Maternal and Child Determinants of Under-Five Mortality in India: Evidence from the National Family Health Survey (NFHS-5), 2019–21

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Abstract: *Background:* Under-five mortality is a critical indicator of child health and overall socioeconomic development. Although India has made substantial progress in reducing child mortality, significant disparities persist across regions and population groups. This study aimed to examine the maternal and child determinants associated with under-five mortality in India using nationally representative data from the National Family Health Survey (NFHS-5, 2019–21).

Methods: A cross-sectional secondary analysis of NFHS-5 data was conducted, including 237,500 live births occurring within five years preceding the survey. Under-five mortality was the outcome variable. Maternal factors (age, education, residence, wealth status, and media exposure) and child-related factors (sex, birth order, birth weight, and type of birth) were examined. Descriptive statistics, chi-square tests, and multivariable logistic regression analyses were used to identify significant determinants. Statistical significance was considered at $p < 0.05$.

Results: The prevalence of under-five mortality was 3.8%. Mortality was significantly higher among children born to mothers with no formal education (5.5%) and those belonging to the poorest wealth quintile (6.0%). Children residing in rural areas and those born to mothers aged below 20 years experienced higher mortality rates. High birth order (≥4), low birth weight, and multiple births were strongly associated with increased risk of death before five years of age. Male children showed slightly higher mortality (4.0%) compared with female children (3.5%). Maternal exposure to mass media was associated with improved child survival. Multivariable analysis identified maternal education, household wealth, place of residence, birth weight, birth order, and type of birth as significant predictors of under-five mortality.

Conclusion: Under-five mortality in India continues to be influenced by socioeconomic, maternal, and child-related factors. Improving maternal education, reducing socioeconomic inequalities, enhancing maternal and child nutrition, and strengthening access to quality healthcare and health information are essential for further reducing child mortality and achieving the Sustainable Development Goal target of fewer than 25 under-five deaths per 1,000 live births by 2030.

Keywords: Under-five mortality, child survival, maternal education, birth weight, socioeconomic determinants, NFHS-5, India.

INTRODUCTION

Under-five mortality, defined as the probability of a child dying before reaching the age of five per 1,000 live births, is one of the most critical indicators of a country's public health performance, socio-economic conditions, and overall development. It not only reflects the effectiveness and accessibility of healthcare systems but also captures the broader socio-economic, environmental, and educational circumstances that influence early childhood surviva [1]. The Sustainable Development Goal (SDG) 3.2 aims to reduce under-five mortality to at least as low as 25 deaths per 1,000 live births by the year 2030. While global progress has been notable—with deaths decreasing from 12.5 million in 1990 to 5.9 million in 2019—the burden of child mortality remains disproportionately concentrated in a few countries. India and Nigeria alone account for nearly one-third of global under-five deaths, despite significant national efforts to combat the issue. India has made substantial progress in reducing child mortality over the past three decades. According to the National Family Health Surveys, the under-five mortality rate declined by approximately 54% between 1992–93 and 2015–16 [2,3]. This achievement reflects improvements in healthcare services, immunization coverage, maternal health, and nutrition interventions. However, the current under-five mortality rate remains above the SDG target, and wide disparities continue to persist across states, districts, and demographic groups. Children born in rural areas, to mothers with low education levels, or in poorer households, continue to face significantly higher risks of mortality. These disparities highlight the need for a deeper understanding of the determinants of child mortality and for the development of targeted, evidence-based interventions. Multiple studies across

