Original Article

Mapping Child Survival: A District-Level Assessment of SDG-3 Target for Under-five Mortality Rate in Assam

Arjina Begum[1], Sanjay Sinha[2]

[1]Research Scholar, [2] Assistant Professor, Department of Economics, Assam University, Silchar, Assam, India.

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Abstract

Objective: This study aims to present the district-level estimates of under-five mortality rate of Assam, with specific emphasis on assessing its progress towards attainment of Sustainable Development Goal 3.2.1 target by 2030. The paper additionally presents sex differentials in target achievement and identifying districts' likelihood of meeting or missing the goal by 2030. The under-five mortality rate indirectlyoffers insight into the overall health, quality of life, welfare, and development of an area.

Materials and methods: The study uses the unit-level data from National Family Health Survey 5 (2019-20) and 4 (2015-16). A synthetic cohort probability approach is used to obtain the district-wise estimates of the under-five mortality rate for the state of Assam.

Results: The analysis shows that 12 per cent out of all the districts across the state have already attained the target outlined in Sustainable Development Goal 3.2.1. However, nearly 30 per cent of the districts are unlikely to achieve it by 2030. Moreover, there exists a significant difference in attainment of the target across the two sexes. It is seen that female under-five mortality rates fluctuate relatively more across districts compared to male under-five mortality rate. Additionally, more districts are on track to meet the target in case of female under-five mortality rate by 2030.

Conclusions: Strategic adoption of policies, effective implementation, and efficient healthcare interventions is necessary in narrowing the gap and enabling all districts to meet the Sustainable Development Goal 3.2.1 by 2030. It is expected that 20 districts of Assam would attain the target by 2030.

Keywords: Child health, Under-five mortality, Sustainable development goals, Sex differential, Assam

Introduction

A nation's true prosperity is fundamentally vested in its children, a sentiment powerfully articulated by Kahlil Gibran,[(1)] who noted that a country's wealth and prosperity reside not in its material assets, but are deeply driven by its future generations. The children represent the bedrock of a

Corresponding Author: Arjina Begum, Research Scholar, Department of Economics, Assam University, Silchar, Assam, India.

E-mail: arjina.begum@aus.ac.in, ORCID 0009-0007-6323-9915

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nation's workforce, and safeguarding their health and well-being becomes an imperative. Consequently, the child mortality rate, a critical measure of child survival, is a key indicator of a nation's overall health, quality of life, welfare, and development.[2–4] A persistent decline in child mortality is both sought after and indicative of increased public health and well-being.

The UN's International Children's Emergency Fund (UNICEF) defines the Under-five mortality rate (U5MR) as the "probability a newborn would die before reaching exactly five years of age, expressed as per 1,000 live births."[2] The U5MR provides information regarding nutritional conditions[5–8] and indirectly provides insight into the health conditions of a region. Health is a necessary source of productivity because it can be considered a proxy for labour quality.[9]

The SDG-3.2.1 (Sustainable Development Goal 3.2.1) is regarding the under-five mortality rate, which is a key indicator within the framework of Sustainable Development Goal 3 (SDG 3) for "ensuring healthy lives and promoting well-being for all at all ages". The target of SDG-3.2.1 is to end preventable deaths of children under age five years,to reduce under-five mortality to at least 25 per 1,000 live births by 2030. [10–12]

India has significantly lowered its Under-five Mortality Rate in recent decades. From 2019 to 2020, this rate fell by 8.6 per cent annually, representing a three-point reduction in child mortality. As per reports, eleven States/Union Territories—namely Kerala, Tamil Nadu, Delhi, Maharashtra, Jammu & Kashmir, Karnataka, Punjab, West Bengal, Telangana, Gujarat, and Himachal Pradesh—have already attained the target U5MR.[13] However, disparities in accessibility to the health care system across regions and sex exists.Consequently, over the past few years, there has been an influx of information regarding socio-economic and geographical disparity in child mortality,[14,15] and only a limited number of research have explored the disparities in mortality at the district level.[7,8,16–19] This needs to be addressed to achieve the SDG-3.2.1 target better.

