Correlation of Maternal Comorbidities and Neonatal Outcomes in Patients With Non-Reassuring Fetal Status Undergoing Caesarean Section

Nasrudin,[1] Edy Priyanto,[2] Dodi Suardi[1]
[1]Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Padjadjaran – Dr. Hasan Sadikin General Hospital, Bandung, Indonesia
[2]Department of Obstetrics and Gynecology, Faculty of Medicine, Jendral Soedirman University – Margono Hospital, Purwokerto, Indonesia
Correspondence: Nasrudin, Email: nasrudin22001@mail.unpad.ac.id

Abstract
Objective: Non-reassuring fetal status (NRFS) is an obstetric emergency characterized by abnormal fetal heart rate patterns requiring immediate intervention, often through cesarean section. Maternal comorbidities such as obesity, hypertension, and anemia are suspected to increase the risk of NRFS and adversely affect neonatal outcomes, particularly in developing countries. This study aimed to evaluate the relationship between maternal comorbidities and neonatal outcomes, including low birth weight (LBW), APGAR scores, and the need for Neonatal Intensive Care Unit (NICU) admission, in NRFS cases undergoing cesarean section at Prof. Dr. Margono Soekarjo Hospital, Purwokerto, from September 2023 to April 2024.
Methods: A cross-sectional study used secondary (medical) data with total sampling. Bivariate and multivariate logistic regression analyses reported odds ratios (ORs) and 95% confidence intervals (CIs). A p-value of <0.05 was considered statistically significant.
Result: Maternal obesity, hypertension, and anemia were significantly associated with LBW, low APGAR scores, and NICU admission. All comorbidities showed ORs <1, indicating increased risk for adverse neonatal outcomes.
Conclusion: There was a significant correlation between maternal comorbidities and poor neonatal outcomes in NRFS cases delivered via cesarean section.

Keywords: Anemia, APGAR, Low Birth Weight, Hypertension, NICU, NRFS, Obesity

Hubungan antara Komorbiditas Maternal dan Luaran Neonatus pada Pasien dengan *Non-Reassuring Fetal Status* yang Menjalani Seksio Sesarea

Abstrak
Tujuan: *Non-reassuring fetal status (NRFS)* adalah kondisi kegawatdaruratan obstetri yang ditandai oleh pola detak jantung janin abnormal dan membutuhkan intervensi segera, sering berupa seksio sesarea. Komorbiditas maternal seperti obesitas, hipertensi, dan anemia diduga berperan dalam meningkatkan risiko NRFS dan memengaruhi luaran neonatal, terutama di negara berkembang. Penelitian ini bertujuan mengevaluasi hubungan antara komorbiditas maternal dan berat badan lahir rendah (BBLR), skor APGAR, dan kebutuhan perawatan *Neonatal Intensive Care Unit* (NICU) pada pasien NRFS yang menjalani seksio sesarea di RSUD Prof. Dr. Margono Sokearjo Purwokerto dari September 2023 hingga April 2024.
Metode: Penelitian potong lintang ini menggunakan data (rekam medis) dengan teknik total sampling. Analisis bivariat dan multivariat dilakukan menggunakan regresi logistik dengan odds ratio (OR) dan interval kepercayaan 95%. Nilai p <0,05 dianggap signifikan.
Hasil: Obesitas, hipertensi, dan anemia maternal secara signifikan berhubungan dengan BBLR, skor APGAR rendah, dan kebutuhan NICU. Semua komorbiditas menunjukkan *odd ratio* <1, mengindikasikan peningkatan risiko terhadap luaran neonatal yang merugikan.
Kesimpulan: Terdapat hubungan signifikan antara komorbiditas maternal dan luaran neonatal yang buruk pada pasien NRFS yang menjalani seksio sesarea.

Kata kunci: Anemia, APGAR, Berat Badan Lahir Rendah, Hipertensi, NICU, NRFS, Obesitas