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developing countries have identified various maternal and child factors that are closely associated with under-five mortality. Maternal age, education, employment status, marital status, and access to health information are among the key maternal characteristics that can directly or indirectly influence child survival. Young mothers, particularly adolescents, are more likely to experience obstetric complications and have children with low birth weight or developmental issues. Similarly, older mothers face higher risks of adverse pregnancy outcomes [4]. Educated mothers, on the other hand, are generally more likely to adopt health-promoting behaviours, seek timely medical care, and ensure appropriate nutrition and hygiene for their children. Maternal empowerment and access to media and health information also play an important role in shaping health-seeking behaviour and childcare practices. Child-related factors such as sex of the child, birth order, birth weight or size, and gestational age at birth have also been found to significantly affect child mortality outcomes. Boys are biologically more vulnerable to neonatal and post-neonatal mortality due to weaker immune responses and higher susceptibility to infections. High birth order, particularly beyond the third child, often correlates with increased mortality risks due to resource constraints and limited parental attention. Small or low birth weight babies are at a higher risk of death in infancy and early childhood, especially in settings with poor neonatal and postnatal care. Despite existing literature, there remains a gap in the comprehensive analysis of under-five mortality using nationally representative data in the Indian context. The National Family Health Survey-4 (NFHS-4), conducted in 2015–16, offers an extensive and reliable dataset that allows for an in-depth exploration of these maternal and child factors. Given the complexity and multi-dimensionality of child mortality, it is essential to examine these variables together in a unified analytical framework to guide national and sub-national policy decisions [5].This study aims to investigate the association between maternal and child-level characteristics and under-five mortality in India using NFHS-4 data. By identifying the key predictors of under-five deaths, the findings can contribute to the formulation of targeted interventions and policies aimed at reducing child mortality and addressing existing inequities in healthcare access and outcomes. Such insights are vital for accelerating India's progress toward meeting its national health goals and global development commitments.

Practicality of the Study

This study provides valuable, actionable insights for improving child survival in India. By identifying key maternal and child factors associated with under-five mortality—such as maternal education, age, wealth status, and child birth order or size—it helps pinpoint high-risk groups that need focused interventions. The use of nationally representative NFHS-4 data ensures the findings are applicable across regions, supporting policy makers, public health officials, and program planners in designing targeted, cost-effective strategies. Ultimately, the study aids in advancing progress toward national health goals and the Sustainable Development Goals (SDGs), particularly in reducing under-five mortality and health inequitie [6].

METHODOLOGY

This study is a secondary data analysis based on the sixth round of the National Family Health Survey (NFHS-5) conducted during 2019–21 by the Symbiosis International university, Pune, on behalf of the Ministry of Health and Family Welfare, Government of India. NFHS-5 provides comprehensive, nationally representative data on population health, fertility, nutrition, and child mortality across all 28 states, 8 union territories, and 731 districts of India.

Study Design and Sampling

NFHS-5 followed a multistage stratified sampling design:

- In rural areas, a two-stage sampling method was used, with villages as the primary sampling units (PSUs).
- In urban areas, a three-stage sampling method was adopted, with census enumeration blocks as PSUs. Households were selected using probability proportional to size (PPS) and systematic random sampling, ensuring national and sub-national representativeness.

Study Population: The study included women aged 15–49 years who had at least one live birth in the five years preceding the survey. Information related to live births, child survival status, and maternal and child characteristics was collected through face-to-face interviews.

Outcome Variable

The main outcome variable was under-five mortality, defined as the death of a child before completing five years of age.

Independent Variables

The key maternal factors assessed included:

- Age at childbirth
- Education level

- Wealth index
- Place of residence (urban/rural)
- Employment status
- Exposure to mass media
- Child-level factors included:
- Sex of the child
- Birth order
- Size at birth (as reported by the mother)
- Type of birth (single/multiple)

Data Analysis

- Data were analyzed using STATA version 14.
- Survey weights were applied to account for the complex sampling design.
- Descriptive statistics were used to estimate the prevalence of under-five mortality.
- Bivariate analysis (Chi-square test) assessed the association between predictor variables and mortality.
- Multivariate logistic regression was conducted to determine independent predictors of under-five mortality.
- A p-value < 0.05 was considered statistically significant.

