Effectiveness of Mother's Lullaby on Selected Physiological Parameters among Pre Term Low Birth Weight Neonates in Santom Hospital, Delhi

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Abstract:
Introduction: Preterm infants face significant health challenges, particularly in the Neonatal Intensive Care Unit (NICU) environment, where sensory overload can stress their fragile physiological systems. Auditory interventions, such as maternal lullabies, have shown potential in improving physiological stability by mimicking in-utero sensory stimulation. **Objective:** This pilot study assessed the effects of maternal lullabies on respiratory rate, heart rate, and oxygen saturation in hemodynamically stable preterm, low birth weight neonates. **Methods:** Twenty neonates, born at 28-34 weeks' gestation and weighing 0.8-2.0 kg, were randomly assigned to an experimental group (maternal lullaby) or control group (routine care). Over three days, neonates were exposed to the maternal lullaby "Chanda Mama Dur Ke" for 20 minutes, and their physiological parameters were measured before, during, and after the intervention. Data were analyzed using descriptive statistics and statistical tests, including t-tests and ANOVA. **Results:** In the experimental group, the respiratory rate significantly decreased ($p = 0.000$) from 53.00 to 44.20 breaths per minute, heart rate reduced from 165.60 to 143.20 bpm ($p = 0.000$), and oxygen saturation increased from 90.00% to 95.40% ($p = 0.000$). The control group showed modest improvements, with less pronounced physiological changes. **Conclusion:** Maternal lullabies significantly improved respiratory rate, heart rate, and oxygen saturation in preterm neonates, suggesting that maternal auditory interventions could enhance neonatal care. Further research is recommended to explore the long-term benefits and broader applicability of this intervention in diverse neonatal populations.

Keywords: Pre-term, NICU, lullaby, physiological parameters.

Introduction

Preterm birth, defined as delivery before 37 weeks of gestation, presents significant challenges for newborns, as their underdeveloped systems increase the risk of health complications. Preterm infants often face developmental delays, cognitive impairments, and issues with sensory and neural systems, which can adversely affect their quality of life.[1] These complications are exacerbated in Neonatal Intensive Care Units (NICUs), where premature infants are exposed to harsh, unfiltered stimuli that further stress their fragile physiological states. The NICU environment, particularly the excessive noise, poses a significant challenge to neonatal development, leading to elevated heart rates, respiratory issues, and oxygen deprivation.[2]

A key aspect of early development is the stimulation provided by maternal-infant interactions, particularly through the mother's voice. In the womb, a foetus experiences not only the sound of the mother's voice but also the synchronized movements and vibrations of her body. These stimuli help the foetus develop cognitive and language skills by establishing early sensory processing patterns. Preterm infants, however, are deprived of this natural sensory stimulation in the NICU, where the environment is starkly different from the womb.[3]

Recent studies have explored the potential of using maternal lullabies and other auditory interventions in NICUs to support the development of preterm infants. Maternal lullabies, which combine familiar auditory stimuli with soothing melodies, have been shown to positively impact the physiological parameters of preterm infants.[4] Research indicates that exposure to the mother's voice or lullaby can stabilize heart rate, improve oxygen saturation, and promote relaxation in preterm infants, thus reducing stress and enhancing developmental outcomes. This form of auditory stimulation helps recreate aspects of the intrauterine environment, providing preterm infants with the benefits of maternal interaction, which is often lacking in the clinical setting.[5]

The NICU environment plays a critical role in the well-being of preterm infants. Sensory overload in these units, particularly from noise, disrupts normal development and prolongs hospital stays. Premature babies often exhibit heightened stress responses to these environmental stimuli, which include elevated heart rates, altered skin pigmentation, and episodes of apnoea.[6] This stress negatively impacts their development and can lead to long-term health complications. Addressing the auditory landscape of NICUs is, therefore, an important aspect of improving the care of preterm infants. Reducing excessive noise and incorporating soothing auditory stimuli, such as maternal lullabies, can create a more nurturing environment that supports the physiological stability and neurodevelopment of these vulnerable infants.[7]

Music therapy, particularly involving the mother's lullaby, is emerging as an effective intervention in NICU settings. Studies have demonstrated that the mother's lullaby can regulate respiratory patterns, reduce heart rate, and improve oxygenation in preterm infants.[8] By synchronizing with the infant's physiological rhythms, the lullaby provides

a calming effect, fostering relaxation and promoting sleep, which is essential for growth and development. Additionally, the use of the mother's voice, which is familiar to the infant from the womb, adds a comforting and emotionally supportive element that aids in bonding between the mother and child, even in the clinical environment.[9]

In summary, the rising incidence of preterm births highlights the need for innovative and supportive care strategies in NICUs. Maternal lullabies offer a promising, non-invasive, and cost-effective method for improving the developmental and physiological outcomes of preterm infants. By reducing stress and promoting stability in critical physiological parameters, maternal lullabies could play an integral role in enhancing neonatal care and supporting the early development of preterm infants in NICU settings. Further research in this area could solidify the clinical benefits of incorporating maternal auditory stimulation into standard neonatal care protocols, improving long-term health outcomes for preterm infants.

This pilot research aims to assess the effectiveness of maternal lullabies on selected physiological parameters—specifically respiratory rate, heart rate, and oxygen saturation—among hemodynamically stable preterm, low birth weight neonates. The study evaluates whether the intervention of the mother's lullaby, compared to routine NICU care, can improve these vital physiological outcomes.

Methodology

This study with an aim to assess the effectiveness of maternal lullabies on physiological parameters such as respiratory rate, heart rate, and oxygen saturation among hemodynamically stable preterm, low-birth-weight neonates compares outcomes between infants exposed to maternal lullabies and those who received routine care in the NICU.

The study was conducted in the Neonatal Intensive Care Units (NICUs) of Santom Hospital Pitampura and Santom Hospital Rohini in New Delhi. Administrative clearance was obtained from the NICU authorities of both hospitals before initiating the study. The research investigation was conducted with ethical authorization granted by Institution Ethics Committee. Every parent/guardian of the research participant provided written informed permission. They received assurances regarding the privacy of the data they submitted for the study.