 DOI: 10.24198/obgynia.v8i2.854

Introduction

A fetal hypoxia condition is called non-reassuring fetal status (NFRS). It is indicated by changes in the fetal heart rate pattern, reduced fetal movement observed on cardiotocography (CTG), meconium-stained amniotic fluid, and poor fetal growth. It needs to be treated right away with intrauterine resuscitation, but if the condition does not improve, the pregnancy will end by cesarean section.[1–3] NRFS contributes significantly to intrapartum complications globally, with a reported incidence ranging from 2.1% to 16.6% of all deliveries, and is associated with increased rates of cesarean delivery and neonatal morbidity.[4] In Indonesia, the Minister of Health reported that NRFS accounted for approximately 15.3% of cesarean deliveries, indicating its substantial impact on obstetric decision-making and neonatal outcomes.[5] Several maternal comorbidities thought to be related to increased cesarean section rates include hypertension, anemia, and obesity, which will affect the outcome for the baby, resulting in fetal hypoxia, fetal growth disorders, and the need for NICU after delivery.[3,6] Although this is not fully understood, several studies hypothesize that these factors will affect the maternal-fetal oxygenation process, disrupting fetoplacental angiogenesis, which can lead to a higher number of deliveries by cesarean section due to indications of non-reassuring fetal status.[2,7]

This study analyzes the causes of cesarean section deliveries related to maternal comorbidities such as hypertension, maternal anemia, and obesity, as well as their impact on fetal outcomes, including APGAR score, birth weight, and the need for NICU admission after delivery.

Method

This study employed a cross-sectional approach, collecting secondary data from all patients who underwent cesarean sections at Prof. Dr. Margono Soekarjo Hospital, Purwokerto, using a systematic sampling method. The study included a total of 379 cesarean section patients. A sampling selection was conducted on patients giving birth by cesarean section due to indications of non-reassuring fetal status, specifically 103 patients.

This study used secondary data from patient medical records through systematic sampling. Furthermore, this study used odds ratios with a 95% confidence interval for both bivariable and multivariable logistic regression analyses. Variables were considered statistically significant if the p-value was less than 0.05 in the multivariable analysis.

This study classified the cesarean section as a dependent variable, indicated as either yes or no, to reflect non-reassuring fetal status. The researcher included independent variables such as body mass index (BMI), parity status, quantity of antenatal care (ANC), education level, maternal comorbidity (hypertension, anemia, obesity), labor induction, amnionicity, preterm rupture of membrane (PROM), antepartum hemorrhage, and infant outcomes in terms of birth weight, APGAR score, and the need for Neonatal Intensive Care Unit (NICU).

All variables in this study were subjected to chi-square analysis with a p-value <0.05 and a 95% confidence interval, which was statistically significant.

In this study, data were analyzed using IBM SPSS Statistics Version 26 (for Windows). The data were tested for normality using the Kolmogorov-Smirnov test, with a normal distribution serving as the standard deviation. The chi-square method was applied to all variables, yielding a 95% confidence interval and a p-value of less than 0.05, indicating significant results for all analyzed

Table 1 Description of variables, samples, and characteristics of research data

Variables analyzed	n = 103 (100%)	*p-value*
Age		0.023
Normal age of pregnancy (≤34 years)	76 (73.78%)	
High risk pregnancy age (≥35 years)	27 (26.21%)	
BMI		0.045
Underweight (<18.5 kgBW/m^2)	15 (14.6%)	
Normal (18.5 – 24.9 kgBW/m^2)	50 (48.5%)	
Overweight (25 – 29.9 kgBW/m^2)	15 (14.6%)	
Obese (>30 kgBW/m^2)	23 (22.3%)	
Obstetric Status		0.038
Primipara	43 (41.74%)	
Multipara	60 (58,25%)	
Antenatal care (ANC) frequency		0.012
Visits >6x (Category 1)	67 (65%)	
Visits ≤5x (Category 2)	36 (34.95%)	
Level of education		0.003
Senior High School, associate degree, and bachelor (Category 1)	59 (57,28%)	
No school, elementary and middle school (Category 2)	44 (42,71%)	
Blood pressure (mmHg)		0.043
Normal (<139/89 mmHg)	42 (40.77%)	
Hypertension (>140/90 mmHg	61 (59.22%)	
Induction		0.007
Yes (Category 1)	80 (77,66%)	
No (Category 2)	23 (22.33%)	
Maternal Anemia		0.010
Normal (Hb ≥ 10 g/dl)	22 (21.35%)	
Anemia (Hb ≤ 9.9 g/dl)	81 (78,64%)	
Amniotic fluid		0.002
Normal (Category 1)	89 (86,40%)	
Abnormal (oligo/polyhydramnios/meconium) (Category 2)	14 (13.59%)	
Premature rupture of membranes **(PROM)**		0.004
No (Category 1)	75 (72,81%)	
Yes (Category 2)	28 (27.18%)	
Antepartum hemorrhage (APH)		0.018
No (Category 1)	91 (88,34%)	
Yes (Category 2)	12 (11.65%)	
Baby birth weight		0.000
Normal birth weight >2500 gr (Category 1)	73 (70,87%)	
Low birth weight <2500 gr (Category 2)	30 (29,12%)	
APGAR score		0.000
APGAR normal 7/8 (Category 1)	69 (66.99%)	
Moderate asphyxia score 5/6 (Category 2)	34 (33%)	

