001$
Uterine rupture	5 (1.7)	19 (0.3)	$p = 0.003$
Puerperal DRGs*			
O01A	141 (49.1)	431 (6.5)	χ2 = 779.519, $p < 0.001$
O01B	116 (40.4)	1,621 (24.3)	
O02A	6 (2.1)	521 (7.8)	
O02B	4 (1.4)	414 (6.2)	
O60Z	20 (7.0)	3,675 (55.2)	

*O01A– CS terminated delivery with major/severe complications; O01B - CS terminated delivery with no major/severe complications; O02A– Vaginal delivery with surgical procedures and major/severe complications; O02B– Vaginal delivery with surgical procedures and no major/severe complications; O60Z– SVD

Table 4 Extreme maternal healthcare cost predictors

Variable	Univariate			Multivariate		
	B	*p*	OR (95% CI)	B	*p*	OR (95% CI)
Age of mother (years)	0.037	0.001	1.04 (1.02–1.06)	−0.009	0.552	0.99 (0.96–1.02)
Parity	0.345	0.005	1.41 (1.11–1.79)	0.343	0.066	1.41 (0.98–2.03)
Gestation age	2.630	< 0.001	13.88 (10.81–17.81)	0.546	**0.007**	1.73 (1.16–2.56)
Conception type	1.364	< 0.001	3.91 (2.82–5.42)	−0.155	0.594	0.86 (0.48–1.52)
Delivery method	2.956	< 0.001	19.22 (13.12–28.15)	2.636	**< 0.001**	13.96 (8.20-23.75)
Type of pregnancy	1.954	< 0.001	7.06 (5.32–9.37)	0.019	0.941	1.02 (0.62–1.68)
Severe maternal morbidity	3.414	< 0.001	30.39 (21.91–42.14)	2.454	**< 0.001**	11.63 (7.03–19.24)
Other comorbidities	3.628	< 0.001	37.65 (23.29–60.85)	1.433	**< 0.001**	4.19 (2.32–7.56)
Epidural anesthesia	− 0.545	< 0.001	0.58 (0.46–0.74)	−0.244	0.180	0.78 (0.55–1.12)
Number of days of hospitalization in standard and semi-intensive care	0.243	< 0.001	1.28 (1.25–1.30)	0.184	**< 0.001**	1.20 (1.17–1.23)

p values < 0.05

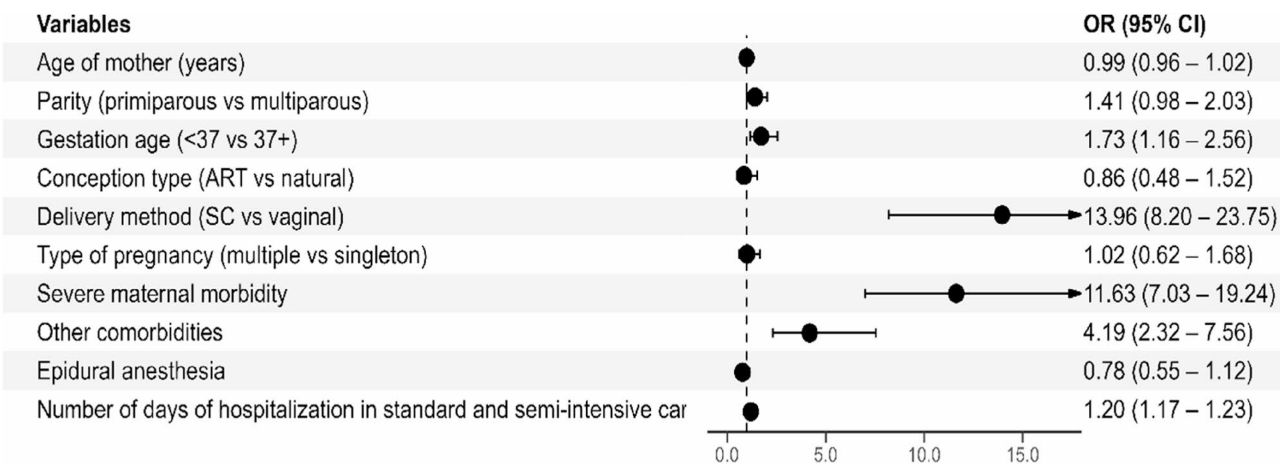

Fig. 1 Multivariate logistic regression model with the existence of extreme maternal healthcare costs as an outcome variable

analysis. The final model incorporated 16 predictors. No significant multicollinearity was detected between predictors.

