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Fetal Indications and Neonatal Outcomes of Emergency versus Elective Caesarean Section and Associated Factors in Mosul City: A Cross-Sectional Study

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ABSTRACT

Background: Cesarean section (CS) is a surgical delivery with procedure in which the fetus is delivered through an incision in the increasing rates steadily over recent decades in many countries.

Objective: To describe fetal indications for CS according to its type (emergency vs. elective), and to assess the association between neonatal outcomes and maternal socio-demographic, health care service and obstetric characteristics among women who underwent CS in Mosul city.

Methods: A hospital based analytical cross section was carried out in four hospitals in Mosul city (Al-Batoul Teaching Maternity, Mosul General, Al-Khansaa Teaching Maternity and Al-Salam Teaching Hospital) from 1 January to 1 July 2026. A total of 2,159 women who underwent CS (1,519 emergency, 640 elective) were selected by simple random sampling. Data were collected by interview and from medical records. Bivariate associations were examined with the chi-square and Fisher–Freeman–Halton exact tests ($P \leq 0.05$).

Results: The most frequent fetal indications were malpresentation (17.4%), postdate pregnancy (15.0%) and preterm gestation (11.7%); emergency CS was more frequent among preterm, post-term, postdate and oligohydramnios cases (all $P < 0.001$). A 1-minute Apgar score < 7 was recorded in 64.4% of cases, NICU admission in 20.0%, neonatal resuscitation in 14.1%, early neonatal death in 2.5% and stillbirth in 1.9%. Age group was significantly associated with Apgar score 1 min < 7 ($P = 0.006$), NICU admission ($P < 0.001$) and stillbirth ($P < 0.001$). Two third (67.3%) of women with primary education had Apgar score at 1 min < 7, illiterate women had early neonatal death (5.1%).Rural residence was associated with higher NICU admission, resuscitation, stillbirth and early neonatal death .Percentage of Apgar score at 1 min < 7, (75.2%) and Stillbirth (2.7%) in Al-Batoul Teaching Hospital. NICU admission (37.5%), need for neonatal resuscitation (24.7%) and early neonatal death (4.3%) in Mosul General Hospital. Neonatal resuscitation (17.4% vs. 6.3%) and early neonatal death (3.1% vs. 1.3%) were higher after emergency CS, whereas Apgar score < 7 (72.5% vs. 61.0%) and NICU admission (24.8% vs. 18.0%) were higher after elective CS.

Conclusions: Fetal indications for CS in Mosul were malpresentation, postdate and preterm gestation, and adverse neonatal outcomes were common. Rural residence, extremes of maternal age, emergency referral, type of CS and hospital were associated with some adverse outcomes.

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Introduction

Cesarean section (CS) is a surgical procedure in which the fetus is delivered through an incision in the abdominal wall and uterus; it is classified as elective CS (scheduled in advance) or emergency CS (performed in response to acute complications that threaten the safety of the mother and/or fetus) [1]. Cesarean section rates have increased steadily over recent decades in many countries, exceeding the World Health Organization (WHO)-recommended range of 10–15% [2]. In Mosul hospitals, the CS rate reported in 2020 was 28.8% [3]. This trend has encouraged researchers to investigate the underlying causes and broader health implications of CS [1]. The indications for CS may be maternal, fetal or placental. Maternal indications include a previous uterine scar, cephalopelvic disproportion, failure to progress, antepartum hemorrhage, medical conditions, maternal request and abnormalities of the birth canal [4,5]. Demographic and social factors, such as maternal age, inadequate antenatal care and late referral to a health care institution, may also increase the likelihood of emergency CS [6]. Fetal indications include malpresentation, preterm or post-term delivery, postdate pregnancy, oligohydramnios or polyhydramnios, suspected macrosomia and congenital anomalies that may interfere with normal labor [7]. Although emergency CS is life-saving for the mother and fetus when indicated, unjustified or delayed use is associated with adverse neonatal outcomes. These include lower Apgar scores, higher rates of admission to the neonatal intensive care unit (NICU) with or without resuscitation after birth, and higher rates of stillbirth and early neonatal death compared with elective CS [1,8]. These risks may be partly attributable to the emergency setting, which is often accompanied by pre-existing fetal distress, delays in the decision to operate, and inadequate preparation of the mother and the medical team [8]. In Mosul, a 2025 study comparing 120 elective CS deliveries versus 85 vaginal deliveries found that CS was linked to a higher risk of respiratory distress and longer NICU stay [9]. However, Mosul's health care infrastructure has faced significant disruption in recent years and its maternity services are still being rebuilt, while most available Iraqi data originate from other governorates such as Basra and Diyala [10,11]. This leaves a gap in understanding how local obstetric practices, patient risk profiles and health-system constraints in Mosul relate to neonatal outcomes after CS. The aims of the present study were to describe the fetal indications for CS according to its type, and to assess the association between neonatal outcomes and maternal socio-demographic, health care service and obstetric characteristics among women who underwent CS in Mosul city.