NICU needs		0.000
No (Category 1)	77 (74.75%)	
Yes (Category 2)	26 (25,24%)	

Note: If the chi-square condition is not satisfied, the p-value for categorical data is determined using the Fisher's exact tests. P value <0.05 for statistically significant.

variables. For correlation, an odds ratio assessment was conducted between maternal comorbidities (hypertension, obesity, and anemia) and fetal outcomes (birth weight, APGAR score, and NICU needs).

It was sent to and received by the Ethics and Research Committee of the Development and Research Section at Prof. Dr. Margono Soekarjo Hospital, Purwokerto, Indonesia, with referral number 003/KEPK/PE/I/2025 on January 8th, 2025, in accordance with protocol 12/2003. The medical record data for this study will only be used for research purposes and will not be shared with anyone other than the researcher and research supervisor, ensuring it is solely for academic objectives.

Results

Maternal obesity, hypertension, and anemia were significantly associated with adverse neonatal outcomes. Among obese pregnant women, incidences of low birth weight (24.3% vs. 4.9%, p = 0.046), low APGAR scores (27.2% vs. 5.8%, p = 0.047), and NICU admissions (20.4% vs. 4.9%, p = 0.001) were notably higher compared to those with normal weight. Similarly, hypertensive mothers exhibited higher rates of low birth weight (15.5% vs. 13.6%, p = 0.036), low APGAR scores (19.4% vs. 13.6%, p = 0.040), and NICU admissions (16.5% vs. 8.7%, p = 0.039) than their normotensive counterparts. In addition, anemia during pregnancy was linked to increased risks of low birth weight (23.6% vs. 5.8%, p = 0.047), low APGAR scores (26.2% vs. 6.8%, p = 0.018), and NICU admissions (20.4% vs. 4.9%, p = 0.039) compared to non-anemic mothers. These findings highlight the significant impact of maternal comorbidities on neonatal health outcomes.

Discussion

Non-reassuring fetal status (NRFS) is an abnormality in fetal heart rate monitoring that can be detected on a cardiotocography (CTG) scan, such as bradycardia, tachycardia, minimal or absent variability, and recurrent decelerations. These abnormalities often indicate compromised fetal oxygenation and are associated with increased risks of perinatal morbidity and mortality, as well as the need for a neonatal intensive care unit (NICU) due to fetal hypoxia.[1,3] Fetal

Table 2 Correlation of maternal comorbidities and fetal outcomes

Maternal comorbidities	Fetal outcomes		
	Low birth weight	Low APGAR score	NICU
Obesity	OR: 0.046; 95% CI 0.424-0.945	OR: 0.047; 95% CI 0.412-0.426	OR: 0.01; 95% CI 0.135-0.329
Hypertension	OR: 0.036; 95% CI 0.524-0.631	OR: 0.040; 95% CI 0.472-0.514	OR: 0.039; 95% CI 0.295-0.880
Anemia	OR: 0.047; 95% CI 0.311-0.552	OR: 0.018; 95% CI 0.340-0.560	OR: 0.039; 95% CI 0.276-0.560

Note: If the chi-square condition is not satisfied, the p-value for categorical data is determined using the Fisher's exact tests. P value <0.05 for statistically significant.

hypoxia, birth asphyxia, and metabolic acidosis can lead to permanent neurological damage and even perinatal death.[6] Birth asphyxia is defined as a neonatal failure to respire normally during the first minutes after birth, resulting in progressive hypoxia and causing intrauterine acidosis.[3] Non-reassuring fetal status (NRFS) can arise from impaired blood supply, placental transfer, or fetal gas transport.[1] Some maternal comorbid conditions associated with NRFS include cardiovascular disease, anemia, diabetes, hypertension, infection, placental abruption, abnormal fetal presentation, intrauterine growth restriction, and umbilical cord compression.[8,9]

