Accessed on: http://jkb.ub.ac.id/index.php/jkb/article/view/3398
Jurnal Kedokteran Brawijaya Vol. 32, No. 4, Agustus 2023, pp. 223-227
Article History: Received 10 April 2023, Accepted 28 July 2023

Research Article

The Relationship between APGAR Score and Delivery Mode with Neonatal Sepsis in Ulin Regional Hospital Banjarmasin

Hubungan antara Skor *APGAR* dan Jenis Persalinan dengan Sepsis Neonatal di RSUD Ulin Banjarmasin

Monica Anggriana Salim[1], Pricilia Gunawan Halim[2], Ari Yunanto[3], Pudji Andayani[4]

[1]Department of Pediatrics Ulin Hospital Banjarmasin

[2,3,4]Division of Neonatology Department of Pediatrics Ulin Hospital Banjarmasin

[1,2,3,4]Faculty of Medicine Universitas Lambung Mangkurat Banjarmasin

ABSTRACT

Neonatal sepsis is one of the most common causes of neonatal death worldwide, affecting up to 3 million neonates each year. Deaths related to neonatal sepsis are more common in developing countries with lower middle incomes. This study aims to find a relationship between APGAR scores at the 1st, 5th, and 10th minutes and delivery mode on the incidence of neonatal sepsis. This research is a retrospective study with a cross-sectional approach at High-Risk Neonatal Installation (INRiT) of Ulin Regional Hospital Banjarmasin, South Kalimantan, conducted from January to December 2022. The total sample was 200 babies divided into the sepsis and the control group. APGAR score data at the 1st, 5th, and 10th minutes and delivery mode were taken through medical records. In this study, the average APGAR score at 1st minute in the sepsis group was 5.11; at 5th minute was 6.56; and at 10th minute was 7.65. The results of APGAR score analysis at the 1st, 5th, and 10th minutes in the sepsis and control groups using the Mann -Whitney test obtained a p-value of 0.000. In the sepsis group, 30 babies were born spontaneously, and 70 babies were born with tools (caesarean section/vacuum extraction). The results of the delivery mode analysis in the sepsis and control groups using Fisher's test obtained a p-value of 0.000 (OR: 3.807) which means that there is a relationship between the APGAR score at the 1st, 5th, and 10th minutes and the delivery mode with the incidence of neonatal sepsis.

Keywords: *APGAR score, delivery mode, neonatal sepsis*

ABSTRAK

Sepsis neonatal merupakan salah satu penyebab kematian terbanyak neonatal di dunia yang mempengaruhi hingga 3 juta neonatus setiap tahun. Kematian terkait sepsis neonatal lebih sering ditemukan pada negara berkembang dengan pendapatan menengah ke bawah. Penelitian ini bertujuan untuk mencari hubungan antara skor APGAR menit ke 1,5,10 dan cara persalinan terhadap kejadian sepsis neonatal. Penelitian ini merupakan penelitian retrospektif dengan pendekatan cross sectional di INRiT RSUD Ulin Banjarmasin, Kalimantan Selatan, Januari-Desember 2022. Total sampel sebanyak 200 bayi yang terbagi dalam grup sepsis dan grup kontrol. Data skor APGAR menit ke 1,5,10 dan cara persalinan diambil melalui rekam medis dan kemudian ditabulasi. Pada penelitian ini didapatkan rerata skor APGAR menit ke 1 pada kelompok sepsis sebesar 5,11; menit ke 5 sebesar 6,56; dan menit ke 10 sebesar 7,65. Hasil analisis skor APGAR menit ke 1,5,10 pada kelompok sepsis dan kelompok kontrol menggunakan uji Mann Whitney didapatkan nilai p sebesar 0,000; 0,000; 0,000. Pada kelompok sepsis pada penelitian ini didapatkan 30 bayi lahir spontan dan 70 bayi lahir dengan procedural. Hasil analisis jenis persalinan pada kelompok sepsis dan kontrol menggunakan uji Fisher didapatkan nilai p sebesar 0,000 (OR: 3.807). Terdapat hubungan antara skor APGAR menit 1,5,10 dan jenis persalinan dengan kejadian sepsis neonatal.

