Understand the Rural-Urban Patterns of Under-Five Mortality by Mother's Education in India: A Trend Analysis of Four National Family Health Surveys from 1992-92 to 2016-15

Abstract

India, along with Nigeria, accounted for almost a third of under-five deaths globally. The under-five mortality (U5M) was constantly higher in the rural areas. Previous studies recognized mother education as a primary indicator for reducing U5M; however, no study examined rural-urban trends by mothers' educational attainment. Using the Sample Registration Survey and four rounds of National Family Health Surveys (NFHS-1, II, III, IV), we analyzed the rural-urban differences in U5M rates across the regions and by mother education level during 1991-92 to 2015-16. Multilevel Cox-proportional Hazard model used to understand rural-urban differences in U5M after controlling for mothers' socioeconomic characteristics, reproductive behavior, and community and state-level socioeconomic status, public health facilities. Results suggest that U5M rate remained higher in rural areas across the region during study period. U5M rates are higher among the children born to low educated mothers across the NHFS rounds; however, difference reduced during NHFS-IV. Regression results suggest the rural-urban differences disappear after controlling for significant predictors, and surprisingly, the risk of U5M becomes higher in urban areas. The impact of a mother's educational attainment differs between rural-urban; child born to a mother is more advantageous in the urban setting than in the rural parts of India.

Background

Under-five mortality remained one of the most important health indicators and is regularly priorities in the global health targets. Despite the significant reduction of under-five death, it is still a matter of grave concern, particularly for developing countries. India has achieved an impressive decline in the under-five mortality rate (U5MR) from 126 (deaths per 1,000 live births) to 34 between 1990 and 2019. However, along with Nigeria, the country still accounted for almost a third of under-five deaths globally in 2019 (UNIGME, 2020). The level of under-five mortality differed enormously between rural-urban with in the country. These differences may be attributed to the rural-urban disparities in health, socioeconomic, political, and environmental conditions (Azam, 2017). Recent research analyzed the socioeconomic factors affecting the under-five mortality in developing countries (Saikia et al., 2013; Khan and Awan, 2017). Mother education is recognized as a primary indicator for reducing child mortality across the country (Bicego and Boerma 1990; Caldwell 1979; Cleland et al. 1992; Keats 2016). Very few studies analyzed the rural-urban difference of under-five mortality in India; hardly any study examined this long-term rural-urban trend by the mother's educational attainment.

Evidence of under-five mortality trends by rural-urban is crucial for the better understanding of contemporary demographic transition within the country. The fundamental rural-urban differences

in the individual and structural factors may contribute to the under-five mortality differences between rural and urban parts of India. Recently few studies using the demographic and health surveys analyzed the rural-urban differences in under-five mortality for the developing countries suggested rural disadvantage mortality among children below age 5 (Saikia et al., 2013; Khan and Awan, 2017).

Evidence has accumulated that mother educational attainment plays a significant role in determining infant and child mortality. Still, the evidence from the existing literature is unclear whether the magnitude of maternal education impact varied in rural and urban areas. First, the objective of the present study is to assess the long-term trends of the under-five mortality in rural and urban residences by the mother's educational attainment using the 4 rounds of the National Family Health Survey (NFHS) between 1992-93 to 2015-16. Second, this study examines the rural-urban gap in under-five mortality after accounting for the socioeconomic, demographic characteristics, and reproductive behavior of women in addition to the community level, the states wise socioeconomic and public health infrastructure heterogony were controlled.

Data and methods

This study used the four rounds of the Sample Registration System during 1991-95 to 2011-15; National Family Health Survey (NFHS) was conducted between 1992-93 to 2015-16. Further, we have compiled the data on per capita public health separately for medical and public health and family welfare expenditure for the major Indian states from 1995-96 to 2014-15. These data have been compiled from RBI's annual study on state finances published in RBI Bulletin for the available detail expenditure for years 1995-96, 1997-98, 2004-05, and 2014-15 nearest survey year NFHS rounds.