Neonates with gestational age of 28-34 weeks at birth, birth weight between 0.800-2.000 kg, Apgar score of more than 6 at five minutes post-birth were included in the study and those who did not meet these criteria were excluded from the study. 20 neonates were included in this pilot study, 10 in experimental group and control group each. The neonates were randomly assigned to either the experimental or control group, and data were collected using the tools. The physiological parameters of the neonates were measured over three consecutive days for 40 minutes each day. Measurements were taken before, during, and after the lullaby intervention. Continuous monitoring ensured accurate and consistent measurements.

Data collection

Case record form and structured physiological parameters assessment sheet were the two primary tools used for data collection. Case Record Form was used for collection of demographic data and background information of the neonates (age, gender, birth weight, gestational age, and feeding practices) and maternal factors (age, weight, antenatal risk factors, medical history, and mode of delivery). While the Structured Physiological Parameters Assessment Sheet recorded the neonates' physiological parameters, including respiratory rate, heart rate, and oxygen saturation, both before and after the intervention.

The intervention for the experimental group was the maternal lullaby, specifically the traditional song “Chanda mama dur ke,” which was familiar across different cultures. The mothers were asked to sing the lullaby to their neonates for 20 minutes, providing a soothing auditory stimulus. The physiological parameters of the neonates were recorded at three intervals: at Baseline (recorded 10 minutes before the intervention began), during mid-intervention (Recorded 20 minutes after the lullaby started), at post-intervention (recorded 10 minutes after the lullaby ended). In contrast, the control group received no auditory intervention, and their physiological parameters were recorded at corresponding time points for comparison. Both groups were monitored using a multichannel monitor, which provided real-time data on oxygen saturation, heart rate, and respiratory rate.

The data were analysed using SPSS version 22. Descriptive statistics, including means and standard deviations, were used to summarize the data. Various statistical tests including Friedman Test, t-test and ANOVA. A p-value of less than 0.05 was considered statistically significant.

Results

This pilot study evaluated the effect of exposure to Mother’s Lullaby on the physiological parameters of pre-term low birth weight neonates compared to routine care. The parameters measured were respiratory rate, heart rate, and oxygen saturation before, during, and after the intervention.

Demographic Characteristics of Neonates

The demographic characteristics of the neonates in the study sample are presented in **Table 1 and depicted graphically in Graph 1 through Graph 5. The majority of neonates (30%) were between 4-6 days old, while 15% were aged 10-12 days. The mean age was 2.45 days with a standard deviation of 1.234 days. The neonates were predominantly male (55%) and the mean birth weight was 3.75 Kg. The most frequent gestational age was 32+1 to 34 weeks (35%), with the least frequent being 28+1 to 30 weeks (5%). The majority of neonates (40%) were fed both breast milk and formula, while 25% were exclusively formula-fed. These trends indicate a diverse neonatal sample in terms of age, gender, weight, gestational age, and feeding practices.

Demographic Characteristics of Mothers

Table 2 and Graph 6 through Graph 10 present the demographic characteristics of the mothers. The mothers were mostly between 18 and 26 years old (70%), and none were over 30 years of age. The most common antenatal risk factor was hyperemesis (20%), while bleeding per vaginum and leaking per vaginum were the least common (15% each). The most frequent medical issue was severe anemia (25%), and heart disease was the least common (5%). There was an equal number of vaginal deliveries and cesarean sections (50% each). This data suggests that the maternal group was relatively young, of low weight, and exhibited diverse medical histories and risk factors.

Table 3 represents the physiological Parameters of Neonates in the Experimental Group measured before, during, and after the lullaby intervention. The mean respiratory rate decreased from 53.00 breaths per minute (pre-intervention) to 44.20 breaths per minute (post-intervention), with a statistically significant difference ($p = 0.000$). Similarly, the mean heart rate dropped from 165.60 to 143.20 beats per minute, a significant reduction ($p = 0.000$). The oxygen saturation levels increased significantly from 90.00% to 95.40% ($p = 0.000$). These results indicate a substantial improvement in respiratory and heart rates and oxygen saturation following exposure to the Mother's Lullaby.

Physiological Parameters of Neonates in the Control Group

Table 4 shows the physiological parameters of the control group, which received routine care.

There was a significant reduction in the respiratory rate from 51.20 to 48.20 breaths per minute ($p = 0.005$). The heart rate decreased slightly from 163.80 to 161.20 beats per minute, though the changes were not statistically significant ($p = 0.097$). Oxygen saturation increased from 90.60% to 92.40%, a statistically significant change ($p = 0.008$). Although the control group exhibited some improvements, the effects were not as pronounced as those observed in the experimental group.

Comparison Between Experimental and Control Groups

Table 5 compares the physiological outcomes between the control and experimental groups. There was no significant difference between the groups pre- and during intervention; however, post-intervention, the experimental group showed a significantly lower respiratory rate compared to the control group ($p = 0.043$). Similarly, while there were no significant differences in heart rates pre- and during intervention, the experimental group had a significantly lower heart rate post-intervention ($p = 0.001$). The experimental group exhibited a significantly higher oxygen saturation than the control group after the intervention ($p = 0.003$). These findings suggest that the lullaby intervention had a more substantial impact on the physiological parameters of neonates than routine care alone.

Table 6 presents the results for respiratory rate, heart rate, and oxygen saturation across both groups. Significant differences were observed in post-intervention respiratory rates between the two groups ($p = 0.043$). Post-intervention heart rates showed a highly

significant difference (p = 0.001). The post-intervention oxygen saturation levels were also significantly different between the groups (p = 0.003).
These results confirm that the intervention of Mother's Lullaby had a statistically significant impact on neonatal physiological outcomes.

