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IMPACT OF MATERNAL ANAEMIA ON NEONATAL OUTCOMES: A SINGLE-CENTRE EXPERIENCE

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Abstract: **Background:** Maternal anaemia is one of the most common complications of pregnancy and is associated with adverse outcomes such as preterm delivery, impaired fetal development, and increased risks of morbidity and mortality in the perinatal period. The high prevalence of anaemia in pregnancy and its impact on fetal development represents a significant public health issue. The aim of this study was to analyze the influence of maternal anaemia on neonatal outcomes.

Patients and Methods: In a two-year prospective study conducted at the Clinic of Gynecology and Obstetrics and the Clinic of Children's Diseases of the University Clinical Center Tuzla, 177 newborns and their mothers were analyzed—127 in the experimental group (mothers with anaemia) and 50 in the control group (without anaemia). Sociodemographic and clinical data of the mothers and newborns were collected. Data were processed using conventional statistical techniques. Ethical approval was obtained from the relevant institutional review board.

Results: Of the 120 (70.58%) mothers with anaemia included in the study, 106 (88.3%) were between 18 and < 35 years of age. Working mothers had lower odds of anaemia ($p = 0.025$), while mothers who did not use supplements during pregnancy had higher odds ($p = 0.001$). Maternal anaemia was significantly associated with smoking or tobacco use ($p = 0.015$). Mothers living outside of marriage were more likely to be anaemic. A higher percentage of vaginal bleeding ($p = 0.0001$), uncontrolled pregnancies ($p = 0.011$), and caesarean section as the mode of delivery ($p = 0.000$) were recorded among anaemic mothers. Babies born to anaemic mothers had lower birth weight compared to those born to non-anaemic mothers ($p = 0.004$). Maternal anaemia significantly affected gestational age ($p = 0.024$) and Apgar scores in the 1st ($p = 0.006$) and 5th minutes ($p = 0.0031$). In this study, maternal anaemia during pregnancy had a statistically significant impact on perinatal outcomes including perinatal asphyxia, respiratory distress syndrome, neonatal infections, icterus neonatorum, intracranial hemorrhage, and hypoxic-ischemic encephalopathy.

Conclusion: In developing countries, current strategies for the prevention of anaemia in pregnancy have had limited success. Programs for careful monitoring and management of anaemia during pregnancy need to be developed in order to prevent poor perinatal outcomes.

Keywords: neonatal outcome, anaemia, pregnancy.

INTRODUCTION

Anaemia in pregnancy is a global health concern. While mild dilutional anaemia is considered a normal physiological adaptation during pregnancy, more pronounced anaemia can negatively affect both maternal and neonatal health. Therefore, recognising iron deficiency anaemia and distinguishing it from normal physiological changes is essential, along with identifying rarer causes that may require clinical intervention (1).

According to the World Health Organization (WHO), haemoglobin levels below 11 g/dL during gestation are indicative of maternal anaemia. Maternal anaemia is classified as mild, moderate, or severe based on haemoglobin levels: 10–10.9 g/dL for mild, 7–9.9 g/dL for moderate, and below 7 g/dL for severe cases (2).

In 2019, the global prevalence of anaemia among women of reproductive age was 29.9%, translating to more than half a billion women aged 15 to 49. Among pregnant women, the prevalence was 36.5%, compared to 29.6% in non-pregnant women of reproductive age (3). These differences across regions are largely influ-

enced by socioeconomic conditions and related nutritional deficiencies (4).

Maternal anaemia is one of the most common complications of pregnancy, associated with adverse outcomes such as preterm delivery, restricted fetal growth, and increased perinatal morbidity and mortality (5).

Additionally, anaemia is linked to a higher risk of maternal mortality in developing countries, as well as a variety of complications, including infections, pregnancy-induced hypertension, preeclampsia, eclampsia, premature rupture of membranes, and postpartum depression. Adverse pregnancy outcomes occur 30–45% more frequently in anaemic mothers (6, 7).

Due to its high prevalence and impact on fetal development, anaemia in pregnancy remains a significant public health issue.

The aim of this study was to analyse the perinatal risks in anaemic pregnant women and associated neonatal outcomes.