Under this study, we have considered the children born in five years preceding the survey in each of the four NFHS rounds. The children who died before reaching their 5th birthday were treated as failure cases; the children who were still alive and did not reach their fifth birthday were considered the censored cases in the analysis. We have assigned value 1 for children who died before reaching their fifth birthday, 0 if they were still alive and not reached their fifth birthday.

This study considered a range of demographic, socioeconomic, and community characteristics as explanatory variables recognized as important predictors of infant and child mortality. The explanatory variables considered in our study place of residence (rural, urban), child sex (male, female), maternal education (no education, below primary, primary, lower secondary, upper secondary, and above), wealth status of the household (Poorest, poorer, middle, richer, richest), Caste (Schedule caste/Schedule tribe (SC/ST) [socially disadvantage], Non-SC/ST), religion (Hindu, Muslim, Others), place of delivery (Hospital, Home), Birth order and birth interval (First birth, 2-4 and short interval, 5+ and short interval, 2-4 and Medium interval, 5+ and Medium interval, 2-4 and Large interval, 2-4 and Large interval). Media exposure (yes, no). Moreover, the survival status of the children correlated within the community; therefore, we have controlled for the community level education and economic status calculated by average cluster years of schooling, cluster average wealth quintile (Kravdal, 2004).

Due to India's federalized system of government, the states and union territories have autonomy for the governances and the operations of the health system. Thereby a considerable difference in the human capital and health care investment across the states and UTs, which leads to substantial regional inequality in the economic development and variation in time and the speed of demographic and health transitions across the region (Visaria, 2004; James & Syamala, 2010; James and Goli, 2016). Therefore, we have controlled for women literacy, per capita income, and per capita, public health expenditure (PHE) across the states/UT considered as indicators of

socioeconomic development and public health care predicators. We have compiled the women literacy data from the Census of India, and Per capita income of the states, and public health spending from the RBI's annual study on state finances published in the RBI Bulletin for the available detailed expenditure for the nearest survey year of the NFHS rounds.

Methods:

We have estimated the under-five rates for rural-urban by mother's educational attainment. U5MR estimated five-year periods preceding the survey for the four NFHS rounds conducted during 1992-93 (NFHS-I), 1998-99 (NFHS-II), 2005-06 (NFHS-III), and 2015-16 (NFHS-IV). U5MR defined the probability of dying between birth and the fifth birthday of the child. Further, using four rounds together, we employed a multilevel Cox proportional Hazard model to predict the urban-rural gap in risk of death among children aged 5 years. The model used examines whether the rural penalty exists after controlling for various socioeconomic and reproductive behaviors of women in the multilevel approach.

Results and conclusion

Figure 1 shows the trends of U5MR across the mothers' educational attainment in rural-urban areas during the four consecutive rounds of NFHS. The trends clearly show the U5MR is higher in rural parts of India during the all-time points of the survey; the mortality has been declined for both rural and urban areas; however, rural-urban differences remained constant around 1.6 times higher mortality among rural children during NFHS-I and NFHS-IV. Further, the figure shows that the probability of death among under-five children differs considerably by the level of mother education attainment for rural and urban areas. The risk of death before reaching to age 5 was three times higher among the children their mother is not educated compared to the child their mother completed upper secondary education in rural and urban areas during NFHS-1. Further, there are evidence of differences in the level of under-five mortality by rural-urban across the education group, except for NFHS-II; results show the rural-urban differences were increased in a higher level of educational attainment, it indicates that a child of a mother with higher education living in the urban areas has a lower level of mortality than a child of the same education mother living in rural areas.

