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RESEARCH ARTICLE

ESTIMATION OF INFANT MORTALITY AND UNDER-FIVE MORTALITY BY PLACE OF RESIDENCE AND RELIGION AND ITS PREDICTIVE FACTORS IN NORTHEAST INDIA

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Abstract

Background: Infant mortality rate (IMR) and under five mortality rates (UFMR) are the sensitive indicators to assess health status and indicators of overall progress of a country. In India, IMR and UFMR is relatively high, and is unable to achieve the Millennium Development Goal (MDG) by 2015. Northeastern states of India depict a captivating trend in child mortality according to the report of NFHS-4 (2015-16). Therefore, the objective of this study is to estimate infant and under five mortality by place of residence and religion. In addition, to determine the factors affecting infant and under-five death.

Data and Methods: This study utilizes data of National Family Health Survey (NFHS-4). Eight northeastern states and 37,167 children under-five years were included in the analysis. Synthetic cohort probability method was used to calculate IMR and UFMR. To find the nature of the association between infant and under five death with selected socioeconomic characteristics, Bivariate analysis, and Binary logistic regression were used.

Result: Study revealed that children in rural areas has higher risk of infant and under five mortality. Muslims has the highest IMR and UFMR i.e. 52 and 56 per 1000 live births respectively. Adjusted odds ratio shows that wealth index, size of child, sex of child, caesarean-section delivery has impact on infant and under five death at 95% CI and p-value (<=0.05). However, in contrary with existing literature, adjusted odds ratio shows that there is negative association between age of mother, mother education, place of delivery with infant and under five death at 95% CI and p-value (<=0.05).

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Introduction:-

The Global burden of child death remains high; probabilities of children's survival vary across countries and regions. Several newborns and children continue to die from preventable and treatable causes, because the world has failed to safeguard their basic right to survival and health [1]. Infant mortality rate (IMR) is a measure of children's well-being and a crude indicator of the overall health scenario of a country or a region [2, 3]. IMR is one of the most sensitive indicators to assess health status of any country and indicator of the overall progress of a society [4]. Under-five mortality rate (UFMR) is known to be the result of a wide variety of inputs. Therefore, its decline reflects improvements in other areas of child survival and development [5].

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In 2017, Global IMR has been decreased from 65 deaths per 1000 live births in 1990 to 29 deaths per 1000 live births as in 2017. While, the global UFMR rate was reduced from 93 in 1990 to 39 deaths per 1,000 live births in 2018. SDG goal 3 calls for an end to preventable deaths of newborns and children under five years of age, and specifies that every country should aim to decrease under-five mortality to at least 25 deaths per 1,000 live births by 2030 [1,6]. However, in India, infant mortality and under five mortality is relatively high which is 41 and 50 respectively as per NFHS-4. Among all the States of India, Uttar Pradesh recorded the highest in both IMR and UFMR i.e. 64 and 78 per 1000 live births respectively as per NFHS 4(2015-16) [7].

India has made significant strides in reducing both infant mortality and under-five mortality but has been unable to achieve the Millennium Development Goal (MDG) by 2015 [8]. In India, there is huge differentials across states and socio-economic groups in terms of health outcomes, access and utilization of health services [9]. Due to its diversity, newborn and children exposure to varied disease is different between regions. Evidently, in India there is an enormous rural-urban difference in both infant and under-fivemortality, which indicates unequal distribution of resources in rural and urban areas [10]. In India, the effect of poverty on infant and under-five mortality reduced with time, whereas, female literacy had a consistent effect [11]. Place of residence, birth interval, antenatal care was found to be significantly associated with infant mortality [12]. Numerous studies conducted globally and India shows association of age of mother, education of women, size of the child, sex of child, birth order, wealth index, place of delivery, with infant and under five death. Analysis for rural India demonstrates the importance of mother's education and poverty level in explaining regional differences in infant mortality [8, 13]. Mosley Chen Framework categorizes the determinants of infant and child mortality into three categories i.e. biological, socio-economic and environmental factors [14].

Northeastern states consist of eight states namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Northeastern states of India depict a captivating trend in child mortality, and health care according to NFHS-4 (2015-16). Over the year there is substantial decline of IMR in Northeastern states of India i.e. 89, 64 and 76 per 1000 live births in NFHS-1 (1992-93) to 48, 30 and 27 per 1000 live births in NFHS 4 (2015-16) in Assam, Meghalaya and Tripura respectively, with similar trend for UFMR [7]. Overall, the Northeastern States has an infant mortality rate and under five mortality rates lower than the Indian average. One factor that seems to be affecting the under-five mortality rates is the location of residence. It is Higher in rural areas when compared to urban areas. Apparently, this has to do with both poverty and availability of healthcare services.

Northeast region is not only geographically isolated from the rest of the country due to poor infrastructure, it also has diverse socio-cultural practices of raising up children, which directly or indirectly affect the child mortality in the region, i.e., because of its geographical location and it's cultural and religious behavior which contributes significantly to the child mortality, makes it important to study the effect of various socio-demographic and cultural factors of individual as well as maternal factors on child mortality under the age of five specifically in northeast states of India. Northeastern states are socially advanced in terms of literacy, women empowerment, women autonomy, but lack behind the other states in terms of infrastructure facilities, economic development and accessibility. The lack of basic amenities is also directly or indirectly responsible for affecting on the early life of childhood than the other demographic, and genetic factors [15].