Assam, despite being identified as a high risk state,[16] has made considerable progress in reducing the U5MR to 39.1, outperforming the national average of 49.1 as per the National Family Health Survey-5 (NFHS-5). Regardless, many districts still face challenges related to inadequate healthcare infrastructure and limited access to quality medical services. Moreover, the district-level figures of U5MR are not readily available, and minimal studies have explored disparity across the district level.

In this context, no prior study has comprehensively traced the pathway towards achieving the target SDG 3.2.1 at the district level for Assam, specifically utilizing the latest unit-level data from the National Family Health Survey (NFHS-5) 2019-20 dataset. Furthermore, numerous studies indicate a persistent gender gap in under-five mortality, characterized by an excess of female deaths, whether a similar pathway or disparity is observed within the state of Assam remains an unexplored area.

This study primarily presents the estimates of U5MR at the district level in Assam as per unit level NFHS-5 data. More specifically the paper assesses the state's progress towards reaching the Sustainable Development Goal 3.2.1 (SDG-3.2.1). Secondly, the paper analyses sex differentials across districts in achieving the target, identifying the districts likely to meet the SDG 3.2.1 by 2030, and highlight those which are at high risk of failure. This would enable policymakers to effectively identify high-risk districts and facilitate the necessary allocation of resources.

Materials and Methods

The current study uses the data at the unit-level from the fourth and fifth rounds of the Demographic and Health Survey (DHS) of India, which is also known as the National Family Health Survey-5 (NFHS-5)[14,20] and National Family Health Survey-4 (NFHS-4)[15,21] conducted in 2019-21 and 2015-16, respectively.

There are two principal methods to obtain estimations of early childhood mortality rate: the direct method and the indirect method. The direct method has been used to minimise errors and get a robust estimated rate. This direct method of estimation is also known as the synthetic cohort probability method and is, in fact, consistent with the approach used in DHS reports. We employed STATA software version 17, alongside appropriate packages to conduct the analysis.[22]

The synthetic cohort probability method is used in DHS to determine death rates. Based on the entire birth history survey approach, the synthetic cohort probability approach enquires mothers about each

child's date of birth, current survival status, and, if deceased, the age at when the child died. By default, death rates are deduced for the five years preceding the interview period,[23] but for robustness of the study, we compute death rates for 10 years preceding the interview period.[16,23] We have separately estimated the district-level U5MR for the female, male, and total population. The result of this study is strictly based on the U5MR estimates, which are statistically significant at the5 per cent level.

To undertake a comparative analysis of the status of all the districts across Assam, with specific reference to the attainment of SDG-3.2.1 target pertaining to the reduction of preventable deaths among newborns and children, we have categorised all districts into distinct three categories based on some conditions.

a. **Already achieved:** Districts that had **already achieved or attained** the U5MR target outlined as per SDG-3.2.1 (i.e., less than or equal to 25 deaths per 1000 live births).

b. **Likely to achieve:** Districts that are **likely to achieve** or are on track to attain the U5MR target outlined as per SDG-3.2.1 by 2030 (i.e., less than or equal to 25 deaths per 1000 live births by the end of 2030).

c. **Not likely to achieve:** Districts that are **not likely to achieve** or are not on track or will not attain the U5MR target as per SDG-3.2.1 by 2030.

The following steps have been undertaken to include a district either in the category **likely to achieve** or **not likely to achieve**: We first obtain the U5MR estimates for all the districts across Assam for both NFHS-5 (five years preceding the survey) and NFHS-4 (five years preceding the survey). Secondly, we calculate the district-specific yearly reduction rate in U5MR from NFHS-4 to NFHS-5. Lastly, we adjust the district-specific yearly reduction rate to the mortality estimates obtained from NFHS-5 for a future period of 15 years. The reason for taking 15 years is that the period between 2015 (mid-point for the reference period of mortality estimates of NFHS-5, 10 years prior to the survey) and 2030 (SDG-3 achievement target year) is 15 years.

