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A Statistical Investigation of the Determinants of Infant Mortality Rate (IMR) In Various Areas of Lower Dir, Khyber Pakhtunkhwa

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Abstract

The Infant Mortality Rate (IMR) is widely recognized as a crucial indicator of overall population health. This study explores the trends, causes, and factors influencing the IMR in the Lower Dir district of Khyber Pakhtunkhwa, Pakistan. Using secondary data collected from four major public hospitals, DHQ Hospital Temargara, THQ Hospitals in Chakdara, Samar Bagh, and Maidan, this research investigates the neonatal and post-neonatal mortality trends for the years 2023 and 2024. A total of 16,339 live births were analyzed over the two-year period. The study employs descriptive statistics, mortality rate calculations, and inferential analysis using the Chi-Square test to identify associations between hospital and type of infant death. The findings show a decline in IMR from 81.37 per 1,000 live births in 2023 to 69.24 in 2024, while neonatal mortality remained significantly higher than post-neonatal mortality in both years. DHQ Hospital Temargara recorded the highest IMR and neonatal death proportion. Key factors contributing to infant mortality include inadequate maternal healthcare, lack of skilled birth attendants, malnutrition, and limited access to postnatal care. The study highlights disparities in healthcare service delivery among hospitals and emphasizes the urgent need for targeted interventions, improved health infrastructure, and community health education to reduce preventable infant deaths. The results provide valuable insights for public health planners and policymakers aiming to strengthen child health outcomes and align with national and global health objectives, including the Sustainable Development Goals (SDGs).

Key words: Infant Mortality Rate**, Neonatal Deaths,** Post-Neonatal, **Healthcare Access, Dir Lower.**

Introduction

Infant Mortality Rate (IMR) is widely recognized as a key indicator of a country's health, development, and quality of life. Many researchers around the world have studied various factors that affect infant and neonatal mortality. Below is a summary of some important studies:

In developing nations, birth and death records often suffer from underreporting and inaccuracies. To tackle this, India launched the Sample Registration System (SRS) in 1960. However, challenges remain due to misreporting and respondent biases. The study aimed to develop statistical models, considering that many infant deaths occur within the first month of life Brijesh P. Singh et al. (2015). Research on infant mortality in England reveals that it has one of the highest rates in Europe. This study emphasizes that while social and economic factors contribute to mortality differences among ethnic groups, the precise influence of race and deprivation is still not entirely understood David E. Odd et al. (2024). In Italy, an analysis comparing infants of Italian and foreign parents highlighted the impact of the COVID-19 pandemic on infant mortality in 2020, providing insights alongside data from previous years Luisa Frova et al. (2024).

Ohio ranks 43rd in the U.S. for infant mortality, with Non-Hispanic Black infants experiencing a mortality rate almost three times higher than other groups, indicating significant racial disparities Topista et al. (2024). The final infant mortality data for the U.S. in 2022 showed a 3% increase from the previous year, with rates rising from 5.44 to 5.61 deaths per 1,000 live births. This study also delved into causes of death and demographic trends Driscoll, Ph.D. et al. (2024).

A study on the effects of air pollution, particularly methane emissions, on infant mortality in Europe linked environmental factors with newborn health across 53 countries from 1990 to 2018, aligning with the Sustainable Development Goals (SDGs) Bosede Ngozi Adeleye et al. (2024). Moreover, the challenges of accurately tracking infant deaths due to congenital cytomegalovirus (cCMV) were discussed, pointing to delays in investigation and biases in data that can change research outcomes Patrick Fleming et al. (2024).

In Pakistan, despite a decline in the infant mortality rate (IMR) from 86 to 62 per 1,000 live births over the last 30 years, the country still holds one of the highest rates globally Rashmi Rai et al. (2021). A study focusing on South Asia indicated that gender differences significantly contribute to perinatal deaths, stillbirths, and neonatal mortality Zubair H et al. (2020).

The relationship between health indicators, such as infant mortality and life expectancy, and labor force participation in Pakistan was surveyed. Results indicated that better health, including a lower IMR, correlates with higher economic activity (Raza A et al., 2023). Moreover, the importance of low birth weight (LBW) as a key factor in infant mortality was emphasized, with the study investigating both visible and hidden effects on LBW and infant mortality, exploring spatial patterns across various regions Arup Jana et al. (2023).

