Original Research Article

Sociodemographic and Pathological Study of Sudden Death Among Neonates and Infants: An Autopsy Based Study

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How to cite this article: Anargha M Sasidharan, Ratheesh P T. Sociodemographic and Pathological Study of Sudden Death Among Neonates and Infants: An Autopsy Based Study. Medico Legal Update / Vol. 24 No. 4, October-December 2024.

Abstract

Children dying within the first year of life is referred to as infant mortality and is an important key indicator for a country's health and standard of living. Every year, there is an estimated 4.5 million infant deaths around the world, accounting for almost 75% of deaths in children younger than 5 years. The studies based on infant deaths are relatively less in number worldwide. This study investigates the sociodemographic and pathological aspects of infant deaths through autopsy data.

The objective of the study was to evaluate the pathology and causes of infant/neonatal deaths and analyze related social and demographic factors.

A cross-sectional descriptive autopsy study was conducted at the Government Medical College, Kozhikode, covering 66 medicolegal infant death cases from April 2018 to October 2022. Data were collected via questionnaires and analyzed using SPSS software.

Respiratory infections (37.14%) were the leading cause of infant deaths, while perinatal complications and congenital abnormalities each accounted for 25% of neonatal deaths. Most deaths occurred in the postneonatal period (77.1%), predominantly among male infants (63%) from rural areas (84.3%). Key findings included consolidation and bronchopneumonia in lung examinations.

Significant associations were found with various factors, including the period of infancy, delivery type, co-sleeping history, and prior hospitalizations. Birth weight and histopathological lung findings were linked to sudden infant death syndrome (SIDS).

Keywords: Infant death; neonatal death; Sudden Infant Death Syndrome.

Introduction

Public health organizations, decision-makers, and governments utilize the infant mortality rate as a measure to assess the general level of pediatric

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Submission date: July 18, 2024 **Revision date:** August 13, 2024 **Published date: October 28, 2024**

health among a certain population living within geographically specified limits. The number of infant deaths per 1,000 live births is used to express the rate[1]. Infants' health and mortality status have been referred to as a synoptic indicator of the social conditions in a community (Gortmaker and Wise 1997)[2]. India has the highest infant mortality, accounting for around 23% of all infant deaths worldwide. According to the sustainable development goal, by 2030, preventable deaths of newborns should be ended, with all nations striving to reduce neonatal mortality to at least as low as 12 per 1000 live births[3].

Infant death is most often a product of multi factorial interplay and has a detrimental effect on the mental and physical health of the parents and even the whole family. Most often, there may be little or no symptoms in infants prior to death and may leave a doubt as to the cause of death in both parents and the attending physician. This is where the role of a forensic pathologist becomes crucial. Even then, no cause of death could be attributed to some of the cases of infant deaths after complete laboratory investigations. Though there were studies on socio economic, demographic and regional variations associated with infant deaths, autopsy based studies are relatively less in Kerala, India. Furthermore, this study also gives emphasis on the factors tied to Sudden Infant Death Syndrome, an apparent natural death in infants.

Materials and Methods

Objectives:

(i) To evaluate the pathology of infant/ neonatal deaths (gross and microscopy) and to analyze the cause of infant /neonatal deaths.

(ii) To study the social and demographic factors related to infant /neonatal deaths.

Study Design: Cross sectional study

Setting: All cases of sudden death in children less than one year of age subjected for medicolegal autopsy done at Government Medical College, Kozhikode over a period of 4.5 years.

Study period: April 2018 to October 2022

Sample size: 66 [As per the study conducted by Yanfei Deng et.al, 60.9% of infant deaths were due to respiratory infection (p=60.9)]

Sampling procedure: Autopsy of the infants brought to the Department of Forensic Medicine, Government Medical College, Kozhikode were done to analyze the cause of death and appropriate samples were collected from the body for pathological and / or toxicological studies. An informed consent was obtained from the close relative of the deceased baby and a detailed history of the deceased baby and adequate history of the parents were also taken. Retrospective data was collected through medicolegal records and also through concerned Police Officials. Standard weight-for-age of the infants was calculated using WHO growth chart (in term babies) and Fenton's chart (in preterm babies) and the grade of malnutrition was assessed as per the IAP classification of malnutrition.