Methods

A hospital-based analytical cross-sectional study was carried out in Mosul city, Nineveh Governorate, Iraq, in four governmental hospitals providing obstetric and cesarean delivery services: two maternity departments within general hospitals and two obstetrics and gynecology maternity hospitals. The hospitals were Al-Batoul Teaching Hospital (634), Mosul General Hospital (587), Al-Khansaa Teaching Hospital (600) and Al-Salam Teaching Hospital (338). The study was conducted over six months, from 1st January to 1st July 2026 among women who underwent CS (emergency or elective). Private hospitals were excluded. According to the monthly statistical report of the Nineveh Health Directorate (vital statistics, planning department), about 40 CS were performed daily in the governmental maternity hospitals of Mosul (about 1,200 per month), i.e. an estimated 7,200 CS in six months. Women were selected by simple random sampling from the daily delivery registers of each hospital (the sampling frame), and the number of women sampled in each hospital was proportional to the hospital's CS volume.

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A total of 2,309 women were initially selected; 150 were excluded because of incomplete forms or refusal to participate, leaving 2,159 women (1,519 emergency [70.4%] and 640 elective [29.6%]) in the final analysis (about 29.6% of the estimated CS deliveries in the period. The unit of analysis was the woman and percentages are expressed per woman and not per neonate. The operational definitions used were as follow. Elective CS: planned, scheduled surgery performed before the onset of labor. Emergency CS: unscheduled surgery performed in response to an urgent maternal and/or fetal complication, before or during labor. Preterm: gestational age < 37 completed weeks. Postdate: pregnancy continuing beyond the expected date of delivery (≥ 40 weeks) up to 41 weeks and 6 days. Post-term: gestational age ≥ 42 completed weeks. A woman could have more than one fetal indication. Apgar score < 7 at 1 minute: score recorded by the attending health professional at one minute after birth. NICU admission: admission to the neonatal intensive care unit after birth. Neonatal resuscitation: need for assisted ventilation and/or chest compressions after birth. Stillbirth: fetal death before delivery at ≥ 28 weeks of gestation. Early neonatal death: death of a live-born infant within the first 7 days of life.

General information was collected by direct interview with participants with the assistance of members of the research sub-committee in the health institutions of the Nineveh Health Directorate. Information on fetal indications for CS and on neonatal outcomes was collected from medical records and delivery registers using a structured data-collection form developed from the relevant literature. The form included three sections: section 1, fetal indications (9 items); section 2, neonatal outcomes (5 items); and section 3, socio-demographic and general characteristics (10 items).

Face and content validity were assessed by an expert panel (n = 16): obstetricians and gynecologists (n = 5), neonatologists (n = 5), pediatricians (n = 2), consultants in community medicine (n = 2) and family medicine (n = 2), working at the Colleges of Medicine of Mosul and Nineveh Universities and in the Nineveh Health Directorate, who evaluated the accuracy, acceptability and applicability of the items and whether they adequately covered the study objectives. The scale-level content validity index was 0.80, which is considered acceptable [12].

The reliability of the interview-based items was assessed in a pilot study of 20 women, who were excluded from the final sample. A test–retest examination at a seven-day interval gave an overall percentage agreement of 75.0%, indicating moderate reliability [13].

Statistical analysis

Data were coded, entered into a computer and analyzed using SPSS version 27 and Microsoft Excel [2019]. Categorical variables are presented as numbers and percentages. Neonatal outcomes are not mutually exclusive, as one woman may have more than one outcome. Therefore, the total percentage exceeds 100%, each percentage was calculated from the number of women in the corresponding row (the Total column) . The Total column shows the number of women in each category and its percentage of the whole sample (n = 2,159). Associations were tested with Pearson's chi-square test for 2 × 2 and larger contingency tables. When at least one expected cell count was less than 5, the Fisher–Freeman–Halton exact test was used for tables larger than 2 × 2. A P-value ≤ 0.05 was considered statistically significant. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to compare emergency with elective CS, with the CI estimated using the Woolf (logit) method.