International aid and vaccination campaigns have contributed to improvements in child health; however, Afghanistan continues to face alarmingly high infant mortality rates. The study assessed the underlying reasons and proposed policy-level solutions Ariba Salman et al. (2024). The implications of post-term pregnancies (those extending beyond 42 weeks), linked to adverse infant outcomes, were also considered. High-income countries manage these risks with proactive measures, while low- and middle-income nations often struggle to implement similar interventions Zeina Jamaluddine et al. (2024).

In particular, the province of Khyber Pakhtunkhwa (KP) in Pakistan faces a staggering IMR, displaying significant disparities across districts. The Lower Dir district exemplifies a region burdened by high infant mortality, attributed to factors such as limited maternal healthcare, insufficient skilled birth attendants, poor nutrition, and inadequate access to postnatal care. Although previous studies have identified these issues, there remains a lack of localized, data-driven research.

Methodology

The research was conducted in District Lower Dir, located in Khyber Pakhtunkhwa (KP) province, Pakistan. Data were collected from four public-sector hospitals: District Headquarter (DHQ) Hospital, Timergara; Tehsil Headquarter (THQ) Hospital, Chakdara; Tehsil Headquarter (THQ) Hospital, Samar Bagh; and Tehsil Headquarter (THQ) Hospital, Maidan. These hospitals were selected from a total of seven public hospitals in the district using purposive sampling, as they are the primary healthcare providers in their respective tehsils and maintain official records on births and infant mortality. Purposive sampling, a non-probability sampling technique, was employed to intentionally select these hospitals based on their relevance to the research objectives.

Source and Nature of Data

This study utilized secondary data sourced from hospital registries for the years 2023 and 2024. The data included the following variables: Total Live Births (TLB), Neonatal Deaths (deaths within 28 days of birth), and Post-Neonatal Deaths (deaths from 29 days to under one year of age). Formal permission for data access was obtained from hospital authorities in compliance with the General Data Protection Regulation (GDPR). The collected data were verified for consistency and entered into Microsoft Excel and R software for analysis.

Sample Size

The recorded live births from the selected hospitals are 7,312 births in 2023, and 9,027 births in 2024. This results makes a total sample size of 16,339 live births over the two-year period.

The Dependent Variable

Infant Mortality Rate (IMR) is our dependent variable in the study.

Independent Variables

i. Type of hospital
ii. Estimated population served
iii. Year of data
iv. Crude Birth Rate (CBR)
v. Crude Death Rate (CDR)

Descriptive Statistics

For the following measures to be calculated so different descriptive statistical like frequency distributions and different graphical presentation techniques are presented in this section. For this we use, total and average number of neonatal and post-neonatal deaths. Percentages and proportions, Mortality rates (IMR, NMR, and PNMR), Crude birth and death rates (CBR, CDR).To examine whether there is a significant association between the type of infant death (neonatal or post-neonatal) and the hospital, the Chi-Square test is applied.

Formulas Used

Infant Mortality Rate (IMR)

$$\text{IMR} = \frac{\text{Neonatal Deaths+Post Neonatal Deaths}}{\text{Total live Births}} \times 1000 \quad (1)$$

Neonatal Mortality Rate (NMR)

$$\text{NMR} = \frac{\text{Neonatal Deaths}}{\text{Total live Births}} \times 1000 \quad (2)$$

Post-Neonatal Mortality Rate (PNMR)

$$\text{PNMR} = \frac{\text{Post Neonatal Deaths}}{\text{Total live Births}} \times 1000 \quad (3)$$

Crude Birth Rate (CBR)

$$\text{CBR} = \frac{\text{Total live Births}}{\text{Total Population}} \times 1000 \quad (4)$$

Crude Death Rate (CDR)

$$\text{CDR} = \frac{\text{Total infant Deaths}}{\text{Total Population}} \times 1000 \quad (5)$$

Proportion of Neonatal to Infant Deaths

$$\text{Neonatal Proportion (\%)} = \frac{\text{Neonatal Deaths}}{\text{Total Infant Deaths}} \times 1000 \quad (6)$$

Chi-Square Test:

To examine whether there is a significant association between the type of infant death (neonatal or post-neonatal) and the hospital, the Chi-Square test is applied.

$$\chi^2 = \sum \frac{(o_i - e_i)^2}{e_i} \quad (7)$$

Where:

- o_i = Observed frequency
- e_i = Expected frequency

Software

For data analysis the Microsoft Excel is used for preliminary data entry, tabulation, and descriptive statistics. R Programming Language is used for advanced calculations, including mortality rates and hypothesis testing (e.g., Chi-square test).