PATIENTS AND METHODS

This prospective study was conducted over a two-year period (from January 1, 2020, to January 1, 2022) at the Clinic of Gynecology and Obstetrics and the Clinic of Pediatrics of the University Clinical Center Tuzla. The study included 177 neonates and their mothers, with 127 in the test group (born to mothers with confirmed anaemia) and 50 in the control group (mothers without anaemia). Twin pregnancies were also included in the analysis.

Data were collected using a pre-designed proforma that included sociodemographic and clinical parameters of both mothers and neonates. Maternal parameters included age, place of residence, employment status, marital status, education level, type of diet, smoking/tobacco use, and haemoglobin concentration. Neonatal parameters included sex, gestational age, birth weight, Apgar scores, and overall health status. Obstetric history was also recorded, including parity, twin pregnancy, vaginal bleeding, antenatal care, and mode of delivery.

Maternal anaemia in pregnancy was categorised as mild (10–10.9 g/dL), moderate (7–9.9 g/dL), or severe (below 7 g/dL), depending on haemoglobin concentration (2).

Blood samples for haemoglobin measurement were collected in heparinised tubes and analysed using a Sysmex XE-2100 haematological analyser (TOA Medical Electronics Co., Ltd., Kobe, Japan) at the Department of Biochemistry, Polyclinic for Laboratory Diagnostics, University Clinical Center Tuzla.

The New Ballard Score was used to assess neonatal postnatal gestational age (8). Gestational age was categorised as preterm (< 37 weeks), term (37 to <42 weeks), and post-term (≥ 42 weeks) (8).

The Apgar score was recorded at 1 and 5 minutes after birth, assessing five vital signs: respiration, heart rate, muscle tone, reflexes, and colour (9). Birth weight (BW) was measured in grams (g) using a Libela Celje weighing scale and categorised into four groups: < 2500 g, 2500–3499 g, 3500–4000 g, and > 4000 g.

All data were entered into a Microsoft Excel spreadsheet. Data analysis, including descriptive statistics and the chi-squared test, was performed using SPSS software version 20.0. Differences were considered statistically significant at $p < 0.05$. All analyses were conducted using a 95% confidence interval.

The study followed ethical principles outlined by institutional and/or national ethics committees, in accordance with the 1964 Declaration of Helsinki and its subsequent amendments (10). Ethical approval was obtained from the Institutional Ethics Committee.

RESULTS

Of the 120 (70.58%) mothers with anaemia included in the study, 106 (88.3%) were between the ages of 18 and < 35 years. The mean maternal age was 27.94 years, the mean body weight was 80.39 kg, and the mean height was 167.44 cm. The mean body mass index (BMI) was 28.62 kg/m².

In the control group of 50 (29.41%) mothers without anaemia, 44 (88%) were also of middle age. The mean maternal age was 28.52 years, mean body weight was 78.96 kg, and mean height was 166.22 cm. The mean BMI in this group was 28.61 kg/m².

Among the 177 newborns observed, the majority were born to mothers with moderate anaemia—109 (61.60%).

The association between maternal anaemia and the sociodemographic characteristics of mothers is summarised in Table 1. Employed mothers had lower odds of being anaemic ($p = 0.025$), while mothers who did not use supplements during pregnancy had higher odds ($p = 0.001$). In our study, no statistically significant association was found between maternal educational status and anaemia. A significant association was observed between anaemia and smoking/tobacco use ($p = 0.015$). The most common marital status in both groups was married, and a statistically significant association was found between marital status and group ($p = 0.026$). Mothers who were unmarried were more likely to be anaemic.

Additionally, a statistically significant association was observed between anaemia and the presence of vaginal bleeding, antenatal care, and mode of delivery ($p < 0.05$). A higher proportion of vaginal bleeding