Kata Kunci: Cara persalinan, sepsis neonatal, skor APGAR

Correspondence: Monica Anggriana Salim. Department of Pediatrics Ulin Hospital , Jl. A. Yani Km. 2,5 No. 43, RW.05, Sungai Baru, Kec. Banjarmasin Tengah, Kota Banjarmasin, Kalimantan Selatan 70233 Tel. +62821571960472 Email: monica.ang.salim@gmail.com

DOI: http://dx.doi.org/10.21776/ub.jkb.2023.032.04.4

INTRODUCTION

Neonatal sepsis is an infection that can be life-threatening. Neonatal sepsis is the most common cause of child mortality worldwide, affecting up to 3 million neonates each year. Deaths from neonatal sepsis are more common in developing countries with lower middle incomes (1).

The Global Burden of Disease (GDB) 2016 estimated that there were 1.3 million annual neonatal sepsis cases (937 cases per 100,000 live births), with an estimated rate of 203,000 deaths related to sepsis. Fleischmann *et al.*, conducted meta-analysis research in 2020, stating that for the period 1979-2019, there were 2,824 cases per 100,000 live births, with an estimated mortality rate of 17.6% (95% CI 1892 to 4194) (2).

World Health Organization (WHO) 2019 declared that Indonesia is in the place of 7th as the country with the higher neonatal mortality rates, with an estimation of 60,000 neonatal death each year (3). Indonesia Health Profile data in 2020 stated that there were 28,158 under-fifth-year deaths, most of which happened at neonatal age (approximately 72%) (4).Neonatal infection and sepsis were the most common cause of neonatal mortality in High-Risk Neonatal Installation (INRiT) at Ulin Regional Hospital Banjarmasin in 2021 (45.5%).

Global Antibiotic Research & Development Partnership (GARDP) conducted research in 2022, with a total sample of more than 3,200 neonates in 19 places in 11 countries in the world, states that the mortality rate due to neonatal sepsis in the first 28 days of life is considered high at 11.3% and 17.7% in cases where a positive culture was found. Fifty-nine percent of deaths from infections are caused by nosocomial infections (1).

Risk factors for neonatal sepsis can be divided into two main groups, including neonatal risk factors and maternal risk factors. Several preliminary studies state that neonatal risk factors include gender, birth weight, APGAR score at birth, gestational age, and location of delivery. Maternal risk factors include education level, socioeconomic status, number of antenatal visits, type of delivery, history of premature rupture of membranes for more than 12 hours, history of urinary tract infection in pregnancy, and presence of multiple pregnancies (5,6).

Yismaw's research in 2019 stated that neonates with low APGAR scores at birth were 2.7 times more at risk of experiencing neonatal sepsis (AOR=2.69), neonates with low APGAR scores can trigger immunological reactions and tend to have a history of resuscitation at birth (7).

Hikmah's 2016 study in East Nusa Tenggara states that babies born with surgical procedures were 2,142 times more at risk of experiencing neonatal infections (p=0.000). Neonatal infection caused by the delivery modelivery may be influenced by contaminated delivery tools (8).

This study aimed to determine the relationship between the APGAR score and the delivery mode with the incidence of neonatal sepsis, especially at Ulin General Hospital, Banjarmasin.

METHOD

This study aimed to assess the relationship between APGAR Score and delivery mode with the incidence of neonatal sepsis with a cross-sectional approach. Samples obtained by purposive sampling method for each group. This research was conducted at the High-Risk Neonatal Installation (INRiT) at Ulin Regional Hospital, Banjarmasin, from January to December 2022. The inclusion criteria in this study were all patients diagnosed with sepsis, both clinical or proven with positive culture results. APGAR score data, delivery mode, and sepsis diagnosis obtained from the patient's medical record data. This study was approved by the ethics committee of Ulin Regional Hospital, Banjarmasin (No. 95/VII-Reg Riset/RSUDU/22).