Ethical considerations

The study was approved by the scientific and ethical committee of the Nineveh Health Directorate, Ministry of Health, Iraq (approval number 272, dated 1st September 2025; research protocol number 2025225), and permission was obtained from the maternity hospitals concerned. Verbal informed consent was obtained from all participants before the interview, after explaining the purpose of the study.

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Results

Association between type and fetal indication of CS

Table 1 shows the fetal indications for CS according to its type. The most frequent indications were malpresentation 375 (17.4%), postdate 323 (15.0%) and preterm 252 (11.7%), followed by oligohydramnios 238 (11.0%), post-term 222 (10.3%), suspected macrosomia 142 (6.6%) and polyhydramnios 135 (6.3%).

Emergency CS was more frequent among women with preterm (OR 5.29; 95% CI 3.35–8.35), oligohydramnios (OR 3.66; 95% CI 2.43–5.53), post-term (OR 2.43; 95% CI 1.67–3.53) and postdate indications (OR 1.89; 95% CI 1.41–2.53), all $P < 0.001$. It was also more frequent with congenital anomaly (OR 2.19; 95% CI 1.20–4.00; $P = 0.009$), other indications (OR 2.00; 95% CI 1.30–3.07; $P = 0.001$) and malpresentation (OR 1.32; 95% CI 1.02–1.70; $P = 0.033$).

No significant association was found between the type of CS and suspected macrosomia (OR 1.42; 95% CI 0.95–2.12; $P = 0.084$) or polyhydramnios (OR 1.51; 95% CI 1.00–2.29; $P = 0.051$).

Table 1: Association between type of cesarean section and fetal indications

Categories	Emergency CS (1519)		Elective CS (640)		Total (2159)		P-value* / OR (95% CI)
	No.	%	No.	%	No.	%	
Malpresentation							
Yes	281	74.9	94	25.1	375	17.4	0.033
No	1238	69.4	546	30.6	1784	82.6	OR 1.32 (1.02–1.70)
Suspected macrosomia							
Yes	109	76.8	33	23.2	142	6.6	0.084
No	1410	69.9	607	30.1	2017	93.4	OR 1.42 (0.95–2.12)
Preterm							
Yes	231	91.7	21	8.3	252	11.7	<0.001
No	1288	67.5	619	32.5	1907	88.3	OR 5.29 (3.35–8.35)
Post term							
Yes	187	84.2	35	15.8	222	10.3	<0.001
No	1332	68.8	605	31.2	1937	89.7	OR 2.43 (1.67–3.53)
Post date							
Yes	260	80.5	63	19.5	323	15.0	<0.001
No	1259	68.6	577	31.4	1836	85.0	OR 1.89 (1.41–2.53)
Oligohydramnios							
Yes	211	88.7	27	11.3	238	11.0	<0.001
No	1308	68.1	613	31.9	1921	89.0	OR 3.66 (2.43–5.53)
Polyhydramnios							
Yes	105	77.8	30	22.2	135	6.3	0.051
No	1414	69.9	610	30.1	2024	93.7	OR 1.51 (1.00–2.29)
Congenital anomaly that interferes with normal labor							
Yes	66	83.5	13	16.5	79	3.7	0.009
No	1453	69.9	627	30.1	2080	96.3	OR 2.19 (1.20–4.00)
Others**							
Yes	123	82.0	27	18.0	150	6.9	0.001
No	1396	69.5	613	30.5	2009	93.1	OR 2.00 (1.30–3.07)