Inferential data analysis:

Here we provide the inferential statistical analysis of the data collected. Percentages and proportions, Mortality rates (IMR, NMR, and PNMR), Crude birth and death rates (CBR, CDR).To examine whether there is a significant association between the type of infant death (neonatal or post-neonatal) and the hospital, the chi-squared test is applied.

The study analyzes data from four health centers in Lower Dir to investigate neonatal and post-neonatal mortality patterns. It focuses on live births and deaths occurring within the first year, specifically within the first 28 days and from 29 days to one year of age. The aim is to identify trends and potential causes of infant mortality in the region.

Table 1:

Hospitals data table for 2023

Year	T.L.B	Neonatal	Post-Neonatal
2023	447	49	5
2023	456	23	3
2023	496	43	3
2023	395	41	1
2023	396	42	1
2023	375	32	3
2023	309	34	2
2023	346	28	1
2023	300	34	4
2023	453	33	2
2023	535	38	4
2023	552	35	2
2023	1030	43	19
2023	698	26	13
2023	524	22	9
Total	**7312**	**523**	**72**

Infant Mortality Rate (IMR) 2023 = 81.37

In 2023, the Infant Mortality Rate (IMR) in District Lower Dir is 81.37 per 1,000 live births, indicating significant challenges in neonatal and maternal healthcare. This important rate suggests deficiencies in services and highlights the urgent need for improvements in healthcare access and education. Immediate attention from health authorities is necessary to address these gaps and enhance outcomes for newborns.

Neonatal Mortality Rate (NMR) 2023 = 71.526

In 2023, the Neonatal Mortality Rate in the region was 71.52 per 1,000 live births, indicating significant issues in neonatal care due to factors like inadequate antenatal services and skilled health professionals. Reinforcing maternal and child healthcare services is crucial to reduce these preventable deaths and meet health objectives.

Post Neonatal Mortality Rate (PNMR) 2023= 9.85

In 2023, the Post Neonatal Mortality Rate (PNMR) in the region was 9.85 per 1,000 live births, highlighting ongoing risks for infants after their first month. Contributing factors include lack of immunization, infectious diseases, poor nutrition, and limited healthcare access. To reduce mortality, it's vital to improve parental education, enhance child health services, and ensure regular health check-ups for infants.

Table 2:

Hospitals Data Table For 2024

Year	T.L.B	Neonatal	Post Neonatal
2024	616	43	2
2024	547	45	3
2024	578	50	1
2024	616	39	2
2024	526	36	1
2024	495	29	3
2024	568	37	6
2024	513	25	2
2024	448	31	1
2024	510	38	5
2024	588	32	6
2024	581	42	5
2024	712	30	13
2024	1150	43	21
2024	579	24	10
Total	**9027**	**544**	**81**

Infant Mortality Rate (IMR) 2024= 69.24

In 2024, the Infant Mortality Rate (IMR) in the target area was notably high at 69.24 per 1,000 live births, reflecting serious health challenges for infants. This rate is influenced by factors such as maternal health issues, inadequate care, and low birth weight. To reduce infant mortality, enhancing healthcare services and preventive measures is essential for improving child survival rates.

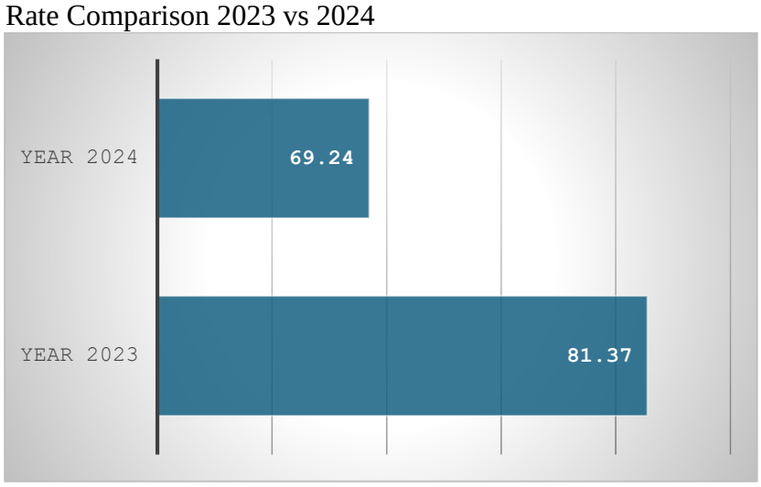
Neonatal Mortality Rate (NMR) 2024= 60.26

The Neonatal Mortality Rate (NMR) in 2024 was estimated at 60.26 deaths per 1,000 live births, reflecting significant challenges in early neonatal care. Contributing factors include limited access to quality maternal healthcare and complications during delivery. Strengthening maternal health services and enhancing early postnatal care are essential for improving neonatal survival rates.

