Under-five Mortality Among Informal Workers of Assam: An Empirical Analysis

Kanchan Devi[1] **and Vandana Upadhyay**[2]

Abstract

Background:*Despite global reductions, high U5 mortality persists in different regions of India and Assam is no exception. Children of informal workers are often vulnerable because their parents are less educated, earn limited income, and face precarious situations such as lack of social security, due to temporary work conditions. Therefore, this study examines U5 mortality trends and determinants among informal workers in Assam.*

Methods: *The study uses both primary data and secondary data. Primary data is collected from a field survey and secondary data from various reports. It examines U5 mortality among Assam's informal workers using logistic regression methods, considering variables like maternal education, family income, healthcare access, and household conditions. Data analysis tools employed are SPSS and Stata 14 software.*

Results: *From 1990 to 2021, global Under-Five Mortality Rate (U5MR) declined significantly from 93 to 38 deaths per thousand live births. India's U5MR also dropped notably from 74.44 in 2005 to 32.63 in 2020. Disparities remain, with higher rates in rural areas and among informal workers. Factors contributing to this include lack of maternal education, poor healthcare access, and inadequate living conditions.*

Conclusion:*Under-Five mortality in Assam is linked to total household births, mother's occupation, ventilation, drinking water, toilet facilities and post-natal visits. Emphasis should be on child care, family planning, support for working mothers, improving environmental and sanitary conditions, and increasing post-natal visits.*

[1]Research Scholar,Rajiv Gandhi University, Itanagar. E-mail: kdevi6044@gmail.com
[2] Rajiv Gandhi University, Itanagar. E-mail: vandanaupadhyay.rgu@gmail.com

Background

The mortality rate of children under five years old is referred to as the "under-five" or "U5" mortality rate. A child's physical and intellectual development begins between the ages of 0 and 5, making this a very important developmental stage of human life (Zewudie et al, 2020). Children are the future assets of a nation. So, child health is an important resource for the development of a nation. The well-being of the child is directly linked to the attainment of a peaceful, productive and prosperous future for mankind. Around 27 per cent of the world population is constituted by children (United Nations Population Division, 2011). Since children constitute 1/3 of the world population, child health is considered a strong indicator to represent the condition of public health in a nation. According to the World Health Organization (WHO), a total of 28 per cent of U5 mortality occurs in the Southeast region only (*Maternal and Child Epidemiology Estimation | Institute for International Programs*, n.d.).

Besides this many children from this region are bearing the burden of various diseases. Diseases among children are the common cause of mortality in many developing countries. Even though the global rate of U5 mortality has sharply decreased in recent years, certain Sub-Saharan African nations continue to have higher rates of U5 mortality. The 2018 U5 mortality rate was fifteen times higher than the global average for developed nations, including Ethiopia, Nigeria, Pakistan, and India (Gebretsadik & Gabreyohanne, 2016). With current U5 mortality rate, the achievement of Sustainable Development goals i.e., to reduce U5 mortality to at least 25 per thousand live births may be challenging for India. The challenge becomes more severe as there exist a regional variation in U5 mortality rate among within the country. Shin (1977) examined infant mortality of 63 selected countries and found that child mortality is very closely related to the social class of the people as well as the level of the level of national socio-economic development. Casterline et al. (1989) observed a relationship between income and child mortality in Egypt. He found that though income had little effect on infant mortality but it was inversely child mortality in the study area. Jatrana (2007) conducted research on April 1976 to February 1997 on the infant and child survivorship in Mewat region of Haryana state. He found an association between child mortality and environmental factors in Haryana. Amouzou and Hill (2004) studied under-five mortality in Sub-Saharan Africa and found an association between per capita incomes, literacy, and urbanization in determination of U5 mortality for the 1960-2000. The study found a negative relationship between U5 mortality and per capita income, a positive relation between illiteracy and U5 mortality and a negative relationship between urbanization and child mortality in the study area. Prakasam and Krishnaiah (2000) found household environment factors as an influential factor for determining maternal and child mortality.

Previous studies showed that maternal education, quality and skill care, drinking water quality, birth order, birth weight, birth interval, family income, breast feeding practices, etc., are the responsible factors for U5 mortality rate (Ettarh & Kimani,

2012). Caldwell (1979) found that educational attainment of the mother leads to adopt modern ideas for better hygiene and nutrition, which are supportive to prevent the incidence of common childhood diseases. Adongo et al. (2024) observed that adoption of health care services after child birth is an important factor to determine child mortality differential. Amin et. al. (1986) found that socio-economic variables play an important role in infant and child mortality determination. Hossain et al. (2012) examined the effect of demographic and household variable on the determination of child and child mortality in Charghat than in Rajasthani district of Bangladesh. The logistic regression shows that maternal factor (age at marriage, present age, housing condition) as determinant for infant and under five mortalities in particular region of Bangladesh. The under-five health is strongly dependent on health care behavior (Mishra et.al, 2019). So, the improvement in educational coverage and provision of educational messages is required for improving child health condition (Tarkang, 2004).

Informal workers generally are low-educated, earns limited income and works in vulnerable situation with adverse socio-economic conditions due to temporary and casual nature of work and not availability of social security measures. This study aims to explore the trends and pattern of Under Five Mortality (U5 Mortality) based on secondary data. It also provides an insight into the extent and determinants of under-five mortality among informal workers of Assam based on primary data.

Methods

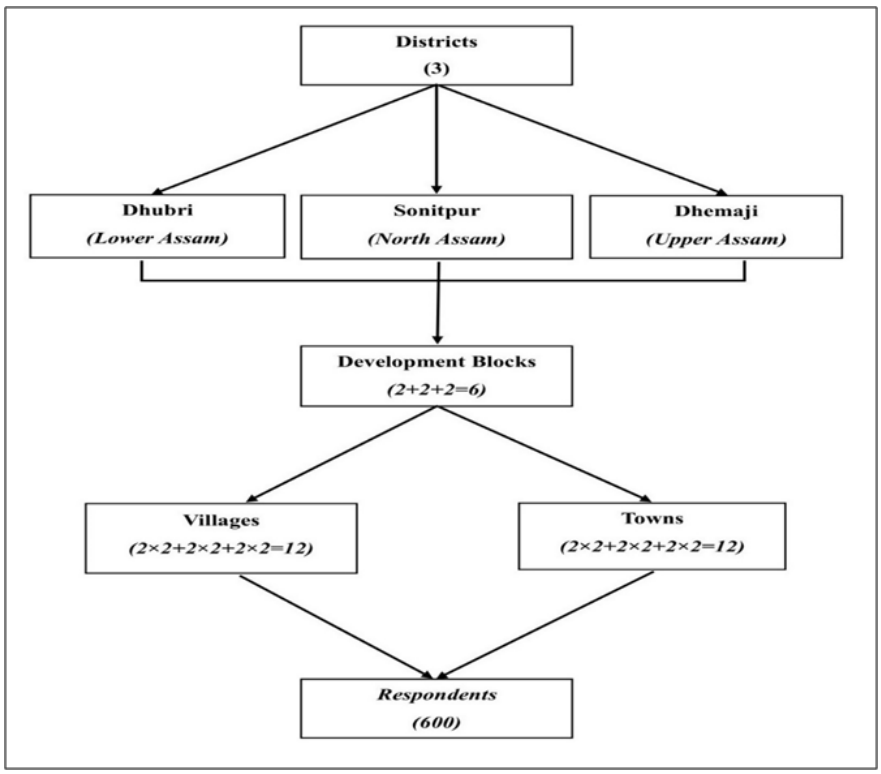
Data Source

The study utilizes both primary and secondary sources of data. Secondary data sources include information from various published sources, articles, WHO reports, the Economic Survey, and multiple rounds of the National Family Health Survey. Primary data has been collected through a field survey.