We assume that the district-specific annual reduction rate remains constant over the 15-year period from 2015 to 2030. Therefore, a district is included in the **likely to achieve** category only it is expected to attain the target U5MR by 2030.Conversely, a district falls into the **not likely to achieve** category if it does not meet both the criteria. In other words, if their projected progress doesn't show them reaching the target by 2030, they'll be placed in this category. For the newly formed districts, the district-specific yearly reduction rate of the parent districts has been taken. For instance, the districts like West Karbi Anglong, South Salmara-Mankachar, Majuli, Biswanath, Hojai, and Charaideo are bifurcated out of Karbi Anglong, Dhubri, Jorhat, Sonitpur, Nagaon, and Sivasagar, respectively. So, districts like West Karbi Anglong will carry the rate of Karbi Anglong and so on.

Results

Under-five mortality rate across districts of Assam: We estimated the mortality rates of under-fives for the 10 years preceding the survey by sex and total for each districts across Assam. The estimates, including the confidence intervals at 95 per cent, are presented in Table A (Appendix) for a detailed overview, and for better visualisation, a choropleth map of the estimates of U5MR of all districts of Assam is illustrated in Figure1. It is seen that Bongaigaon district has the lowest U5MR estimate, with 17.58 deaths per 1000 live births, and Hailakandi has the highest U5MR estimate of 67.52 deaths per 1000 live births. Further, Table 1 provides descriptive statistics of these estimates

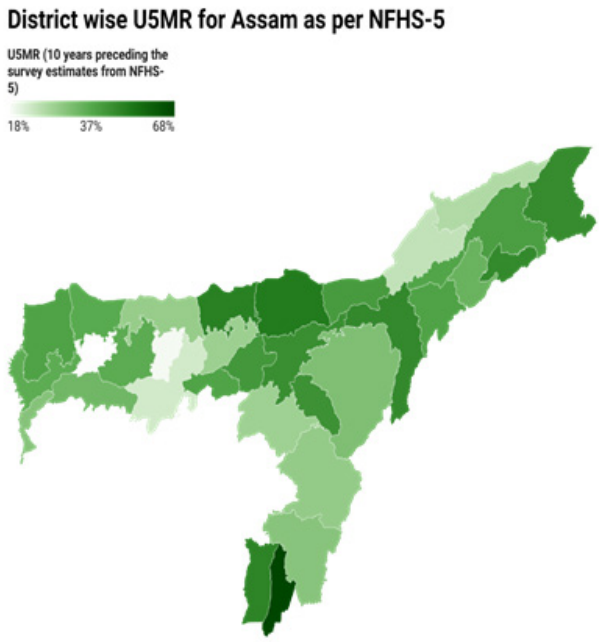


Figure-1: Choropleth map of Assam showing the U5MR estimates from unit level data of NFHS-5
Source: Author's Calculation • Map data: © OSM • Created with Datawrapper

Table 1: Descriptive statistics of the U5MR estimates (10 years preceding the survey) across the districts of Assam

U5MR	Total No. of districts	No. districts with significant estimates of U5MR	Mean U5MR	Standard Deviation	Min	Max	Coefficient of variation
Male	33	33	42.08	13.20	20.17	71.73	0.31
Female	33	32	31.93	11.16	14.65	63.39	0.35
Total	33	33	36.75	10.26	17.58	67.52	0.28

The average U5MR across the districts vary significantly for males and females. With a mean rate of 31.93 deaths per 1,000 live births, females have a significantly lower under five deaths compared to males having a mean under five death rates of 42.08 deaths per 1,000 live births. This disparity is noticeable and statistically significant at 5 per cent level of significance (results of paired t-test is presented in Table 2, where we reject the Null-hypothesis: there is no significant difference between the male U5MR and female U5MR). Female mortality rates fluctuate relatively more across districts compared to male U5MR, which can be seen through the coefficient of variation (CV) of female U5MR (0.35) being relatively higher than male U5MR (0.31).