Key statistically significant predictors of extreme hospital treatment costs, as identified by the multivariate logistic regression analysis, included gestation age, delivery method, presence of SMM, presence of other comorbidities, and length of hospitalization in standard and semi-intensive care (Table 4; Fig. 1).

Discussion

This study revealed that 4.1% of pregnant women in our sample incurred extreme costs of childbirth, and the highest costs were observed among those who faced CS-terminated delivery with severe complications. The total average cost of maternal healthcare during childbirth, in our sample, was 604.3 USD. Two-thirds of women underwent SVD, while those who had a CS were approximately four times more likely to incur extreme costs compared to those who had SVD.

We identified gestational age, delivery method, presence of SMM, presence of other comorbidities, and length of hospitalization in standard and semi-intensive care units as statistically significant predictors of extreme costs. In our sample, SVD was the most common delivery method overall, and it was also the most frequent among patients facing expected delivery costs.

To our knowledge, this is the first study that focuses on the cost analysis of childbirth care in a tertiary-level hospital in Serbia. The gathered sample of pregnant women is, therefore, large, and the data obtained are of high quality. We acknowledge that this type of study comes with limitations, primarily regarding its generalizability due to its monocentric nature. However, given that the Serbian healthcare system is highly centralized, and this health institution is among the largest maternity centers in our country, our findings could provide valuable insights as a case study for future multicentric research. Moreover, several critical factors remain unaddressed, particularly those concerning social and economic determinants of health, healthcare quality, patient satisfaction, and long-term outcomes. This information must be taken into account to formulate well-rounded conclusions that can guide health policy.

Considering that the study was conducted in a single tertiary-level teaching hospital, the high rate of CSs can be attributed to the fact that this health institution also serves as a reference for the termination of high-risk pregnancies, a pattern observed in other similar institutions, as evidenced by data from London in 1994 [17]. Here, we would like to note that, since similar studies are not yet routinely conducted in Serbia, neighboring countries, or nations with similar healthcare financing systems, we have relied on evidence from various countries for comparison. Nonetheless, these comparisons should be approached with caution because of the varying funding and organization of healthcare systems.

Our analysis found that older participants were more frequently present in the group where significant treatment costs were recorded. However, age was not identified as a statistically significant predictor of extreme costs using the multivariate regression analysis method. A study in the Czech Republic indicates that age can predict extended hospitalizations in mothers younger than 20, 20–24, 35–39, and older than 40, compared to the reference age group of 30–34 [18].

In 1991, Clark et al. analyzed maternity costs based on the delivery mode among 36,727 women [19]. They quantified the cost differences between SVD (GBP 360 [10–90 inter-percentile range, IPR_{10-90} = 189–773]) and CS (GBP 1,123 [IPR_{10-90} = 837-1,560]), supporting the notion that CS, associated with a higher number of medical interventions, could be considered as a driver of extreme maternal healthcare costs.

Serbia implements the Australian Refined DRG Version 6.0 model to monitor healthcare service utilization, enabling more efficient planning, reporting, and cost evaluation. In our study population, most patients belonged to the DRG O60Z group, corresponding to SVD, which incurred the lowest costs. Conversely, the highest costs were recorded in the O01A group, which includes CS with severe clinical complications and exhibited the most significant cost variability (59.7%), reflecting individualized patients' needs and more expensive, advanced care services. Similar cost variability patterns have been observed in other countries, including those where private health insurance plays a substantial role in healthcare financing. However, some studies suggest that CS does not necessarily have to be more expensive than SVD [20, 21].

From a public health perspective, available evidence does not indicate that a higher CS rate contributes to lower maternal and neonatal mortality [22, 23]. On the contrary, evidence implies that a higher frequency of CS may be associated with a higher frequency of adverse events, both for the mother and the newborn, as confirmed by a study conducted in eight Latin American countries [23].