Discussion

Preterm birth remains a critical issue in neonatal care due to the vulnerability of preterm infants to various health complications. These infants, born before 37 weeks of gestation, often face underdeveloped physiological systems, making them susceptible to developmental delays, cognitive impairments, and sensory issues. Among these challenges, the auditory environment of Neonatal Intensive Care Units (NICUs) has emerged as a significant factor affecting neonatal outcomes. The findings of this pilot study suggest that maternal lullabies can significantly enhance the physiological stability of preterm infants, thereby offering a promising intervention in neonatal care.
Preterm neonates are admitted to NICUs for specialized care, as they require continuous monitoring and interventions to survive and develop. However, the NICU environment itself, with its excessive noise levels, bright lights, and lack of familiar stimuli, can be overwhelming for preterm infants, whose sensory systems are still developing. Several studies have indicated that environmental stressors in the NICU can adversely affect the autonomic and physiological responses of neonates, leading to elevated heart rates, increased respiratory effort, and diminished oxygen saturation levels.[10, 11] Therefore, the NICU environment, while crucial for providing life-saving interventions, can paradoxically also contribute to the stress and instability of preterm infants.
In this study, the physiological outcomes of neonates in the control group who were exposed solely to the standard NICU environment were generally less favourable compared to those in the experimental group exposed to maternal lullabies. Although there was some improvement in respiratory rates, heart rates, and oxygen saturation in the control group, the changes were not as pronounced or consistent as those observed in the experimental group. These findings are consistent with research conducted by Symington A and Pinelli J indicating that routine NICU care, without environmental modifications or interventions, may not fully support the developmental needs of preterm infants.[12]
The present study supports the growing body of evidence suggesting that maternal auditory interventions can have a significant positive effect on the physiological stability of preterm neonates. The lullaby intervention resulted in statistically significant improvements in respiratory rate, heart rate, and oxygen saturation, demonstrating that maternal voice-based interventions can recreate aspects of the prenatal environment. By familiarizing neonates with their mother's voice, these interventions appear to offer a sense of comfort and calm, which can help mitigate the stress associated with NICU settings.

The mechanisms by which maternal lullabies affect neonatal physiological outcomes are not fully understood, but several hypotheses have been proposed. One possibility is that the familiar sound of the mother's voice and the rhythmic patterns of lullabies mimic the in-utero environment, which is characterized by steady and rhythmic auditory stimuli. The rhythmic patterns of lullabies may entrain the infant's physiological rhythms, leading to improved regulation of breathing and heart rate.[13] This hypothesis is supported by the findings of this study, where neonates exposed to maternal lullabies exhibited lower respiratory rates and heart rates compared to the control group, alongside higher oxygen saturation levels.

Additionally, maternal lullabies may provide emotional and psychological benefits to both the neonates and their mothers, which could contribute to the improved physiological outcomes observed.[14] The act of singing to a preterm infant in the NICU may enhance maternal bonding and reduce the stress that mothers often experience when separated from their newborns. The psychological comfort provided by maternal voice interventions could further promote neonatal well-being by fostering a supportive and nurturing environment, even within the clinical setting.[15]

The findings of this study have important clinical implications for the care of preterm infants in NICU settings. First and foremost, the significant improvements in physiological outcomes observed with the maternal lullaby intervention suggest that such auditory interventions should be incorporated into routine neonatal care. Given the low cost and non-invasive nature of maternal lullabies, this intervention offers a feasible and accessible method for improving neonatal outcomes across diverse clinical settings.[16]

NICUs should consider implementing protocols that encourage maternal involvement through auditory stimulation, whether through live singing or recorded maternal voices.[17] These interventions not only benefit the neonate but also help mothers feel more connected to their infants, potentially reducing maternal anxiety and enhancing the overall experience of care. In situations where mothers cannot be physically present, recorded maternal lullabies could serve as a valuable alternative, ensuring that preterm infants still receive the benefits of maternal auditory stimulation.[18]

Future research should aim to further investigate the long-term benefits of maternal lullabies and other auditory interventions on preterm neonates. While the present study focused on short-term physiological outcomes, it is critical to explore whether these interventions contribute to improved cognitive, emotional, and neurological development as the child grows. Longitudinal studies that track developmental milestones, language acquisition, and emotional regulation in preterm infants exposed to maternal lullabies would provide valuable insights into the lasting effects of these interventions.

Although the significant differences between the experimental and control groups suggest that maternal lullabies have a meaningful impact, larger studies are needed to

confirm these findings and ensure that they apply to a broader population of preterm infants.

Additionally, this study focused exclusively on preterm, low-birth-weight neonates who were hemodynamically stable. It is unknown whether similar benefits would be observed in more critically ill neonates or those with different health conditions. Future studies should investigate the potential benefits of maternal lullabies in a wider range of neonatal populations, including those with more severe complications or different gestational ages.

Conclusion

In conclusion, the current study provides compelling evidence that maternal lullabies, such as "Chanda Mama Dur Ke," can significantly improve the physiological outcomes of preterm neonates in NICU settings. The reduction in respiratory and heart rates, alongside the increase in oxygen saturation, demonstrates that maternal voice-based interventions offer a simple yet effective means of enhancing neonatal care. By recreating aspects of the intrauterine environment and promoting maternal-infant bonding, these interventions hold great promise for improving the developmental outcomes of preterm infants. As the incidence of preterm births continues to rise globally, integrating maternal lullabies into routine NICU care could play a crucial role in supporting the health and well-being of this vulnerable population. Further research is needed to solidify the clinical benefits of maternal lullabies and establish their place in standardized neonatal care protocols.

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Table 1: Demographic characteristics of the study sample (Neonatal parameters)

N=20

Characteristics		Frequency	Percentage	Mean ± SD
Age of Neonate	4-6 days	6	30.0	2.45 ± 1.234
	7-9 days	5	25.0	
	10-12 days	3	15.0	
	More than 12 days	6	30.0	
Gender	Male	11	55.0	1.45 ± 0.510
	Female	9	45.0	
Weight of Neonate at birth	0.800-1.000 Kg	3	15.0	3.75 ± 1.773
	1.001-1.200 Kg	2	10.0	
	1.201-1.400 Kg	4	20.0	
	1.401-1.600 Kg	4	20.0	
	1.601-1.800 Kg	2	10.0	
	1.801-2.000 Kg	5	25.0	
Gestational age of Neonate	28+1- 30 weeks of gestation	1	5.0	2.90 ± 0.912
	30+1- 32 weeks of gestation	6	30.0	
	32+1- 34 weeks of gestation	7	35.0	
	34+1- 36 weeks of gestation	6	30.0	
Feeding Practices	Breastfeeding	7	35.0	2.05 ± 0.887
	Formula feeding	5	25.0	