Table 2: Results of Paired Sample Test

Pair 1	Mean	Standard Deviation	Standard Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Male U5MR - Female U5MR	10.91	14.20	2.47204	5.88	15.95	4.41	32	0.00

SDG-3.2.1 and the districts of Assam: There exists mixed progress across districts towards the attainment of Sustainable Development Goal-3.2.1 (SDG-3.2.1) target on under-five deaths. As of 2021,a notable disparity in progress towards achieving the SDG-3.2.1 target for under-five deaths is observed in Assam across male and female children. For the female U5MR, 25 per cent of the districts have already met the SDG-3.2.1 target, whereas only 9 per cent of the districts have achieved the same target for male U5MR.

Table 3: Status as of 2021 for the progress of SDG-3.2.1 for children under five.

U5MR	Number of districts with significant estimates (out of 33 districts)	Already achieved SDG 3.2.1	Likely to achieve by 2030	Not likely to achieve in 2030
Female	32	8 (25%)	21 (65.63%)	3 (9.37%)
Male	33	3 (9.09%)	17 (51.51%)	13 (39.39%)
Total	33	4 (12.12%)	20 (60.60%)	9 (27.27%)

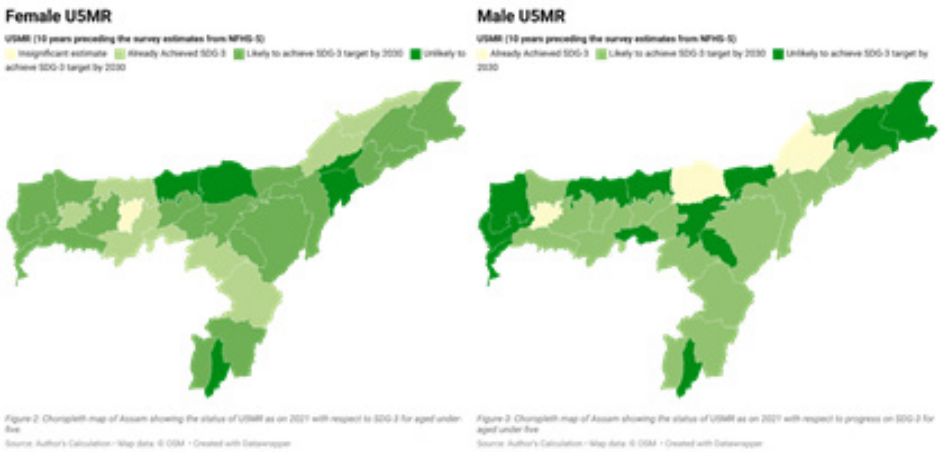
Additionally, more than 65 per cent of the districts are likely to achieve the target for the female U5MR, whereas it is around 51 per cent for the male U5MR. Also, around 40 per cent of the districts are not likely to achieve the target for male U5MR, compared to 9.37 per cent of the districts for female U5MR by the end of 2030. We therefore observe a clear advantage of female survivorship on under-five mortality (U5M) across the districts (Table 3).

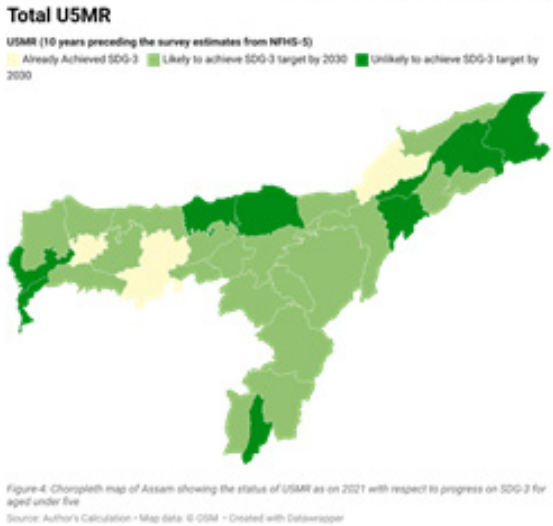
These findings highlight the necessity for focused interventions to mitigate the inequalities in under-five mortality rates among districts in Assam, especially concerning male children. It is also seen that 12 per cent of the districts have already met the

U5MR target outlined in SDG-3.2.1, irrespective of sex. However, nearly 30 per cent (27.27% to be exact) of the districts are not likely to achieve the 2030 target, despite reductions in mortality observed in the last two rounds of the National Family Health Survey.