Operational Definition

Sepsis group was characterized by clinical feature which include: 1. General state: bad appearance baby, poor feeding, hyper/hypothermia, edema, sclerema; 2. Central nervous system: hypotonia, irritable, high pitch cry, seizure, lethargy, tremor, bulging fontanel; 3. Respiratory system: irregular breath, fast breathing (>60x/minute), apnea, dyspnea, cyanosis; 4. Cardiovascular system: tachycardia (>160 beats/ minute), bradycardia (<60 beats/minute), cold extremity, shock; 5. Gastrointestinal system: gastric retention, hepatomegaly, diarrhea, vomiting, distended abdomen; 6. Hematology system: jaundice, pale, splenomegaly, petechia, purpura, bleeding. Proven sepsis if there are 3 clinical features from 6 systems, with positive blood culture. Sepsis clinic if there are 3 clinical features without blood culture.

Control group was characterized by healthy infants (non-sepsis case) born in Ulin Regional Hospital. APGAR score data that we collect is APGAR score in 1th minute, 5th minute, and 10th minute after baby was born. We categorized delivery mode by two group; procedural group (caesarean section and vacuum extraction) and spontaneously (without the help of tools).

Data Analysis

Statistical analysis in this study used SPSS 26 software. The data of delivery mode and APGAR score were analyzed using the Kolmogorov-Smirnov normality test. Relationship between APGAR score and sepsis neonatorum was analyzed with an unpaired T-test if data normally distributed; whereas, if the data is not normally distributed, then the data analysis is continued with Mann Whitney alternative test with a confidence level of 95%. Relationship between delivery mode and sepsis neonatorum was analyzed with the Chi-Square test if the data is normally distributed; whereas, if the data is not normally distributed, then the data analysis is continued with Fisher's alternative test with a confidence level of 95%.

RESULTS

This study included 200 infants divided into two groups; the sepsis group consisted of 100 infants with sepsis, and the control group consisted of 100 healthy infants. The characteristics of the participants can be seen in Table 1.

Table 1. Characteristics of respondents

Characteristic	Sepsis Group (n=100)	Control Group (n=100)
Gender		
Male	64	46
Female	36	54

Table 1. Characteristics of respondents (Cont.)

Characteristic	Sepsis Group (n=100)	Control Group (n=100)
Delivery mode		
Spontaneous	30	62
With tools (Caesarean Section/ Vacuum Extraction)	70	38
Gestation Age	36	38.56
Birth Weight	2286.4	3041.4
Parity	2.02	2.3
Mother Age	29.48 years	30.4 years
Length of hospitalization	13.9 days	0.66 day
Mortality Rate		
Health	77	100
Death	18	0
Home by family request	5	0

Table 2 includes data regarding APGAR scores in the two study groups. The average APGAR score in the 1st minute in the control group was 7.04, while the average in the sepsis group was 5.11. The mean APGAR score in the 5th minute in the control group was 8.06, while the mean in the sepsis group was 6.56. The mean APGAR score at the 10th minute in the control group was 9.06, while the mean in the sepsis group was 7.65. Data analysis using the Kolmogorov-Smirnov test obtained that all data was not normally distributed ($p < 0.05$). Data analysis was continued using the Mann-Whitney analysis test with a 95% confidence level. APGAR score data analysis at the 1st minute, 5th minute, and 10th minutes for the control group and the sepsis group using the Mann- Whitney test obtained a p-value of 0.000 ($p < 0.05$); therefore, there was a relationship between the APGAR score and the incidence of neonatal sepsis.