	Both Breastfeeding & Formula feeding	8	40.0	

Table 2: Demographic characteristics of mothers of the study sample (Maternal parameters)

N=20

Characteristics		**Frequency**	**Percentage**	**Mean ± SD**
Maternal Age	18-22 years	7	35.0	1.95 ± 0.826
	22-26 years	7	35.0	
	26-30 years	6	30.0	
	>30 years	0	0	
Maternal Weight	<40 Kg	5	25.0	2.20 ± 0.894
	40-45 Kg	7	35.0	
	45-50 Kg	7	35.0	
	50-55 Kg	1	5.0	
	>55 Kg	0	0	
Antenatal Risk Factors	Bleeding per Vaginum	3	15.0	3.60 ± 1.759
	Fever	4	20.0	
	Hyperemesis	2	10.0	
	Leaking per Vaginum	3	15.0	
	UTI	5	25.0	
	None of the above	3	15.0	
Maternal Medical History	PIH	4	20.0	3.00 ± 1.556
	Severe Anemia	5	25.0	
	Hypothyroidism	4	20.0	

	Heart Disease	1	5.0	
	None of the above	6	30.0	
Mode of Delivery	Normal Vaginal Delivery	10	50.0	1.50 ± 0.513
	Lower Segment Cesarean Section	10	50.0	
	Forceps assisted Delivery	0	0	
	Vacuum assisted Delivery	0	0	

Table 3: Physiological Parameters (Respiratory Rate, Heart Rate, and Oxygen Saturation) Before, During, and After Intervention in Experimental Group

N=10

Groups	**Pre-intervention Mean ± SD**	**During intervention Mean ± SD**	**Post-intervention Mean ± SD**	**p-value**
Respiratory Rate	53.00 ± 6.616	48.40 ± 4.695	44.20 ± 3.706	.000
Heart Rate	165.60 ± 8.934	156.80 ± 7.786	143.20 ± 10.465	.000
Oxygen Saturation	90.00 ± 2.211	92.60 ± 2.413	95.40 ± 1.838	.000

Table 4: Physiological Parameters (Respiratory Rate, Heart Rate, and Oxygen Saturation) Before, During, and After Intervention in Control Group

N=10

Groups	**Pre-intervention Mean ± SD**	**During intervention Mean ± SD**	**Post-intervention Mean ± SD**	**p-value**
Respiratory Rate	51.20 ± 5.007	48.80 ± 5.095	48.20 ± 4.467	.005
Heart Rate	163.80 ± 10.218	162.80 ± 9.295	161.20 ± 9.716	.097

Oxygen Saturation	90.60 ± 2.503	90.90 ± 2.644	92.40 ± 2.011	.008

Table 5: Comparison of Mean Physiological Parameters Between Neonates in the Control Group and Intervention Group

N=20

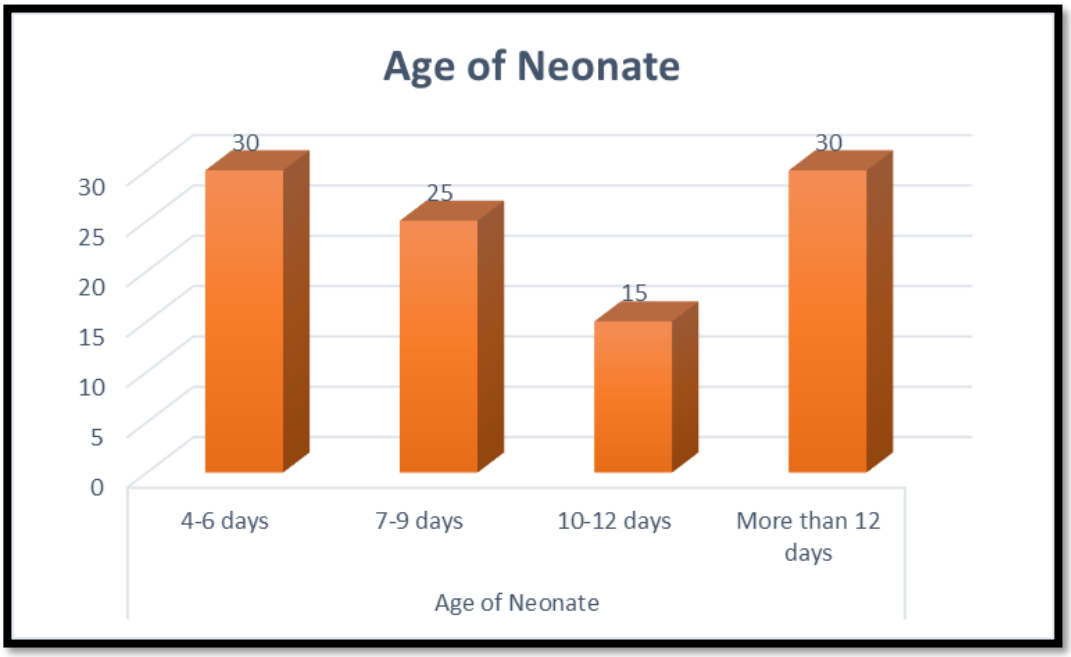
Variables		Control Group **Mean ± SD**	Intervention Group **Mean ± SD**	p-value
Respiratory Rate	Pre-intervention	51.20 ± 5.007	53.00 ± 6.616	.501
	During intervention	48.80 ± 5.095	48.40 ± 4.695	.857
	Post-intervention	48.20 ± 4.467	44.20 ± 3.706	.043
Heart rate	Pre-intervention	163.80 ± 10.218	165.60 ± 8.934	.680
	During intervention	162.80 ± 9.295	156.80 ± 7.786	.135
	Post-intervention	161.20 ± 9.716	143.20 ± 10.465	.001
Oxygen Saturation	Pre-intervention	90.60 ± 2.503	90.00 ± 2.211	.577
	During intervention	90.90 ± 2.644	92.60 ± 2.413	.150
	Post-intervention	92.40 ± 2.011	95.40 ± 1.838	.003

Table 6:Comparison of Physiological parameters (Respiratory rate, heart rate, oxygen saturation) across control and intervention groups (within and between groups)