Efforts to lower the U5MR over the years have set over 60 per cent of the districts on track to reach the U5MR target by 2030. While the coefficient of variation is higher for female U5MR, more districts are on track to meet the SDG 3.2.1 target for Female U5MR by 2030 compared to Male U5MR. The choropleth map of Assam shows the status of female U5MR, male U5MR and the total U5MR towards the progress of SDG-3.2.1 for under-fives in Figures 2, 3, and 4 respectively.

Discussion





A significant challenge in tracking child health progress, particularly in low and moderate-income nations, is the lack of routine checks of unit-level U5MR. Therefore, government and concerned authorities must conduct periodic surveys, and estimations to keep a check on these measurements. (24–26)

Our findings show a considerable disparity in the U5MR across the state. The estimates presented in the Table A (Appendix) shows notable variability, with a coefficient of variation of 0.28 (Table 1). A child born in Bongaigaon has a far greater chance of reaching their fifth birthday (U5MR estimate is as low as 17.58 deaths per 1000 live births) than a child born in Hailakandi (U5MR estimate is the highest, at 67.52 deaths per 1000 live births), where the death rate is nearly four times higher. Additionally, disparities exist between female and male U5MR, with a higher

proportion of districts likely to achieve the target for female U5MR (65.63 per cent) compared to male U5MR (51.51 per cent). The probable reason for these wide disparities is the differences in the level of socio-economic development among the districts.[16,17,27] As of 2021, eight districts have already attained the SDG target for the under-fives for females, compared to only three districts for males. The analysis shows a clear advantage of female child survival over male child in our study area. The study's findings are also consistent with those from sub-Saharan African nations, where male under-five deaths were found to be 17-54 percent higher than female deaths.[28] But our findings deviate from the already established demographic trend typically observed in developing nations.[16–19,24,26,27,29] Additionally, this particular result is also inconsistent with national level analysis of under-five mortality using NFHS-4 data where districts with high risk of female under-five mortality were identified in northeast region.[16]

Thirdly, there has been a significant reduction in morality which can be seen in the reports from the subsequent rounds of NFHS-3, NFHS-4 and NFHS-5 due to continuous efforts of the government both the central and state on improving the health infrastructure and accessibility through the National Rural Health Mission (NHM), and other initiatives.[20,21,30] But there has been a pronounced district-level variation in the mortality.[16,27,31]As an instance, the state estimate U5MR is 39 (10 years prior to the survey), whereas the district estimates vary from 17.58 to 67.52. This emphasises the need for district-level planning[25,32] Identifying high-priority areas, increase in community-level awareness and engagement, and, most importantly, reduce socio-economic inequalities in accessing health care facilities.[7,8,16]

Conclusion

The novelty of this particular study lies in its estimation of district-level under-five mortality rates across Assam, taking into account the unit-level data of NFHS 4 and 5. Our findings underscore significant and persistent disparities in under-five mortality rates across Assam's districts, notably revealing a survival advantage for females, where female under-five mortality rate is relatively lower than that of males, a pattern that challenges conventional demographic theories.

The foremost limitation of the study is that it assumes that the yearly reduction rate in mortality that the districts would experience is at a constant level. Specifically, the reduction of U5MR from NFHS-3 to NFHS-4 and subsequently to NFHS-5 is not constant; therefore, it is expected that the reduction in mortality rate would be higher for districts with high mortality levels and vice versa.

Furthermore, this study provides a roadmap for all the districts of Assam on the progress of the SDG-3.2.1 target for children under five. The reason of relatively higher under five deaths of male child over the female requires exploration. Additionally, the unreleased NFHS-6 dataset is expected to offer substantial insights into mortality trends for both genders. Also, replicating this detailed district-level analysis nationwide will shed light on the healthcare and socioeconomic conditions of the region. Such a deeper understanding will eventually facilitate exploration into the exact root cause of these disparities across regions.

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Ethical Clearance: The manuscript does not involve any intervention on human subjects; therefore, ethical clearance has not been obtained. SAGER guidelines have been followed while preparing the manuscript. On conducting a Drill Bit Similarity check, a 9 percent similarity report was obtained.