Field survey was carried out to collect primary data, reference period of the data was 2015-2020. Multi-stage sampling was employed to select the respondents. In the first stage, three districts are selected based on the performance of various health outcomes based on cluster sampling (figure.1). Thus, Dhubri as poorly performing district, Sonitpur as moderately performing and Dhemaji as better performing district were selected from three clusters to represent Assam. In the second stage, distance from the district head quarter was taken as the criterion to select developmental blocks. From each district, the nearest and the farthest developmental blocks were selected. In the third stage also two villages and two towns from each development block were selected based on the distance criterion i.e., the nearest and the farthest. Finally, sample unit i.e., respondent was selected purposively and to identify informal workers appropriate definition of informal worker was taken into consideration. In addition to Yamane's formula, 200 more samples were considered to make it more

representative. Thus, a total of 600 samples from both rural and urban area were selected on the proportionate basis. Information was collected and analyzed on the household basis.

Figure.1 Sampling Framework



Study Variables

The outcome variable in this case is under-five mortality, which is dichotomous in nature and is coded as "0" for households with living children and "1" for households with deceased children.

Independent variables were: Proximal variables such as, number of child birth occurred in the household during the reference period, intermediate variables, viz., maternal education, employment status of the mother, antenatal visits, postnatal visits, breast feeding practices, mother's age at marriage and employment status and distant variables includes per capita family income, source of drinking water, toilet facility, ventilation facility, utilisation of nearest Health Centre and age of the head of the household (table.1).

Table. 1 Description and Measurements of Independent Variables

Independent Variables and their categorization		Description
Proximal Variable	Birth Type	The variable birth type was recoded in to two categories as "0" for single birth and "1" for multiple birth.
Intermediate variables	Maternal education	Mother's education was recoded into two groups with a value of "0" for no education and "1" for primary education and above.
	Antenatal visits	The variable ANC visit was recoded in to two categories, "0" for woman who had no any ANC visit during their pregnancy and "1" for woman who had at least one ANC visit during their pregnancy.
	Post natal visits	Coded as "0" for woman who had no any Postnatal visit during their pregnancy and "1" for woman who had at least one Postnatal visit during their pregnancy.
	Breast feeding practices	Recoded as "0" for Partial feeding and "1" for Complete feeding
	Mother's age at marriage	Continuous variable
	Mother employment Status	Mother's education was recoded into two groups with a value of "0" for Unemployed mother and "1" for Employed mother.
Distant variables	Per capita family income	Continuous variable
	Source of drinking water	Coded as "1" for in-house source, "0" for out-house source
	Toilet facility	if the Toilet type is Pit, it is "1", else "0"; if the Toilet type is Open, it is "1", else "0".
	Ventilation Facility	if the Ventilation type is moderate, it is "1", else "0"; if the Ventilation type is poor, it is "1", else "0".
	Utilization of nearest health center	Recoded as "0" for Not utilisation and "1" for otherwise
	Age of the Head of the Household	Continuous variable

Data Analysis

Software's like SPSS and Stata 14 were used to recode and analyse the data. For descriptive statistics frequencies and percentages were used. Estimation is done and results are compared using two sets of logistic methods: binary logistic regression and mixed effect logistic regression method.

Binary Logistic Method

Since, the dependent variable i.e., Occurrence of Under Five Death (U5 Death) in the household, is a qualitative variable, which can only take the value of either 0 or 1. The U5 Death is taken as 1, if the family experience one or more Under 5 death,

otherwise 0. Thus, the following model is estimated:

$$P_i = \frac{1}{1+e^{-z_i}} \ldots\ldots\ldots (1)$$

Where,

$$Z_i = \alpha_0 + \alpha_1 TB_i + \alpha_2 MOCC_i + \alpha_3 MEDU + \alpha_4 PCI + \alpha_5 UTI_i + \alpha_6 BF_i + \alpha_7 MA_i + \alpha_8 DW_i + \alpha_9 ANC_i + \beta_1 PNC_i + \beta_2 AHH_i + \sum_{k=1}^{2} \sigma_k VEN_{ki} + \sum_{k=1}^{2} \theta_k TOI_{ki} + \varepsilon_i$$

Where,

Z_i = Occurrence of U5 Death (1 for Yes and 0 otherwise)

α_0 = Intercept (Constant)

TB_i= Natural log of the number of total births in the household i.

$MOCC_i$ = Employment Status of the mother i, 0 for Unemployed and 1 for Employed

$MEDU_i$ = Education status of the mother i, 0 for Uneducated and 1 for at least basic education

PCI_i = Per Capita Family Income of the respondent i.

UTI_i = Utilisation of the health care facility, 0 for No utilisation and 1 for otherwise

BF_i = Type of the breastfeeding by mother, 0 for Partial and 1 for Complete

MA_i = Marriage Age of the mother i.

DW_i = Drinking water source, 0 for out-house and 1 for in-house

ANC_i = Availed pre-natal care, 0 for Yes and 1 for No

PNC_i = Availed post-natal care, 0 for Yes and 1 for No

AHH_i = Age of the Head of the Household.

VEN_i = Type of ventilation (Good is the reference Category).

VEN_{1i}= if the Ventilation type is moderate, it is 1, else 0.

VEN_{2i}= if the Ventilation type is poor, it is 1, else 0.

TOI_i = Type of toilet (Sanitary is the reference category).

TOI_{1i}= if the Toilet type is Pit, it is 1, else 0.

TOI_{2i}= If the Toilet type is Open, it is 1, else 0.

Multilevel Fixed Effect Logistic Regression

This estimation method is chosen because the sample shows the characteristic of hierarchical structure. The dependent variable Occurrence of Under-five death (U5 Death) is a qualitative variable, which can only take the value of either 0 or 1. The

U5 death is taken as 1, if the household experience one or more under five death, otherwise 0. Thus, the following model is estimated:

$$P_i = \frac{1}{1+e^{-z_i}} \ldots \ldots \ldots (1)$$

Where,

$$Z_i = \alpha_0 + \alpha_1 TB_i + \alpha_2 MOCC_i + \alpha_3 MEDU + \alpha_4 PCI + \alpha_5 UTI_i + \alpha_6 BF_i + \alpha_7 MA_i + \alpha_8 DW_i + \alpha_9 ANC_i + \beta_1 PNC_i + \beta_2 AHH_i + \sum_{k=1}^{2} \sigma_k VEN_{ki} + \sum_{k=1}^{2} \theta_k TOI_{ki} + \varepsilon_i$$

Where,

Z_i = Occurrence of Child Death (1 for Yes and 0 otherwise)

α_0 = Intercept (Constant)

TB_i= Natural log of the number of total births in the household i.