Study variables:

Details of the baby at the time of death (age, weight, sex, residence)

Year, month, season and time of death

Delivery details

Details of parents

Autopsy findings-gross and microscopy.

FINDINGS

70 cases of infant deaths were studied and analyzed using SPSS version 18 software. Associations with a p-value of 0.05 or less is taken as statistically significant.

In the current study, maximum number of infant deaths occurred due to respiratory infection (37.14%), followed by aspiration of stomach contents (18.57%). The least number of deaths occurred due to other infections (2.86%).

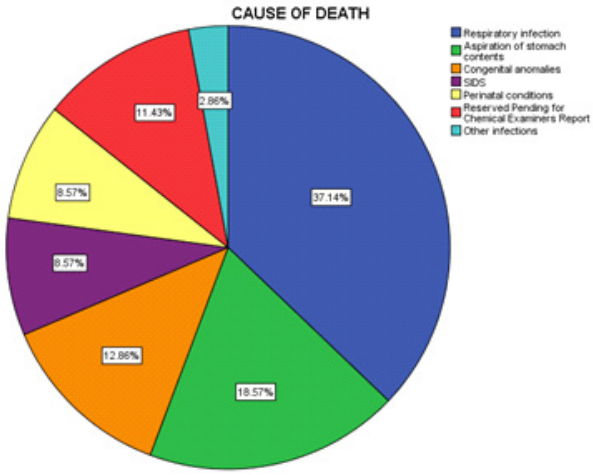

Figure 1: Distribution of cause of death in infants

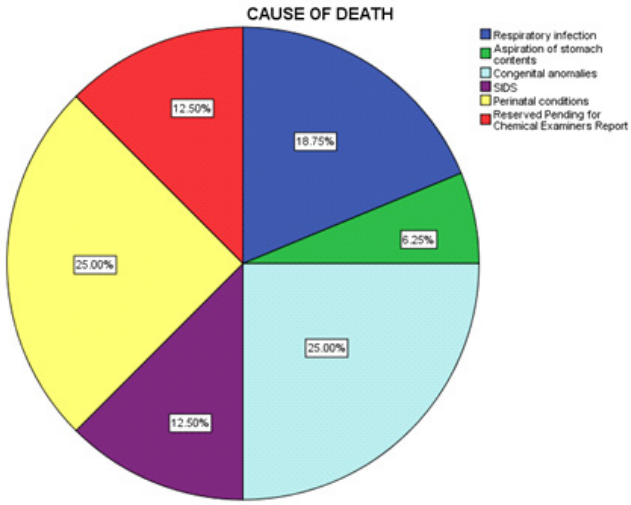

Figure 2: Distribution of cause of death in neonates

Table 1: Distribution of description of cause of infant death

	Frequency	Percent
Respiratory infections	20	28.6
Aspiration of stomach contents	12	17.1
Congenital anomalies	8	11.4
Delayed complication of HIE	1	1.4
SIDS	6	8.6
Reserved Pending for chemical examiners report	8	11.4
Perinatal conditions	4	5.7
Miliary TB	1	1.4
Bronchopneumonia + microcephaly	1	1.4
Myocarditis	1	1.4
Aspiration + congenital heart disease	1	1.4
Respiratory infections + congenital heart disease	3	4.3
Respiratory infection + purulent meningitis	1	1.4
Congenital storage disorder	1	1.4
Intracranial hemorrhage	1	1.4
Respiratory infection +Glycogen storage disease	1	1.4
Total	70	100.0

