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Causes and prevalence of prenatal and neonatal mortality in the District Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

Objectives: Perinatal mortality is among the key health, prosperity, and economic status indicators. This retrospective study determines the causes of prenatal (stillbirth) and neonatal mortality during July–December 2021 and their yearly prevalence during 2013–2021 in the Women and Children's Hospital in the district Dera Ismail Khan.

Materials and Methods: The data were extracted from the admission registers maintained by the said hospital and were found not in organized and consolidated form. A month-wise organized/consolidated report for each cause of mortality was prepared.

Results: A total of 508 cases of both prenatal and neonatal mortality in the nursery ward indicated hypoxic-ischemic encephalopathy (HIE) showed overall 39.8% mortality in the study area, followed by premature (15.4%), senile prostatic enlargement (10%), low birth weight revealed (9.3%), birth asphyxia (5.3%), neonatal jaundice (4.5%), respiratory distress syndrome (4.3%), non-nutritive sucking (3.5%), congenital heart defects (2.4%), meconium aspiration syndrome (1.8%), and the remaining cases each contributed to ≤0.6% of overall mortality. The isolation ward contributed (48.5%), followed by the labor room (42.4%), the nutrition ward (6.1%), and the Gynae wards (3%) of all 33 cases. The overall highest mortality occurred in 2019 (15.4%) and lowest in 2013 (6.8%). The remaining years showed each <10% mortality. Neonatal mortality was mostly higher than prenatal mortality during 2013–2021 and highest (85.8%) in 2013 and the lowest (19%) in 2014. The highest and lowest prenatal mortality was 81% (2014) and 14.2% (2013), respectively.

Conclusion: HIE caused about 40% of perinatal mortality. Neonatal mortality showed higher prevalence than prenatal mortality except in 2014.

Keywords: Causes, Prenatal mortality, Neonatal mortality, Nursery ward, Prevalence

INTRODUCTION

One of the global concerns is the health problems which mainly affect human well-being and their activities.[1] The most critical period in an individual's life is the perinatal period which has the highest mortality rate.[2] Over 25% and 75% of mortality of neonates take place before the completion of the first 24 h of birth and the 1st week of life, respectively, globally.[3-5] More than two-thirds of all infants as well as about 50% of all children aged <5 years died as neonates.[3,6] It is estimated that the neonates (27.8 million) will die between 2018 and 2030,[7,8] if efforts are not successful to reduce neonates' mortality.

Global 99% of death of neonates occurs in undeveloped and less developed countries,[9] whereas South Asia and sub-Saharan Africa contributed about 77% of all stillbirths.[10,11] Ten countries including Pakistan (ranks third) accounted for over 65% of the total neonatal deaths globally and are estimated to contribute 300,000/year newborn deaths globally.[4,12]

Hypoxic ischemic encephalopathy (HIE) occurs when an infant's brain does not get enough oxygen before or shortly after birth. Prematurity is birth before 37 weeks of pregnancy. Senile prostatic enlargement (SPE) is the enlargement of the prostate gland at birth. Low birth weight (LBW) and heavier low birth weight (HLBW) are the weight of an infant <2500 g and <1500 g within hours of birth. Respiratory distress syndrome (RDS) is a common breathing disorder in neonates. Birth asphyxia (BA) is characterized by the infant not getting adequate oxygen before, during, or just after birth. Non-nutritive sucking (NNS) is the sucking of a pacifier or fingers. Neonatal jaundice (NNJ) shows yellowing of the skin and whites of the eyes of a newly born infant. Congenital heart defects (CHDs) are malformations of the heart or large blood vessels near the

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heart. Meconium aspiration syndrome (MAS) is because meconium (the earliest stool/feces of the newborn) get into the lungs. Neonatal tetanus (NNT) is newborn muscle spasms. Dilated cardiomyopathy (DCM) is a disorder of heart muscles. Melnick-Needles syndrome (MNS) is a rare disorder of the gene of the bones and skull abnormalities. Protein-calorie malnutrition (PCM) occurs when both a child's calorie and protein intake are inadequate. Hemolytic disease of the newborn (HDN) is a blood disorder. Sepsis or neonatal sepsis (NNS) is the body's extreme response to an infection. Late-onset sepsis (LOS) is a sepsis onset after 72 h of stillbirth. Down syndrome is a chromosomal disorder. *Haemophilus influenzae* type b (Hib) is a bacterial infection. Myelomeningocele (MMC) is a congenital birth defect of the spine and spinal cord. Lower respiratory tract (LRT) disease is a disorder of mainly the lungs. Protein C Deficiency Next-Generation Sequencing (PCNGS) varies is a congenital deficiency of protein C caused by alterations in the *PROC* gene. Postpartum hemorrhage (PPH) is a woman's heavy bleeding after delivery.