Post Neonatal Mortality Rate (PNMR) 2024= 8.97

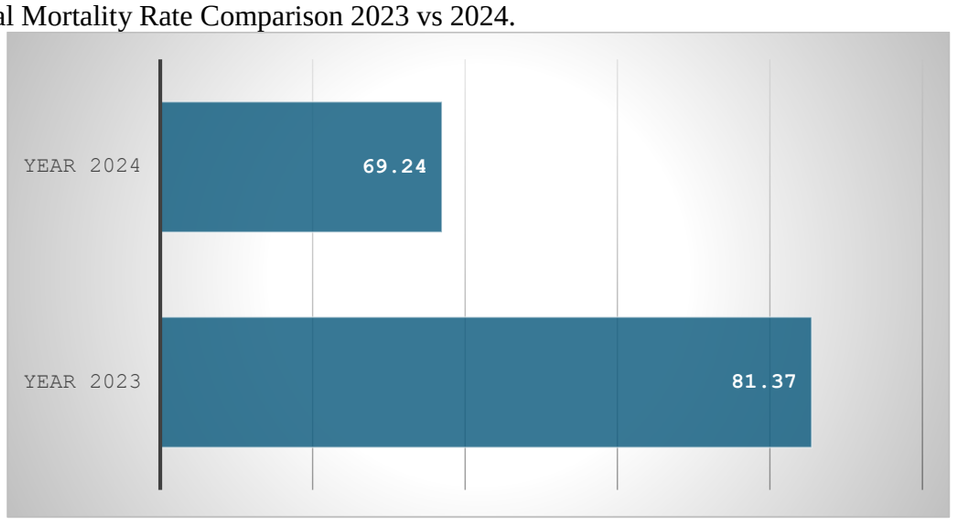
Based on the available data, the Post neonatal Mortality Rate (PNMR) in 2024 was the post-neonatal mortality rate is approximately 8.97 deaths per 1,000 live births, highlighting the need for improved child healthcare services after the neonatal period. Key contributing factors include infections, poor nutrition, and limited access to care. Enhancing healthcare infrastructure and access to routine check-ups is crucial for reducing mortality and improving child survival.

Figure 1:
Infant Mortality Rate Comparison 2023 vs 2024



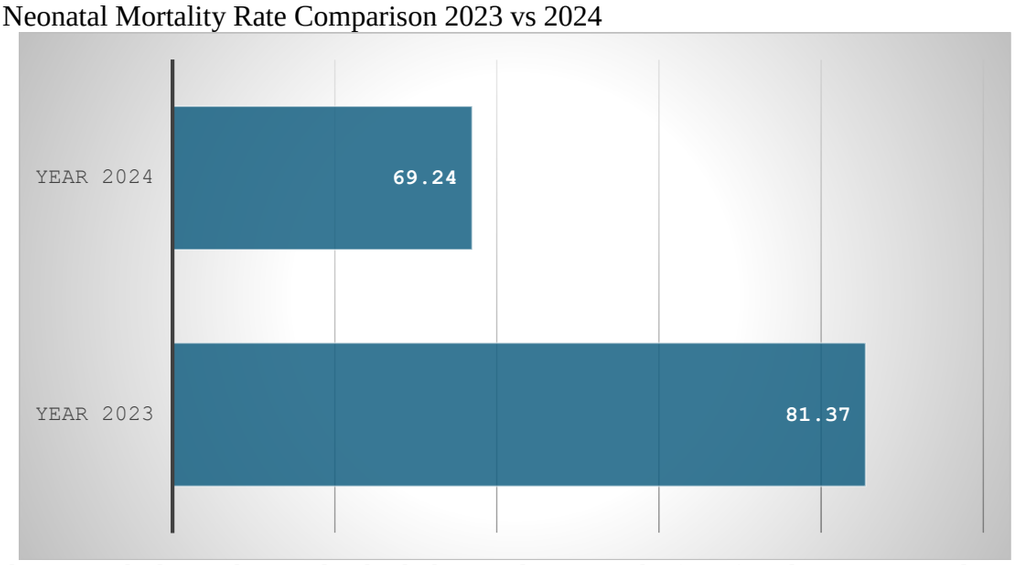
The Infant Mortality Rate (IMR) decreased from approximately 81.37 in 2023 to around 69.24 in 2024, indicating an improvement in infant health outcomes. Similarly, the Neonatal Mortality Rate (NMR) fell from around 71.53 to 60.26 in the same period. These trends suggest better access to healthcare and increased awareness of maternal and child health.