Table 2: Distribution of sex in infant deaths

Sex	Cause of death							Total
	Respiratory infection	Aspiration of stomach contents	Congenital anomalies	SIDS	Perinatal conditions	RPCER	Other infections	
Female	12	3	1	2	3	3	2	26
	46.2%	11.5%	3.8%	7.7%	11.5%	11.5%	7.7%	100.0%
Male	14	10	8	4	3	5	0	44
	31.8%	22.7%	18.2%	9.1%	6.8%	11.4%	.0%	100.0%
Total	26	13	9	6	6	8	2	70
	37.1%	18.6%	12.9%	8.6%	8.6%	11.4%	2.9%	100.0%

P=0.206

Table 3: Distribution of period of infancy in infant death due to respiratory infection

Neonates	Respiratory or non respiratory cause of death		Total
	Respiratory infection	No respiratory infection	
Neonates	3	13	16
	18.8%	81.3%	100.0%
Postneonates	24	30	54
	44.4%	55.6%	100.0%
Total	27	43	70
	38.6%	61.4%	100.0%

p=0.064

Table 4: Distribution of residence in infant deaths due to respiratory infection

Residence	Respiratory or non respiratory cause of death		Total
	Respiratory infection	No respiratory infection	
Rural	20	39	59
	33.9%	66.1%	100.0%
Urban	7	4	11
	63.6%	36.4%	100.0%
Total	27	43	70
	38.6%	61.4%	100.0%

P=0.063

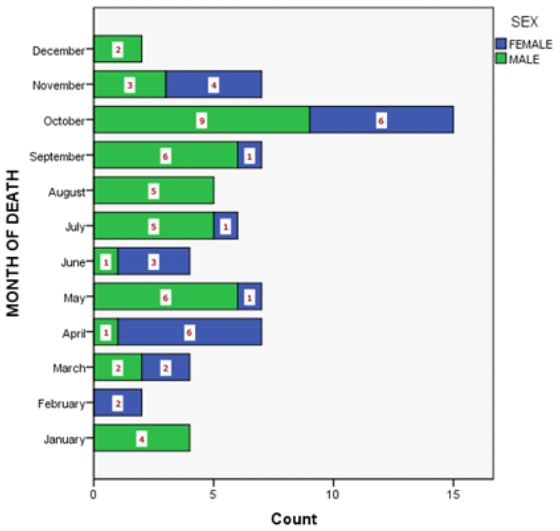

Figure 3: Distribution of infant deaths according to the month of death

Among 70 cases, 3 neonates and 24 post-neonates had respiratory infections, while 43 died from other causes, showing a significant correlation ($p < 0.05$). SIDS occurred in 6 cases, mostly post-neonatal (4) and males (66.7%), but the associations were not significant. Respiratory infection deaths were common in rural areas (74%) and most occurred in October (21.4%). The association between the cause of infant death and the month of death was statistically significant ($p = 0.007$). In Kerala, there were seasonal variations in causes of death, with respiratory infection deaths high during the monsoon season (48.6%). Deaths peaked early morning (22.9%) but was not statistically significant. Most deaths were term babies (84.3%). Normal deliveries were 61.4%, C-sections 35.7%, and vacuum/forceps 2.9%, with a significant association ($p = 0.009$).