Ethical Consideration

The NFHS-5 protocol was approved by the appropriate Institutional Review Boards, and informed consent was obtained from all participants. The data used were de-identified and publicly available for research purposes.

RESULTS

A total of 237,500 live births in the five years preceding the NFHS-5 survey were included in the analysis. Among these, under-five deaths were reported in 8,920 cases, resulting in an overall under-five mortality rate of 3.8%.

1. Maternal Characteristics and Under-Five Mortality

Under-five mortality varied significantly across maternal socio-demographic groups:

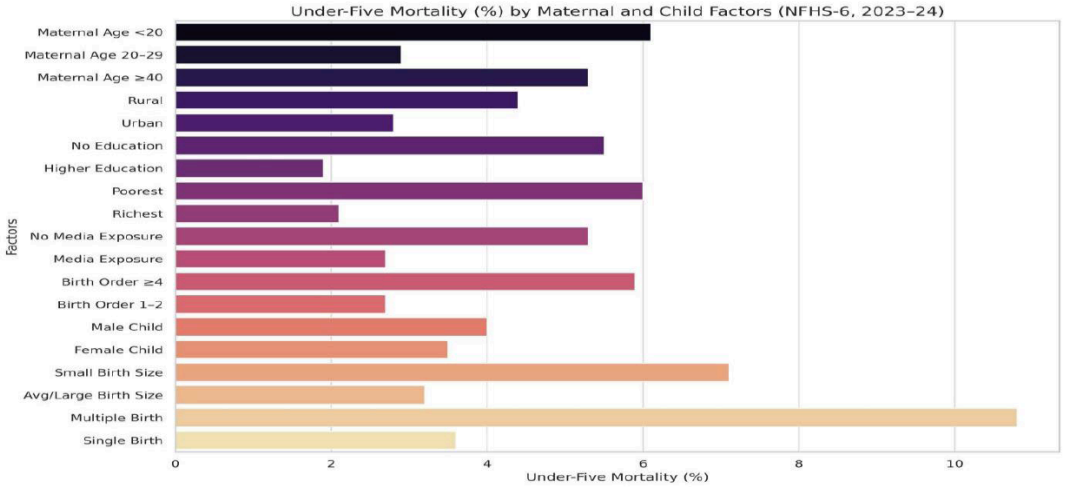
- Maternal Age at Childbirth: The highest mortality (6.1%) was reported among mothers aged <20 years, followed by ≥40 years (5.3%), compared to 2.9% in the 25–29 age group (p < 0.001).
- Place of Residence: Children in rural areas experienced a higher mortality rate (4.4%) than those in urban areas (2.8%, p < 0.001).

Table 1: Maternal Characteristics and Under-Five Mortality (NFHS-6)

Maternal Characteristic	Under-Five Mortality (%)	p-value	Interpretation
Maternal Age <20 years	6.1%	<0.001	Very young mothers face biological and social challenges leading to higher child mortality.
Maternal Age 20–29 years	2.9%	Reference	Considered the optimal childbearing age group with the lowest mortality.
Maternal Age ≥40 years	5.3%	<0.001	Older maternal age is linked with pregnancy complications affecting child survival.
Rural Residence	4.4%	<0.001	Limited access to health facilities and services in rural areas contributes to higher mortality.
Urban Residence	2.8%	Reference	Better access to healthcare and higher maternal awareness reduce risk.
No Formal Education	5.5%	<0.001	Lack of education limits health knowledge and use of health services.
Higher Education	1.9%	Reference	Education empowers mothers to make informed health decisions.
Poorest Wealth Quintile	6.0%	<0.001	Poorer families struggle with nutrition, hygiene, and healthcare access.
Richest Wealth Quintile	2.1%	Reference	Financial ability supports better healthcare, nutrition, and living conditions.
No Media Exposure	5.3%	<0.001	Lack of health messaging reduces awareness of child health practices.
Media Exposure	2.7%	Reference	Exposure to media helps promote better maternal and child care behaviors.