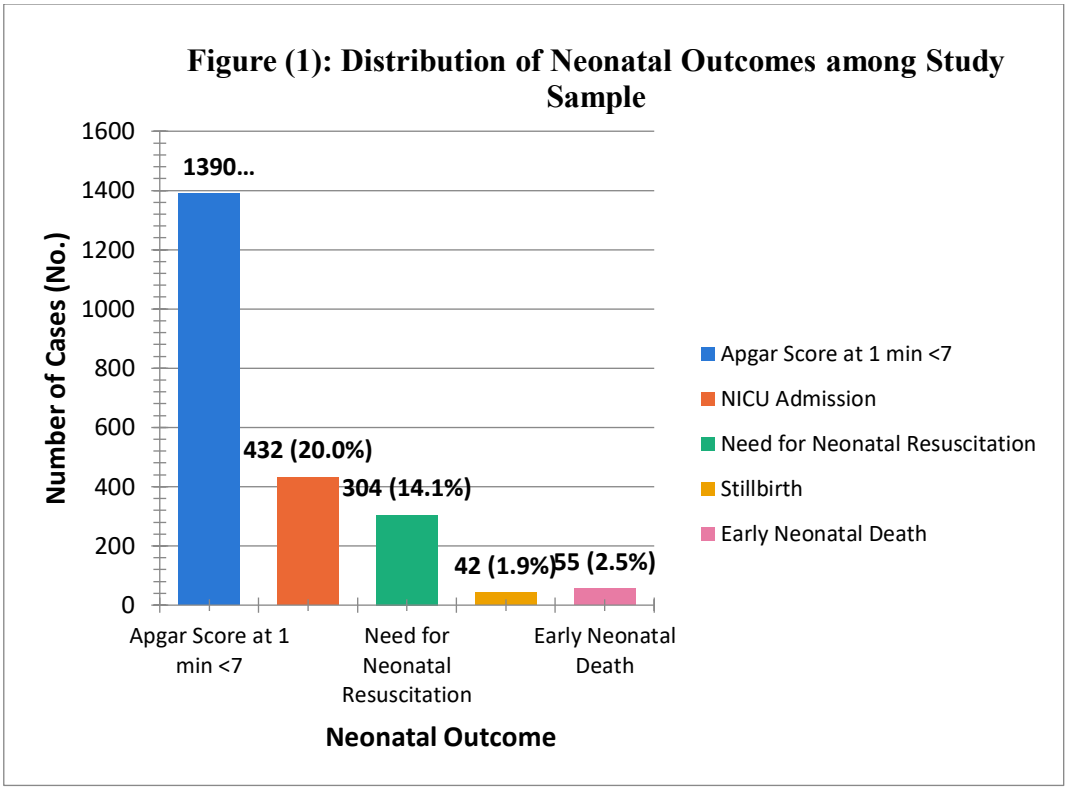
*** Pearson chi-square test (no continuity correction), significant at ≤ 0.05, OR = odds ratio; CI = confidence interval. The 95% CI for OR was calculated using the Woolf method.**

****others include (twin 1st one abnormal lie, twin with previous scar).**

Distribution of neonatal outcomes among the study sample

Apgar score at one minute less than seven was recorded in 1390 (64.4%) of the neonates, NICU admission in 432 (20.0%), need for neonatal resuscitation in 304 (14.1%), early neonatal death in 55 (2.5%) and stillbirth in 42 (1.9%), as shown in Figure (1).

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Note: Bars show the percentage of women (n = 2,159) with each outcome, NICU, neonatal intensive care unit.

Association between neonatal outcomes and maternal, health care service and obstetric characteristics

1. Neonatal outcomes and maternal socio-demographic characteristics

Table 2 shows the association between neonatal outcomes and maternal socio-demographic characteristics. Most mothers were aged 21–30 years (1,160; 53.7%), had primary education (958; 44.4%) and lived in urban areas (1,364; 63.2%). Age group was associated with Apgar score < 7 (P = 0.006), NICU admission (P < 0.001) and stillbirth (P < 0.001). Apgar score at 1 min < 7 was most frequent among women with primary education (645; 67.3%), NICU admission among women with university education or higher (77; 26.9%), and early neonatal death among illiterate women (20; 5.1%; P = 0.002). Residence was associated with all outcomes: rural residence was associated with higher NICU admission (25.8% vs. 16.6%, P < 0.001), neonatal resuscitation (16.9% vs. 12.5%, P = 0.005), stillbirth (3.0% vs. 1.3%, P = 0.006) and early neonatal death (3.5% vs. 2.0%, P = 0.028), whereas Apgar score at1 min < 7 was more frequent among urban women (67.2% vs. 59.6%, P < 0.001).