$MOCC_i$ = Employment Status of the mother i, 0 for Unemployed and 1 for Employed

$MEDU_i$ = Education status of the mother i, 0 for Uneducated and 1 for at least basic education

PCI_i = Natural log of Per Capita Family Income of the respondent i.

UTI_i = Utilisation of the health care facility, 0 for No utilisation and 1 for otherwise

BF_i = Type of the breastfeeding by mother, 0 for Partial and 1 for Complete

MA_i = Natural log of Marriage Age of the mother i.

DW_i = Drinking water source, 0 for out-house and 1 for in-house

ANC_i = Availed pre-natal care, 0 for Yes and 1 for No

PNC_i = Availed post-natal care, 0 for Yes and 1 for No

AHH_i = Natural log of Age of the Head of the Household.

VEN_i = Type of ventilation (Good is the reference Category).

VEN_{1i}= if the Ventilation type is moderate, it is 1, else 0.

VEN_{2i}= if the Ventilation type is poor, it is 1, else 0.

TOI_i = Type of toilet (Sanitary is the reference category).

TOI_{1i}= if the Toilet type is Pit, it is 1, else 0.

TOI_{2i}= If the Toilet type is Open, it is 1, else 0.

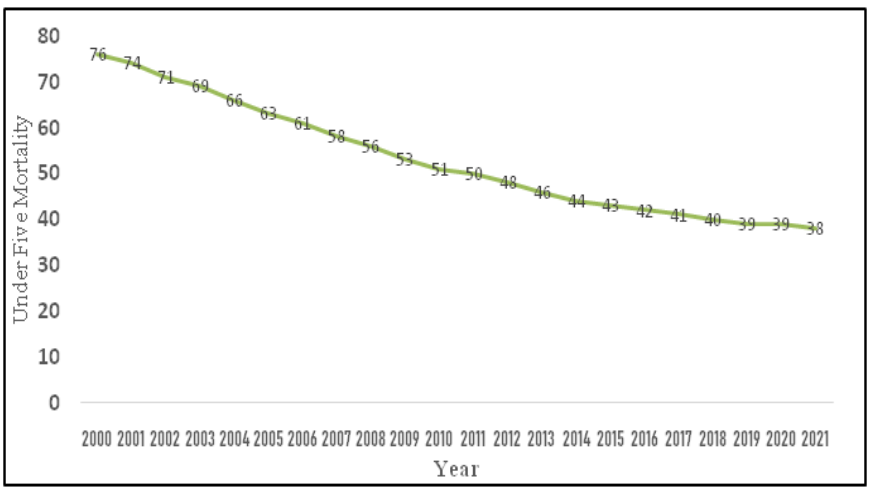
Results

Trends and Pattern of Under Five Mortality: Analysis of Secondary Data

There has been a substantial decrease in decline in child mortality worldwide since the 1990s. During the years 1990 to 2020, a 60 per cent reduction in under-five mortality was experienced by the world (Perin J et. al., 2022). Table 4.5 shows the under-five mortality ratio of some selected countries of the world for the years 2005, 2010, 2015 and 2020. It is seen that the under-five ratio in India has declined from 74.44 per 1000 live births to 32.63 per thousand live births in 2020. Under-five mortality ratio is higher for females than males in all the years, but the decline in U5 mortality during 2020 also shrunk the gap between male and female U5 mortality ratios. Since 1990, the world has shown a remarkable improvement in reducing the cases of child mortality. Under Five Mortality (U5 Mortality) has drastically declined from 93 deaths per thousand live births in 1990 to 38 deaths per thousand live births in 2021 (World Health Organization, n.d.). One of the main reasons for the higher rate of child mortality is the higher rate of death of children at the neonatal stage. Over the years U5 mortality shows a declining trend (Figure.2).

The U5 mortality ratio of India, compared to the U5 mortality of developed nations like Canada, Japan, Germany, Australia, Singapore, Switzerland, United Kingdom, is considerably higher. However, U5 mortality among male children is higher in the aforementioned nations than that in India. The U5 mortality ratio of India is more than other developing nations and neighbours like Bangladesh, Nepal, Srilanka and Bhutan (Table.2).

Figure.2 Trend of U5 Mortality Rate at Global Level



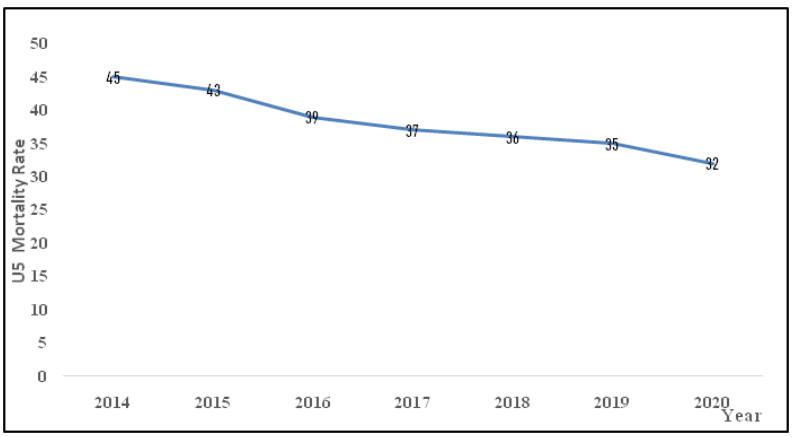
Source: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/under-five-mortality-rate-(probability-of-dying-by-age-5-per-1000-live-births).