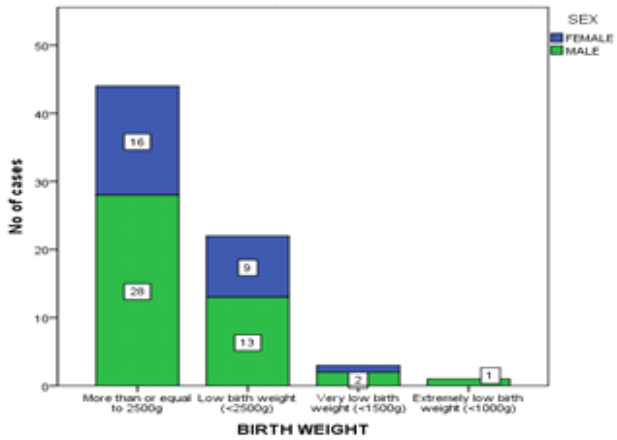

Figure 4: Distribution of birth weight in infant deaths

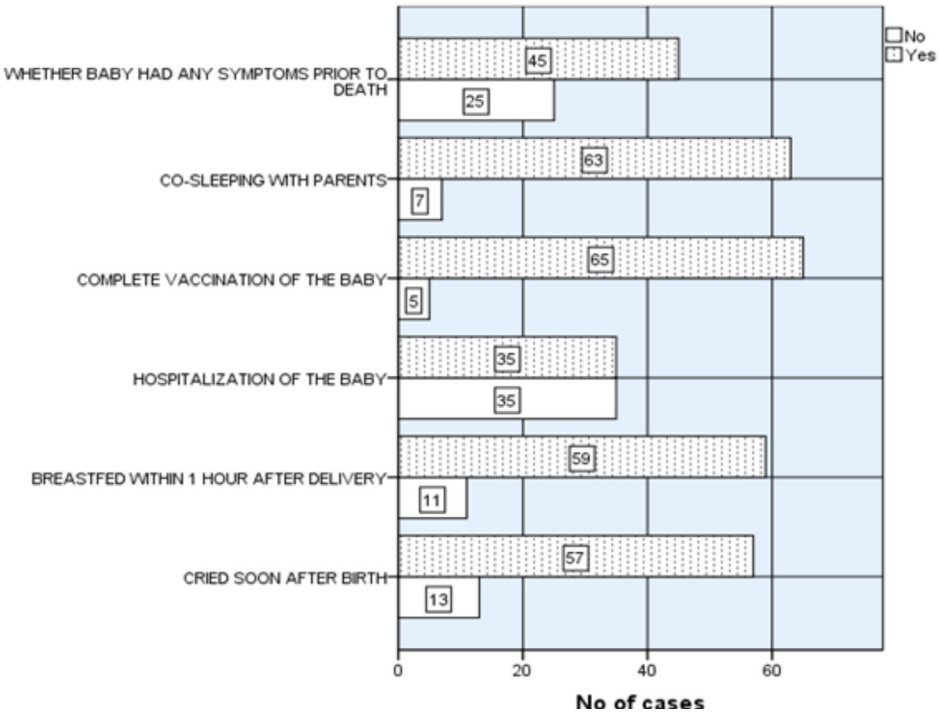

Figure 5: Distribution of details of infants after delivery in infant deaths

The study found a significant association between being breastfed within an hour of birth and infant death causes (p=0.010), as well as between prior hospitalizations and congenital anomalies causing death (p=0.009). Out of 45 cases with symptoms before death, 13 were due to congenital anomalies (p=0.013). A significant link was also found between cosleeping and infant death (p<0.05).All six cases of SIDS involved a history of cosleeping with parents but was not statistically significant. Most infants (87.1%) were from non-consanguineous marriages, with no significant associations found for family histories of sudden infant deaths or socio-economic status.

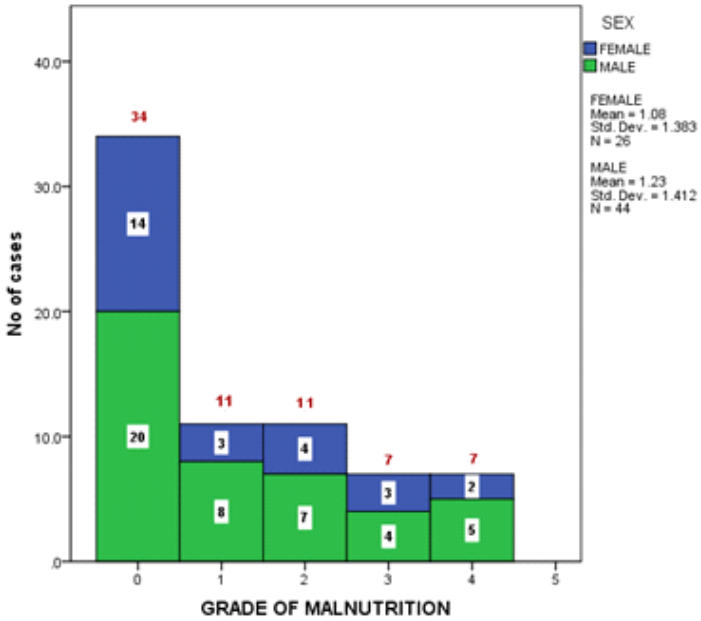

Figure 6: Distribution of nutritional status in infant death

There was no statistically significant association between grade of malnutrition and cause of infant death.