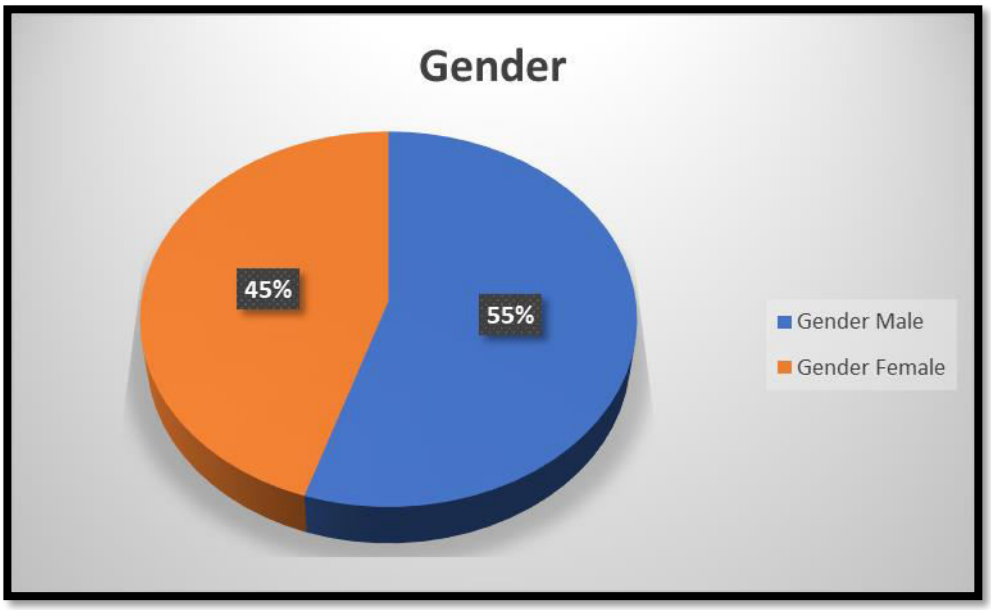
N=20

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Pre RR	Between Groups	16.200	1	16.200	.471	.501
	Within Groups	619.600	18	34.422		
	Total	635.800	19			
Intra RR	Between Groups	.800	1	.800	.033	.857
	Within Groups	432.000	18	24.000		
	Total	432.800	19			
Post RR	Between Groups	80.000	1	80.000	4.749	.043
	Within Groups	303.200	18	16.844		
	Total	383.200	19			
Pre HR	Between Groups	16.200	1	16.200	.176	.680
	Within Groups	1658.000	18	92.111		
	Total	1674.200	19			
Intra HR	Between Groups	180.000	1	180.000	2.449	.135
	Within Groups	1323.200	18	73.511		
	Total	1503.200	19			

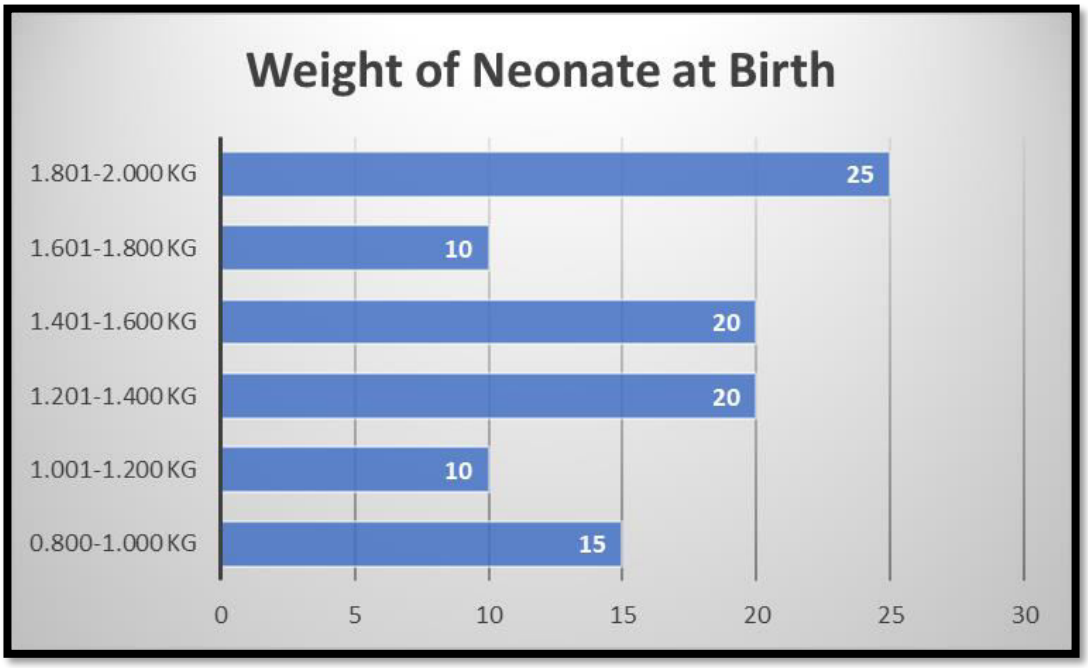
Post HR	Between Groups	1620.000	1	1620.000	15.889	.001
	Within Groups	1835.200	18	101.956		
	Total	3455.200	19			
Pre OS	Between Groups	1.800	1	1.800	.323	.577
	Within Groups	100.400	18	5.578		
	Total	102.200	19			
Intrs OS	Between Groups	14.450	1	14.450	2.256	.150
	Within Groups	115.300	18	6.406		
	Total	129.750	19			
Post OS	Between Groups	45.000	1	45.000	12.126	.003
	Within Groups	66.800	18	3.711		
	Total	111.800	19			