Tabel 2. APGAR score and sepsis

	Sepsis Group (n=100) Mean	Control Group (n=100) Mean	Normality Test	P-Value
1st minute	5.11	7.04	0.00	0.000
5th minute	6.56	8.06	0.00	0.000
10th minute	7.65	9.06	0.00	0.000

Table 3 includes data on the delivery mode in the two study groups. In the control group, there were 62 babies born spontaneously without tools and 38 babies born with tools (Caesarean section/Vacuum extraction). In contrast, in the case group, there were 30 babies born spontaneously without tools and 70 babies born with tools (Caesarean section/Vacuum extraction). Data analysis using the Kolmogorov-Smirnov test found that the data were not normally distributed ($p < 0.05$), so data analysis was continued with Fisher's alternative test analysis with a 95% confidence level. Analysis of data on the delivery mode for the control group and the sepsis group using Fisher's test obtained a p-value of 0.000 ($p < 0.05$); therefore, there was a relationship between the delivery mode and the incidence of neonatal sepsis. In addition, an odds ratio (OR) of 3.807 was obtained to conclude that babies born with tools intervention were 3.807 times more at risk of experiencing neonatal sepsis.

Table 3. Delivery mode and sepsis

	Sepsis Group (n=100)	Control Group (n=100)	Normality Test	P-Value
With tools Caesarean Section Vacuum Extraction)	70 (65/70) (5/70)	38 (34/38) (4/38)	0.00	0,000 (OR= 3.807)
Spontaneous without tools	30	62	0.00	

This is a retrospective study in which data was gained from patients' medical records at the High-Risk Neonatal Installation at Ulin General Hospital, Banjarmasin, from January to December 2022. The sample in this study was 200 infants consisting of 100 infants with sepsis and 100 healthy infants. Neonatal sepsis is a systemic inflammatory syndrome in infants; within the first 28 days of life in response to suspected or proven infections accompanied or not accompanied by bacteremia, documented by positive blood culture results (9,10).

This study involved 200 infants from 100 control group infants (healthy) and 100 sepsis group (infants with sepsis). The sepsis group consisted of 64 male infants and 36 female infants, whereas in this study, the number of male infants who experienced sepsis was higher than female infants. Research by Noah et al. in 2022 states that the male gender is 3.7 times more at risk of experiencing early-onset sepsis than the female gender. The mechanism underlying this is still unclear, but it is believed that several factors, such as genetic, immunological, and hormonal influences, and factors related to the X gene in baby girls can affect the baby's immune system (6). A theory states that the level of pro-inflammatory cytokines IL-6 is higher in male infants with sepsis than in female infants with a similar case. Another theory states that hormonal differences in male (higher androgen level) and female infants (higher estrogen hormone) can affect immune response (11).

In this study, the mean birth weight in the case group was 2,286.4 grams (mostly low birth weight), and in the control group was 3,041.4 grams. A study by Dirirsa *et al.,* states that babies with low birth weight (LBW) are 5.3 times more at risk of experiencing sepsis than babies with normal birth weight. Sepsis in low-birth-weight babies can be caused by changes in the immune system in LBW babies, a decrease in the immune system so that the baby is more susceptible to infection (12).

In this study, the mean gestational age in the sepsis group was 36 weeks, and in the control group was 38.56 weeks. Belachew's study states that infants with a gestational age of <37 weeks are 3.36 times more at risk of experiencing neonatal sepsis than full-term neonates (13). Jimenez's study in 2022 found that infants with sepsis with prematurity (gestational age of < 37 weeks) have 13.92 times greater risk of death (2).

The Relationship between APGAR score and Neonatal

Sepsis in Ulin General Hospital, Banjarmasin

The mean APGAR score at the 1st minute in this study's infants with sepsis group was 5.11, lower than the control group, which was 7.04. The mean APGAR score at the 5th minute in this study's infants with sepsis group was 6.56, lower than the control group, namely 8.06. The mean APGAR score at the 10th minute in the infants with sepsis group in this study was 7.65, lower than the control group, which was 9.06. Analysis of the 1st, 5th, and 10th-minute APGAR score data in the sepsis and control groups concluded a relationship between low APGAR scores and the incidence of neonatal sepsis (0.000).