Declaration of conflicts of interest statement: None of the authors has any conflict of interest to declare.

Appendix

Table A: NFHS-5 U5MR estimates (10 years preceding the survey)

District	Under-five mortality rate (U5MR) estimates (p<0.05) with confidence interval (CI)								
	Male U5MR	CI (Lower)	CI (Upper)	Female U5MR	CI (Lower)	CI (Upper)	Total U5MR	CI (Lower)	CI (Upper)
Bongaigaon	20.17	5.20	35.14	14.65	2.12	27.19	17.58	6.11	29.05
Nalbari	30.02	10.83	49.22	-	-	-	18.71	7.74	29.67
Kamrup	27.83	9.87	45.78	16.26	2.02	30.49	22.61	8.89	36.34
Lakhimpur	24.88	6.41	43.35	23.65	6.61	40.69	24.28	10.8	37.76
Dhemaji	28.30	11.97	44.62	24.06	10.78	37.34	26.16	15.13	37.18
West Karbi Anglong	32.08	16.17	47.98	24.44	7.10	41.78	28.29	15.22	41.37
Darrang	29.70	14.58	44.82	27.04	10.07	44.02	28.53	15.29	41.76
Baksa	37.33	15.79	58.86	20.38	5.31	35.45	29.16	15.53	42.79
Dima Hasao	37.74	16.07	59.40	19.50	2.44	36.56	29.48	14.33	44.63
Cachar	36.03	18.07	53.99	25.65	10.64	40.66	30.95	18.68	43.22
South Salmara Mankachar	33.10	15.65	50.55	29.10	13.07	45.13	31.21	17.01	45.42
Karbi Anglong	35.45	18.83	52.08	28.22	10.11	46.33	32.00	14.99	49.01
Goalpara	37.88	18.95	56.80	29.60	10.85	57.58	33.72	19.92	47.52
Sivasagar	36.71	14.50	58.91	32.16	11.79	52.54	34.55	19.47	49.64
Dhubri	44.04	29.55	58.52	27.14	14.93	39.35	35.88	22.24	49.53
Barpeta	40.36	20.35	60.37	31.60	16.20	47.00	36.03	21.62	50.45
Chirang	39.54	22.33	56.74	32.99	16.29	49.70	36.39	18.85	53.93
Majuli	22.63	5.60	39.65	53.52	32.50	74.54	37.59	24.98	50.21
Kamrup Metropolitan	56.25	25.06	87.44	18.82	3.41	34.23	38.15	23.23	53.06
Jorhat	35.64	19.48	51.81	41.71	16.10	67.31	38.48	20.19	56.77
Kokrajhar	48.92	22.20	75.64	28.32	9.80	46.83	38.49	26.43	50.55
Dibrugarh	53.18	28.46	77.89	26.40	9.26	43.53	39.75	25.3	54.2
Biswanath	54.52	36.17	72.88	28.08	8.64	47.52	40.91	24.67	57.16
Morigaon	30.60	13.78	47.41	53.02	30.87	75.18	41.88	29.58	54.17
Hojai	48.67	31.83	65.51	37.68	15.92	59.44	43.67	24.17	63.17
Nagaon	54.75	32.69	76.81	35.15	17.94	52.35	44.80	27.42	62.18
Tinsukia	51.75	29.39	74.12	38.84	15.81	61.88	45.58	32.34	58.82
Charaideo	57.55	32.39	82.71	34.79	14.24	55.34	46.28	33.61	58.95
Golaghat	57.61	28.00	87.22	34.22	10.85	57.58	46.42	21.39	71.45
Karimganj	53.69	32.27	75.11	42.20	25.09	59.32	47.95	28.66	67.24
Udalguri	49.38	24.89	73.86	48.83	23.87	73.79	49.14	28.59	69.68
Sonitpur	70.72	38.62	102.82	30.34	14.14	46.55	50.57	30.00	71.13
Hailakandi	71.73	47.33	96.13	63.39	38.66	88.12	67.52	51.25	83.78

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