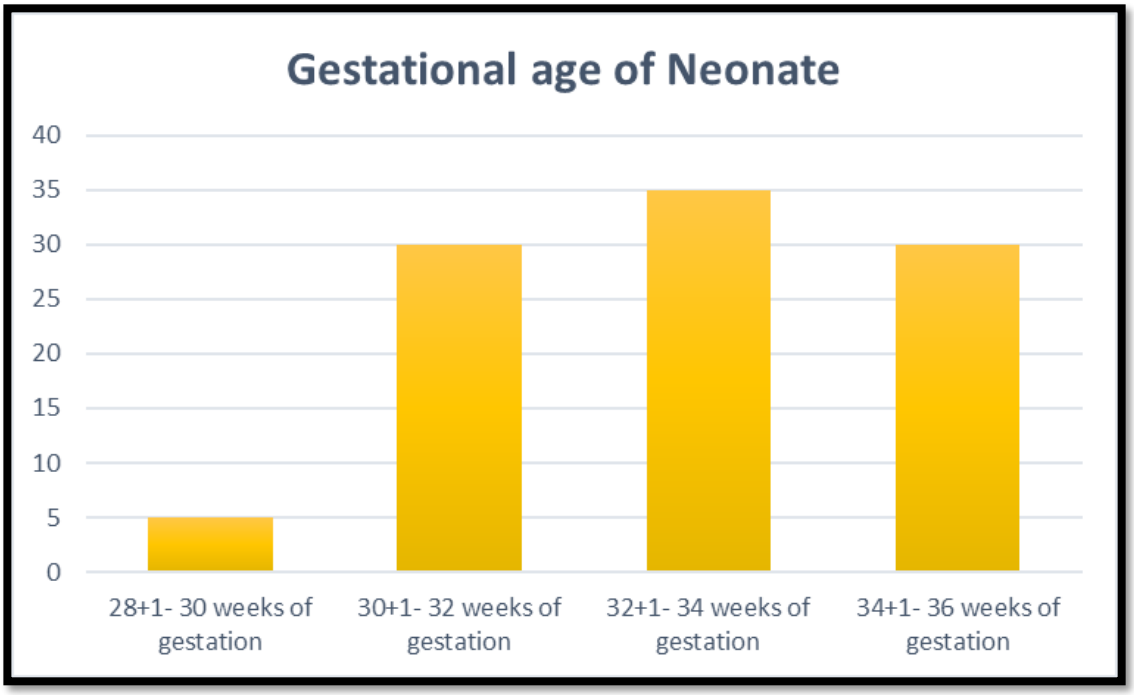
Graph 1: Distribution of Age of neonates (in percentage)



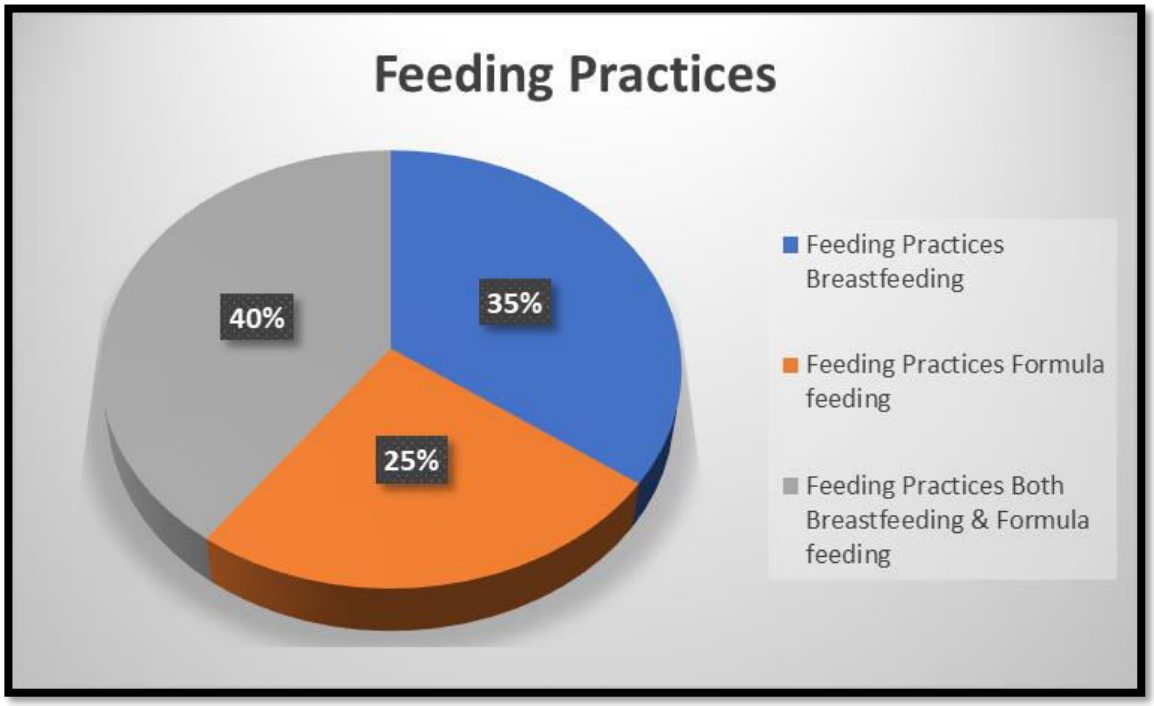
Graph 2: Distribution of Gender of neonates (in percentage)



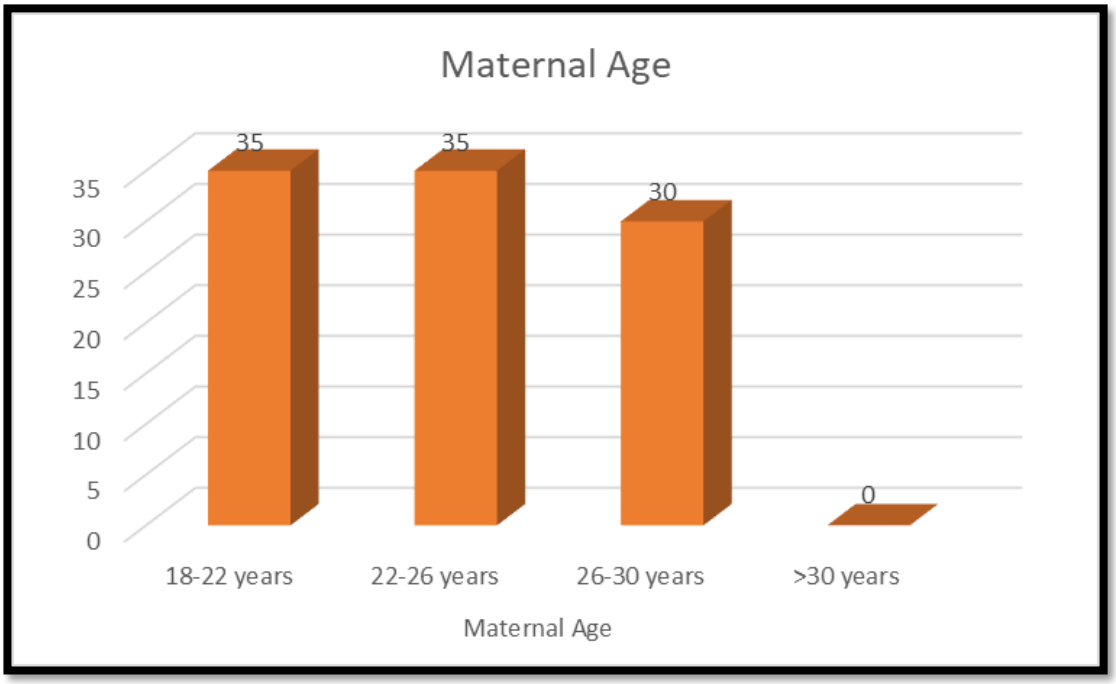
Graph 3: Distribution of weight of neonates at birth (in percentage)