Table.2 Under Five Mortality Ratio in Some Selected Countries of the World

Year	2005			2010			2015			2020		
Countries	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Afghanistan	108.4	112.3	104.4	87.76	91.27	84.0	70.45	73.91	66.73	57.98	61.36	54.34
Australia	5.72	6.29	5.12	4.77	5.24	4.27	3.87	4.21	3.52	3.7	4.0	3.35
Bangladesh	64.55	67.84	61.09	49.15	51.78	46.38	38.07	40.2	35.85	29.1	31.03	27.09
Bhutan	57.55	61.31	53.56	42.36	45.53	38.9	33.13	36.04	30.14	27.62	30.17	24.98
Brazil	24.78	27.64	21.8	18.64	20.78	16.37	15.94	17.75	14.03	14.7	16.36	12.96
Canada	6.09	6.59	5.58	5.73	6.17	5.27	5.36	5.74	4.95	4.99	5.37	4.59
France	4.62	5.13	4.09	4.21	4.62	3.78	4.62	5.13	4.09	4.37	4.79	3.92
Germany	4.73	5.19	4.25	4.17	4.56	3.77	3.93	4.24	3.61	3.65	3.93	3.36
India	74.44	70.59	78.45	58.15	55.26	61.23	43.53	42.12	44.98	32.63	32.24	33.03
Japan	3.74	4.01	3.47	3.21	3.41	2.99	2.75	2.89	2.6	2.49	2.61	2.36
Maldives	21.46	29.91	24.21	13.85	15.26	12.37	9.79	10.71	8.81	6.46	7.02	5.87
Myanmar	77.17	82.95	71.04	63.66	68.82	58.21	46.75	51.08	42.29	43.65	47.76	39.39
Nepal	59.38	61.97	56.69	45.89	48.47	43.18	35.52	37.96	32.96	28.16	30.28	25.54
Pakistan	96.27	100.9	91.41	87.11	91.87	82.11	76.02	80.68	71.13	65.18	69.62	60.5
Singapore	2.94	3.17	2.69	2.83	3.06	2.58	2.74	2.95	2.51	2.24	2.41	2.05
Somalia	172.6	179.5	165.4	157.4	164.2	150.2	134.3	140.7	127.7	114.6	120.3	108.7
South Africa	78.84	82.64	74.82	51.98	55.08	48.73	36.35	39.05	33.52	32.22	34.77	29.52
Sri Lanka	14.2	15.41	12.94	11.38	12.44	10.27	8.72	9.6	7.2	6.93	7.56	6.25
Switzerland	5.06	5.52	4.58	4.56	4.93	4.17	4.28	4.63	3.92	4.0	4.32	3.67
UK	6.03	6.62	5.42	5.17	5.66	4.65	4.47	4.82	3.99	4.21	4.59	3.81
USA	7.96	8.76	7.13	7.34	8.02	6.62	6.79	7.4	6.15	6.35	6.92	5.74
Zimbabwe	93.1	99.06	86.79	86.43	92.1	80.33	61.28	66.31	56.05	53.89	58.58	49.02

*Source: World Health Organization, 2022***.**

Figure.3 U5 Mortality in India (2014-2020)

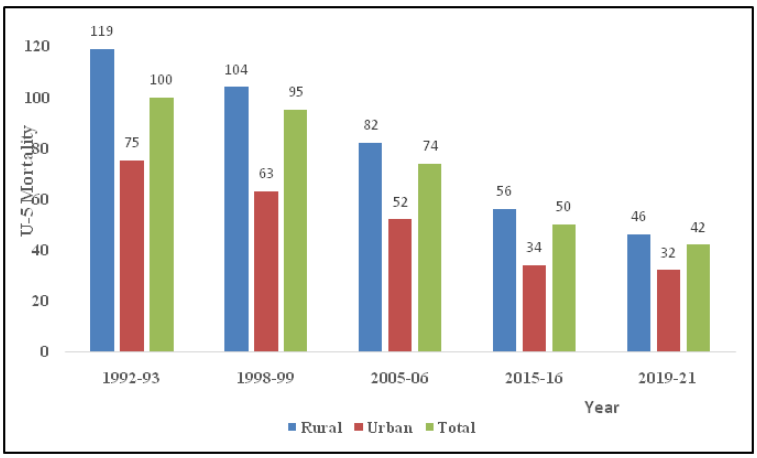


Source:Press Information Bureau. (2022)

Reduction in infant and child mortality has been a long-term issue and an important tenet of the Government of India. It has been a focused subject of different Health Policies, the Twelfth Five Year Plan, the National Health Mission (NHM), and Millenium and Sustainable Development Goals (SDGs). Over the years, it has been observed that India has been making progress towards child survival ratesof children. During 2014, the U5 mortality rate in India was 45 per thousand live births, which is reduced to 32 per thousand live births during 2020 (Figure.3).

In India, mortality including child mortality rate at the rural level is higher than in the urban area. However, the gap in U5 mortality between rural and urban areas has gradually declined. During the period 1992-93, the gap in the number of occurrences of the death of under-five children between rural and urban areas was 44, which declined to 14 during the period 2019-2020 (Figure.4).

Figure.4 Under-five Mortality in India by Area



Source: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-14436-7

The death of children under five always does not happen due to medicinal causes rather it is closely related to the social and economic conditions prevailing in the society. In India the most common cause for U5 Mortality is malnutrition.The negative impact of poor sanitation, impure water consumption and unawareness regarding personal hygiene are responsible for 88 per cent of children's deaths from the disease Diarrhea alone (UNICEF, 2011). Due to the improvements in the public health sector and medical services most of the countries are experiencing a decline in mortality. But in India, overall mortality is still high due to the high infant and child mortality rate. As per *NFHS-5*, the Under-five mortality rate in India is 41.9, which declined from 49.7 per thousand live births during 2014-2016. U5 mortality in the states of Uttarakhand, Uttar Pradesh, Tripura, Madhya Pradesh, Jharkhand and Chhattisgarh is more than the Indian average. The U5 mortality rate in Kerala is the lowest among the states in India. In Assam, it is 39.1 per thousand live births.

Table.3 Under Five Mortality Rates (Per 1000 live births) Across States & UTs in India

State/ Union Territory	Period	
	NFHS-4 (2014-16)	NFHS-5 (2019-21)
Andaman & Nicobar Islands	13.0	24.5
Andhra Pradesh	40.8	35.2
Arunachal Pradesh	32.9	18.8
Assam	56.5	39.1
Bihar	58.1	56.4
Chandigarh	NA	NA
Chhattisgarh	64.3	50.4
Dadra and Nagar Haveli&Daman & Diu	39.9	37.0
Delhi	42.2	30.6
Goa	12.9	10.6
Gujarat	43.5	37.6
Haryana	41.1	38.7
Himachal Pradesh	37.6	28.9
Jammu & Kashmir	37.6	18.5
Jharkhand	54.3	45.4
Karnataka	31.5	29.5
Kerala	7.1	5.2
Lakshadweep	30.2	0.0
Madhya Pradesh	64.6	49.2
Maharashtra	28.7	28.0
Manipur	25.9	30.0
Meghalaya	39.6	40.0
Mizoram	46	24.0
Nagaland	37.5	33.0
Odisha	48.1	41.1
Puducherry	16.2	3.9
Punjab	33.2	32.7
Rajasthan	50.7	37.6
Sikkim	32.2	11.2
Tamil Nadu	26.8	22.3
Telangana	31.7	29.4
Tripura	32.7	43.3
Uttar Pradesh	78.1	59.8
Uttarakhand	46.5	45.6
West Bengal	31.8	25.4
India	**49.7**	**41.9**

Source: Economic Survey 2021-22.

Both India and Assam have been performing well in the reduction in U5 rates but the rate of progress of Assam is greater. During the period 1992-93, the U5 mortality rate of Assam was 144 per thousand live births against 100 per thousand live births of India, which declined to 39.1 per thousand live births against 41.9 per thousand live births of India during 2019-20 (Figure.5).