Figure 2:
Neonatal Mortality Rate Comparison 2023 vs 2024.



The decline in neonatal mortality rates reflects improvements in neonatal health due to better prenatal care and practices. However, the rates remain high, indicating the need for ongoing efforts to enhance healthcare services during the crucial early days of life.

Figure 3:
Post Neonatal Mortality Rate Comparison 2023 vs 2024



The above graph shows the trend in both the Total Live Births (TLB) and Post-Neonatal Mortality Rate (PNMR) between 2023 and 2024. In 2023, there were 7,312 live births, and the PNMR was 9.85 deaths for every 1,000 live births. In 2024, the PNMR somewhat dropped to 8.97, but live

births rose sharply to 9,027. Even though the number of births has increased, this pattern shows a little decrease in post-neonatal mortality. Improving postnatal care, vaccination coverage, diet, or prompt medical interventions could all be contributing factors to the decline in the mortality rate. According to the data, there has been a positive change in child health indicators, and it is possible that the healthcare system is getting better at reducing deaths.

Table 3:

Hospitals Data Table For 2023

Hospital	T.L.B	Neonatal	Post Neonatal	I.M.R
DHQ Temargara	4,508	432	31	102.7
THQ Chakdara	1,030	43	19	60.19
THQ Samar Bagh	698	26	13	55.87
THQ Maidan	524	22	9	59.16
Total	**6,760**	**523**	**72**	**277.92**

Table 4:

The Proportion of Neonatal To Infant Deaths for the Year 2023

Hospital	N.D	PND	TID	N. Proportion %
DHQ Temargara	432	31	463	93.30
THQ Chakdara	43	19	62	69.35
THQ Samar Bagh	26	13	39	66.67
THQ Maidan	22	9	31	70.97

Data from four hospitals in Lower Dir district in 2023 shows significant variation in neonatal death proportions among infant deaths. DHQ Hospital Temargara had the highest at 93.30%, indicating severe birth-related challenges. THQ Hospital Chakdara and THQ Hospital Maidan reported 69.35% and 70.97%, respectively, highlighting gaps in post-neonatal care. THQ Hospital Samar Bagh had the lowest at 66.67%, suggesting ongoing health service issues, emphasizing the need for improved care strategies to reduce overall infant mortality.

Table 5:

Hospitals data table for 2024

Hospital	T.L.B	neonatal	Post neonatal	I.M.R
DHQ Temargara	6,586	447	37	73.48
THQ Chakdara	712	30	13	60.39
THQ Samar Bagh	1,150	43	21	55.65
THQ Maidan	579	24	10	58.72
Total	**9,027**	**544**	**81**	**248.24**

The 2024 data from Lower Dir district hospitals reveals the percentage of neonatal deaths among total infant deaths, highlighting critical timing for infant deaths and potential areas for improving maternal and child healthcare.

Table 6:

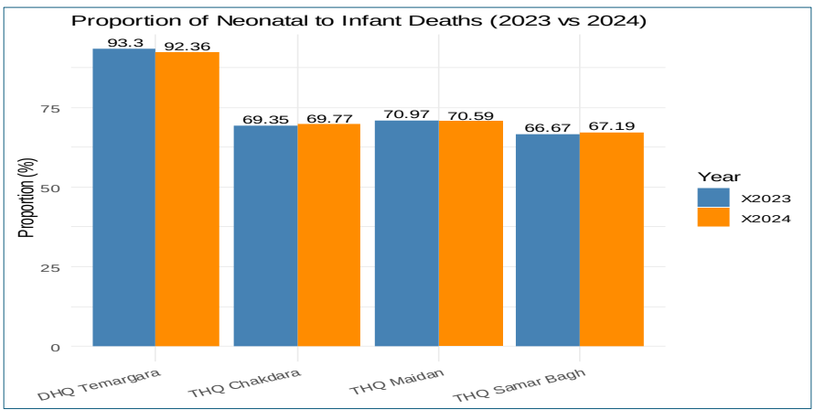
The Proportion of Neonatal To Infant Deaths for the Year 2024

Hospital	N.D	PND	TID	N. Proportion %
DHQ Temargara	44	37	484	92.36
THQ Chakdara	30	13	43	69.77
THQ Samar Bagh	43	21	64	67.19
THQ Maidan	24	10	34	70.59

DHQ Hospital Temargara reported the highest neonatal death rate at 92.36%, indicating severe issues with care during birth. THQ Hospital Chakdara and THQ Hospital Maidan showed significant early deaths as well, emphasizing the need for improved early care and follow-up. THQ Hospital Samar Bagh had a notably lower neonatal proportion, suggesting problems with postnatal

care. Overall, these findings highlight the urgent need for targeted health policies to address both neonatal and post-neonatal infant mortality.