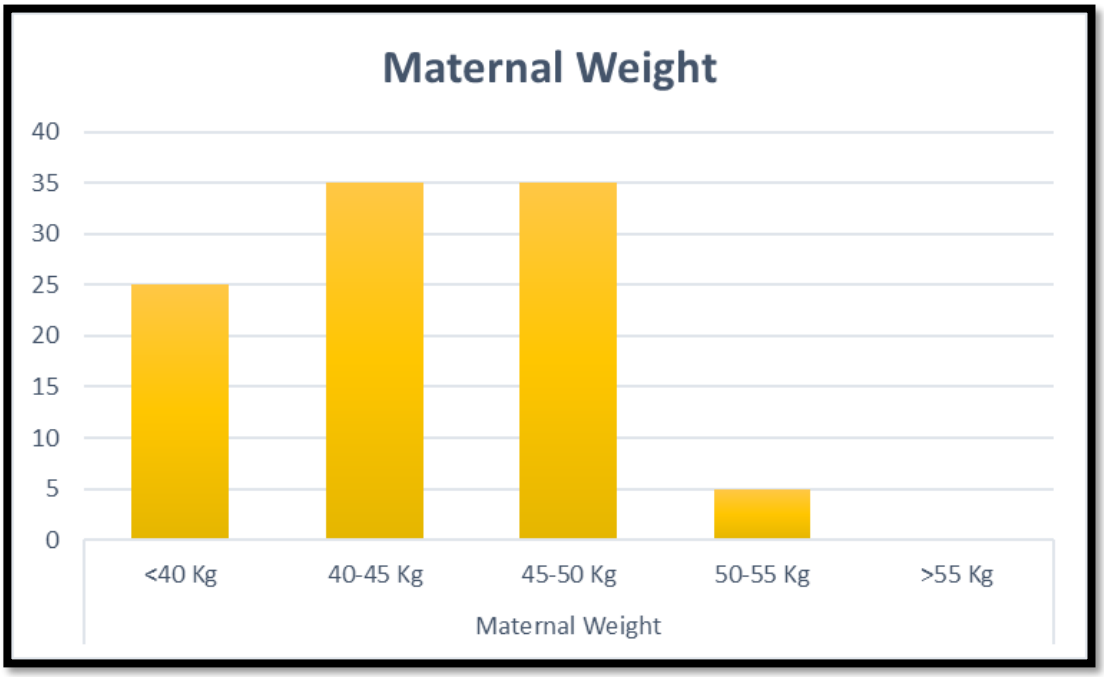
Graph 4: Distribution of gestational age of neonates (in percentage)



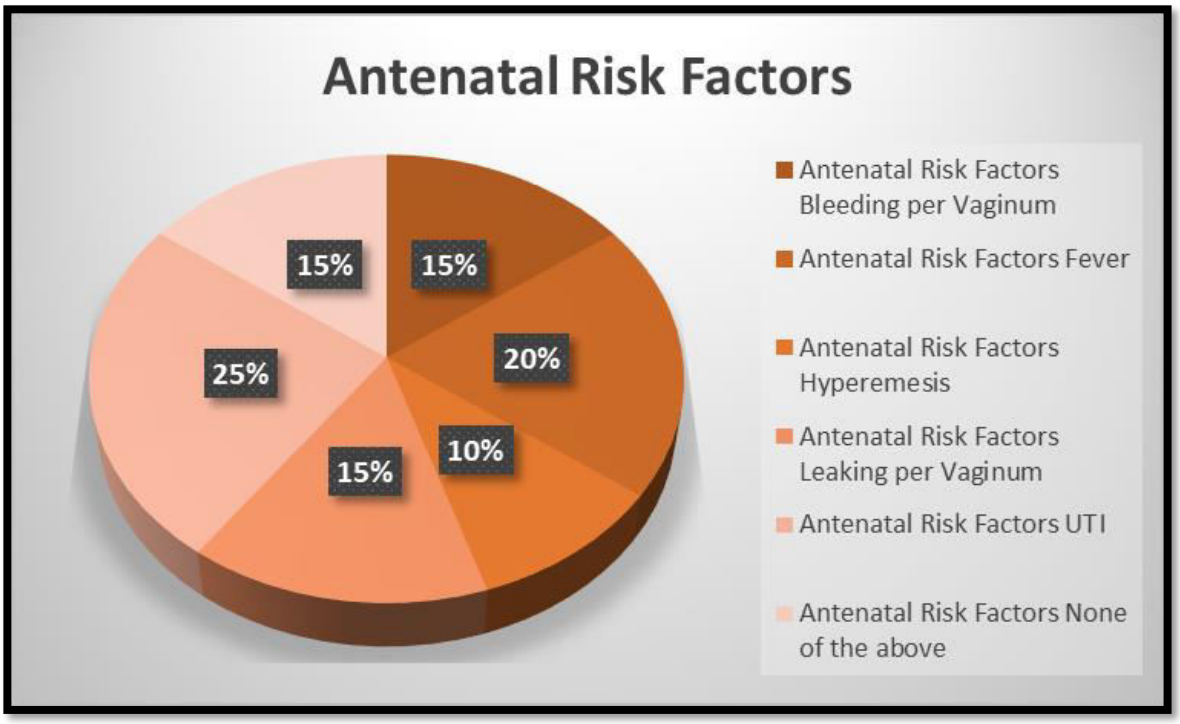
Graph 5: Distribution of feeding practices of neonates (in percentage)