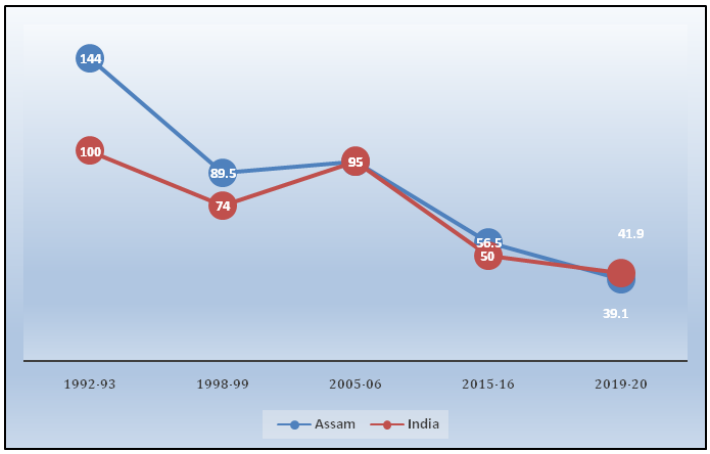
Though the present U5 mortality rate of Assam is relatively lower than India's U5 mortality rate as, but still, it is much higher than the U5 mortality rate of other north-eastern states like Arunachal Pradesh, Manipur, Mizoram, Nagaland and Sikkim.

Table.4 Under-Five Mortality Rate among Northeastern States

Area	Indicators	NFHS-5			NFHS-4
		Urban	Rural	Total	Total
Arunachal Pradesh	Neonatal Mortality Rate	12.5	6.9	7.7	11.8
	Infant Mortality Rate	16.7	12.3	12.9	22.9
	Under-five Mortality Rate	**22.2**	**18.3**	**18.8**	**32.9**
Assam	Neonatal Mortality Rate	15.2	23.4	22.5	32.8
	Infant Mortality Rate	22.7	33.1	31.9	47.6
	Under-five Mortality Rate	**33.0**	**39.9**	**39.1**	**56.5**
Manipur	Neonatal Mortality Rate	5.7	22.7	17.2	15.6
	Infant Mortality Rate	12.2	31.1	25.0	21.7
	Under-five Mortality Rate	**17.1**	**36.2**	**30.0**	**25.9**
Meghalaya	Neonatal Mortality Rate	14.2	20.6	19.8	18.3
	Infant Mortality Rate	23.4	33.6	32.3	29.9
	Under-five Mortality Rate	**23.4**	**42.6**	**40.0**	**39.6**
Mizoram	Neonatal Mortality Rate	14.4	8.4	11.4	11.2
	Infant Mortality Rate	20.6	22.0	21.3	40.1
	Under-five Mortality Rate	**21.8**	**26.2**	**24.0**	**46.0**
Nagaland	Neonatal Mortality Rate	8.4	10.8	10.2	16.5
	Infant Mortality Rate	17.0	25.8	23.4	29.5
	Under-five Mortality Rate	**22.5**	**36.8**	**33.0**	**37.5**
Sikkim	Neonatal Mortality Rate	*	7.8	5.0	20.8
	Infant Mortality Rate	*	17.8	11.2	29.5
	Under-five Mortality Rate	*	**17.8**	**11.2**	**32.2**
Tripura	Neonatal Mortality Rate	13.9	25.2	22.9	13.2
	Infant Mortality Rate	23.2	41.8	37.6	26.7
	Under-five Mortality Rate	**24.4**	**49.0**	**43.3**	**32.7**
India	Neonatal Mortality Rate	18.0	27.5	24.9	39.5
	Infant Mortality Rate	26.6	38.4	35.2	40.7
	Under-five Mortality Rate	**31.5**	**45.7**	**41.9**	**49.7**

Source: National Family Health Survey-5.

Figure.5 U5 Mortality Rate Assam Vis-à-vis India



Source:Various Reports of National Family Health Survey.

Extent of Under Five Mortality Rate (U5 Mortality Rate) in the Study Area

For calculating the Under Five Mortality Rate i.e., the U5 mortality rate formula derived from the definition Under Five Mortality of the World Health Organisation (WHO) is used in this study.

Thus, $U5\ Mortality = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)} x1000$

The table.5 shows the total number of children born alive and surviving in the age group 0-5 years and the number of deaths in the specified age group in the study area during the period 2015-2020.

Table.5 Number of the Live Births and U5 Deaths by Districts

District (1)	Live births (2)	U5 Deaths (3)
Dhemaji	68 (22.97)	3 (18.75)
Sonitpur	83 (28.04)	6 (37.50)
Dhubri	145 (48.99)	7 (43.75)
Total	296 (100.0)	16 (100.0)

Source: Survey data.

Note: Figures in the brackets indicate percentages.

After applying the specified formula to calculate the U5 Mortality, we found that the U5 Mortality Rate in the study area among the informal workers is 54.05 per thousand

live births, which is considerably higher than the state average of 39 per thousand live births and also higher than the national average 41.9 per thousand live births.

Under Five Mortality Rate across Socio-economic Groups

The table.6 shows the proportion of under-five deaths across the socio-economic groups in the study area. The U5 Mortality Rate to a large extent varies among households based on their socio-economic conditions.

Table.6 Number of the Live Births and U5 Deaths by Socio-economic Group

Socio-economic Group (1)	Live births (2)	Number Under Five Deaths (3)
General/Others	194 (65.54)	10 (62.50)
OBC	39 (13.18)	1 (6.25)
SC & ST	63 (21.28)	5 (31.25)
Total	296 (100.0)	16 (100.0)

Source: Survey data.

Note: Figures in the brackets indicate percentages.

It is evident from the table.6 that more than 60 per cent of child deaths under five years occurred in the general/others group, followed by the SC & ST group.

U5 Mortality for General or Others Group

$$U5\ Mortality = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{10}{194}\ x\ 1000$$

= 51.55 per thousand live births.

U5 Mortality for Other Backward Class Group

$$U5\ Mortality = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{1}{39}\ x\ 1000$$

= 25.64 per thousand live births.

U5 Mortality for Scheduled Caste & Scheduled Tribe Group

$$U5\ Mortality = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{5}{63}\ x\ 1000$$

= 79.37 per thousand live births.

Thus, it is found that the Under Five Mortality Rate among the Scheduled Caste and Scheduled Group is the highest i.e., 79.37 per thousand live births and the lowest among the Other Backward Class i.e., 25.64 per thousand live births.

Under Five Mortality Rate across Gender

U5 mortality rate differs between male and female children due to different socio-cultural beliefs and negligence towards female children. One of the common wisdoms of Indian society is the preference of the son over the daughter, for which many female children are not given due attention and care (United Nations Population Fund. n.d.).