APGAR score does not determine the initial need for intervention as resuscitation. The APGAR score consists of components: appearance (skin color), pulse (heart rate), grimace (irritability reflex), activity (tonus), and respiration, where each element has a score of 0, 1, and 2 with a full score of 10. APGAR score of 0-1 at the 1st minute is not a predictor of adverse clinical outcomes or long-term health issues. A low APGAR score at the 5th minute correlate with mortality and may increase the risk of cerebral palsy in population studies (14). A comparative analysis study by Njie et al. in 2023 studied the effectivity comparison between APGAR score to diagnose birth asphyxia and the gold standard by the American Academy of Pediatrics (AAP) ((i) profound metabolic or mixed acidemia (pH<7,00) in umbilical artery blood sample, (ii) persistence of an APGAR score of 0-3 for longer than 5 min, (iii) neonatal neurologic sequel (seizures, coma, hypotonia), and (iv) multiple organ involvement (kidney, lung, liver, heart, intestines)). APGAR score had a sensitivity of 71% and specificity of 89 %. This study concludes that there is a need to adopt the gold standard of birth asphyxia diagnosis into the hospital-based neonatal management guidelines at the tertiary hospital and other resource-constrained healthcare settings (15).

A systematic study review by Lidya *et al.,* states that an APGAR score at the 5th minute less than 7 is a risk predictor of neonatal sepsis (p <0.01). Infants with the APGAR score at the 1st minute below 7 are 1.5 times more at risk of experiencing infection (p =0.01). Meanwhile, infants with a low APGAR score at the 5th minute are 3.47 times more at risk of infection and can cause death than infants with a normal APGAR score (p =0.000). Resuscitation intervention after birth can cause exposure to resuscitation equipment which can lead to sepsis (16).

A case-control study by Akalu *et al.,* states that infants with an APGAR score at 1st minute <7 were estimated to be three times more at risk of experiencing neonatal sepsis than infants with an APGAR score of ≥7 (AOR=3.2). A low APGAR score may contribute to neonatal asphyxia and may require emergency assistance; this can lead to exposure to pathogenic microorganisms due to using unsterile tools. Resuscitation at birth is strongly associated with the risk of neonatal sepsis. Infants who received resuscitation assistance at birth were five times more likely to experience sepsis than those who did not receive resuscitation assistance (AOR=5.4) (17). There is a relationship between low APGAR scores and the incidence of neonatal sepsis in this study. This study didn't include: the history of resuscitation after babies were born, infection risk factors (major and minor), and the history of medical devices used during hospitalization.

The Relationship between Delivery Mode and Neonatal Sepsis in Ulin General Hospital Banjarmasin

The sepsis group consisted of 70 babies born by procedure (cesarean section (65 babies) and vacuum extraction (5 babies)) and 30 babies born spontaneously. It was found that in the sepsis group, there were more births by the procedure. The healthy group consisted of 38 babies born by procedure (cesarean section and vacuum extraction) and 62 babies born spontaneously. Babies born from procedural delivery mode (cesarean section and vacuum extraction) are more at risk 3.807 times to develop sepsis neonatorum than babies born spontaneously. (p=0.000; OR=3.807)

Research by Coelho *et al.,* states that spontaneously born babies have high concentrations of Bacteroides, Bifidobacterial, and Lactobacillus on the first day of life and have more significant microbiological variability in the following weeks. The microbiological characteristics of infants born by section are similar to the microbiology of the maternal skin or in the hospital environment, such as Staphylococcus, Streptococcus, and Clostridium, with fewer microbiological variations. Microbiology of the maternal vagina can support microbiological colonization of the baby, which is useful for enhancing and preparing the immune system (Treg cell response); therefore, spontaneous delivery is considered the ideal delivery mode, while cesarean delivery may only be performed if there is a medical indication. (18).