Figure 3:
Proportion of Neonatal to Infant Deaths 2023 Vs 2024.



In both 2023 and 2024, DHQ Hospital Timergara exhibited the highest neonatal death proportion at 93.3% and 92.36%, indicating ongoing challenges in early neonatal care. THQ Hospitals Chakdara, Maidan, and Samar Bagh showed relatively stable or slight improvements in their proportions, suggesting varied levels of neonatal care. Overall, the data highlights the critical need for enhanced neonatal and post-neonatal healthcare to address the significant proportions of infant mortality across these facilities.

Table 7:
Hospitals Data Table For 2023

Hospital	Estimated Population	TLB	Total Deaths (Neonatal + Post)
DHQ Temargara	574,433	4,508	432 + 31 = 463
THQ Chakdara	287,216	1,030	43 + 19 = 62
THQ Samar Bagh	287,216	698	26 + 13 = 39
THQ Maidan	287,216	524	22 + 9 = 31
Total	**1,436,082**	**6,760**	**595**

In 2023, DHQ Hospital Timergara had the highest crude birth rate (CBR) at 7.85 per 1,000, reflecting its role as a major healthcare facility. In contrast, THQ Chakdara, THQ Samar Bagh, and THQ Maidan had lower CBRs of 3.59, 2.43, and 1.82, respectively, indicating potential underutilization of maternal services. The overall CBR for the four hospitals combined was 4.71 per 1,000, suggesting a lower regional fertility rate or births occurring outside the hospital system.

Table 8:
Hospitals Data Table For 2024

Hospital	Estimated Population	TLB	Total Deaths (Neonatal + Post)
DHQ Temargara	574,433	6,586	447 + 37 = 484
THQ Chakdara	287,216	712	30 + 13 = 43
THQ Samar Bagh	287,216	1,150	43 + 21 = 64
THQ Maidan	287,216	579	24 + 10 = 34
Total	**1,436,082**	**9,027**	**625**

Table 9:
Crude Birth Rate (CBR) Analysis for the Year 2024

Hospital	Population	TLB	CBR
DHQ Temargara	574433	6586	11.47
THQ Chakdara	287216	712	2.48
THQ Samar Bagh	287216	1150	4.00
THQ Maidan	287216	579	2.02

Total	**1436081**	**9027**	**4.99**

The Crude Birth Rate (CBR) in Lower Dir exhibits significant variation among four government hospitals for 2024, with DHQ Hospital Temargara reporting the highest rate of 11.47 per 1,000. In contrast, THQ Hospital Chakdara had a CBR of 2.48, while THQ Samar Bagh and THQ Maidan reported 4.00 and 2.02, respectively. These discrepancies may arise from factors such as population density, healthcare accessibility, and delivery preferences. Overall, the data highlights the influence of institutional roles on birth patterns between 2023 and 2024.

Table 10:

Hospitals Data Table for the Year 2023

Hospital	Estimated Population	TLB	Total Deaths (Neonatal + Post)
DHQ Temargara	574,433	4,508	432 + 31 = 463
THQ Chakdara	287,216	1,030	43 + 19 = 62
THQ Samar Bagh	287,216	698	26 + 13 = 39
THQ Maidan	287,216	524	22 + 9 = 31
Total	**1,436,082**	**6,760**	**595**

Table 11:

Crude Death Rate (CDR) Analysis for the Year 2023

Hospital	Population	TLB	ND	PND	Total Deaths	CDR
DHQ Temargara	574433	4508	432	31	463	0.81
THQ Chakdara	287216	1030	43	19	62	0.22
THQ Samar Bagh	287216	698	26	13	39	0.14
THQ Maidan	287216	524	22	9	31	0.11

Total CDR for all hospitals: 0.4143

In 2023, the Crude Death Rate (CDR) for government hospitals in Lower Dir district was 0.4143 deaths per 1,000 population, indicating a relatively low infant mortality rate compared to national averages. DHQ Temargara had the highest individual CDR at 0.806, reflecting its role as a primary referral center. Other hospitals reported lower CDRs, potentially due to fewer high-risk cases or underreporting. While the figure serves as a valuable baseline for monitoring health performance, it misses deaths outside hospitals, particularly in rural areas. To gain a comprehensive understanding of mortality trends, enhancing community-level death registration and surveillance systems is recommended.