Antenatal care variables, education level, and risk of infection are associated with fetal outcomes in babies born by caesarean section for indications of non-reassuring fetal status.[10] This study conducted a multivariable analysis with a 95% confidence interval and a p-value of less than 0.05, indicating a significant relationship.[3] The study found a significant correlation between the incidence of cesarean section for non-reassuring fetal status (NRFS) and maternal comorbid obesity and low birth weight (OR: 0.046; 95% CI 0.424-0.945); between maternal comorbid obesity and low APGAR score (OR: 0.047; 95% CI 0.412-0.426); and between maternal comorbid obesity and NICU requirement (OR: 0.001; 95% CI 0.135-0.329). According to Gulzhan et al., obesity can lead to several pregnancy complications, including hypertension, impaired fetoplacental perfusion (fetal distress), low nutrition for babies resulting in low birth weight, increased risk of failed labor induction due to less sensitive oxytocin receptors, and neonatal asphyxia (low APGAR score at minutes 1 and 5).[11–14] The pathomechanism explaining this condition is caused by endothelial dysfunction, oxidative stress, and insulin resistance, all of which are common in obese mothers. Intra-abdominal adipose tissue in obese mothers becomes a mechanical inhibiting factor or may exert mechanical pressure, further restricting venous return and oxygen transport to the fetus, which causes fetal distress.[15] Excess adipose tissue contributes to chronic low-grade inflammation; these factors impair endothelial function and reduce nitric oxide bioavailability, leading to vasoconstriction and decreased uteroplacental blood flow. These changes increase the risk of fetal hypoxia, low birth weight due to inadequate nutrient transfer, and perinatal asphyxia resulting in low APGAR scores and NICU admission.

The study found a significant correlation between the incidence of cesarean section for non-reassuring fetal status (NRFS) and maternal comorbid hypertension as well as low birth weight (OR: 0.036; 95% CI 0.524-0.631). It also noted a link between maternal comorbid hypertension and low APGAR score (OR: 0.040; 95% CI 0.472-0.514), as well as between maternal comorbid hypertension and NICU requirement (OR: 0.039; 95% CI 0.295-0.880). Steer PJ et al. reported in a retrospective cohort study a significant relationship between high blood pressure during pregnancy and low birth weight, specifically in those weighing less than 2500 g.[16] Hypertension during pregnancy can lead to endothelial dysfunction and decreased uteroplacental perfusion, resulting in uteroplacental vasculopathy. This condition, characterized by histopathological lesions and intravascular coagulation, can cause growth disorders in the fetus.[16–18] Increased blood pressure affects the development of the placental villous tree, thereby reducing placental function early on, which diminishes the fetus's birth weight.[19] Additionally, hypertension in pregnancy adversely impacts fetal outcomes, including low APGAR scores and the need for NICU care, due to placentation abnormalities, inadequate uteroplacental blood flow, and long-term placental ischemia.[20] Histopathological

findings often reveal fibrinoid necrosis, atherosis, and infarctions within the placenta, all of which compromise oxygen and nutrient exchange. Consequently, fetal adaptive responses such as the redistribution of blood flow to vital organs may occur. However, when decompensated, this can lead to NRFS, intrauterine growth restriction (IUGR), and poor neonatal outcomes.

The study found a significant correlation between the incidence of cesarean sections and non-reassuring fetal status (NRFS) with maternal comorbid anemia and low birth weight (OR: 0.047; 95% CI 0.311-0.552); between comorbid maternal anemia and low APGAR scores (OR: 0.018; 95% CI 0.340-0.560); and between comorbid maternal anemia and NICU requirements (OR: 0.039; 95% CI 0.276- 0.560). Physiological changes occur during pregnancy, specifically an increase in red blood cell volume by 30% and plasma volume from 45% to 55%. These changes occur from 6 to 32 weeks of gestation, a phenomenon known as the hemodilution effect. Hemoglobin functions as a transport medium for oxygen and nutrients (oxygen binding capacity: 1.34 ml O2/gr) [21] Anemia, particularly iron deficiency anemia, diminishes maternal oxygen-carrying capacity due to reduced hemoglobin levels. This limits oxygen delivery to the placenta and fetus, resulting in chronic fetal hypoxia.