The health care sector is unevenly distributed throughout the country, and there is urban-rural disconnect, especially in the rural and the tribal areas and more in the northeastern states of India. Primary health care exist however no function or poor function. Although there has been improvement with the operation of National Rural Health Mission for affordable and accountable quality health services to rural areas, the improvement has been quite uneven across region, which have an impact on the health of children in the region. More over immunization coverage, antenatal care and institutional birth is low compared to the rest of the country, and morbidity levels are high, and relatively poor access to health care. Few researches on determinants child Mortality has so far been undertaking in the Northeastern India. Moreover, there are limited research on difference in child mortality by religion specifically in this region. Therefore, the present study aims to fill this gap.

Data And Methods:-

Data source:

This study utilizes data of National Family Health Survey data, which were conducted during 2015-16 (NFHS-4). NFHS-4 covered a sample of 98,716 ever-married women aged 15-49. It provides information on maternal and

child health, child mortality rates for India and each state/Union territory. NFHS-4 was conducted under the guidance of Ministry of Health and Family Welfare (MoHFW), Government of India, coordinated by the International Institute for Population Sciences, Mumbai. The NFHS-4 provide information on key indicators of all the districts, and produce reliable estimates of indicators for rural, urban and total of the districts as a whole. In Northeastern states of India, the States of Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Tripura covered a sample of 14,294, 28,447, 13,593, 92,02, 12,279, 10,790, 5,293, 4,804, ever-married women aged 15–49 respectively [7].

Variables:
Two outcome variables are used in this study i.e. infant death and under five death. The study incorporates several predictor variables to understand its linkage with the outcome variables. The socio-economic and demographic and lifestyle factors that have been used as predictor variable in the analysis are age of mother, education of mothers, size of the child, sex of child, birth order, religion, sex of the head of household, wealth index, social status, toilet facility, caesarean-section delivery, place of delivery, safe drinking facility, place of residence, state.

Methods:-

NFHS 4 kids file was used for the analysis, and the unit of analysis in this study is the child. Proper sample weights were applied, taking into account the survey design. The mortality estimates were computed with synthetic cohort probabilities. This procedure is based on the procedure developed by Somoza (1980) and Rutstein (1984). Firstly, to calculates IMR and UFMR we have used Syncmrates command, Using STATA 14, [Texas 77845USA College Station, Stata corp]. Syncmrates is used to calculates mortality rates using the synthetic cohort probability method used in Demographic and Health Surveys (DHS), this method is based on the full birth history survey approach, whereby women are asked for the date of birth of each of their children, whether the child is still alive, and the age at death. Mortality rates are calculated over the five years preceding the month interview. Three variables are used to calculate Mortality rates i.e. date of birth, date of interview, and age at death. To calculate the conventional probabilities of dying, first calculated the probability of surviving through the subinterval by subtracting the probability of dying from one. Then they limit and, subtracted this product from one to give the probability of dying within the conventional limits:

$$ {}_nq_x = 1 - \prod_{i=x}^{i=x+n} (1 - q_i) $$

where ${}_nq_x$ is the conventional probability of dying between ages x and x+n and q_i are the subinterval probabilities of dying [16]. Bivariate analysis and Chi-square-Measure of association were used to examine the nature of association between under five death and certain background characteristics. In order to find out the determinants of infant and under five death, Binary logistic regression was used. If Yi is the dependent variable, Xi is a set of independent or explanatory variables, and βi's are its coefficient, then the logistic regression equation is given by,

$$ \text{logit}(P) = \log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots $$

where, the probability of an event occurring is p, the probability of the event not occurring is (1-p), and log odds of p and (1-p) provide the odds ratios [17].

Results:-

Table 1. Shows data pertaining to 37,167 total live births in the five years preceding the survey 2015-16 in the Northeastern states, Arunachal Pradesh (4,966), Assam (10,309), Manipur (5,636), Meghalaya (4,409), Mizoram (4,905), Nagaland (4,607), Sikkim (1,005) and Tripura (1,330). In the last five years period preceding the surveys there are 1,406 child deaths reported in total Northeastern states, 127 child death in Arunachal Pradesh, 518 in Assam, 138 in Manipur, 156 in Meghalaya, 231 in Mizoram, 167 in Nagaland, 30 in Sikkim and 39 in Tripura, out of which 1189 death in rural areas and 217 in urban areas. Whereas, in India, there are 2,59,627 live births in five years preceding the survey 2015-16. Out of which there are 11,869 child death reported in India, 9,718 child death in rural areas and 2,151 child death in urban areas.

Table 1: - Percent distribution of live birth and death among children under five year, by Place of Residence in Northeastern States, India, NFHS 4 (2015-16).