In our study population of Serbian mothers, primiparous women were more frequently classified within the group that incurred extreme perinatal care costs. A study conducted in Australia on 171,157 women found that, regardless of whether childbirth occurred in a public or private facility, primiparous women underwent medical interventions more frequently, including labor induction, assisted vaginal delivery (forceps or vacuum extraction), epidural anesthesia, and episiotomy [24].

Among cases investigated in our study, most women who delivered at term incurred expected healthcare costs. Gestational age was found to be statistically significant as a predictor in the multivariate logistic regression model and is associated with higher maternal healthcare costs. A Californian study analyzing 1,265,212 maternal discharge reports found that preterm births significantly increased maternal healthcare costs, rising from USD 8,204 for term births to USD 22,702 for births occurring before 32 weeks of gestation. Additionally, the study confirmed that similar cost patterns apply to newborns based on birth weight [25].

In our sample, women with multifetal pregnancies were more frequently classified as incurring extreme inpatient maternal healthcare costs, with one in four mothers of multiples falling into the extreme cost group. An observational study conducted in Southeast England between 2001 and 2002 among women with risk factors for fetal congenital heart disease, Down syndrome, and low-risk pregnancies found that most multiple births were delivered by CS, contributing to higher costs. Additionally, the study concluded that pre-existing conditions, such as pregestational diabetes, further increased healthcare expenditures regardless of the number of fetuses [26].

Pre-existing comorbidities, including chronic conditions, doubled the likelihood of increased maternal healthcare costs in our study. A population-based retrospective cohort study in California analyzing nearly 1.5 million hospitalizations found that the presence of at least one comorbidity significantly increased the risk of SMM during pregnancy (adjusted risk ratio, aRR = 3.1) and non-transfusion SMM (aRR = 4.9), necessitating more intensive maternal healthcare, prolonged hospital stays, and higher costs [27]. Debbink et al. demonstrated a 2.5-fold increase in adjusted maternity costs when SMM required blood transfusion and a 3.3-fold increase when transfusion was not needed [28]. A study in South Korea also obtained such a finding, where the occurrence of increased healthcare costs related to childbirth was identified in the population of women with SMM [29].

The findings of our study also highlight that SMM can multiply the likelihood of incurring extreme maternal healthcare costs. This is consistent with a 2019 U.S. study examining both low-income Medicaid and commercially insured women, which found that SMM increased prenatal, childbirth, and postnatal healthcare costs to varying degrees, depending on maternal age, mode of delivery, number of fetuses, and complications such as hypertension, preeclampsia, postpartum hemorrhage, or obstetric infections [30].

Conclusions

This study reveals that gestational age, delivery method, presence of SMM, presence of other comorbidities, and length of hospitalization in standard and semi-intensive care units are drivers of extreme childbirth costs in a tertiary-level hospital sample. These factors may increase healthcare utilization beyond expected levels. Identifying drivers of extreme childbirth costs can help optimize resource allocation and improve hospital financial planning. Future research should investigate cost-effective strategies and ensure a balance between sustainability and the delivery of high-quality maternal care.

Abbreviations

SDGs	Sustainable Development Goals
MMR	Maternal mortality ratio
DRGs	Diagnosis–related groups
SVD	Standard vaginal delivery
CS	Cesarean section
SMM	Severe maternal morbidity
USD	The United States dollar
CI	Confidence interval
IQR	Interquartile range
ART	Assisted Reproduction Technology
ICU	Intensive care unit
GBP	Great British Pound (the pound sterling)
IPR	Interpercentile range
aRR	Adjusted risk ratio

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Authors' contributions

RM, RA, SB and BM designed the study. RM and RA drafted the manuscript. SB and BM supervised and edited the manuscript drafts. RM, RA and SB performed data analysis and visualization. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted following the Declaration of Helsinki and was reviewed and approved by the Ethics Committee of the Clinic for Gynecology and Obstetrics "Narodni Front" (decision: 05006-2021-20698, December 6, 2021). Patient consent was waived due to the study's retrospective nature, which used anonymized data. No identifiable patient information was used, and the study was conducted with respect to institutional guidelines for data protection and ethical research practices.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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