As the author know the present research is the first study in Khyber Pakhtunkhwa to determine different causes of perinatal mortality as well as the first study to know relative prevalence of perinatal mortality in Pakistan.

MATERIALS AND METHODS

Study site

District Dera Ismail Khan is surrounded to the east by the districts of Bhakkar and Dera Ghazi Khan, southwest by the district South Waziristan, in the north by Lakki Marwat, and northwest by the district Tank.[13] The district comprised fertile alluvial plains along the Indus River, and farther lands are made up of clay soil cut by ravines from rainfall. The total area of the district is 9,334 km^2 with a population of 1.8 million (Digital Census 2023).

Data extraction/data maintenance

All the raw data of wards including nursery, isolation, labor room, Gynae, and nutrition ward were obtained from admission registers/death registers maintained by the nursery ward in the district Women and Children Hospital D. I. Khan. The data on the causes of mortality was not computerized and were not in consolidated form. The author worked very hard and made a consolidated report of different causes of prenatal and neonatal mortality for each of the 6 months (July–December of 2021).

Ethics approval statement

The study was approved by Dr. Farah Jamil, the medical director of DHQ hospital D.I. Khan, who is also incharge of

Table 1: Causes of prenatal (stillbirths) and neonatal mortality in the nursery ward in Dera Ismail Khan in 2021.

Months	HIE	Pre-mat	SPE	LBW/HLBW	BA	NNJ	RDS	NNS	CHD	MAS	NNT	DCM	MNS	PCM	HDN	Uk	Re. cases	Total
July	24	11	5	5	11	7	3	4	2	3	0	0	0	0	0	0	0	75[a]
August[a]	52	19	13	12	0	3	6	5	2	2	0	0	0	0	0	0	0	114[bc]
September	49	22	11	3	1	4	6	5	0	0	0	0	0	0	0	0	0	101[b]
October	31	7	3	5	8	3	4	0	2	0	1	1	1	0	0	1	1	68[a]
November	28	12	8	13	3	4	3	3	2	0	1	1	0	0	0	1	2	81[ac]
December	18	7	11	9	4	2	0	1	4	4	1	0	1	2	2	0	3	69[a]
Total	202[a]	78[ab]	51[ab]	47[b]	27[c]	23	22	18	12	9	3	2	2	2	2	2	6	508

[a]August show 1 case of HLBW. Uk for unknown has 1 case each in October and November. Remaining cases including LOS have 1 case in October. Down syndrome and Hib each have 1 case in November. MMC, LRT, and PCNGS each 1 case in December. The total cases for the months and causes of mortality with the different letters are significantly different (alpha, $P<0.05$): Chi-square test and the multiple comparison ("*post hoc*") test, the method used was the Benjamini and Hochberg (1995), which is based on $P=0.05$. HIE: Hypoxic-ischemic encephalopathy, SPE: Senile prostatic enlargement, PCM: Protein–calorie malnutrition, MNS: Melnick–Needles syndrome, DCM: Dilated cardiomyopathy, HDN: Hemolytic disease of the newborn, LOS: Late-onset sepsis, BA: Birth asphyxia, LBW: Low birth weight, HLBW: Heavier Low birth weight, NNJ: Neonatal jaundice, PPH: Postpartum hemorrhage, RDS: Respiratory distress syndrome, NNS: Non-nutritive sucking, CHD: Congenital heart defects, MAS: Meconium aspiration syndrome, NNT: Neonatal tetanus, Uk: unknown, Re.cases: Remaining cases, Pre-mat: Prematurity.

the Institutional Review Board, with reference No. 2754/MD, dated: May 30, 2022.

Statistical analysis

Pearson's Chi-squared test showed significant differences between months (χ^2 = 64, df = 25, P < 0.001) for Table 1. For the multiple comparisons ("*post hoc*") test, the method used was of Benjamini and Hochberg,[14] which is based on P = 0.05. For Table 1, this test showed a significant difference by month [Table 1] as indicated by the "lettering" for the total cases as the months with the same letter are not significantly different. There are three groups.