Cohort studies in several countries in 2020 state that babies born by section are at greater risk of developing infections than babies born spontaneously (CI 1.09-1.12, p<0.001). The increased risk of infection can persist for up to 5 years; the highest risk of infection occurs in respiratory, gastrointestinal, and viral infections. Section delivery method can be a lifesaving intervention for mother and baby and is a major surgical procedure in many countries. It is estimated that there are 6.2 million sections performed without medical indications worldwide. This study states that there is a relationship between the delivery mode and the incidence of hospitalization related to infection in 5 populations in 4 countries. The hypotheses of this study included hospitalization related to infection associated with children born by elective cesarean delivery who were not exposed to maternal vaginal microbiology during delivery; and the presence of foci of infection such as in the respiratory tract and digestive tract which are affected by the absence of an optimal mucosal response due to the absence of inoculation from maternal vaginal microbiology (19).

A literature review study by Araujo and Guimaraes states that the method of delivery by tools (section/vacuum extraction) was related to the incidence of neonatal sepsis (p=0.026, AOR=6.3). Babies born by section were 4.3 times more at risk of experiencing sepsis (p=0.046, AOR=4.3) (20).

APGAR scores at the 1st, 5th, and 10th minutes in the sepsis group were lower when compared to the control group. In the sepsis group, the most common methods of delivery were procedural deliveries (cesarean section or vacuum extraction). Therefore, in this study, it can be concluded that there is a relationship between the APGAR score and the delivery mode with the incidence of neonatal sepsis at

Ulin Regional Hospital, Banjarmasin, from January to December 2022. There were some limitation in this study which include: the relationship between APGAR score with delivery mode was not conducted in this study, this study didn't conclude data about neonatal resuscitation after babies are born, infection risk factors (major and minor), the use of medical devices (oxygenation supply) during hospital stays. Further studies on the relationship between APGAR score and delivery mode with neonatal sepsis are needed.

CONFLICTS OF INTEREST

None

FUNDING SOURCES

None

ACKNOWLEDGMENT

The author would like to thank the patients and patients' parents who had agreed to become part of this study. The author also would like to thank all the staff in the High-Risk Neonatal Installation (INRiT) of Ulin Regional Hospital Banjarmasin for allowing us to use the patients as subjects in this research. The author would like to thank Julia Kasab, MD for all useful and helpful comments on this manuscript.