Further, we have used multilevel cox proportional hazard models with various combination of predictors to examine the rural-urban differences in the risk of death among children below age 5 in India in the four NFHS surveys (pooled data for 1992-93, 1998-99, 2005-06, 2015-16). Table 1 shows the results of the Hazard ratio for four models obtained from the three-level Cox proportional hazard model. Model-1 shows the hazard ratio of under-five death only adjusted for time; It shows that the risk of death is significantly lower among the urban child compared to their rural counterparts. It also shows the risk of under-five death reducing significantly with the consecutive survey rounds. Model-2 includes the sex of the child, mother's educational attainment, mother's age at birth, and survey years. The model shows that the hazard ratio is lower in urban areas than in rural areas; however, the rural-urban differences have been reduced after controlling the sex of the child, the mother's education level, and the mother's age at birth. Results also suggested a significant association between sex of the child, and female child have a significantly lower risk of death during under age 5 compared to the male child. Mothers' education attainment considerably reduced the risk of under-five death; with the increasing level of mother education, the risk of under-five deaths decreased significantly. The risk of death reduced to 8% among below primary, 24% among primary, 32% among below secondary, and 52% among higher secondary educated mothers compared to the no educated mothers' child. At birth, the mother's age is retained

as a significant predictor of child death within age five years. Children from mother age at birth 20-24 years had a lower probability of death than those born to mothers aged less than 20 years.
Model 3 includes the socioeconomic characteristics, wealth status, caste group, and religion of the household and women reproductive behavior such as birth interval, birth order of the child, and place of delivery to control for the household characteristics of the women in addition to model-2 predictors. The result shows that the rural penalty disappears after controlling for the household and reproductive characteristics of the women. The household's economic status has a significant impact on child death; children born to women of affluent wealth quintile were less likely to die than those born to economically poor households. Social characteristics have a significant impact on child death; children whose mothers belonged to Muslim and Other religious groups were less likely to die before the age of five than those whose mothers belong from Hindu religious groups. Children born to women belong from the SC/ST caste group had higher Hazard ratios than the child born in the Non-SC/ST household. The place of delivery significantly affects the child's survival status. The probability of death was lower among the child their mothers used institutional health facilities at the time of birth than the child born at home. Preceding birth interval and birth order are also associated with child mortality. In addition, children of 2-4 and short birth intervals were at higher risk of death than the children who were first birth; the risk of death increased 5 and higher birth. But the probability of death decline with medium birth and higher birth interval for the 2-4 and 5 and above birth order of the child.

Model-4 includes community and state/UTs level variables to capture the socioeconomic development heterogeneity at the community level across the states/UTs in India and household and women characteristics to understand the effect of place residences on the under-five mortality in India. The finding from model-4 reveals that the probability of child death at the age of five was higher in the urban areas after controlling for the household socioeconomic characteristics, birth interval, birth order, place of delivery, and community and sates/UTs level socioeconomic predictors. Community-level education has a significant impact on child survival; the child born to women residing in the higher educated community has a positive effect on the survival status of the child; however, the community's wealth status does not have a significant effect on child survival. The results of state/UTs level per capita public health expenditure and women literacy level significantly impact the risk of child death. The child born in the states/UTs spending more on public health reduces child death significantly. Similarly, the states/UTs with a higher level of women literacy also lower the risk of under-five death. However, the state/UTs level per capita income does not seem protective to reduce the risk of child death. The regional division of India shows a significant impact on the survival status of the child under age 5. The likelihood of death is significantly higher among children born to women living in the North, Central, East, and Northeast region compared to those born to women living in the South region of India.
Further, we have investigated the role of mother's education in rural-urban areas separately to understand whether the mother's educational attainment impacts under-five mortality differently between rural and urban settings of India. Model-1 and Model-2 in table 2 show the results of the cox-proportional hazard model controlled for the education level of mothers and survey years. It shows that mothers' educational attainment has significantly reduced the risk of under-five deaths in rural and urban areas. However, while comparing the magnitude of the educational impact differs clearly between rural and urban areas, compared to the child born to no educated mother reduce 6% probability of dead among the women below primary educated, 22% among primary educated, 29% among lower secondary educated, and 41% among the higher secondary and above

educated women. On the other side, the risk of death of a child born compare to no educated women residing in the urban areas reduced 4% for the child born to below primary education, 29% to primary education, 38% for lower secondary educated, 58% for higher secondary and above educated women. This indicates the child born to the mother completed primary education and lower secondary education; higher secondary and above education is more advantageous in the urban setting than the rural parts of India.