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Table 2: Association between neonatal outcomes and maternal socio-demographic characteristics

Category**	Neonatal outcome*					Total
	Apgar score at 1 min < 7	NICU admission	Need for neonatal resuscitation	Stillbirth	Early neonatal death	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
All women	1390 (64.4)	432 (20.0)	304 (14.1)	42 (1.9)	55 (2.5)	2159 (100)
Age group (years)	P = 0.006	P < 0.001	P = 0.732	P < 0.001 ‡	P = 0.060 ‡	
≤ 20	167 (60.9)	64 (23.4)	43 (15.7)	11 (4.0)	12 (4.4)	274 (12.7)
21–30	773 (66.6)	203 (17.5)	156 (13.4)	9 (0.8)	21 (1.8)	1160 (53.7)
31–40	388 (64.1)	124 (20.5)	86 (14.2)	12 (2.0)	19 (3.1)	605 (28.0)
≥ 41	62 (51.7)	41 (34.2)	19 (15.8)	10 (8.3)	3 (2.5)	120 (5.6)
Educational level	P < 0.001	P < 0.001	P = 0.059	P = 0.437	P = 0.002	
Illiterate	218 (55.6)	56 (14.3)	72 (18.4)	4 (1.0)	20 (5.1)	392 (18.2)
Primary	645 (67.3)	179 (18.7)	128 (13.4)	20 (2.1)	24 (2.5)	958 (44.4)
Secondary	350 (66.9)	120 (22.9)	66 (12.6)	13 (2.5)	8 (1.5)	523 (24.2)
University and higher	177 (61.9)	77 (26.9)	38 (13.3)	5 (1.7)	3 (1.0)	286 (13.2)
Residence	P < 0.001	P < 0.001	P = 0.005	P = 0.006	P = 0.028	
Urban	916 (67.2)	227 (16.6)	170 (12.5)	18 (1.3)	27 (2.0)	1364 (63.2)
Rural	474 (59.6)	205 (25.8)	134 (16.9)	24 (3.0)	28 (3.5)	795 (36.8)

*** Outcomes are not mutually exclusive. Percentages are row percentages (denominator = number of women in that category, Total column), so rows do not sum to 100%., NICU = neonatal intensive care unit.**
****Pearson chi-square is used when all expected counts are ≥ 5**
‡ Fisher–Freeman–Halton exact test (used when ≥ 1 expected count < 5). NICU, neonatal intensive care unit.

2. Neonatal outcomes and health care service characteristics

Table (3) shows that the highest percentages of Apgar score < 7 (477; 75.2%) and stillbirth (17; 2.7%) were in Al-Batoul Teaching Hospital, whereas NICU admission (220; 37.5%), neonatal resuscitation (145; 24.7%) and early neonatal death (25; 4.3%) were highest in Mosul General Hospital. The lowest percentages of neonatal resuscitation (31; 5.2%) and **early neonatal** death (5; 0.8%) were in Al-Khansaa Teaching Hospital, and the lowest percentage of stillbirth (3; 0.9%) was in Al-Salam Teaching Hospital. Only 512 women (23.7%) had ≥ 8 antenatal visits; 974 (45.1%) received antenatal care in private clinics and 750 (34.7%) were referred to hospital from private clinics. Women who attended private clinics for antenatal care had the lowest NICU admission (15.4%) and neonatal resuscitation (8.5%). Women referred as emergencies had the lowest frequency of Apgar score < 7 (53.0%) but the highest NICU admission (186; 34.8%), neonatal resuscitation (128; 24.0%) and early neonatal death (26; 4.9%). Women with ≥ 8 antenatal visits had a higher frequency of neonatal resuscitation (18.2% vs. 12.8%, P = 0.002) and stillbirth (6.3% vs. 0.6%, P < 0.001) than those with fewer visits.

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Table 3: Association between neonatal outcomes and health care service characteristics