The same Chi-squared test showed a significant difference in the number of cases for prenatal versus neonatal mortalities (χ^2 = 1323, df = 8, P < 0.001) for Table 2. The multiple comparison tests further showed a significant difference in the number of cases of prenatal versus neonatal mortalities between years in Table 2. The years with the same letter show for which years the number of cases is not significantly different from each other. Note that for the years 2014[b] and 2019[e], the number of prenatal versus neonatal cases was unique and different from all other years.

RESULTS

Causes and prevalence of mortality in nursery ward

Overall 21 known causes of 506 cases of prenatal and neonatal mortality are reported in the present study [Table 1]. HIE showed the largest share of (39.8%) cases of prenatal and neonatal mortality, followed by premature (15.4%), SPE (10%), LBW/HLBW (9.3%), BA (5.3%), NNJ (4.5%), RDS (4.3%), NNS (3.5%), CHD (2.4%), MAS (1.8%), NNT (0.6%) and DCM, MNS, PCM and HDN each contributed two cases (0.4%) to overall cause known mortality. The remaining cases include LOS, Down syndrome, Hib, MMC, LRT, and PCNGS each contributed (0.2%), and the two cases (0.4%) of unknown causes were also recorded. The highest mortality (22.4%) occurred in August, whereas the lowest was in October (13.4%).

Prevalence and comparison of prenatal and neonatal mortality during 2013–2021

Overall 11,554 cases including prenatal mortality (34.2%) and neonatal mortality (65.8%) were recorded during 2013–2021 [Table 2], and the highest overall mortality 15.4% occurred in 2019, followed by 2021 (14.4%) and 2018 (14.1%), and the lowest mortality occurred in 2013 (6.8%) during the study period.

The neonatal mortality is higher than prenatal mortality during 2013–2021 except in 2014 [Table 2 and Figure 1] in the study area, whereas relative percentage mortality demonstrated neonatal mortality was highest (85.8%) in 2013, followed by 84.1% (2020) and the lowest 19% (2014) [Figure 1]. The highest relative prenatal mortality was 81% (2014) and was lowest 14.2% in 2013 [Figure 1]. The higher rate of neonatal mortality relative to prenatal mortality [Figure 1] indicated the comparatively higher risk of mortality in the neonates than stillbirth in the study area.

Causes and prevalence of mortality in other wards

Prenatal and neonatal mortalities accounted for isolation ward 48.5%, followed by labor room (42.4%), nutrition ward (6.1%) and gynae ward (3%) of all 33 cases [Table 3]. December demonstrated the highest mortality of (30.3%) cases, followed by October (27.3%) and lowest in July (3%). The causes of mortality in the isolation ward are temperature, tetany, measles, and unknown causes, while that of the labor room are NNJ, PPH, and unknown causes. The nutrition ward has only sepsis cause, whereas an unknown cause of mortality was recorded for Gynae ward [Table 3].

Yearly based relative prevalence of prenatal and neonatal mortality during 2013–2021

Yearly-based percentage prevalence showed prenatal mortality was highest in 2014 (20%), followed by 2019 (about 18%) and lowest in 2013 (2.8%) and increased from 2015 to 2019. Neonatal mortality is relatively highest in 2021 (14.7%), followed by 2018 and 2019 (each 14.1%), 2017 (13.3%) and the lowest in 2014 (2.4%).

DISCUSSION

Perinatal mortality is the sum of prenatal death which is the *in utero* death of a fetus during pregnancy at 20 or more

Table 2: Annual prevalence of prenatal (stillbirth) and neonatal mortality in the Dera Ismail Khan.

Years	Prenatal (stillbirth)	Neonatal	Total
2013	111	671	782[a]
2014	790	185	975[b]
2015	309	753	1062[c]
2016	312	761	1073[c]
2017	435	1014	1449[c]
2018	558	1073	1631[d]
2019	709	1070	1779[e]
2020	182	960	1142[a]
2021	540	1121	1661[cd]
Total	3946	7608	11554

The total cases for the months with the different letters are significantly different (alpha, P<0.05): Chi-square test and the multiple comparisons ("*post hoc*") test, the method used was the Benjamini and Hochberg (1995), which is based on P=0.05, [a-e,cd]: These are letter of statistical significance

Table 3: Causes of prenatal (stillbirths) and neonatal mortality other than the nursery ward in Dera Ismail Khan in 2021.