***Table 1**. Sociodemographic parameters of mothers (n = 170)*

Clinical parameters	Anemic mothers		Non-anemic mothers		χ^2	P value
	f	%	f	%		
Age groups (years)						
18 to < 35	106	88.33	44	88.00	0.038	0.950
≥ 35-49	14	11.67	6	12.00		
Place of living						
Urban	56	46.67	25	50.00	0.157	0.691
Rural	64	54.17	25	50.00		
Employment						
Employed	84	70.00	26	52.00	5.007	0.025
Un-employed	36	30.00	24	48.00		
Marital status						
In marriage	109	90.83	50	100.00	4.900	0.026
Common-law marriage	11	9.17	0	0		
Mother's education						
Primary school	12	10.00	3	6.00	1.794	0.180
Middle school	70	58.33	32	64.00		
High school	10	8.33	6	12.00		
Graduate	28	23.33	9	18.00		
Use of supplements						
No	23	19.17	1	2.00	10.386	0.001
Yes	7	5.83	1	2.00		
First trimester only	90	75.00	48	96.00		
Smoking/tobacco abuse						
Yes	54	45.00	13	26.00	5.847	0.015
No	66	55.00	37	74.00		

χ^2 - chi-squared test; p - probability value

***Table 2.** Obstetric parameters of mothers (n = 170)*

Obstetric parameters	Anemic mothers		Non-anemic mothers		χ^2	P value
	f	%	f	%		
Parity						
Parity 1	62	51.69	27	54.00	1.294	0.255
Parity 2	49	33.33	19	38.00		
Parity ≥ 3	18	15.00	4	8.00		
Twin pregnancy						
No	113	94.17	50	100.00	3.041	0.081
Yes	7	5.43	0	0.00		
Vaginal bleeding						
Yes	29	24.17	0	0.00	14.56	0.0001
No	91	75.83	50	100.00		
Pregnancy control						
Optimal	98	81.67	48	96.00	6.462	0.011
Suboptimal	13	10.83	2	4.00		
No control	9	7.50	0	0.00		
Mode of delivery						
Vaginal	48	40.00	38	76.00	18.398	0.000
Vacuum exstractio	1	0.83	0	0.00		
Sectio Caesarea	71	59.17	12	24.00		

χ^2 - chi-squared test; p - probability value

Table 3. *Association of maternal anemia with clinical parameters of neonates (n = 177)*

Clinical parameters	Anemic mothers		Non-anemic mothers		χ^2	P value
	f	%	f	%		
Gender						
Male	57	44.88	23	46.00	0.0181	0.893
Female	70	55.12	27	54.00		
Gestational age						
Preterm (< 37)	25	19.69	3	6.00	5.045	0.024
Term (37 to 42)	102	80.31	47	94.00		
Post-term (> 42)	0	0.00	0	0.00		
Birth Weight for Gest. age						
Eutrophic	112	88.19	48	96.00	3.333	0.067
Hypotrophic	7	5.51	0	0.00		
Hypertrophic	8	6.30	2	4.00		
Birth weight (grams)						
< 2500	22	17.32	1	2.00	8.266	0.004
2500-3500	58	45.67	29	58.00		
3500-4000	39	30.71	15	30.00		
> 4000	8	6.30	5	10.00		
APGAR score in the 1st minute						
8-10	93	73.23	46	92.00	7.498	0.006
4-7	34	26.77	4	8.00		
≤ 3	0	0. 00	0	0.00		
APGAR scorein the 5th minute						
8-10	116	91.34	50	100.00	4.617	0.031
4-7	11	8.66	0	0.00		
≤ 3	0	0.00	0	0.00		

χ^2 - chi-squared test; p - probability value

Table 4. *Association of maternal anemia with perinatal outcome in neonates (n = 177)*

Perinatal outcome	Anemic mothers		Non-anemic mothers		χ^2	P value
	f	%	f	%		
Perinatal asphyxia						
No	103	88.03	43	94.00	4.616	0.031
Yes	24	20.51	3	6.00		
RDS						
No	110	94.02	49	98.00	5.091	0.024
Yes	17	14.53	1	2.00		
Neonatal infection						
No	100	85.47	46	92.00	4.366	0.036
Yes	27	23.08	4	8.00		
Icterus neonatorum						
No	108	92.31	48	96.00	4.062	0.043
Yes	19	16.24	2	4.00		
HIC						
No	101	86.32	48	96.00	7.310	0.006
Yes	26	22.22	2	4.00		
HIE						
No	108	92.31	50	100.00	8.379	0.003
Yes	19	16.24	0	0.00		

χ^2 - chi-squared test; p - probability value; RDS - Respiratory distress syndrome; HIC - Haemorrhagia intracranialis; HIE - Hypoxic-ischemic encephalopathy

($p = 0.0001$), lack of antenatal care ($p = 0.011$), and caesarean section as the mode of delivery ($p = 0.000$) were recorded among mothers with anaemia. Table 2 summarises the obstetric parameters.