Category**	Neonatal outcome*					Total
	Apgar score at 1 min < 7	NICU admission	Need for neonatal resuscitation	Stillbirth	Early neonatal death	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
All women	1390 (64.4)	432 (20.0)	304 (14.1)	42 (1.9)	55 (2.5)	2159 (100)
Health institution	P < 0.001	P < 0.001	P < 0.001	P = 0.135	P = 0.002	
Al-Batoul Teaching Hospital	477 (75.2)	50 (7.9)	76 (12.0)	17 (2.7)	19 (3.0)	634 (29.4)
Mosul General Hospital	345 (58.8)	220 (37.5)	145 (24.7)	14 (2.4)	25 (4.3)	587 (27.2)
Al-Khansaa Teaching Hospital	356 (59.3)	82 (13.7)	31 (5.2)	8 (1.3)	5 (0.8)	600 (27.8)
Al-Salam Teaching Hospital	212 (62.7)	80 (23.7)	52 (15.4)	3 (0.9)	6 (1.8)	338 (15.7)
Antenatal care ≥ 8 visits	P = 0.701	P = 0.089	P = 0.002	P < 0.001	P = 0.204	
Yes	326 (63.7)	89 (17.4)	93 (18.2)	32 (6.3)	17 (3.3)	512 (23.7)
No	1064 (64.6)	343 (20.8)	211 (12.8)	10 (0.6)	38 (2.3)	1647 (76.3)
Type of antenatal care	P < 0.001	P < 0.001	P < 0.001	P < 0.001 ‡	P = 0.031 ‡	
Governmental	287 (61.2)	90 (19.2)	72 (15.4)	15 (3.2)	7 (1.5)	469 (21.7)
Private clinic	648 (66.5)	150 (15.4)	83 (8.5)	18 (1.8)	20 (2.1)	974 (45.1)
Mixed	352 (58.0)	158 (26.0)	105 (17.3)	2 (0.3)	23 (3.8)	607 (28.1)
Others§	103 (94.5)	34 (31.2)	44 (40.4)	7 (6.4)	5 (4.6)	109 (5.0)
Type of referral to hospital	P < 0.001	P < 0.001	P < 0.001	P = 0.225	P < 0.001	
Self referral	360 (62.8)	106 (18.5)	67 (11.7)	17 (3.0)	16 (2.8)	573 (26.5)
Emergency	283 (53.0)	186 (34.8)	128 (24.0)	9 (1.7)	26 (4.9)	534 (24.7)
Private clinic	524 (69.9)	95 (12.7)	55 (7.3)	11 (1.5)	9 (1.2)	750 (34.7)
Governmental institutions	223 (73.8)	45 (14.9)	54 (17.9)	5 (1.7)	4 (1.3)	302 (14.0)

*** Outcomes are not mutually exclusive. Percentages are row percentages (denominator = number of women in that category, Total column), so rows do not sum to 100%. NICU, neonatal intensive care unit.**
****Pearson chi-square is used when all expected counts are ≥ 5**
‡ Fisher–Freeman–Halton exact test (used when ≥ 1 expected count < 5).
§ Others include nursing clinics and/or friends or relatives with a medical background.

3. Neonatal outcomes and obstetric characteristics

Table 4 shows that 1,474 women (68.3%) were multigravida, 1,107 (51.3%) had one or more previous scars and 1,519 (70.4%; 95% CI 68.4–72.2) underwent emergency CS. Gravidity was significantly associated only with stillbirth (P = 0.001), which was higher among primigravida (3.4%) than multigravida (1.3%). Previous scar was significantly associated with all outcomes (Table 4); women with no previous scar had higher NICU admission, resuscitation, stillbirth and early neonatal death, but a lower frequency of Apgar score < 7. The type of CS was significantly associated with Apgar score < 7, NICU admission, neonatal resuscitation and early neonatal death, but not with stillbirth (P = 0.058). Apgar score < 7 (72.5% vs. 61.0%) and NICU admission (24.8% vs. 18.0%) were higher after elective CS, whereas neonatal resuscitation (17.4% vs. 6.3%) and early neonatal death (3.1% vs. 1.3%) were higher after emergency CS.

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Table 4: Association between neonatal outcomes and obstetric characteristics

Category**	Neonatal outcome*					Total
	Apgar score at 1 min < 7	NICU admission	Need for neonatal resuscitation	Stillbirth	Early neonatal death	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
All women	1390 (64.4)	432 (20.0)	304 (14.1)	42 (1.9)	55 (2.5)	2159 (100)
Gravidity	P = 0.846	P = 0.823	P = 0.735	P = 0.001	P = 0.454	
Primigravida	439 (64.1)	139 (20.3)	99 (14.5)	23 (3.4)	20 (2.9)	685 (31.7)
Multigravida	951 (64.5)	293 (19.9)	205 (13.9)	19 (1.3)	35 (2.4)	1474 (68.3)
Previous scar	P = 0.011	P < 0.001	P < 0.001	P < 0.001	P = 0.025	
No scar	649 (61.7)	251 (23.9)	181 (17.2)	38 (3.6)	35 (3.3)	1052 (48.7)
≥ 1 scar	741 (66.9)	181 (16.4)	123 (11.1)	4 (0.4)	20 (1.8)	1107 (51.3)
Type of cesarean section	P < 0.001	P < 0.001	P < 0.001	P = 0.058	P = 0.013	
Emergency	926 (61.0)	273 (18.0)	264 (17.4)	24 (1.6)	47 (3.1)	1519 (70.4)
Elective	464 (72.5)	159 (24.8)	40 (6.3)	18 (2.8)	8 (1.3)	640 (29.6)

* Outcomes are not mutually exclusive. Percentages are row percentages (denominator = number of women in that category, Total column), so rows do not sum to 100%. NICU, neonatal intensive care unit.
**Pearson chi-square is used when all expected counts are ≥ 5

Discussion

BackgroundIn this multicentre study of 2,159 women who underwent CS in Mosul, malpresentation, postdate pregnancy and preterm gestation were the most frequent fetal indications, emergency CS was more frequent among several indications, and adverse neonatal outcomes were common.