Additionally, anemia may impair placental development and angiogenesis, affecting villous maturation and capillary network formation. These disruptions can contribute to fetal growth restriction and increase susceptibility to intrauterine distress. Maternal anemia can affect placental angiogenesis, limit the oxygen supply to the fetus, and impair fetal growth, leading to low birth weight. A meta-analysis study found a positive correlation between maternal anemia and the incidence of low birth weight.[9,22] Farah *et al*. found that maternal anemia poses a 2.1x higher risk of giving birth to a baby with a low APGAR score, which can cause neonatal morbidity, than mothers with normal hemoglobin levels. [23] Maternal anemia as a risk factor for NRFS conditions will increase mortality and morbidity rates, as well as the need for neonatal intensive care units (NICU).[22]

This study demonstrated a statistically significant association between NRFS-related caesarean sections and the presence of maternal comorbidities: obesity, hypertension, and anemia, with adverse neonatal outcomes (p<0.05). The strength of the study lies in its multivariable analysis, control of confounding variables, and the use of robust statistical measures such as odds ratios and confidence intervals. However, limitations of this study include the retrospective design, potential bias in clinical decision-making for caesarean delivery, and the lack of data on gestational age, timing of onset, or severity of the comorbidities. Moreover, long-term neonatal outcomes were not assessed, which limits the understanding of sustained impacts.

Understanding the underlying pathogenesis and pathophysiology of NRFS in the context of maternal comorbidities is crucial for early identification and intervention. Optimizing maternal health before and during pregnancy, especially by managing chronic conditions, could reduce the incidence of NRFS and improve perinatal outcomes. Future prospective studies with larger cohorts and mechanical evaluations are needed to deepen insight and guide clinical strategies.

Conclusion

The study revealed a positive correlation between the incidence of cesarean sections, an indication of non-reassuring fetal status, and maternal comorbidities such as hypertension, obesity, and anemia, along with infant outcomes like low birth weight,

APGAR scores, and NICU needs. Several other factors, including being a first-time mother, having anemia, starting labor early, amniotic fluid (amnion-meconium) presence, and premature rupture of membranes, were associated with NRFS.

Acknowledgement: none declared.

Financial disclosure or funding: None.

Conflict of interest: No potential conflict of interest relevant to this article was reported.

Ethical Compliance: This study was conducted in compliance with the ethical standards of the responsible institution on human subjects and with the Helsinki Declaration.

Data availability: The datasets used and/or analyzed in the current study are available from the corresponding author on reasonable request.

Consent for publication: Not applicable.

Author contributions: Study concept and design were done by NS and EP; Data collection and statistical analysis by NS and DS; data interpretation and presentation by NS, EP, and DS; manuscript drafting by NS; and research supervision by EP and DS. All authors discussed the results, contributed to the final manuscript, and approved the version for publication.

References

1. Chetandas P, Zahiruddin S, Jabeen N, Baloch R, Shaikh F. Increasing rate of Caesarean Section Due to Non-Reassuring Cardiotocography. Open J Obstet Gynecol. 2017;07(03):351–7.
2. Rimsza R, Stout MJ, Kelly J, Carter EB, Cahill AG, Raghuraman N. 670 Neonatal outcomes after cesarean for non-reassuring fetal status in the first stage of labor. Am J Obstet Gynecol. 2021 Feb;224(2):S421.
3. Belete E, Bazezew Y, Desta M, Misganaw D, Tefera M. Magnitude, Associated Factors and Immediate Outcomes of Non-Reassuring Fetal Heart Rate Status Among Laboring Mothers at South Gondar Zone Public Hospitals, North, West Ethiopia, 2022; Cross Sectional Study. 2022.
4. Belete E, Bazezew Y, Desta M, Misganaw D, Tefera M. Magnitude, Associated Factors and Immediate Outcomes of Non-Reassuring Fetal Heart Rate Status Among Laboring Mothers at South Gondar Zone Public Hospitals, North, West Ethiopia, 2022; Cross Sectional Study. Available from: https://doi.org/10.1101/2022.10.02.22280615
5. Islam MdA, Shanto HH, Jabbar A, Howlader MdH. Caesarean Section in Indonesia: Analysis of Trends and Socio-Demographic Correlates in Three Demographic and Health Surveys (2007–2017). Dr Sulaiman Al Habib Medical Journal. 2022 Sep;4(3):136–44.
6. Lu J, Jiang J, Zhou Y, Chen Q. Prediction of non-reassuring fetal status and umbilical artery acidosis by the maternal characteristic and ultrasound prior to induction of labor. BMC Pregnancy Childbirth. 2021 Dec 6;21(1):489.
7. Gravett C, Eckert LO, Gravett MG, Dudley DJ, Stringer EM, Mujobu TBM, et al. Non-reassuring fetal status: Case definition & guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine. 2016 Dec;34(49):6084–92.
8. Rathoria R, Rathoria E. Effect of maternal anemia on cord blood haemoglobin of newborn. Int J Reprod Contracept Obstet Gynecol. 2021 Dec 28;11(1):64.
9. Adam I, Salih Y, Hamdan HZ.