Months	Isolation ward		Labor room		Nutrition ward		Gynae ward		Total
	No. of cases	Cause	No. of cases	Cause	No. of cases	Cause	No. of cases	Cause	
July	1	Temp.	0	-	0	-	0	-	1
August	1	Temp.	2	1-Uk 1-NNJ	0	-	0	-	3
September	3	Uk	0	-	0	-	0	-	3
October	1	Tetany	6	4-Uk 2-PPH	2	2-Sepsis	0	-	9
November	4	1-Tetany 3-Measles	3	3-PPH	0	-	0	-	7
December	6	4-Unknown 2-Measles	3	3-Uk	0	-	1	Uk	10
Total	16	-	14	-	2	-	1	-	33

Uk: unknown, NNJ: neonatal jaundice, PPH: Postpartum hemorrhage

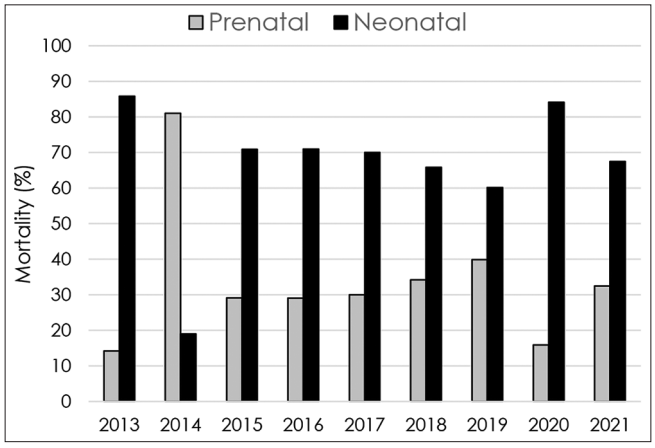

Figure 1: Relative percentage of prenatal (stillbirth) and neonatal mortality in Dera Ismail Khan.

weeks of gestation,[15] and early neonatal death, i.e., death of a live newborn in the first 7 days of life.[16] While infant deaths are classified into neonatal death (during 0–28 days of age) and post-neonatal death (during 29–364 days of age). A global target under the sustainable development goal of 2030[7,8] is the decrease in the death of neonates (12 out of 1000 live births) by 2030[17] as well as to reduce stillbirths and early neonatal deaths to end preventable child deaths by 2030.[18]

The previous literature showed most of the work carried out is on the risk factors of stillbirth/neonatal mortality or risk factors of their causes, and few studies were conducted to determine the causes of both prenatal and neonatal mortality in Pakistan. Moreover, previous studies on the seasonal, monthly/yearly-based, or relative prevalence of mortality (stillbirth and neonates) have not been found globally.

HIE showed the highest mortality [Table 1] in the present study (39.8%), followed by premature (15.4%), SPE (10%), LBW/HLBW (9.3%), BA 27 (5.3%), NNJ (4.5%), RDS (4.3%), NNS (3.5%), CHD (2.4%), MAS (1.8%), and NNT (0.6%), whereas LOS, Down syndrome, Hib, MMC, LRT, and PCNGS are reported each with 1 case (0.2%) and 2 unknown cases (0.4%). The highest mortality (22.4%) occurred in August, whereas the lowest was in October (13.4%).

The three main causes of neonatal mortality are HIE, prematurity, and infections.[3] Jehan *et al.*[19] found death by premature birth (34%) and intrapartum asphyxia (21%), immaturity related (26%), BA or hypoxia (26%), and infection (23%) in urban areas in Pakistan. Manzar *et al.*[20] reported specific infections accounted for neonates mortality (47.9%), followed by prematurity (31.9%) and BA (15.9%) in Karachi (Pakistan). Quddus *et al.*[21] reported 36 neonatal deaths, out of 1547 live births due to tetanus in Loralai (Pakistan).

Abdulrasol *et al.*[22] reported neonatal mortality rate was 42.9 and 38 (per 1000 live birth) in 2020 and in 2021, respectively, in Babylon hospitals (Iraq) and found RDS accounted for 48% in 2020 and 55.2% in 2021 neonatal mortality, followed by LBW preterm resulted in neonates mortality (25.8% in 2020 and 10.3% in 2021). Chowdhury *et al.*[23] reported prematurity/LBW mortality (30%), followed by difficult labor (16%), unhygienic birth practices (16%), others (4%), and unknown (34%) in neonates, and recorded direct causes were sepsis (32%), BA (26%), tetanus (15%), respiratory distress (6%), others (6%), and unknown (14%) in Bangladesh.