State	Rate	Rural	Urban	Total

Arunachal Pradesh	Live birth	4079(82%)	887(18%)	4966
	Death	109(86%)	18(14%)	127
Assam	Live birth	9371(91%)	938(9%)	10309
	Death	485(94%)	33(6%)	518
Manipur	Live birth	3965(70%)	1671(30%)	5636
	Death	102(74%)	36(26%)	138
Meghalaya	Live birth	3845(87%)	564(13%)	4409
	Death	145(93%)	11(7%)	156
Mizoram	Live birth	2817(57%)	2088(43%)	4905
	Death	148(64%)	83(36%)	231
Nagaland	Live birth	3545(77%)	1062(23%)	4607
	Death	138(83%)	29(17%)	167
Sikkim	Live birth	756(75%)	249(25%)	1005
	Death	28(93%)	2(7%)	30
Tripura	Live birth	1024(77%)	306(23%)	1330
	Death	34(87%)	5(13%)	39
Total Northeast	Live birth	29402(79%)	7765(21%)	37167
	Death	1189(85%)	217(15%)	1406
India	Live birth	198248(76%)	61379(24%)	259627
	Death	9718(82%)	2151(18%)	11869

Table 2. Shows the percent distribution of live birth and death by Religion in Northeastern states, India, NFHS-4. In the last five year preceding the surveys there are 1,406 child death reported in Northeastern States, out of which 411 deaths among Hindu, 273 deaths among Muslim, 652 deaths among Christians, 70 deaths among others religious group. Whereas in India, out of 11,869 child death, 8,848 deaths are among Hindu, 1,944 deaths among Muslim, 749 deaths among Christians, 328 deaths among others religious group.

Table 2:- Percent distribution of live birth and deaths by Religion in Northeastern States, India, NFHS 4 (2015-16).

State	Rate	Hindu	Muslim	Christian	Others	Total
Arunachal Pradesh	Live birth	1154(23%)	119(2%)	2262(46%)	1431(29%)	4966
	Death	37(29%)	4(3%)	65(51%)	21(17%)	127
Assam	Live birth	5779(56%)	4034(39%)	465(4.5%)	31(0.5%)	10309
	Death	283(55%)	214(41%)	18(3%)	3(1%)	518
Manipur	Live birth	2082(37%)	599(11%)	2409(43%)	546(9%)	5636
	Death	34(25%)	25(18%)	69(50%)	10(7%)	138
Meghalaya	Live birth	199(5%)	170(4%)	3626(82%)	414(9%)	4409
	Death	7(4%)	13(8%)	118(76%)	18(12%)	156
Mizoram	Live birth	25(0.5%)	20(0.5%)	4673(95%)	187(4%)	4905
	Death	0	1(0.5%)	226(98%)	4(1.5%)	231
Nagaland	Live birth	165(3.6%)	177(4%)	4250(92%)	15(0.4%)	4607
	Death	8(5%)	8(5%)	151(90%)	0	167
Sikkim	Live birth	530(53%)	16(1%)	97(10%)	362(36%)	1005
	Death	15(50%)	1(3%)	4(13%)	10(34%)	30
Tripura	Live birth	1041(78%)	150(11%)	56(4%)	83(7%)	1330
	Death	27(69%)	7(18%)	1(3%)	4(10%)	39
Total Northeast	Live birth	10975(30%)	5285(14%)	17838(47%)	3069(9%)	37167
	Death	411(30%)	273(19%)	652(46%)	70(5%)	1406
India	Live birth	187573(72%)	40950(16%)	20934(8%)	10170(4%)	259627
	Death	8848(75%)	1944(16%)	749(6%)	328(3%)	11869

Table 3. Shows infant and under-five mortality rates for the five-year period preceding the survey by place of residence in Northeastern states, India NFHS-4, it shows that there are huge rural-urban differences. In total northeastern states the rural urban gap in IMR is 21 per 1000 live births and UFMR is 17 per 1000 live births. However, it varies between the eight states, Sikkim has recorded the highest rural-urban gap in IMR with the gap of 32 per 1000 live births. While, lowest rural urban gap in IMR was observed in Arunachal Pradesh 4 per 1000 live births. Similarly, Sikkim has highest rural urban gap in UFMR with the gap of 36 per 1000 live births. While, the lowest rural urban gap in UFMR was observed in Assam i.e. 4 per 1000 live births. Whereas in India, in IMR there is a rural urban gap of 18 per 1000 live births, which is lower than total Northeastern states. On the otherhand the rural- urban gap in UFMR is 20 per 1000 live births which is higher than the total Northeastern states.

Table 3:- Infant and under-five mortality rates for the five-year period preceding the survey by Place of Residence in Northeastern States, India, NFHS 4 (2015-16).