Type and fetal indications of caesarean section

The three leading fetal indications (malpresentation 17.4%, postdate 15.0% and preterm 11.7%) were partly similar to reports from Duhok, Iraq, where malposition and oligohydramnios were the most common reasons for primary CS [14], and from Rasht, Iran, where breech presentation and multiple pregnancy were the commonest fetal indications among women with preterm labour [15]. Emergency CS predominated in every category and was most frequent with preterm gestation (91.7%) and oligohydramnios (88.7%), consistence with the strong relation between iatrogenic prematurity and CS in Rasht [15] and with the higher rates of CS, fetal distress, low Apgar scores and NICU admission reported for oligohydramnios in India [16]. Among the significant indications, malpresentation showed the weakest association with CS type (OR 1.32; P=0.033) which is plausible because breech presentation is an accepted indication for planned CS [17]. Polyhydramnios (P = 0.051) was borderline, consistent with the high CS rate reported in Kirkuk [18], and suspected macrosomia (P = 0.084) was not significantly associated with CS type, although birth weight above 4 kg doubled the odds of emergency CS in Riyadh [19]. Because preterm, postdate and post-term describe gestational age rather than a specific clinical indication, the underlying reason for CS in these cases could not be separated in our data.

Neonatal outcomes

A 1-minute Apgar score < 7 was the commonest adverse outcome (64.4%), followed by NICU admission (20.0%) and neonatal resuscitation (14.1%), whereas early neonatal death (2.5%) and stillbirth (1.9%) were less frequent. The Apgar prevalence is unusually high and higher than the 29.7% reported among pregnancies with oligohydramnios in India [16]; adverse neonatal outcomes occurred in 40% of emergency obstetric referrals in Uganda [20], and no

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neonatal deaths and only 2.5% poor Apgar scores were found among term CS in Nepal [21]. Possible explanations include the inclusion of high-risk and referred cases, prematurity, the type of anaesthesia, the greater sensitivity of the 1-minute score to transient depression compared with the 5-minute score, and differences in documentation practice between hospitals; we could not verify these explanations. NICU admission (20.0%) lay between the 16% reported in Nepal [21] and the 27.6% in Uganda [20] and 30% in Jordan [22]. Neonatal morbidity after CS is also a concern elsewhere in Mosul [9] and in Sudan [7].

Neonatal outcomes and maternal socio-demographic characteristics

NICU admission and stillbirth were more frequent at the extremes of maternal age (NICU admission 23.4% at ≤ 20 years and 34.2% at ≥ 41 years; stillbirth 4.0% and 8.3% vs. 0.8% at 21–30 years). This agrees with higher neonatal mortality among adolescent and older mothers in low-resource settings [23], more adverse neonatal outcomes after 35 years in Ethiopia [24], more NICU admission and low Apgar scores among adolescents in Nepal [25], and higher NICU admission and early neonatal death among adolescents in Kirkuk [26]. Early neonatal death was most frequent among illiterate women (5.1%), consistent with the association between education and stillbirth in Ethiopia [27]. Rural women had more NICU admission, resuscitation, stillbirth and early neonatal death, which may reflect limited awareness of antenatal care, inadequate health facilities, delay in seeking care and transport difficulties [20,28].