Association of Maternal Anemia and Cesarean Delivery: A Systematic Review and Meta-Analysis. J Clin Med. 2023 Jan 6;12(2):490.
10. Brizan JB, Amabebe E. Maternal Obesity as a Risk Factor for Caesarean Delivery in Sub-Saharan Africa: A Systematic Review. Life. 2022 Jun 17;12(6):906.
11. Maternal Factors Affecting the Incidence of Low Birth Weight (LBW) in Indonesia. International Journal of Pharmaceutical Research. 2021 Jan 1;13(01).
12. Joewono HT, Sulistyono A, Kahayani NE, Aditiawarman. Maternal obesity: Impact in pregnancy outcome at tertiary referral hospital. Systematic Reviews in Pharmacy. 2020 Apr;11(2):695–8.
13. Monaco-Brown M, Munshi U, Horgan MJ, Gifford JL, Khalak R. Association of Maternal Obesity and Neonatal Hypoxic-Ischemic Encephalopathy. Front Pediatr. 2022 Apr 29;10.
14. Lewandowska M. Maternal Obesity and Risk of Low Birth Weight, Fetal Growth Restriction, and Macrosomia: Multiple Analyses. Nutrients. 2021 Apr 7;13(4):1213.
15. Nkoka O, Ntenda PAM, Senghore T, Bass P. Maternal overweight and obesity and the risk of caesarean birth in Malawi. Reprod Health. 2019 Dec 3;16(1):40.
16. Rocha de Moura MD, Margotto PR, Nascimento Costa K, Carvalho Garbi Novaes MR. Hypertension induced by pregnancy and neonatal outcome: Results from a retrospective cohort study in preterm under 34 weeks. PLoS One. 2021 Aug 18;16(8):e0255783.
17. Liu Y, Li N, An H, Li Z, Zhang L, Li H, et al. Impact of gestational hypertension and preeclampsia on low birthweight and small-for-gestational-age infants in China: A large prospective cohort study. The Journal of Clinical Hypertension. 2021 Apr 28;23(4):835–42.
18. Ramos Filho FL, Antunes CM de F. Hypertensive Disorders: Prevalence, Perinatal Outcomes and Cesarean Section Rates in Pregnant Women Hospitalized for Delivery. Revista Brasileira de Ginecologia e Obstetrícia / RBGO Gynecology and Obstetrics. 2020 Nov 30;42(11):690–6.
19. Hudayah N, Fauziah H, Pratiwi UM, Helvian FA, Dahlan M, Ridha NR, et al. THE RELATION BETWEEN HYPERTENSION IN PREGNANCY WITH LOW BIRTH WEIGT IN MAKASSAR CITY. Jambura Journal of Health Sciences and Research. 2022 Nov 22;5(1):35–41.
20. Mehnaz Gondal, Bushra Sayyed, Rabia Wajid, Ayesha Inayat, Robina Kosar, Sofia Tariq. Poor Apgar Score of Neonates Born to the Females Presenting with Pregnancy Induced Hypertension for Delivery. Pak-Euro Journal of Medical and Life Sciences. 2022 Jun 30;5(2):339–44.
21. Dwipayana CAP, Bayuningrat IGNM, Permatananda PANK, Lestarini A. Anemia in pregnant mothers and the apgar score of newborn babies at secondary refferal hospital, Bali. Science Midwifery. 2023 Apr 11;11(1):69–75.
22. Hamood MA, Abid SJ, Abdulla TN, Akram W. Correlation between Neonatal Outcomes and Maternal Anemia among Attending Pregnant Women in Al-Elwiya Maternity Teaching Hospital. J Pharm Bioallied Sci. 2023 Jul;15(Suppl 2):S1164–7.
23. Shah T, Khaskheli MS, Ansari S, Lakhan H, Shaikh F, Zardari AA, et al. Gestational Anemia and its effects on neonatal outcome, in the population of Hyderabad, Sindh, Pakistan. Saudi J Biol Sci. 2022 Jan;29(1):83–7.