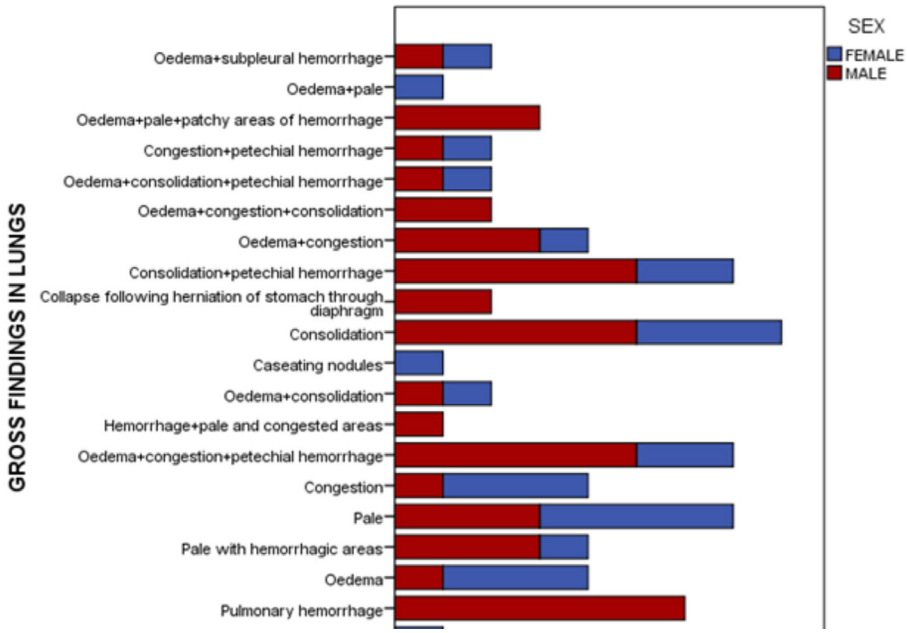

Figure 7: Distribution of gross findings in lungs in infant deaths

In this study, 20 cases showed brain congestion and 10 had edema; 7 had edema alone. One case had purulent CSF. Most brain histopathology was unremarkable. Bronchopneumonia was common in lungs; 21.7% had lung hemorrhage. Heart was normal in 75.7% of cases, with 10% showing congenital heart disease. Eight had epicardial petechial hemorrhage. Liver congestion was seen in 40%, fatty changes in 2.8%, and one case each of cirrhosis with biliary atresia and miliary TB. Kidney congestion appeared in 47.1%, with 14.3% pale. Spleen histopathology showed 40% congestion, and 20% were unremarkable. Adrenal glands showed 25.7% congestion and 15.7% were pale.

Table 6: Distribution of major gross and histopathological findings of internal organs in cases of SIDS

ORGAN	GROSS FINDING	HISTOPATHOLOGY	
BRAIN	Congestion : 83.3%	Unremarkable : 50%	
LUNGS	Pulmonary haemorrhage: 33.3%	Intra alveolar haemorrhage + pulmonary oedema : 33.3%	
	Petechial haemorrhage+ oedema+ congestion	16.7% each	Congestion : 33.3%
	Patchy areas of haemorrhage+ oedema+ pale		Congestion + haemorrhage : 16.7%
	Pale		Oedema+ peribronchial inflammation : 16.7%
	Oedema + congestion		
HEART	-	Unremarkable : 83.3%	
LIVER	Unremarkable : 66.7%	Unremarkable : 50%	
	Congestion : 33.3%	Sinusoidal congestion :50%	
KIDNEY	Unremarkable : 50 %	Congestion :83.3%	
	Congestion :66.7%	Unremarkable : 16.7%	
SPLEEN	Congestion :66.7%	Congestion :66.7%	
	Unremarkable : 33.3%	Unremarkable : 33.3%	
ADRENAL GLANDS	Unremarkable : 83.3%	Unremarkable : 50%	
	Congestion :16.7%	Congestion :33.3%	
THYMUS	Unremarkable : 66.7%	Unremarkable : 33.3%	
	Congestion : 16.7%		
AIRWAYS	Unremarkable : 50%		