State	Rate	Rural	Urban	Total	Rural-Urban Gap
Arunachal Pradesh	IMR	24	20	23	4
		[18.7-28.7]	[9.6-29.9]	[17.4-28.4]	
	U5MR	40	25	37	15
		[28.7-50.7]	[14.5-34.6]	[28.5-44.7]	
Assam	IMR	50	30	48	20
		[45.5-54.2]	[17.4-42.8]	[43.6-52.0]	
	U5MR	57	53	57	4
		[50.2-62.9]	[22.1-83.4]	[51.1-61.7]	
Manipur	IMR	25	15	22	10
		[20.05-29.6]	[8.5-21.5]	[17.2-25.8]	
	U5MR	28	17	24	11
		[22.9-33.3]	[10.6-23.5]	[19.9-28.9]	
Meghalaya	IMR	32	17	30	15
		[25.7-38.6]	[5.9-27.9]	[24.7-35.5]	
	U5MR	49	21	45	28
		[35.7-61.4]	[8.8-32.4]	[34.6-54.6]	
Mizoram	IMR	47	30	38	17
		[32.6-61.03]	[20.3-40.4]	[30.6-46.2]	
	U5MR	60	34	46	26
		[41.9-78.4]	[21.8-45.8]	[37.2-55.7]	
Nagaland	IMR	33	21	30	12
		[26.9-39.3]	[12.7-30.3]	[24.7-35.3]	
	U5MR	52	27	45	25
		[37.2-67.5]	[17.3-37.6]	[34.7-55.8]	
Sikkim	IMR	39	7	29	32
		[23.8-55.5]	[2.6-17.5]	[18.8-39.2]	
	U5MR	43	7	32	36
		[24.31-62.13]	[2.6-17.5]	[19.02-44.3]	
Tripura	IMR	32	13	27	19
		[19.8-44.3]	[-0.7-26.5]	[16.8-37.8]	
	U5MR	40	17	34	23
		[25.4-54.3]	[1.11-33.4]	[19.7-48.7]	
Total Northeast	IMR	45	24	42	21
		[40.6-11.6]	[17.7-30.2]	[38.9-44.7]	
	U5MR	53	37	51	16
		[48.3-58.1]	[23.3-50.05]	[46.5-55.8]	
India	IMR	46	28	41	18
		[44.5-46.6]	[26.5-30.3]	[39.7-41.8]	
	U5MR	57	37	51	20
		[55.4-58.7]	[34.3-40.5]	[49.9-53.1]	

Table 4.Shows infant and under-five mortality rates for the five-year period preceding the survey by Religion in Northeastern states, NFHS-4 (2015-16). It shows that Muslim has the highest IMR and UFMR i.e. 52 and 56 per 1000 live births respectively in total Northeastern States, whereas Christian has lower IMR and UFMR. However, it varies between the States, whereas in majority of the States, Muslim has the highest IMR and UFMR. The highest IMR i.e. 75 per 1000 live births was observed among the Muslim religious group in Meghalaya. While the highest UFMR i.e.120 per 1000 live births was observed in others religious group in Assam. The lowest IMR was observed among others religious group in Mizoram i.e. 8 per 1000 live births, and the lowest UFMR was observed among Christian in Tripura i.e. 9 per 1000 live birth. It is observed that, there is a huge gap or differences between the states among different religious group i.e. IMR ranging from 75 to 8 per 1000 live births, and UFMR ranging from 120 to 9 per 1000 live births approximately. On the other, in India Hindu religion has recorded the highest in both IMR and UFMR i.e. 41 and 52 per 1000 live births respectively, and the lowest IMR and UFMR is among the Christian religious group i.e. 25 and 35 per 1000 live births respectively

Table 4:- Infant and under-five mortality rates for the five-year period preceding the survey by Religion in Northeastern States, India, NFHS 4 (2015-16**).**

State	Rate	Hindu	Muslim	Christian	Others	Total
Arunachal Pradesh	IMR	30	27	25	12	23
		[18.8-40.9]	[-5.4-59.3]	[15.7-34.3]	[5.8-18.3]	[17.4-28.4]
	U5MR	33	45	46	23	37
		[21.5-44.1]	[-6.7-96.2]	[29.2-61.9]	[10.3-35.5]	[28.5-44.7]
Assam	IMR	45	52	30	73	48
		[39.4-50.9]	[44.9-59.4]	[11.8-48.1]	[-32.1-78.2]	[43.6-52.0]
	U5MR	57	57	32	120	56
		[48.1-66.5]	[48.8-64.5]	[13.4-50.07]	[-19.9-60.5]	[51.08-61.7]
Manipur	IMR	13	35	27	17	22
		[7.8-18.7]	[18.4-52.6]	[20.4-34.2]	[5.5-28.7]	[17.2-25.8]
	U5MR	16	39	31	17	24
		[9.6-22.3]	[20.6-56.8]	[23.04-39.0]	[5.4-28.7]	[19.9-28.6]
Meghalaya	IMR	31	75	25	40	30
		[4.4-58.1]	[28.8-120.7]	[19.8-30.05]	[20.8-58.8]	[24.7-35.5]
	U5MR	31	75	43	48	45
		[4.4-58.1]	[28.8-120.7]	[31.9-53.4]	[24.02-71.7]	[34.6-54.6]
Mizoram	IMR	*	40	40	8	38
		*	[-45.5-26.1]	[31.4-49.04]	[-2.4-17.8]	[30.6-46.2]
	U5MR	*	40	48	25	46
		*	[-45.5-26.1]	[36.8-58.7]	[-3.6-53.1]	[37.1-55.7]
Nagaland	IMR	51	33	29	*	30
		[19.3-82.5]	[5.6-60.6]	[23.3-34.1]	*	[24.7-35.3]
	U5MR	51	51	45	*	45
		[19.3-82.5]	[11.6-89.3]	[31.8-57.6]	*	[34.6-55.8]
Sikkim	IMR	24	56	42	32	29
		[8.9-39.2]	[-67.1-79.6]	[2.5-81.1]	[10.9-52.6]	[18.8-39.2]
	U5MR	29	56	42	32	32
		[11.3-46.1]	[-67.1-79.6]	[2.2-81.1]	[10.9-52.6]	[19.02-44.2]
Tripura	IMR	24	44	9	56	27
		[14.8-33.2]	[15.4-74.1]	[-7.5-25.1]	[-0.5-112.3]	[16.8-37.8]
	U5MR	33	45	9	56	34
		[21.4-43.9]	[15.4-74.2]	[-7.5-25.1]	[-0.5-112.3]	[19.6-48.7]
Total Northeast	IMR	41	52	28	31	42
		[35.9-45.5]	[43.3-60.5]	[25.1-31.5]	[18.8-43.9]	[38.9-44.7]
	U5MR	52	56	41	40	51
		[45.6-57.6]	[46.9-65.7]	[35.9-46.4]	[26.8-53.9]	[46.4-55.3]
India	IMR	41	40	25	31	41