Table.7: Number of the Live Births and U5 Deaths by Gender

Gender (1)	Live births (2)	Number Under Five Deaths (3)
Male	152 (51.35)	8 (50.0)
Female	144 (48.65)	8 (50.0)
Total	296 (100.0)	16 (100.0)

Source: Survey data.

Note: Figures in the brackets indicate percentages.

In the study area, the proportion of U5 deaths for both male and female has no significant difference.

$$U5\ Mortality\ for\ male = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{8}{152}\ x\ 1000$$

= 52.63 per thousand live births.

$$U5\ Mortality\ for\ male = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{8}{144}\ x\ 1000$$

= 55.60 per thousand live births.

Thus, the study found that U5 mortality for female children is relatively higher than that of males in the study area.

U5 Mortality Rate across Area

The table.8 shows the number of live births and deaths of children of the age of five

during the period 2015-2020.

Table.8 Number of the Live Births and U5 Deaths by Area

Area (1)	Live births (2)	Number Under Five Deaths (3)
Rural	242 (51.35)	14 (87.5)
Urban	54 (48.65)	2 (12.5)
Total	296 (100.0)	16 (100.0))

Source: Survey data.

Note: Figures in the brackets indicate percentages.

A total of 2.5 per cent of the surveyed households had cases of U5 death during the reference period, of which 87.5 per cent occurred in the rural area and only 12.5 in the urban area.

$$U5\ Mortality\ in\ Rural\ area = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{14}{242}\ x\ 1000$$

= 57.85 per thousand live births.

$$U5\ Mortality\ in\ Urban\ area = \frac{(Deaths\ at\ age\ 0-5\ years)}{(Number\ of\ surviving\ children\ in\ the\ specified\ age\ range)}\ x1000$$

$$= \frac{2}{54}\ x\ 1000$$

= 37.04 per thousand live births.

The study found a large gap in child deaths both in rural and urban areas. U5 mortality Rate in the rural area is around 36 per cent more than in the urban area.

Prevalence of Under Five Deaths among Informal Workers

Out of total sample (600), 2.67 per cent households experienced death of under-five child during the period 2015 to 2020. In the household having multiple births during the reference period, the proportion of U5 deaths were much higher (76.2 per cent) than the household having single birth (76.2 per cent) (Table.9). U5 deaths were found different among the mothers. U5 death among mother without education was (15.6 per cent) and for mother having at least primary education or above was 84.4 per cent. Among the mothers with no antenatal visits during last pregnancy, the percentage of U5 death was (66.7 per cent), relative to mother with antenatal visits (33 per cent). The prevalence of U5 deaths were also found higher for the mothers with no postnatal visits (60 per cent), compared to the mothers with post-natal visits (40 per cent). The proportion of U5 death was (33.3 per cent) and (66.7 per cent)

for the breast-feeding practices partial and complete feeding respectively. Among the mothers without any job, the proportion of U5 death was (34.1 per cent) than those with employed mothers (65.9 per cent).

Table.9 Prevalence of U5 Deaths among Sample Participants

Variable	U5 Deaths (in per cent)
Birth Type	
Single	23.8
Multiple	76.2
Maternal Education	
No Education	15.6
At least primary education or above	84.4
Antenatal Visits	
No	66.7
Yes	33.0
Postanal Visits	
No	60.0
Yes	40.0
Type of Breast-Feeding Practices	
Partial Feeding	33.3
Complete Feeding	66.7
Mother Employment Status	
Unemployed	34.1
Employed	65.9
Source of drinking water	
Out-house premises	57.8
In-house premises	42.2
Toilet Facility	
No standard toilet	55.6
Else	44.4
Ventilation Facility	
Poor	44.4
Else	55.6
Utilisation of nearest healthcare services at least once during the year	
No	68.9
Yes	31.1

In the households with Outhouse water sources, the proportion of U5 deaths was found (57.8 per cent) than the households with in house water sources (42.2 per cent). Among the households with no standard toilet, U5 deaths were higher (55.6 per cent), compared to others (44.4 per cent). U5 deaths among households with poor

ventilation was (44.4 per cent) and it was (55.6 per cent) for others. The prevalence of U5 death was found much higher, among the households no use of nearest hospital services during the year (68.9 per cent), than those which utilized hospital services at least once during the year (31.1 per cent).

Determinants of Under-five Mortality among Informal Workers

Model Comparison/ Binary Logistic Analysis

Due to the binary nature of the dependent variable, the logistic regression analysis is employed. From the analysis, Total Birth (TB at 5 per cent level), Mother's Occupation (MOCC at 5 per cent level), Ventilation Facility (VEN at 10 per cent level), Drinking Water Facility (DW at 10 per cent level) and Post Natal Care (PNC at 1 per cent level) are found to be statistically significant determinants of U5 mortality among informal workers in the study area (Table.10).

Table.10 Result of the Binary Logistic Regression

Dependent Variable: Child Death (Yes: 1, No: 0)				
Variables			**Coefficients**	**VIF**
Notation	**Description**			
α	Constant		-20.50	---
TB	Total Birth		1.78**	1.59
MOCC	Employment Status	Unemployed	Reference Category	
		Employed	3.78**	1.20
MEDU	Education	Uneducated	Reference Category	
		Basic Education	-12.95	1.11
PCI	Per capita Income		0.17	3.42
UTI	Utilisation	No	Reference Category	
		Yes	-0.35	2.12
BF	Type of Breast Feeding	Partial	Reference Category	
		Complete	1.12	2.31
MA	Age at Marriage		-0.10	1.19
VEN	Ventilation Facility	Good	Reference Category	
		Moderate	2.02*	3.42
		Poor	-2.61	3.31
TOI	Toilet	Sanitary	Reference Category	
		Pit	5.81	3.22
		Open	9.37	3.21
DW	Drinking Water Source	Out House	Reference Category	
		In House	-2.35*	3.12

ANC	Pre-Natal Care	Yes	Reference Category	
		No	1.33	4.41
PNC	Post Natal Care	Yes	Reference Category	
		No	4.73***	3.87
AHH	Age of Household Head		0.02	1.91
Mean VIF				**2.63**
Cox and Snell R2			**0.20**	
Nagelkerke R2			**0.59**	
Hosmer and Lemenshow Test			**20.54*** **	

*Notes: ***, **, * represent statistically significant at 1 per cent, 5 per cent and 10 per cent level.*

Model Fit and Model Diagnostics: A high Pseudo R^2(Nagelkerke) represent a good fit of the model. In this model, the Nagelkerke Pseudo R^2 value is 0.59 and Cox and Snell R^2 is 0.20 along with a significant Hosmer and Lemenshow test statistic; these represent that the model has a good fit.

Further, the multicollinearity of the model is checked using Variance Inflation Factor (VIF) reported on the last column of the Table 6.4. Since, all the values of VIF are less than 10 (even 5) and mean VIF is 2.63, it can be inferred that the model is free from any severe multicollinearity problem.