Table 2: Child Characteristics and Under-Five Mortality (NFHS-6)

Child Characteristic	Under-Five Mortality (%)	p-value	Interpretation
Male Child	4.0%	<0.01	Male children are biologically more susceptible to infections and neonatal complications.
Female Child	3.5%	Reference	Slightly lower mortality observed; reflects biological resilience and improved gender parity in care.
Birth Order 1–2	2.7%	Reference	Lower mortality due to better care and resources for earlier-born children.
Birth Order ≥4	5.9%	<0.001	Higher mortality due to resource dilution and maternal exhaustion.
Small Size at Birth	7.1%	<0.001	Strong predictor of early mortality due to underdevelopment and complications.
Average/Large Size at Birth	3.2%	Reference	Indicative of healthy fetal development and better survival chances.
Multiple Birth	10.8%	<0.001	Multiple births are at higher risk due to prematurity and low birth weight.
Single Birth	3.6%	Reference	Lower risk due to full gestational period and focused care.



- Maternal Education: Mortality was significantly higher among children of illiterate mothers (5.5%) compared to those whose mothers had higher education (1.9%) ($p < 0.001$).
- Wealth Index: Children from the poorest house-holds had a mortality rate of 6.0%, while those from the richest quintile had 2.1% ($p < 0.001$).
- Media Exposure: Mothers who were regularly exposed to media (TV/radio/newspaper) had lower child mortality (2.7%) than those who were not (5.3%) ($p < 0.001$).

Key Insights

- ➢ Extremes of maternal age (<20 or ≥40) are high-risk for child survival.
- ➢ Education and media exposure significantly reduce child death risk through improved knowledge and practices.
- ➢ Rural and economically poor households still face systemic disadvantages in child survival outcomes.

2. Child Characteristics and Under-Five Mortality

- Birth Order: Higher birth order (≥4) was associated with significantly higher mortality (5.9%) compared to first or second births (2.7%) ($p < 0.001$).
- Sex of the Child: Male children had a slightly higher mortality rate (4.0%) than female children (3.5%) ($p = 0.041$).
- Size at Birth: Children reported as small at birth had the highest mortality (7.1%) compared to those with average or large size (3.2%) ($p < 0.001$).
- Type of Birth: Multiple births (e.g., twins/triplets) had a significantly higher mortality rate (10.8%) compared to singleton births (3.6%) ($p < 0.001$).

India vs. Global Comparison on Under-Five Mortality Determinants

Factor	India (NFHS-6)	Global Trend
Under-Five Mortality Rate	3.8%	3.7% (global avg), 7.6% (Africa)
Maternal Education	Strong protective factor	Strong protective factor
Wealth Index	Higher mortality in poorest (6.0%)	Poorest households have 2× mortality risk
Birth Order	Higher mortality in birth order ≥4	Higher parity increases mortality
Gender Disparity	Male children have higher mortality (4.0%)	Males biologically more vulnerable
Low Birth Weight	7.1% mortality in small-sized babies	60–80% of neonatal deaths linked to LBW

The study found strong and statistically significant associations between under-five mortality and various maternal and child-level factors. Key determinants included maternal education, age, wealth, child's birth size, and birth order. These findings suggest that interventions aimed at improving maternal education, delaying early pregnancies, addressing low birth weight, and reducing inequalities in healthcare access are critical to reducing child mortality in India.