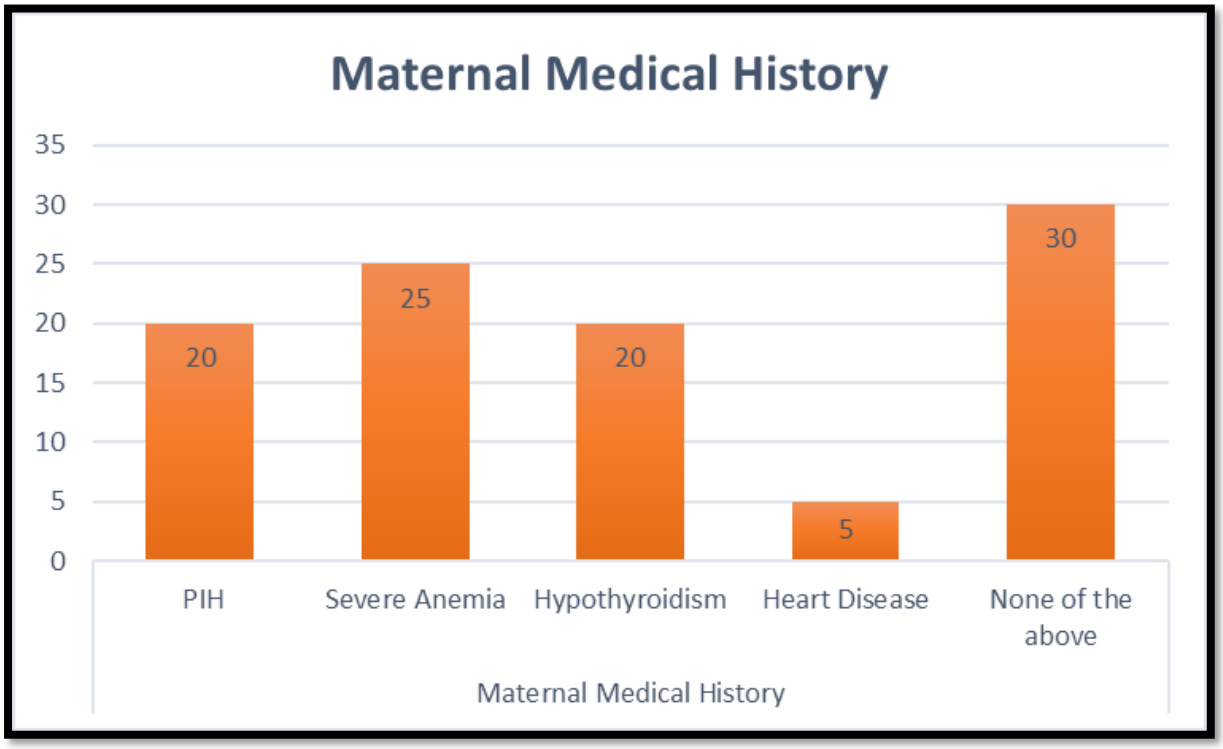
Graph 6: Distribution of maternal age (in percentage)



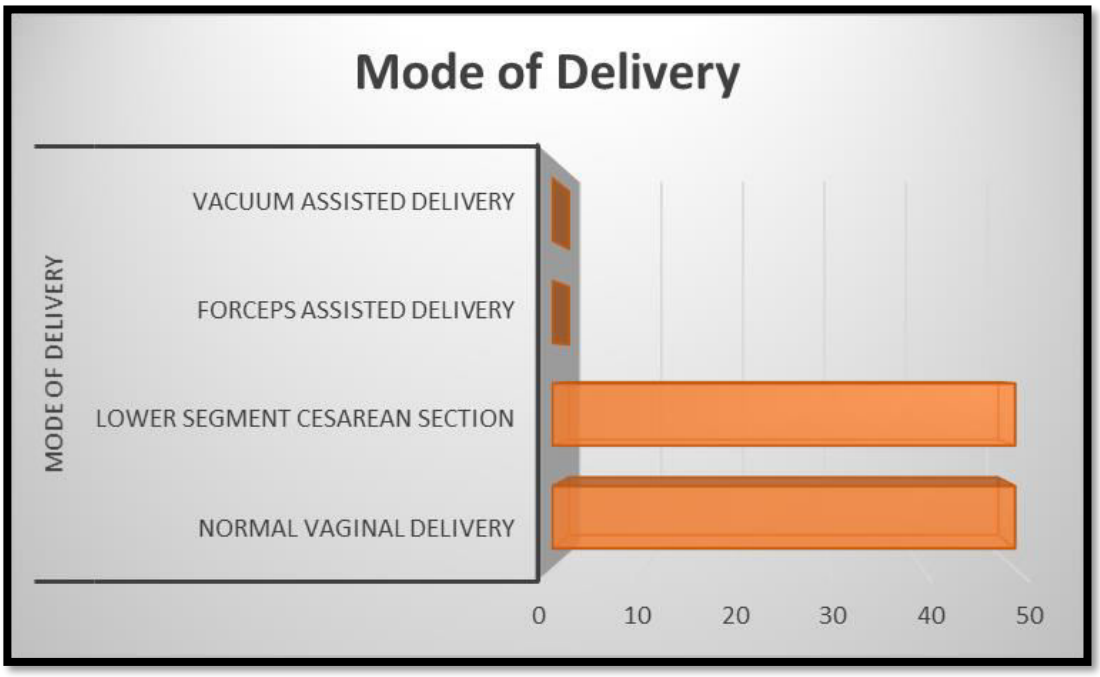
Graph 7: Distribution of maternal weight (in percentage)



Graph 8: Distribution of antenatal risk factors (in percentage)



Graph 9: Distribution of maternal medical history (in percentage)



Graph 10: Distribution of mode of delivery (in percentage)