Table 12:

Hospitals Data Table For 2024

Hospital	Estimated Population	TLB	Total Deaths (Neonatal + Post)
DHQ Temargara	574,433	6,586	447 + 37 = 484
THQ Chakdara	287,216	712	30 + 13 = 43
THQ Samar Bagh	287,216	1,150	43 + 21 = 64
THQ Maidan	287,216	579	24 + 10 = 34
Total	**1,436,082**	**9,027**	**625**

Table 13:

Crude Death Rate (CDR) Analysis for the Year 2024

Hospital	Population	Total Deaths	CDR
DHQ Temargara	574433	463	0.81
THQ Chakdara	287216	62	0.22
THQ Samar Bagh	287216	39	0.14
THQ Maidan	287216	31	0.11

Total CDR for all hospitals: 0.435

The Crude Death Rate (CDR) for 2024 in Lower Dir is 0.435 deaths per 1,000 population, reflecting recorded infant deaths in four government hospitals. Limitations in hospital data, referral patterns, and improved reporting may have influenced this slight increase from 2023. To enhance the accuracy of mortality statistics, community death registration and integration of data from all

healthcare settings are crucial. This information is vital for health planners and policymakers to effectively address infant mortality and improve newborn care.

In summary, two hospitals (DHQ Temargara and THQ Samar Bagh) reported an increase in CDR, while THQ Chakdara showed a decrease, and THQ Maidan had a small increase. These variations could be influenced by differences in healthcare quality, population size, or disease outbreaks, which need further investigation. DHQ Temargara had the highest Crude Death Rate (CDR) in both years, increasing from 0.806 to 0.843 per 1,000 population. THQ Chakdara saw a decrease in CDR from 0.216 to 0.15, indicating improved mortality. THQ Maidan experienced a small rise from 0.108 to 0.118, while THQ Samar Bagh had a significant increase from 0.136 to 0.223. These differences in CDRs may reflect variations in healthcare quality, population factors, or disease outbreaks, requiring further investigation.

Table 14:

Hospitals Data Table For 2023

Hospital	Neonatal	Post Neonatal
DHQ Temargara	432	31
THQ Chakdara	43	19
THQ Samar Bagh	26	13
THQ Maidan	22	9

The analysis of 2023 data using Pearson's Chi-Square test indicated a significant relationship between the type of death (neonatal vs post-neonatal) and the hospital, with a Chi-square value of 57.649 and a p-value of 0.000. This suggests that neonatal and post-neonatal deaths vary by hospital, indicating that some hospitals experience higher rates of certain types of deaths.

Table 15:

Hospitals Data Table For 2024

Hospital	Neonatal	Post Neonatal
DHQ Temargara	447	37
THQ Chakdara	30	13
THQ Samar Bagh	43	21
THQ Maidan	24	10

A Chi-Square test analyzed data from 2024, revealing a statistically significant association between the type of infant death (neonatal or post-neonatal) and the hospital where it occurred, of 54.014 with 3 degrees of freedom, and with a p-value of 0.000. This indicates that neonatal and post-neonatal deaths are not evenly distributed across hospitals. In essence, the type of death varies by hospital.

Conclusion

Tehsil Headquarter Hospital Chakdara, Tehsil Headquarter Hospital Samar Bagh, Tehsil Headquarter Hospital Lal Qilla, District Headquarter Hospital Timergara are the four Tehsil Headquarter Healing centers in Lower Dir. The data of the present study are accumulated from these health centers are displayed in this chapter. The foremost point of this inquire about is to examine the patterns and potential causes of neonatal and post-neonatal newborn child mortality. The point of investigation is to assess the patterns and results related with newborn child mortality within the range by concentrating on the information collected on live births, neonatal passing's (inside the primary 28 days of life), and post-neonatal passing's (from the 29th day up to one year of age). Based on the data collected for the year 2023, the evaluated Infant Mortality Rate (IMR) in District Lower Dir stands at 81.37 per 1,000 live births. This indicates that approximately 81 infants die within their first year of life for every 1,000 live births in the region. This figure reflects the prevailing state of neonatal and post-neonatal healthcare services and highlights significant challenges within the existing maternal and child health framework.