Neonatal outcomes and health care service characteristics

Differences between hospitals should not be interpreted as differences in quality of care, because case mix was not adjusted for. Mosul General Hospital had the highest NICU admission, resuscitation and early neonatal death, probably because complicated and referred cases were concentrated there: Al-Khansaa Maternity Hospital was operating from a temporary location and the gynaecology units at Al-Salam Hospital were under construction after severe damage during the war against ISIS. The proportion of women with ≥ 8 antenatal visits (23.7%) were higher than the 8.9–9.6% reported in 14 sub-Saharan African countries and in Ethiopia [29,30]. Although those estimate come from population-based survey and are not directly comparable with hospital-based sample if women underwent CS. Unexpectedly, women with ≥ 8 visits had more resuscitation and stillbirth; this probably reflects confounding by indication, since women with high-risk pregnancies attend more often and are more likely to be referred, rather than a harmful effect of antenatal care. Private-clinic antenatal care was associated with the lowest NICU admission and resuscitation, possibly because of closer follow-up of selected pregnancies; adequacy of antenatal care has been linked to perinatal outcomes [8]. Emergency referral was associated with higher NICU admission, resuscitation and early neonatal death, consistent with the 40% adverse outcomes among emergency referrals in Uganda [20] and with the adverse neonatal outcomes linked to delayed decision-to-delivery time [28].

Neonatal outcomes and obstetric characteristics

Gravidity was associated only with stillbirth, which was higher among primigravidae (3.4% vs. 1.3%). Women with no previous scar had higher NICU admission, resuscitation, stillbirth and early neonatal death but a lower frequency of Apgar score < 7. This should not be read as a protective effect of a previous scar: women without a scar include those undergoing a first, often emergency, CS in labour, whereas repeat CS is mostly planned; moreover, neonatal risk rises with the number of repeat CS, with NICU admission and low Apgar about doubled after five or more [31]. Emergency CS was associated with more neonatal resuscitation (17.4% vs. 6.3%) and early neonatal death (3.1% vs. 1.3%), in agreement with poorer immediate outcomes after emergency CS reported elsewhere [21,32]. Conversely, elective CS was associated with more Apgar score < 7 (72.5% vs. 61.0%) and NICU admission (24.8% vs. 18.0%), consistent with the respiratory morbidity reported after elective and early-term CS

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[33,34]. Without data on continuous gestational age, anaesthesia type and birth weight, we cannot separate these possibilities.

Strengths and limitations

The strengths of this study include its multicentre design covering the four main governmental maternity hospitals in Mosul, random sampling with proportionate allocation, and a relatively large sample. The limitations include the following

1- The cross-sectional design and bivariate analysis, without adjustment for confounders such as gestational age, birth weight, anaesthesia type and maternal indications for CS, preclude causal inference, and the associations for type of CS and previous scar in particular may be confounded by indication.

2- Data quality may have been affected: the 1-minute Apgar score was unusually high and probably varied in documentation between hospitals, the data-collection form showed modest test–retest agreement (75%), and early neonatal death may have been under-ascertained after discharge.

3- Outcomes were expressed per woman rather than per live birth, which limits comparison with other studies, and differences between hospitals should not be read as differences in quality of care.

4- Private hospitals were excluded and the sampling frame was estimated from historical daily CS figures, which limits generalizability to all CS deliveries in Mosul.

Conclusions

Fetal indications for CS in Mosul maternity hospitals were dominated by malpresentation, postdate pregnancy and preterm gestation, and emergency CS was more frequent among preterm, post-term, postdate and oligohydramnios cases. Adverse neonatal outcomes were common, particularly a low 1-minute Apgar score and NICU admission. Rural residence, extremes of maternal age, emergency referral, type of CS and hospital were associated with some adverse outcomes, and the 1st caesarean scar was associated with higher NICU admission, resuscitation, stillbirth, and early neonatal death, but with a lower frequency a low Apgar score. Neonatal resuscitation and early neonatal death were higher after emergency CS, whereas low Apgar scores and NICU admission were higher after elective CS. These findings suggest for improving the quality and coverage of antenatal care, strengthening referral pathways and transport (especially in rural areas) and standardizing Apgar scoring and neonatal documentation across hospitals deserve attention. Further studies include private hospital, collect data on gestational age and birth weight, and apply multivariable analysis are recommended.

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Author Contributions

Marab Younis Abdullah Al-Fathy: Study design, data collection, manuscript drafting, and team supervision.
Yusra Ali Mohammed Ali: Supervision and coordination of hospital data collection.
Maan Younis Al-Fathi: Statistical analysis and data interpretation.
Hiba Farooq Mohamed Ameen: Statistical analysis and data interpretation.

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Israa Mahmood Mustafa: Online form design, sample collection supervision, manuscript review, and correspondence.

Israa Mohamad Zaky: Supervision and coordination of hospital data collection.

Declaration of Artificial Intelligence (AI) use

The authors used AI to improve grammar, sentence structure, and readability of the manuscript. All suggested changes were reviewed and edited by the authors, who take full responsibility for the accuracy and integrity of the final manuscript.

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