REFERENCES

1. The Gobal Antibiotic Research and Development Partnership. *Transforming the Care of Babies with Sepsis*. (Online) 2022. https://gardp.org/wp-content/uploads/2022/10/GARDP-Neonatal-sepsis-study-results-2022.pdf
2. Vizcarra-Jiménez D, Copaja-Corzo C, Hueda-Zavaleta M, *et al. Predictors of Death in Patients with Neonatal Sepsis in a Peruvian Hospital*. Tropical Medicine and Infectious Disease. 2022; 7(11): 1-18.
3. World Health Organization. *Newborns: Improving Survival and Well Being*. (Online) 2020. https://www.who.int/news-room/fact-sheets/detail/newborns-reducing-mortality [accessed 2022 March 11].
4. Kementerian Kesehatan Republik Indonesia. *Profil Kesehatan Indonesia Tahun 2020*. Jakarta: Kemenkes RI; 2021; p. 1–480.
5. Wilar R and Lestari H. *Risk Factors and Clinical Outcomes of Neonatal Sepsis in Manado Tertiary Referral Hospital: A Single-Center Study*. Open Access Macedonian Journal of Medical Sciences. 2022; 10: 93–98.
6. Noah FN, Doya LJ, and Jouni O. *Perinatal Risk Factors and Early Onset of Neonatal Sepsis*. International Journal of Pediatric Research. 2022; 8(1): 1-5.
7. Yismaw AE, Abebil TY, Biweta MA, and Araya BM. *Proportion of Neonatal Sepsis and Determinant Factors among Neonates Admitted in University of Gondar Comprehensive Specialized Hospital Neonatal Intensive Care Unit Northwest Ethiopia 2017*. BMC Research Notes. 2019; 12(1): 1-5.
8. Hikmah EN. *Hubungan Persalinan dengan Tindakan Sectio Caesarea dengan Kejadian Infeksi Neonatorum di RSUD Kabupaten Bima Tahun 2016 (Studi di Wilayah Kerja RSUD Kabupaten Bima Provinsi NTB)*. Jurnal Kebidanan dan Kesehatan Akbid Surya Mandiri Bima. 2018; 5(2): 22-26.
9. Nyenga A, Mukuku O, and Wembonyama S. *Neonatal Sepsis: A Review of the Literature*. Journal of Pediatrics & Child Health Care. 2021; 6(2): 1–6.
10. Tewabe T, Mohammed S, Tilahun Y, *et al. Clinical Outcome and Risk Factors of Neonatal Sepsis among Neonates in Felege Hiwot Referral Hospital, Bahir Dar, Amhara Regional State, North West Ethiopia 2016: A Retrospective Chart Review*. BMC Research Notes. 2017; 10: 1-7.
11. Angele MK, Pratschke S, Hubbard WJ, and Chaudry IH. *Gender Differences in Sepsis: Cardiovascular and Immunological Aspects*. Virulence. 2014; 5(1): 12–19.
12. Dirirsa DE, Degefa BD, and Gonfa AD. *Determinants of Neonatal Sepsis among Neonates Delivered in Southwest Ethiopia 2018: A Case-Control Study*. SAGE Open Medicine. 2021; 9: 1-9.
13. Belachew A and Tewabe T. *Neonatal Sepsis and Its Association with Birth Weight and Gestational Age among Admitted Neonates in Ethiopia: Systematic Review and Meta-Analysis*. BMC Pediatrics. 2020; 20(1): 1-7.
14. Simon LV, Hashmi MF, and Bragg BN. *APGAR Score*. (Online) 2022. https:/www.ncbi.nlm.nih.gov/books/NBK470569/#_NBK470569_pubdet [accessed 2022 June 14].
15. Njie AE, Nyandiko WM, Ahoya PA, and Moutchia JS. *A Comparative Analysis of APGAR Score and the Gold Standard in the Diagnosis of Birth Asphyxia at a Tertiary Health Facility in Kenya*. PLoS One. 2023; 18(5): 1-13.
16. Lidya M, Fetriyah UH, Rahmayani D, and Ariani M. *The Relationship between Apgar Score and Gender with the Incidence of Neonatal Sepsis: Systematic Review*. International Journal of Community Medicine and Public Health. 2021; 8(11): 5473-5480.
17. Akalu TY, Gebremichael B, Desta KW, Aynalem YA, Shiferaw WS, and Alamneh YM. *Predictors of Neonatal Sepsis in Public Referral Hospitals, Northwest Ethiopia: A Case Control Study*. PLoS One. 2020; 15(6): 1-12.
18. Coelho GDP, Ayres LFA, Barreto DS, Henriques BD, Prado MRMC, and Passos CMD. *Acquisition of Microbiota According to the Type of Birth: An Integrative Review*. Revista Latino-Americana de Enfermagem. 2021; 29: 1–11.
19. Miller JE, Goldacre R, Moore HC, *et al. Mode of Birth and Risk of Infection-Related Hospitalisation in Childhood: A Population Cohort Study of 7.17 Million Births from 4 High-Income Countries*. PLoS Medicine. 2020; 17(11): 1-19.
20. Araújo BC and Guimarães H. *Risk Factors for Neonatal Sepsis: An Overview*. Journal of Pediatric and Neonatal Individualized Medicine. 2020; 9(2):1–15.