		[40.5-42.6]	[37.5-42.8]	[19.3-30.6]	[25.3-37.8]	[39.7-41.8]
	U5MR	52	51	35	37	51
		[50.9-54.1]	[46.7-55.2]	[26.6-43.7]	[29.8-44.3]	[49.9-53.1]

Note: * Rate not shown i.e. zero death

Table 5.Represent the percentage distribution of children under five years by background characteristics in northeastern states, India. More than 52% of children were among the mothers whose age at birth 13-24 years. Approximately 60.2% children born to mothers' whose level of education is secondary and above. About 79% of the children were having size average and above, and 51.8% of the children are male. The table shows that 40.9% of the child are of birth order one. And almost 89% of the children's head of the households were male. The proportion of children was maximum among the Hindus i.e. 46.2%, followed by Muslims with 32.8% then Christians with 18.1% and of other religion was 2.9%. In the above table 26% children are from the poorest family, 21.4% children from the poorer family, 19.7% from the middle-income family, 18.3% from the richer family and 14.6% belong to the richest family. Maximum number of children 44.5% belong to others social group, 28.6% belong to ST, followed by, OBC 18.3% and minimum children in SC 8.6%. About 60.6% of children were living in household with improved toilet facilities, and 78.9% of children were living in households having safe drinking water facility. 68.2% women has child delivery in the institution. And 13.4% women has Caesarean-section delivery. 85.1% of the children under five years lives in rural areas. Approximately, 70% of children lives in the states of Assam.

Table 5:- Percentage distribution children under five year by selected individual, household and community characteristics, in Northeastern States, India, NFHS 2015-16**.**

	Sample size (n=37,167)	Percentage (%)	95% CI
Mother's age at birth			
13-24	19,483	52.4	[51.4-53.4]
25-34	15,031	40.4	[39.5-41.4]
35-49	2,635	7.1	[6.7-7.6]
Total	37,167	100.0	
Mother's level of education			
No Education	8,130	21.9	[20.7-23.1]
Primary	6,657	17.9	[17.1-18.7]
Secondary and above	22,380	60.2	[58.8-61.6]
Total	37,167	100.0	
Sex of the child			
Male	19,238	51.8	[51.0-52.5]
Female	17,929	48.2	[47.5-49.0]
Total	37,167	100.0	
Size of Child			
Small	7,988	21.5	[20.4-22.6]
Average and above	29,179	78.5	[77.4-79.6]
Total	37,167	100.0	
Birth order of child			
1	15,230	40.9	[67.8-69.9]
2-3	15,913	42.8	[14.4-15.5]
4+	6,024	16.21	[15.4-17.1]
Total	37,167	100.0	
Sex of Household head			
Male	32,977	88.7	[88.0-89.4]
Female	4,190	11.3	[10.6-12.0]
Total	37,167	100.0	
Religion			
Hindu	17,189	46.2	[44.0-48.6]
Muslim	12,173	32.8	[30.2-35.4]
Christian	6,709	18.1	[16.8-19.4]

Others	1,096	2.9	[2.6-3.4]
Total	37,167	100.0	
Wealth index			
Richest	5,434	14.6	[13.6-15.7]
Rich	6,797	18.3	[17.4-19.2]
Middle	7,322	19.7	[18.8-20.6]
Poorer	7,967	21.4	[20.4-22.5]
Poorest	9,647	26.0	[24.6-27.4]
Total	37,167	100.0	
Caste			
Schedule caste	3,197	8.6	[7.7-9.6]
Schedule Tribe	10,616	28.6	[26.8-30.4]
OBC	6,814	18.3	[16.9-19.9]
Others	16,540	44.5	[42.2-46.8]
Total	37,167	100.0	
Type of toilet facility			
Improved	22,521	60.6	[58.9-62.3]
Not improved	14,646	39.4	[37.7-41.1]
Total	37,167	100.0	
Safe Drinking Water			
Improved	29,312	78.9	[77.3-80.3]
Not improved	7,855	21.1	[19.7-22.7]
Total	37,167	100.0	
Institutional delivery			
Yes	25,338	68.2	[12.6-14.3]
No	11,928	31.8	[85.7-87.4]
Total	37,167	100.0	
Caesarean-section delivery			
Yes	4,995	13.4	[12.6-14.3]
No	32,172	86.6	[85.7-87.4]
Total	37,167	100.0	
Place of Residence			
Rural	31,761	85.5	[84.2-86.6]
Urban	5,406	14.5	[13.4-15.8]
Total	37,167	100.0	
State			
Arunachal Pradesh	895	2.4	[2.2-2.7]
Assam	26,058	70.1	[68.2-72.0]
Manipur	2,043	5.5	[4.9-6.1]
Meghalaya	3,164	8.5	[7.5-9.7]
Mizoram	891	2.4	[2.1-2.8]
Nagaland	1,413	3.8	[3.4-4.3]
Sikkim	252	0.7	[0.6-0.8]
Tripura	2,451	6.6	[5.6-7.7]
Total	37,167	100.0	