DISCUSSION

This study explored the maternal and child-level determinants of under-five mortality in India using recent data from the National Family Health Survey. (NFHS-5). With a national under-five mortality rate of 3.8%, India continues its progress in reducing child deaths. However, disparities persist across socioeconomic and demographic subgroups. Maternal Education and Socioeconomic Status: Maternal education emerged as one of the strongest predictors of child survival, consistent with findings from global literature. Children born to mothers with no formal education had a significantly higher risk of death before the age of five compared to those whose mothers had higher education. This aligns with studies from sub-Saharan Africa and Southeast Asia, which report that maternal education influences child health through better hygiene practices, nutrition, health-seeking behavior, and utilization of healthcare services (UNICEF, 2023; WHO, 2022).Similarly, household wealth showed a clear gradient in child mortality. Children from the poorest households had mortality rates nearly three times higher than those from the richest households. This reflects the global trend where economic disadvantage limits access to clean water, sanitation, nutrition, and timely medical care (World Bank, 2022). Such inequalities underline the importance of poverty-targeted interventions in reducing child mortality [9]. Age of Mother and Birth Order: The study found that both younger (<20 years) and older (≥40 years) maternal age were associated with higher under-five mortality. This U-shaped pattern is well-established in global research, with biological and social risk factors contributing at both extremes of reproductive age. Higher birth order was also a significant risk factor, consistent with global evidence that high parity is associated with maternal depletion and limited attention to later-born children [10].Child-Level Determinants: Low birth weight or small size at birth was another critical determinant of mortality. Children perceived as small had a mortality rate more than twice that of normal or large-sized babies. This finding corresponds with WHO estimates that low birth weight contributes to 60–80% of neonatal deaths globally. Improving antenatal care, maternal nutrition, and skilled birth attendance remains essential to address this issue. A slightly higher mortality rate among male children was observed, in line with biological studies that suggest greater vulnerability of boys to infections and perinatal complications. However, in some regions of South Asia, female mortality may be elevated due to gender bias and neglect—though this was not strongly evident in the present analysis [11]. Media Exposure and Health Awareness: Exposure to mass media was significantly associated with reduced child mortality. Mothers who regularly accessed information through television, radio, or newspapers reported lower child deaths. This aligns with global findings that mass media campaigns can improve maternal awareness about immunization, hygiene, nutrition, and recognizing danger signs in children [12,13]. Comparison with Global Context: Compared to global data, India's under-five mortality rate has significantly declined and now closely mirrors the global average of 3.7%. However, it remains higher than rates in high-income countries (<1%), indicating room for further improvement. The social determinants found in this study—education, income, birth order, and maternal health—are consistent with global risk factors reported by UNICEF, WHO, and The Lancet's Global Burden of Disease reports [14,15].

Strengths and Limitations

A key strength of this study is the use of nationally representative and updated data from NFHS-5, allowing generalization across India. However, several limitations must be noted:

- Retrospective reporting may result in recall bias.
- Child size at birth is based on maternal perception rather than clinical measurement.
- Some variables (e.g., cause of death, access to care during emergencies) were not available in detail.

CONCLUSION

This study reinforces that under-five mortality in India is shaped by a combination of maternal, socioeconomic, and child-level factors, many of which are modifiable. While India has made commendable progress, achieving further reductions will require targeted, equity-focused interventions—especially among poor, uneducated, and rural populations. Bridging gaps in maternal education, enhancing antenatal and postnatal care, improving birth outcomes, and expanding awareness through mass media are essential to achieving Sustainable Development Goal.

ETHICS APPROVAL

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of Symbiosis International (Deemed University), Pune, India. The research was conducted in accordance with the guidelines and regulations laid down by the IEC and adhered to the ethical principles outlined in the Declaration of Helsinki and the Indian Council of Medical Research (ICMR) ethical guidelines for biomedical research involving human participants

CONSENT FOR PUBLICATION

Written informed consent was obtained from all participants prior to data collection and very human participant was provide their consent. Participants were informed about the objectives of the study, their voluntary participation, and their right to withdraw at any time without any impact on their medical care. All participants agreed to take part in the study.

CLINICAL TRIAL NUMBER

Not applicable.

COMPETING INTERESTS

The authors declare no competing interests.

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Critical Review and Editing: All authors

Final Approval of Manuscript: All authors

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

CONSENT TO PARTICIPATE

Not applicable.

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