The high infant mortality rate indicates significant gaps in maternal health services, hygienic practices, and access to emergency neonatal care. It underscores the urgent need to improve healthcare services, community education, and resources in primary care facilities. In 2023, the Neonatal Mortality Rate in the selected region was 71.52 per 1,000 live births, with around 72 newborns dying within the first month. This alarming rate underscores significant shortcomings in early neonatal care and support. Key factors contributing to these deaths include limited access to antenatal services, insufficient skilled professionals during childbirth, and inadequate post-

neonatal care. Common causes such as birth complications, infections, prematurity, and low birth weight also play a significant role. Strengthening maternal and child healthcare is vital to reduce preventable deaths and align regional progress with national and global health objectives, including the Sustainable Development Goals (SDGs).

In 2023, the Post Neonatal Mortality Rate (PNMR) in the study area was 9.85 per 1,000 live births, indicating that many infants remain at risk during their first year. Factors contributing to these preventable deaths include inadequate immunization, infectious diseases, poor nutrition, and limited healthcare access. In 2024, the Infant Mortality Rate (IMR) in the target area was 69.24 per 1,000 live births, highlighting severe health challenges for infants during their first year. This high rate is linked to factors like maternal health issues, inadequate care, infections, low birth weight, and poor infant care practices. In 2024, the Neonatal Mortality Rate (NMR) was estimated at 60.26 deaths per 1,000 live births, indicating that around 60 newborns died within the first 28 days of life. This high rate highlights severe challenges during the early neonatal period. In 2024, the Post Neonatal Mortality Rate (PNMR) was about 8.97 deaths per 1,000 live births, highlighting the need for improved child healthcare during infancy. Contributing factors include infections, poor nutrition, lack of immunization, and limited postnatal care. The Infant Mortality Rate (IMR) decreased from approximately 81.37 in 2023 to around 69.24 in 2024. This decline indicates progress but also emphasizes ongoing challenges in infant health. In 2024, the Post Neonatal Mortality Rate (PNMR) was about 8.97 deaths per 1,000 live births, highlighting the need for improved child healthcare during infancy. Contributing factors include infections, poor nutrition, lack of immunization, and limited postnatal care. The Infant Mortality Rate (IMR) decreased from approximately 81.37 in 2023 to around 69.24 in 2024. This decline indicates progress but also emphasizes ongoing challenges in infant health.

The significant decrease in infant mortality rates (IMR) over the past year indicates positive improvements in infant health outcomes due to better access to healthcare services and increased awareness in the community. The Neonatal Mortality Rate (NMR) fell from approximately 71.53 to 60.26 deaths per 1,000 live births between 2023 and 2024. Live births increased substantially from 7,312 to 9,027, while the Post-Neonatal Mortality Rate (PNMR) slightly decreased from 9.85 to 8.97. This trend suggests enhancements in postnatal care and health interventions. Overall, the data reflects a notable improvement in child health indicators, indicating progress in the healthcare system. The 2023 and 2024 data from four hospitals in Lower Dir district reveals significant variations in neonatal and infant mortality rates, particularly with high neonatal deaths at DHQ Temargara, indicating a need for improved maternal and infant care. The Crude Birth Rate (CBR) was 4.71 per 1,000 people in 2023, suggesting lower fertility rates or births outside hospitals. The Crude Death Rate (CDR) rose from 0.4143 in 2023 to 0.435 in 2024, highlighting the importance of enhanced death registration for health planning. A Pearson's Chi-Square test showed a significant association between types of infant deaths and hospitals, indicating uneven distribution of these deaths. Further investigation is needed to understand these patterns and improve healthcare outcomes in the region. Overall, these findings are crucial for shaping effective health policies to reduce infant mortality.

Limitations of the Study

The research relies only on data from government hospitals. Data from private clinics and home deliveries were unavailable. Incomplete or inaccurate recordkeeping due to human error may affect data quality. The results reflect conditions only in Lower Dir, so generalizations to other regions may be limited. In cases where hospital records were missing or incomplete, interviews were conducted with doctors, nurses, and family members of the deceased infants to supplement the data. This helped ensure the accuracy and completeness of the dataset.

Ethical Considerations

The study adhered to ethical standards. Formal permission (Consent) is obtained from hospital authorities/ administration for data access under the General Data Protection Regulation (GDPR). No personal or identifiable data are collected. All records are used solely for academic purposes and are handled with confidentiality.

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