Table 6. Shows association of infant death and under five death with selected background characteristics in Northeastern States, India 2015-16. It shows the percentage of infant mortality and under five mortality was highest in the age group of the mothers whose age at birth is 35-49 years. As the level of education of the mother increases the percentage of infant death and under five death decreases. Children with small size in time of birth has higher percentage of infant death compared to the average or above size at birth. Male children have higher percentage of infant death and under five death. Birth order four and above have higher percentage of both infant and under five death. The female headed household has higher percentage of infant and under five death. Muslims religion have higher percentage infant and under five death. Also, the percentage is of infant and under five death

is lowest in richest wealth quintile, and highest among the poorest wealth quintile. Those without improved toilet facilities and drinking facilities shows higher percentage of infant and under five death as compared to improved facility. Those children delivered in institution and delivered by Caesarean-section has lesser percentage of infant and under five death. There is a higher percentage of infant and under five mortality in rural areas as compared to urban areas. Percentage of infant and under five mortality is higher in Assam i.e. 4.6% and 5.0% respectively, and lowest in Manipur 2.1% and 2.3% respectively.

Table 6:- Association of infant death and under five death by selected individual, household and community characteristics, in Northeastern States, India: Bivariate analysis, NFHS-4 (2015-16).

	Infant death (%)	Under Five death (%)
Mother's age at birth		
13-24	4.4 [3.9-5.0]	4.9 [4.4-5.5]
25-34	3.3 [2.9-3.8]	3.6 [3.2-4.1]
35-49	4.5 [4.1-7.4]	6.0 [4.6-7.9]
χ^2 value	41.73***	49.82***
Mother's level of education		
No Education	5.4 [4.5-6.4]	5.9 [5.1-7.0]
Primary	4.7 [3.9-5.6]	5.1 [4.3-6.0]
Secondary and above	3.4 [3.0-3.9]	3.7 [3.3-4.2]
χ^2 value	69.58***	77.15***
Religion		
Hindu	3.9 [3.4-4.5]	4.4 [3.8-4.9]
Muslim	5.1 [4.3-5.9]	5.4 [4.6-6.2]
Christian	2.7 [2.4-3.1]	3.1 [2.8-3.5]
Others	3.0 [1.9-4.6]	3.5 [2.3-5.2]
χ^2 value	65.20***	54.92***
Sex of the child		
Male	4.5 [4.0-5.0]	4.9 [4.4-5.4]
Female	3.6 [3.1-4.2]	4.0 [3.5-4.6]
χ^2 value	18.35**	15.78*
Size of Child		
Avg and above	3.1 [2.8-3.5]	3.5 [3.1-3.9]
Small	7.4 [6.4-8.5]	7.9 [6.9-9.0]
χ^2 value	292.55***	283.43***
Birth order of child		
1	4.4 [3.9-5.0]	4.8 [4.2-5.4]
2-3	3.3 [2.8-3.8]	3.6 [3.2-4.2]
4+	5.2 [4.3-6.3]	5.7 [4.7-6.8]
χ^2 value	50.14***	50.92***
Sex of Household head		
Male	4.0 [3.6-4.4]	4.4 [4.0-4.8]
Female	4.6 [3.7-5.8]	4.9 [3.9-6.2]
χ^2 value	3.56	2.56
Wealth index		
Richest	1.9 [1.4-2.7]	2.1 [1.5-3.0]
Rich	3.1 [2.5-3.9]	3.4 [2.8-4.2]
Middle	4.3 [3.5-5.4]	4.7 [3.8-5.7]
Poorer	4.7 [3.9-5.6]	5.1 [4.3-6.1]
Poorest	5.2 [4.5-6.0]	5.8 [5.0-6.6]
χ^2 value	122.34***	135.61***
Caste		
Schedule caste	3.7 [2.8-4.9]	4.1 [3.2-5.4]
Schedule Tribe	3.1 [2.8-3.5]	3.6 [3.2-4.0]