Figure-1 Trends of U5MR by Rural-Urban and Mothers education attainment, India, 1992-93 to 2015-16

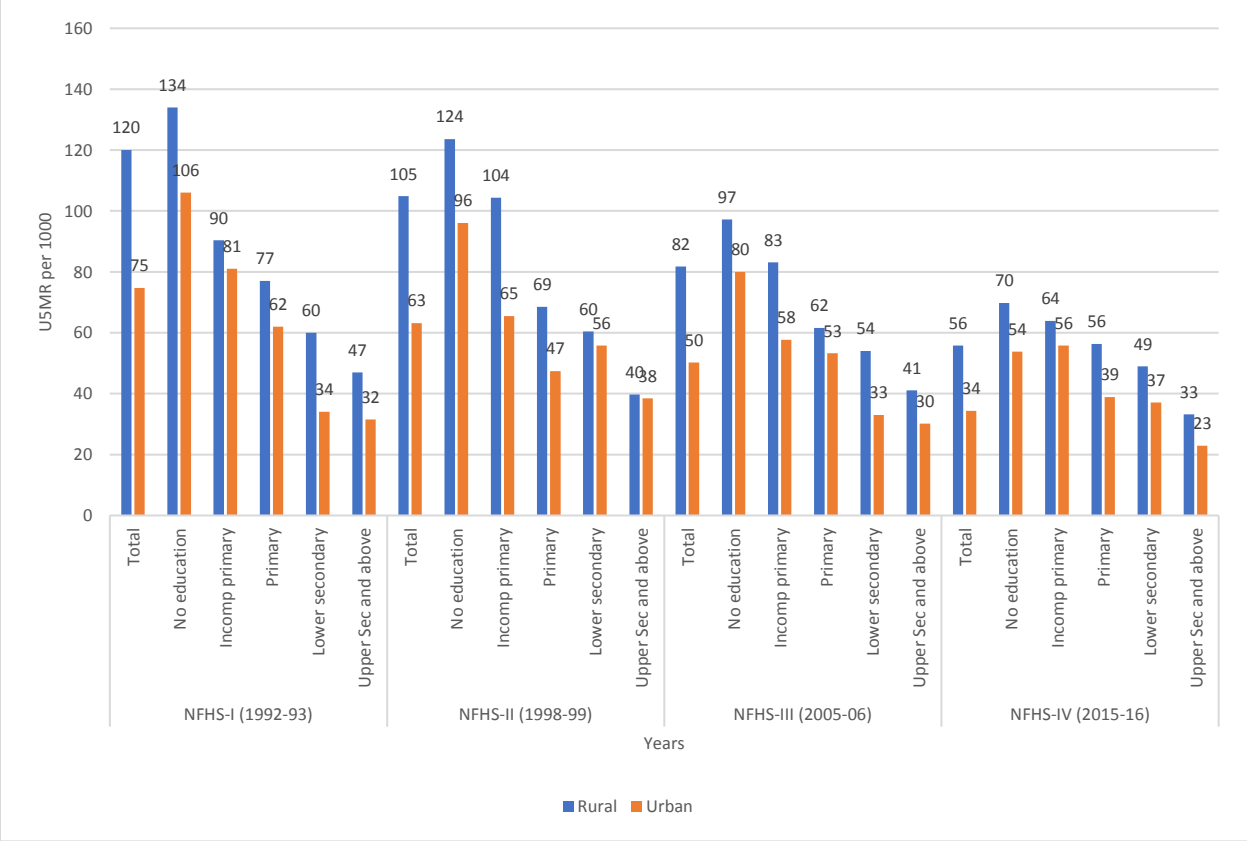

Table 1 Results of Multilevel cox-proportional hazard model: risk of child mortality in India, (NFHS, 1992-2016)