Mixed Effect Analysis

Determinants of Under Five Mortality also checked and compared used mixed effect analysis due to hierarchical structure of the explanatory variables. The result brings quite similar results. The analysis of multi effect logistic regression shows Mother's Occupation (MOCC at 5 per cent level), Drinking Water Facility (DW at 5 per cent level), Toilet Facility (TOI at 5 per cent level) and Post Natal care (PNC at 10 per cent level) are statistically significant (Table.11).

Table.11 Result of the Mixed Effect Logistic Regression

Dependent Variable: Child Death (Yes: 1, No: 0)				
Variables			Coefficients	VIF
Notation	Description			
α	Constant		-3.13	---
TB	Total Birth		0.24	1.28
MOCC	Employment Status	Unemployed	(Reference Category)	
		Employed	1.96**	1.12
MEDU	Education	Uneducated	(Reference Category)	
		Basic Education	1.48	1.24
PCI	Per capita Income		0.09	1.32

UTI	Utilisation	No	(Reference Category)	
		Yes	-1.05	1.15
BF	Type of Breast Feeding	Partial	(Reference Category)	
		Complete	-1.04	1.04
MA	Age at Marriage		-1.87	1.26
VEN	Ventilation Facility	Good	(Reference Category)	
		Moderate	-0.02	1.37
		Poor	-0.64	2.02
TOI	Toilet	Sanitary	(Reference Category)	
		Pit	2.58**	1.18
		Open	---	1.23
DW	Drinking Water Source	Out House	(Reference Category)	
		In House	-2.01**	1.29
ANC	Pre-Natal Care	No	(Reference Category)	
		Yes	-1.43	2.89
PNC	Post Natal Care	No	(Reference Category)	
		Yes	-2.97*	2.92
AHH	Age of Household Head		1.39	1.26
Mean VIF				1.51
Log Likelihood			-27.21	
Wald Chi2			22.86*	

*Notes: ***, **, * represent statistically significant at 1 per cent, 5 per cent and 10 per cent level.*

Model Fit and Model Diagnostics: A significant Wald Test statistic represents that the model has a good fit. Further, the multicollinearity of the model is checked using Variance Inflation Factor (VIF) reported on the last column of the Table 6.5. Since, all the values of VIF are less than 10 (even 5) and mean VIF is 1.51, it can be inferred that the model is free from any severe multicollinearity problem.

Discussion

Death of the Under Five or U5 deaths to large extent are preventable, various Policies at global level including SDGs aim is to reduce such deaths. In this study (2.67 per cent) sample households were found to deaths of the U5 children, which could have been prevented if the factors affecting U5 deaths among the samples were known.

Our study from both binary and multi effect logistic regression, have identified the number of total births, mothers' occupation, ventilation facility, drinking water, toilet facility, post-natal visits as possible determinants of under five deaths among the sample participants.

The coefficient of Total Birth is positive and significant. It reflects that the log-odds of Child death increasesas the number of Total births in the household increases; in other words, the likelihood of Child death increases with the increasing number of births in the household. This finding is consistent with previous study of Worku et. al. 2021. This might be because as the number of new born increases in the households, the availability of the care giver and the resources for child nourishment are declined in the poor households. In addition to this, giving birth of twins and more result in undernourishment due to nutritional deficiency. Total birth may also be increases due to increase in parity, which again limits the mother to be busy with the higher parity and thus the last birth may not get sufficient attention, for which the risk of child death increases (Bai, Ruhai et al., 2021).

The study also found the risk of child mortality is more for employed mothers relative to the mothers without any job. The coefficients of 3.78 indicate that compared to women who are unemployed, log-odds of child death increases 3.78 for women who are employed. The odds-ratio indicates that unemployed women are 43.82 times less likely of experiencing child death than the women who are employed. This study also is found similar to the study by Bora (2020). This might be because the employed mothers of poor households, basically are working in informal sector, which involves long work hours, unhygienic working conditions with a lot of physical work (Bertulfo, 2011). This leads to deterioration of their physical and mental health and also reduces their time for children and family, which increases the risk of U5 death.

Ventilation facility is also found to be significant determinants of child death in the study area. The coefficients of 2.02 indicates that compared to women having good ventilation facility in house, log-odds of child death increases 2.02 for women having moderate ventilation facility in house. The odds-ratio indicates that the women having moderate ventilation facility in house are 7.54 times more likely of experiencing child death than the women having good ventilation facility in house**.** Adebowale (2017) also found good housing conditions as a predicative factor for child death.

Our study also founds drinking water facility as a significant determinant of U5 mortality among the informal workers. The coefficients of -2.35 indicates that compared to women who use out-house source of drinking water, log-odds of child death declines 2.35 for women who uses in-house source of drinking water. The odds-ratio indicates that the women who using *in-house source of drinking water* are 10.49 times less likely of experiencing child death than the women who using *out-house source of drinking water*. This might be due to the fact that using out house as a source of drinking water involves cost of carrying, which reduces usages of water. Moreover, out-house premises also involves the risk of being polluted due to environmental factors. Both the regression analysis reveals drinking water sources as a determinant significant determinant of U5 mortality in the study area. The studies like Patel et.al (2021) also found drinking water sources as a significant determinants of Child mortality.

From the mixed effect analysis, we have found toilet facility also as a significant determinant of U5 mortality among the informal workers. The coefficients of 2.58 indicates that compared to women having sanitary toilet facility in house, log-odds of child death increases 2.58 for women using pit toilet in house. The odds-ratio indicates that the women using Pit toilet facility in house are 13.20 times more likely of experiencing child death than the women using sanitary toilet facility in house**.** Pit toilets are less hygienic from the wellness aspect, which can negatively impact child's health. Getachew and Bekele (2016) also found a similar kind of result in their study.

In addition to this, both the regression analysis shows postnatal care as a significant determinant of U5 death among informal workers. The negative and significant relationship between the postnatal visit and U5 mortality indicates that the risk of U5 mortality declines for the mothers, who have taken postnatal care and vice versa. This might be the reason that the child gets appropriate and timely services related to new-born care if the mothers visit postnatal checkups. Moreover, postnatal care is crucial as crucial as prenatal or antenatal care in order to induce the survival probability of the child. Our finding is consistent with the previous studies done in similar context (Almazrou et al.,2008).

Strength and Limitation of the Study

The study is based on primary survey with a sizeable sample. Besides, it is based on proper statistical approaches (binary regression due to binary character of the dependent variable) and mixed effect analysis (to examine the cluster level variability), which strengthens the robustness of the analysis. Since, the study is done for the informal workers, records of which are not up to date and sufficiently available, the study has the potential to provide insights for the policy makers and planners at various level to design appropriate interventions. However, the study has the limitation as it is purely based on field survey, which limits coverage and bound to a reference period. Besides, the possibility of recall biased may be there as it is based on self-report of the respondent.

Conclusion

The prevalence of under-five mortality in Assam was significantly associated with number of total births occurred in the household, mother's occupation, ventilation facility, drinking water facility, toilet facility and post-natal visits. Thus, special emphasis should be given to child care and family planning policies, working mothers, environmental and sanitary conditions and increases the post-natal visits.