OBC	4.0 [3.3-4.9]	4.3 [3.6-5.3]
Others	4.7 [4.1-5.4]	5.1 [4.4-5.8]
χ^2 value	44.08***	33.92**
Type of toilet facility		
Improved	3.5 [3.1-4.0]	3.9 [3.5-4.4]
Not improved	4.8 [4.2-5.5]	5.3 [4.6-6.0]
χ^2 value	38.30***	38.83***
Drinking Water facility		
Improved	4.0 [3.7-4.5]	4.4 [4.0-4.8]
Not improved	4.1 [3.4-5.0]	4.7 [3.9-5.6]
χ^2 value	0.14	1.11
Institutional delivery		
Yes	3.5 [3.1-3.9]	3.8 [3.4-4.3]
No	5.3 [4.6-6.1]	5.7 [5.0-6.6]
χ^2 value	68.61***	68.47***
Caesarean-section delivery		
Yes	2.2 [1.6-3.0]	2.4 [1.7-3.2]
No	4.4 [4.0-4.8]	4.8 [4.4-5.2]
χ^2 value	52.61***	58.76***
Place of Residence		
Urban	2.3 [1.7-3.1]	2.8 [2.1-3.6]
Rural	4.4 [4.0-4.8]	4.7 [4.3-5.2]
χ^2 value	49.48***	42.61***
State		
Arunachal Pradesh	2.2 [1.7-2.9]	2.7 [2.2-3.4]
Assam	4.6 [4.2-5.2]	5.0 [4.5-5.6]
Manipur	2.1 [1.7-2.6]	2.3 [1.9-2.7]
Meghalaya	2.9 [2.4-3.6]	3.4 [2.8-4.1]
Mizoram	3.7 [2.8-4.8]	4.0 [3.1-5.2]
Nagaland	2.9 [2.4-3.5]	3.4 [2.9-4.1]
Sikkim	2.8 [1.8-4.5]	2.9 [1.9-4.6]
Tripura	2.6 [1.8-3.7]	2.9 [2.0-4.0]
χ^2 value	80.25***	78.89***

*** significant at 5% level of significance, ** significant at 1% level of significance and *** significant at 0.1% level of significance**

Table 7.Represent binary logistic regression (adjusted) for infant and under-five death in the northeastern States, India, NFHS-4 (2015-16). It shows adjusted ORs for the association between infant death and background characteristics. In the table, the children with small size at birth have 2.13 (p=0.001) times higher risk of infant mortality compared to those having size average and above. Female child has 0.64 (p=0.01) times lower risk of infant mortality compared to the male child. Birth order two to three has 0.64 (p=0.001) lower risk of infant mortality compared to birth order one. Among different religious practice, Christian has 0.63(p=0.05) times lower risk of infant mortality. The children born to middle, poorer, and poorest have 1.79 (p=0.01) times, 1.76 (p=0.01) times, 1.35 (p=0.001) times, higher risk of infant mortality as compared with children born in the richest family. The child delivered by c-section has 0.67 (p=0.05) times, lower risk of infant mortality compared to those without c-section delivery. The Northeastern states i.e. Assam has 1.72 (p=0.001) times, Meghalaya has 1.43 (p=0.05) times, Mizoram has 2.55(p=0.001) times, and Nagaland has 1.51 (p=0.05) times, higher risk of infant mortality as compared with Manipur.

In case of under-five death, the children with small size at birth have 2.10 (p=0.001) times higher risk of under-five death compared to those having size average and above. Female child has 0.80 (p=0.01) times lower risk of under-five death compared to the male child. Birth order two to three has 0.65 (p=0.001) lower risk of under-five death compared to birth order one. Among different religious practice in Northeastern states Christian has 0.67(p=0.05) times lower risk of under-five death. The children born to rich, middle, poorer, and poorest have

1.47 (p=0.05) times, 1.94 (p=0.01) times, 2.00 (p=0.01) times, 2.12 (p=0.001) times, higher risk of under-five mortality as compared with children born in the richest family. The child without c-section delivery has 1.47(p=0.05) times, higher risk of under-five death as compared to with c-section delivery. The Northeastern states i.e. Assam has 1.93 (p=0.05) times, Meghalaya has 1.59 (p=0.05) times, Mizoram has 2.68 (p=0.05) times, and Nagaland has 1.72 (p=0.05) times, higher risk of under-five death as compared with Manipur.

Table 7:- Binary logistic regression (adjusted odds ratio) for Infant and Under five death in Northeastern States of India, NFHS-4 (2015-16).