Discussion

In this study, respiratory infections were the leading cause of infant deaths, accounting for 37.14% of cases. Among these, 53.8% were male infants and 46.2% were female. Aspiration of stomach contents followed, contributing to 18.57% of total deaths. Congenital anomalies, including heart defects and pulmonary conditions, accounted for 12.86% of deaths. Sudden Infant Death Syndrome (SIDS) and perinatal conditions each constituted 8.57% of cases.

Comparatively, in Deng et al.'s study(2019) in China, infectious diseases were the primary causes of infant mortality. These included pneumonia, meningitis and viral brainstem encephalitis.

Respiratory infections accounted for 60.9% of total cases (28 out of 46 infant deaths), with pneumonia being the leading cause (24 cases out of 28). Diseases of the nervous system and cardiovascular system disorders accounted for 17.4% & 4.4% of total deaths. Sudden Infant Death Syndrome (SIDS) constituted 4.4% of the total deaths in their study[4].

In a similar study by Tumer et.al, respiratory system pathologies accounted for 35% of deaths and SIDS contributed 19.58% of the total cases in infants aged 1-12 months[5]. A study by Vaid et al. found that 23.3% of total infant deaths were due to gastroenteritis[6].

In this study, neonatal deaths were largely due to perinatal conditions and congenital anomalies, each at 25%. Respiratory infections caused 18.75% of deaths, SIDS accounted for 12.5%, and 12.5% had unexplained causes. There was a significant association between cause of death and neonatal and post neonatal period.

77.1% of cases were infants older than one month, and 22.9% were neonates in our study.Male infants comprised 62.9% of the study population, with SIDS affecting 66.7% of male infant deaths.

Most deaths occurred in rural areas (84.3%).93% of aspiration deaths were in rural areas, where it was significant in 67.8% of cases. Respiratory infections and SIDS were also more common in rural areas but not significant. Gupta's 2021 study found over 70% of deaths in rural India, likely due to limited healthcare access[7].

Infant mortality rates peaked in October (21.4%) in this study & the month of death was significantly associated with the cause of death. Conversely, Gardner et al. found higher mortality in winter[8] and a Belgian study noted excess deaths in January-February and August[9]. Most deaths occurred during the monsoon season (52.8%) & most deaths (42.9%) occurred in the early morning hours (3am-9am), but with no statistical significance.

Birth in hospitals via normal vaginal delivery (61.4%) was statistically associated with causes of death, particularly in cases involving vacuum assistance.

The majority of infants (84.3%) were term births, and 62.9% of total cases were born with normal birth weight. In Western and Southern India, prematurity and low birthweight contributed to a larger share of child deaths[10]. Black et al. found that SIDS occurs more frequently in low birth weight infants[11].

Among those who did not cry after birth, the majority died from perinatal conditions (30.8%) or respiratory infections (30.8%), and this difference was statistically significant.Early breastfeeding (84.3%) showed significance in reducing mortality. In hospitalized cases, 34.3% had congenital abnormalities, and this was statistically significant.

No significant link was found between birth order and SIDS in this study. While overall infant deaths increase with birth order, SIDS was highest in first-borns when mothers were young and less educated[12,13].

64.2% of cases showed symptoms before death, mostly due to respiratory infections (44.4%), which was statistically significant. In SIDS cases, symptoms were present in half and absent in the other half.