The association between maternal anaemia and neonatal clinical parameters is presented in Table 3. Newborns of anaemic mothers had significantly lower birth weights compared to those of non-anaemic mothers ($p = 0.004$). Maternal anaemia also had a significant effect on gestational age ($p = 0.024$), as well as Apgar scores at both 1 minute ($p = 0.006$) and 5 minutes ($p = 0.0031$).

In our study, maternal anaemia during pregnancy had a statistically significant impact on perinatal outcomes such as perinatal asphyxia ($p = 0.031$), respiratory distress syndrome ($p = 0.024$), neonatal infections ($p = 0.036$), icterus neonatorum ($p = 0.043$), intracranial haemorrhage ($p = 0.006$), and hypoxic-ischemic encephalopathy ($p = 0.003$). The results detailing the association between maternal anaemia and perinatal outcomes are shown in Table 4.

DISCUSSION

Data on the age of pregnant women in this study show that the majority of both anaemic (88.3%) and non-anaemic (88%) mothers were in the middle-age category, with average ages of 27.94 and 28.52 years, respectively. A notable proportion—11.6%—were older pregnant women (≥ 35 years). Previous studies have shown that advanced maternal age is associated with increased risks, partly due to pre-existing conditions such as chronic hypertension or hypothyroidism. These risks include EPH gestosis, gestational diabetes, miscarriage, chromosomal abnormalities, macrosomia, low birth weight, and an increased likelihood of caesarean delivery (11).

In our study, the participants were evenly distributed by place of residence, with a slightly higher proportion of anaemic mothers living in rural areas (54.17%). Most pregnant women in both groups had a secondary education, with a substantial proportion (23.33%) of anaemic women having higher education. Anaemic mothers were more frequently unemployed (30%). Regarding marital status, the majority of mothers in both groups were married; however, anaemia was more common among those who lived outside of marriage (9.17%). Existing research shows that better socioeconomic conditions—such as higher levels of education and income—are linked to healthier dietary habits during pregnancy (12).

In this study, maternal anaemia was significantly associated with a vegetarian diet. Similar findings were reported by Bansal et al. and Bhaware et al. (13, 14). Smoking or tobacco use was also significantly associated with anaemia in pregnancy ($p = 0.015$). Likewise, Mistry et al. found a relationship between tobacco abuse and maternal anaemia (15). Smoking during pregnancy is a well-established risk factor for complications in the pregnancy course and for impaired fetal growth and development.

A higher percentage of vaginal bleeding ($p = 0.0001$), inadequate antenatal care ($p = 0.011$), and caesarean section as the mode of delivery ($p = 0.000$) were observed in anaemic mothers.

Among neonatal clinical parameters, maternal anaemia was significantly associated with lower birth weight ($p = 0.004$), shorter gestational age ($p = 0.024$), and lower Apgar scores at both 1 and 5 minutes. These findings are consistent with those of Adhikari et al., who reported a significant association between maternal anaemia and reduced gestational age ($p = 0.033$), lower birth weight ($p = 0.04$), and shorter neonatal length ($p = 0.003$) (16). Similarly, the study by Bakhtiar et al. showed that maternal anaemia is associated with preterm birth, low birth weight, and low Apgar scores at one minute (17).

Reduced maternal haemoglobin levels impair placental angiogenesis, thereby limiting oxygen delivery to the fetus and contributing to intrauterine growth restriction (18).

In our study, maternal anaemia had a statistically significant impact on adverse perinatal outcomes, including perinatal asphyxia, respiratory distress syndrome (RDS), neonatal infections, neonatal icterus, haemorrhagia intracranialis (HIC), and hypoxic-ischemic encephalopathy (HIE) ($p < 0.05$).

The findings confirm the hypothesis of a statistically significant interdependence between maternal anaemia and perinatal outcomes. The percentage of newborns with unfavourable outcomes was significantly higher among those born to anaemic mothers compared to those born to non-anaemic mothers.