Ersdal *et al.*[24] reported 49 neonatal deaths within the first 24 h of birth out of 256 infants in Northern Tanzania and found mortality by BA (61%), followed by prematurity (18%), LBW (8%), infection (2%), congenital abnormalities (8%), and unclear reason (2%). Mangu *et al.*[25] reported the death of neonates contributed 11.3% including 87.5% of mortalities occurred in the 1st week of life in Tanzania and recorded BA contributed 22.3%, followed by RDS (20.8%) to early

neonatal death, whereas sepsis accounted for 29.1%, followed by RDS (20.0%) of late neonatal death in Tanzania. Iyoke *et al.*[26] found 636 (16.9%) were preterm births out of 3,760 live birth in southeast Nigeria, including spontaneous preterm births approximately 57% of preterm births, and provider-initiated births (43%), and further found the adjusted perinatal mortality rate for preterm babies in the study center was 46.1% (236/512), the stillbirth rate was 22% (149/678), and the early neonatal death rate was 24% (87/363). John *et al.*[27] found 114 cases (54.8%) of neonatal deaths occurred within the first 24 h and 94 neonates (45.2%) died after 24 h of admission and found BA resulted in 46.6% of neonatal deaths, followed by prematurity (23.1%) and sepsis (17.8%) in Owo (Nigeria).

Al-Sheyab *et al.*[8] reported respiratory and cardiovascular disorders resulted in 43% in death, followed by LBW and pre-term accounted for 33% of death in pre-discharge neonates, while LBW and pre-term led to 42% of the post-discharge neonatal mortality in Jordan. Erchick *et al.*[28] concluded that sepsis caused 47% of neonatal deaths, followed by BA (16.6%), preterm birth (13.3%), and LBW (5.0%) and also found 27.2% of neonatal deaths occurred during 24 h of birth and 64.8% between days 1 and 6 of the newborn in Nepal. Ramos *et al.*[29] found prematurity contributed 43%, followed by infections (22%) including one case of congenital syphilis, BA (14%), and chromosome abnormality (7%: 1 case) of perinatal death, and respiratory disorder contributed (45%), whereas gastrointestinal infections (28%) of infant deaths in Natal (Brazil). Camara *et al.*[30] recorded that overall, neonatal mortality rate and perinatal mortality rate were 19.3/1,000 live births and 26.1/1,000 total births, respectively, and reported severe clinical infections and BA accounted for 37% and 31% of neonatal deaths, respectively, in urban Gambia.

The current study showed a higher prevalence of neonatal mortality than prenatal mortality. Figure 1 indicates the reason may be the low level of neonatal care atleast in the said hospital in the D. I. Khan.

CONCLUSION

HIE showed the largest share of 39.8% of prenatal (stillbirths) and neonatal mortality in the nursery ward, followed by premature (15.4%), SPE (10%), LBW/HLBW (9.3%), BA (5.3%), NNJ (4.5%), RDS (4.3%), MNS (3.5%), CHD (2.4%), and MAS (1.4%) during the study period. The remaining causes resulted in each in ≤0.6% mortality. August showed the highest mortality (22.4%), and October had the lowest (13.4%).

Isolation ward showed (48.5%) cases of prenatal and neonatal mortality, followed by labor room (42.4%) cases. Overall neonatal mortality accounted for 65.8%, while prenatal mortality was 34.2%. The highest mortality of 15.4% occurred in 2019 and the lowest in 2013 (6.8%). Relative year-wise percentage of both prenatal and neonatal mortality showed comparability during 2015-2019 and 2021. Neonatal mortality has an annual higher rate than prenatal mortality during 2013-2021 except in 2014.

Recommendations

The prevalence of a high rate of HIE followed by preterm births associated with perinatal mortality may reflect a lack of antenatal and postnatal care, and an improper delivery system in the study area, and needs to improve antenatal care services for pregnant women and newborns to provide high-quality services and health care in special care units and enhance common access to the quality of health services in Khyber Pakhtunkhwa to reduce perinatal/infant mortality as well as women mortality during delivery and after birth.

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Ethics approval

The study was approved by Dr. Farah Jamil, who is the medical director and head of the approval board (IRB) with reference No. 2754/MD, dated May 30, 2022.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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