	Infant Death		**Under death**	
	Adjusted OR	95% CI	Adjusted OR	95% CI
Mother's age at birth				
13-24 ®				
25-34	0.88	[0.70-1.11]	0.84	[0.68-1.04]
35-49	1.39	[0.96-2.0]	1.32	[0.93-1.86]
Level of Education				
Secondary and above ®				
Primary	1.12	[0.86-1.45]	1.11	[0.85-1.44]
No Education	1.16	[0.88-1.51]	1.13	[0.87-1.48]
Size of child				
Average and above ®				
Small	2.13***	[1.79-2.69]	2.10***	[1.72-2.55]
Sex of child				
Male ®				
Female	0.64**	[0.65-0.94]	0.80**	[0.67-0.95]
Birth order of child				
1 ®				
2-3	0.64***	[0.51-0.79]	0.65***	[0.53-0.80]
4+	0.84	[0.45-1.38]	0.85	[0.63-1.12]
Religion				
Hindu ®				
Muslim	0.97	[0.76-1.25]	0.83	[0.57-1.23]
Christian	0.63*	[0.45-0.89]	0.67*	[0.48-0.94]
Others	0.78	[0.44-1.38]	0.87	[0.50-1.45]
Sex of household head				
Male ®				
Female	1.24	[0.95-1.62]	1.19	[0.93-1.55]
Wealth index quintile				
Richest ®				
Rich	1.40	[0.94-2.10]	1.47*	[1.00-2.17]
Middle	1.79**	[1.18-2.71]	1.94***	[1.29-2.90]
Poorer	1.76**	[1.12-2.75]	2.00***	[1.30-3.08]
Poorest	1.35**	[1.14-2.76]	2.12***	[1.37-3.27]
Caste				
Others ®				
Other Backward Classes	0.84	[0.60-1.59]	0.83	[0.58-1.19]
Schedule Tribe	0.85	[0.69-1.82]	0.81	[0.56-1.18]
Schedule Caste	0.84	[0.67-1.97]	0.83	[0.54-1.25]
Toilet facilities				
Improved ®				
Not improved	1.13	[0.82-1.56]	0.87	[0.70-1.09]
Safe drinking Facilities				
Yes ®				

No	0.93	[0.69-1.25]	1.11	[0.70-1.09]
Caesarean-section delivery				
Yes				
No	0.67*	[0.42-1.09]	1.47*	[1.06-2.05]
Institutional delivery				
Yes ®				
No	1.10	[0.80-1.53]	1.19	[0.94-1.15]
Place of Residence				
Urban ®				
Rural	1.35	[0.87-2.08]	1.07	[0.79-1.44]
State				
Manipur ®				
Arunachal Pradesh	1.00	[0.71-1.41]	1.17	[0.82-1.66]
Assam	1.72***	[1.27-2.34]	1.93***	[1.42-2.64]
Meghalaya	1.43*	[1.01-2.01]	1.59**	[1.12-2.27]
Mizoram	2.55***	[1.75-3.70]	2.68***	[1.80-3.97]
Nagaland	1.51*	[1.10-2.08]	1.72**	[1.22-2.41]
Sikkim	1.23	[0.74-2.05]	1.43	[0.83-2.45]
Tripura	0.97	[0.59-1.40]	1.02	[0.66-1.57]

*** significant at 5% level of significance, ** significant at 1% level of significance and *** significant at 0.1% level of significance**

Discussion and Conclusion:-

Discussion:

This study revealed that, there is variation of mortality within the states i.e. by place of residence, where children living in rural areas has higher risk of child mortality, Sikkim has recorded the highest rural-urban gap in IMR i.e. 32 per 1000 live births and lowest rural-urban gap is 4 per 1000 live births in Arunachal Pradesh. Similarly, the highest rural-urban gap in UFMR i.e. 36 per 1000 live births in Sikkim, and lowest is 4 per 1000 live births in Assam. Higher mortality in rural area of Northeast India indicates that, there is unequal distribution of resource by place of residence. Different type of religious practices also contributes significantly to infant and under five mortality. Among all the religion Muslims have the highest IMR and UFMR i.e. 52 and 56 per 1000 live births respectively, in contrary with India where Hindu religion has the highest as per NFHS-4. On the other hand, the lowest IMR and UFMR was recorded among the Christian religion i.e. 28 and 41 per 1000 live births respectively. However, there is a huge difference between the States among different religious group i.e. IMR ranging from 75 to 8 per 1000 live births, and UFMR ranging from 120 to 9 per 1000 live births. Children born to a poor household have higher risk of infant and under five mortality. Size of child, sex of child, caesarean-section delivery has impact on infant and under five mortality. However, in Northeastern states, in contrary to the existing literature, the association between age of mother, mother education, place of delivery with infant and under five death are not found to be statistically significant. There could be some underlying factors that are affecting IMR and UFMR i.e. strong social and community bonding and absence of caste and social discrimination, lifestyle cultural habits and positive feeding practices, presence of traditional healer who practices through ages although there is no scientific proof.

Conclusions:-

Our finding also suggests that substantial efforts should be made to improve household wealth and rural women as higher infant mortality in rural areas indicates an unequal distribution of resources by type of residence. High child mortality is one of the drawbacks in the economic and social development of the country which is faced by many developing countries; India is one of this, and similarly in the Northeastern region. Therefore, intervention focusing on the above-mentioned predictors will give a desired outcome and will help in reducing infant mortality and under five mortality. The above evidence demonstrates that the prevalence of child mortality is high in this region, and is a public and community problem. The government must give more additional effort, and action to reduce child mortality in this region. Universal Health Immunization Programme 1985, Child Survival & Safe Motherhood 1992, Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCH+A) 2013, are some

of the key intervention in this area. The challenge is still enormous in this area due to the existence of two excesses, one is low and the other high.

Limitations of the study:
One of the major limitations of the study is that it lacks information on availability of healthcare services. Secondly, only the socio-cultural and demographic factors were considered, biological factors were not included in this analysis. Similarly, all the maternal factors were not considered as covariates including BMI of the mother.

Ethical approval:
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None.

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The authors declare that they have no competing interests.

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