These results highlight the complex relationship between anaemia in pregnancy and perinatal health—an area that warrants further research. Future studies should consider larger and/or higher-risk populations, utilise a broader range of anaemia biomarkers, and assess maternal and neonatal anaemia across multiple time points.

CONCLUSION

Anaemia during pregnancy is recognised as a global public health concern. While mild dilutional anaemia may occur as a normal physiological adaptation, more severe forms can have detrimental effects on both maternal and neonatal health. In developing countries, current strategies for the prevention of anaemia in pregnancy have had limited success. Therefore, comprehensive

programmes for the careful monitoring and management of anaemia during pregnancy should be developed to reduce the risk of adverse perinatal outcomes.

Abbreviations

BMI – Body mass index
EPH gestosis – Edema, proteinuria, hypertension gestosis
HIE – Hypoxic-ischemic encephalopathy
HIC – Haemorrhagia intracranialis
p – Probability value
RDS – Respiratory distress syndrome
WHO – World Health Organization
χ^2 – Chi-squared test

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained by the hospital's ethical board.

Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

UTICAJ ANEMIJE U TUDNOĆI NA NEONATALNI ISHOD - ISKUSTVO JEDNOG CENTRA

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Uvod: Anemija majke je jedna od najčešćih komplikacija u trudnoći, koja je povezana s negativnim ishodima trudnoće poput prevremenog porođaja i poremećajima razvoja fetusa, kao i povećanim rizikom obolevanja i smrti u vreme porođaja. Zbog svoje visoke učestalosti, uticaj anemije u trudnoći na fetalni razvoj ostaje značajan javno zdravstveni problem. Cilj rada je bio ispitati uticaj majčine anemije na neonatalni ishod.

Metode: U dvogodišnjoj prospektivnoj studiji sprovedenoj u Klinici za ginekologiju i akušerstvo i Klinici za dečije bolesti, Univerzitetskog kliničkog centra Tuzla analizirano je 177 novorođenčadi i njihovih majki-127 u eksperimentalnoj grupi (majke sa anemijom) i 50 u kontrolnoj grupi (bez anemije). Evaluirani su sociodemografski i klinički podaci majki i novorođenčadi. Podaci su obrađeni korišćenjem konvencionalnih statističkih metoda. Etičko odobrenje za studiju dobijeno je od nadležnog institucionalnog odbora.

Rezultati: Od 120 (70.58%) majki sa anemijom u trudnoći, 106 (88.3%) je bilo u dobi od 18 do < 35 godina. Zaposlene majke su ređe bile anemične u odnosu na nezaposlene (p = 0.025), dok je kod majki koje nisu koristile suplemente tokom trudnoće zabeležen veći procenat anemije (p = 0.001). Anemija je bila značajnija kod trudnica koje su pušile tokom trudnoće (p = 0.015) kao i kod onih koje su živele u vanbračnoj zajednici. Veći procenat vaginalnog krvarenja (p = 0.0001), nekontrolisanih trudnoća (p = 0.011) i carskog reza kao načina dovršetka porođa (p = 0.000) zabeležen je kod majki sa anemijom. Novorođenčad majki sa anemijom imala su nižu porođajnu težinu u odnosu na novorođenčad majki bez anemije (p = 0.004). Anemija majke značajno je uticala na rađanje novorođenčadi niže gestacijske dobi (p = 0.024) i nižeg Apgar skor u 1. (p = 0.006) i 5. minuti (p = 0.0031). U našem istraživanju, anemija majke tokom trudnoće imala je statistički značajan negativan uticaj na perinatalni ishod kao što su neonatalna asfiksija, respiratorni distres sindrom, neonatalna infekcija i ikterus novorođenčadi, pojava intrakranijalne hemoragije i hipoksično ishemijska encefalopatija.

Zaključak: U zemljama u razvoju trenutna strategija prevencije anemije u trudnoći ima malo uspeha. Trebalo bi razviti programe pažljivog praćenja kriterijuma vezanih za anemiju tokom trudnoće da bi se pravovremenim delovanjem izbegli loši perinatalni ishodi.

Ključne reči: neonatalni ishod, anemija, trudnoća.

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