In our study, 87.1% of deaths were in infants from non-consanguineous marriages, with no link to cause of death, possibly due to the rarity of consanguineous marriages in Kerala. Other studies globally have shown that consanguineous marriages, especially first-degree ones, increase infant mortality[14].

In our study, 54.3% of cases were from BPL families. Respiratory infections were more common in APL families (57.6%) than BPL families (42.3%), while perinatal deaths were higher in BPL families (83.3%). Education levels were generally high, and 60% of fathers were unskilled laborers, with a significant link to cause of death. Morris Jn and Heady Ja also found infant deaths linked to the father's occupation[15].Malnutrition was noted in 51% of cases, with no significant link to SIDS though more than half of the SIDS cases (66.7%) in our study population were malnourished. Co-sleeping with parents was common (90%) but showed no significant statistical association with mortality causes.

In this study, lung consolidation was the primary finding. Of 46 histopathological reports, 26% showed bronchopneumonia, 21.7% had lung hemorrhage,

and 8.6% had epicardial petechial hemorrhages. Sinusoidal congestion of liver was seen in 45.5%, while kidney and spleen congestion was present in 47.8% and 53.6% (gross) and 54.8% and 64.3% (histopathological) cases, respectively. Adrenals and thymus were mostly unremarkable. Meconium was found in one case. In SIDS cases, 66.7% had lung hemorrhage, 33.3% had pulmonary edema or intra-alveolar hemorrhage, and 33.3% had lung congestion and was statistically significant.Kidney congestion was noted in 83.3% of SIDS cases. Other organs were mostly congested or normal, with 33.3% of SIDS cases having blood-stained froth in the airways.

Conclusion

In this study, respiratory infections were the leading cause of infant deaths, predominantly occurring in the post neonatal period (88.8%). Key findings included lung consolidation on gross examination and bronchopneumonia on histopathology. Other significant causes were aspiration of stomach contents and congenital anomalies, with SIDS and perinatal conditions each accounting for 10% of deaths.

Perinatal complications and congenital anomalies were major contributors to neonatal deaths, comprising 50% of cases, while SIDS and unexplained deaths made up 25%. Congenital storage disorders were responsible for 2.8% of deaths. Most deaths occurred in the post neonatal period (77.1%), primarily within the first six months (75.9%). Male infants (63%) and those from rural areas (84.3%) were most affected.

The highest mortality was in the month of October. Deaths predominantly occurred early in the morning (3 a.m. to 9 a.m., 42.9%) and were more frequent in the monsoon season (52.8%), with respiratory infections rising during this period (48.6%).

Factors linked to cause of death included the period of infancy, month of death, delivery type, crying history, breastfeeding within an hour, symptoms before death, co-sleeping, and father's occupation. Rural infants had higher aspiration-related deaths. Term and preterm babies had similar rates of perinatal condition deaths and majority of the total cases had a history of co-sleeping with their parents. Most infants were firstborns (48.6%). Among those with a birth order above three, 75% died of respiratory infections.

SIDS was notably prevalent among first-borns (66.7%) and was more common in males (66.7%), rural areas (83.3%), early morning hours (33.3%) & term babies (83.3%).SIDS caused 11.4% mortality in normal weight infants and 100% in those with extremely low birth weight. Although the association between SIDS and extremely low birth weight was statistically significant, only one such case was reported, indicating the need for further studies.SIDS cases were often in families with no prior sudden deaths, and all cases involved co-sleeping. Significant associations were found between SIDS and lung hemorrhages. While socioeconomic status showed equal distribution among BPL and APL families, SIDS was significantly associated with certain clinical and demographic factors.

Conflict of interest: Nil

Source of funding: Self

Ethical clearance: Obtained from Institutional Ethics committee, Government Medical college,4th floor golden jubilee annexe, IMCH, Medical College(P.O), Calicut, Kerala 673008 . Ref no.GMCKKD/RP 2021/IEC/22 dated 16.02.2021

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