References

Adebowale, S.A., Morakinyo, O.M., & Ana, G.R. (2017). Housing materials as predictors of under-five mortality in Nigeria: evidence from 2013 demographic and health survey. *BMC*

Pediatrics, 17, 30. https://doi.org/10.1186/s12887-016-0742-3

Adongo, A. A., Dapaah, J. M., Azumah, F. D., &Onzaberigu, J. N. (2024). Maternal and child health care access to skilled delivery services among Ghanaian rural mothers. Research in Health Services & Regions, 3(1). https://doi.org/10.1007/s43999-024-00042-0

Almazrou et al. (2008). Factors affecting child mortality in Saudi Arabia. *Saudi Medical Journal, 29*(1), 102–106. https://www.smj.org.sa/index.php/smj/article/view/6111

Amin, Z., Akram, M., Barque, A. U. R., & Rafique, M. (1986). Study on broiler's ration: Comparative nutritive value of expeller and solvent extracted decorticated cottonseed cake and rapeseed cake in broiler's ration. *Pakistan Veterinary Journal, 6*(3), 109-111.

Amouzou, A., & Hill, K.H. (2004). Child mortality and socioeconomic status in sub-Saharan Africa. *African Population Studies, 19*, 1-11.

Bai, R., et al. (2021). Trends in under-5 mortality rates and their associations with socioeconomic factors among countries participating in the Belt and Road Initiative: A panel data analysis. *International Journal of General Medicine, 14*, 7763–7773. https://doi.org/10.2147/IJGM.S332926

Bertulfo, L. (2011). Women and the informal economy: A think piece. AusAID Office of Development Effectiveness.

Bora, J.K. (2020). Factors explaining regional variation in under-five mortality in India: Evidence from NFHS. *Health & Place, 64*, 111. https://doi.org/10.1016/j.healthplace.2020.102363

Caldwell, J. (1979). Education as a factor in mortality decline: An examination of Nigerian data. *Population Studies, 33*(3), 395–413.

Casterline, J. B., Cooksey, E. C., & Ismail, A. F. E. (1989). Household income and child survival in Egypt. *Demography*, *26*(1), 15–35. https://doi.org/10.2307/2061491

Ettarh, R., & Kimani, J. (2012). Determinants of under-five mortality in rural and urban Kenya. *Rural Remote Health, 12*(1812).

Gebretsadik, S., & Gabreyohannes, E. (2016). Determinants of under-five mortality in high mortality regions of Ethiopia: An analysis of the 2011 Ethiopia demographic and health survey data. *International Journal of Population Research*.

Getachew, Y., & Bekele, S. (2016). Survival analysis of under-five mortality of children and its associated risk factors in Ethiopia. *Journal of Biosensors & Bioelectronics, 7*(213). https://doi.org/10.4172/2155-6210.1000213

Government of India. (2022). Economic Survey 2021-22. Ministry of Finance, Department of Economic Affairs, Economic Division.

Hossain, K., Islam, R., & Chowdhury, Q. H. (2012). Socio-Economic and demographic correlates of infant and child mortality: The case of slum areas in Rajshahi District of Bangladesh. International Journal of Prevention and Treatment, 1(1), 11–17. https://doi.org/10.5923/j.ijpt.20120101.02

International Institute for Population Sciences. (2021). National Family Health Survey (NFHS-5), 2019-21: India. Ministry of Health and Family Welfare, Government of India.

Jatrana, S. (2007). Who is minding the kids? Preferences, choices and childcare

arrangements of working mothers in India. *Social Change*, *37*(4), 110-130. https://doi.org/10.1177/004908570703700406.

Maternal and Child Epidemiology Estimation | Institute for International Programs. (n.d.). Institute for International Programs. https://publichealth.jhu.edu/institute-for-international-programs/our-work/past-projects/maternal-and-child-epidemiology-estimation

Mishra, K., Mohapatra, I., & Kumar, A. (2019). A study on the health seeking behavior among caregivers of under-five children in an urban slum of Bhubaneswar, Odisha. *Journal of family medicine and primary care*, *8*(2), 498–503. https://doi.org/10.4103/jfmpc.jfmpc_437_18

Patel, N., &Olickal, J. (2021). Maternal and child factors of under-five mortality in India: Findings from NFHS-4. *Clinical Epidemiology and Global Health*. Advance online publication. https://doi.org/10.1016/S2213-3984(21)00174-3

Perin, J., Mulick, A., Yeung, D., Villavicencio, F., Lopez, G., Strong, K. L., et al. (2022). Global, regional, and national causes of under-5 mortality in 2000–19: An updated systematic analysis with implications for the sustainable development goals. *The Lancet Child & Adolescent Health, 6*(2), 106–115.

Prakasam, C.P, P.K Murthy and S. Krishnaiah. (2000). Evaluation and Adjustment of 1991 Census Data and Estimates of Demographic Indicators: District Wise Analysis. IIPS, Mumbai.

Press Information Bureau. (2022, September 23). India achieves significant landmarks in reduction of child mortality. Ministry of Health and Family Welfare, Government of India. Retrieved May 29, 2024, from https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1861710

Shin, E.H. (1977). Socioeconomic development, infant mortality and fertility: A cross-sectional and longitudinal analysis of 63 selected countries. *Journal of Development Studies, 13*, 398-412.

Tarkang, E.E. (2014). Factors associated with perception of risk of contracting HIV among secondary school female learners in Mbonge subdivision of rural Cameroon. *The Pan African Medical Journal, 17*.

United Nations Department of Econo mic and Social Affairs, Population Division. (2011). *Technical Paper. No. 2011/3. Seven Billion and Growing: The Role of Population Policy in Achieving Sustainability*.

United Nations Population Fund. (n.d.). Son preference and daughter neglect in India. UNFPA. Retrieved May 29, 2024, from https://www.unfpa.org/resources/son-preference-and-daughter-neglect-india

Worku, M. G., Teshale, A. B., & Tesema, G. A. (2021). Determinants of under-five mortality in the high mortality regions of Ethiopia: mixed-effect logistic regression analysis. Arch Public Health, 79, 55. https://doi.org/10.1186/s13690-021-00578-4.

World Health Organization. (2022, May 20). World health statistics 2022. World Health Organization. Retrieved May 29, 2024, from https://www.who.int/news/item/20-05-2022-world-health-statistics-2022

World Health Organization. (n.d.). Child mortality and causes of death. World Health Organization. Retrieved May 29, 2024, from https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/child-mortality-and-causes-of-death

World Health Organization. (n.d.). Child mortality and causes of death. World Health

Organization. Retrieved May 29, 2024, from https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/child-mortality-and-causes-of-death

Zewudie, A.T., Gelagay, A.A., & Enyew, E.F. (2020). Determinants of under-five child mortality in Ethiopia: analysis using Ethiopian demographic health survey. International Journal of Pediatrics.