Predictors	Categories	Model-1	Model-2	Model-3	Model-4
Place of residence	Urban (Rural)	0.723***	0.839***	1.03	1.062***
Child Sex	Female (Male)			0.914***	0.914***
Education level	below primary (No education)		0.943**	1.016	1.037
	Primary		0.761***	0.867***	0.892***
	Lower secondary		0.676***	0.792***	0.831***

	Higher Sec and Above		0.489***	0.628***	0.673***
Wealth status	Poorer (Poorest)			0.978	0.984
	Middle			0.897***	0.909***
	Richer			0.779***	0.788***
	Richest			0.612***	0.637***
Caste	SC/ST (No-SC/ST)			1.059***	1.059***
Religion	Muslim (Hindi)			0.888***	0.875***
	Others			0.863***	0.89***
Mother age at birth	20-34 (Below 20)		0.83***	0.942***	0.948***
	35 and above		1.127***	1.241***	1.251***
Place of delivery	Home delivery (Institutional delivery)			1.049***	1.036*
Birth order and birth interval	2-4 and short interval (First birth)			1.272***	1.272***
	5+ and short interval			1.776***	1.763***
	2-4 and Medium interval			0.692***	0.692***
	5+ and Medium interval			0.856***	0.851***
	2-4 and Large interval			0.718***	0.719***
	5+ and Large interval			0.697***	0.696***
Media exposure	No (yes)			1.012	1.011
Using contraceptive	No (yes)			1.903***	1.889***
Community level predictor	Cluster average years of schooling				0.977***
	Cluster Average wealth quintile				1.008
State level (socio-economic and health characteristics)	Per capita health expenditure (log)				0.875***
	Precariat income (log)				1.031
	Women literacy level (log)				0.726***
Survey year		0.793***	0.854***	0.899***	1.049
Constant		0.026***	0.028***	0.017***	0.07***
Random part	State/UTs	0.146	0.091	0.075	0.047
	Cluster	0.218	0.192	0.151	0.152

Table 2 Results of Multilevel cox-proportional hazard model for rural-urban areas: risk of child mortality in India, (NFHS, 1992-2016)

Predictors	**Categories**	**Model-1**	**Model-2**	**Mother-3**	**Mother-4**
Place of residence	Urban (Rural)	Rural	Urban	Rural	Urban
Child Sex	Female (Male)			0.953***	0.934**

Education level	below primary (No education)	0.938**	0.977	0.995	1.09
	Primary	0.783***	0.713***	0.873***	0.854***
	Lower secondary	0.712***	0.599***	0.814***	0.782***
	Higher Sec and Above	0.518***	0.42***	0.652***	0.664***
Wealth status	Poorer (Poorest)			0.965*	1.055
	Middle			0.865***	1.028
	Richer			0.715***	0.923
	Richest			0.603***	0.699***
Caste	SC/ST (No-SC/ST)			1.081***	1.034
Religion	Muslim (Hindi)			0.959	0.812***
	Others			0.922**	0.926
Mother age at birth	20-34 (Below 20)			0.957*	0.969
	35 and above			1.260***	1.274***
Place of delivery	Home delivery (Institutional delivery)			1.068***	1.066
Birth order and birth interval	2-4 and short interval (First birth)			1.113***	1.244***
	5+ and short interval			1.519***	1.764***
	2-4 and Medium interval			0.585***	0.739***
	5+ and Medium interval			0.739***	0.924
	2-4 and Large interval			0.609***	0.785***
	5+ and Large interval			0.639***	0.843
Media exposure	No (yes)			1.016	1.061
Using contraceptive	No (yes)				
Community level predictor	Cluster average years of schooling			0.978***	0.959***
	Cluster Average wealth quintile			0.982	1.004
State level (socio-economic and health characteristics)	Per capita health expenditure (log)			0.897***	0.953
	Precariat income (log)			0.978	0.976
	Women literacy level (log)			0.644***	0.7**
Survey year		0.85***	0.864***	1.064	1.005
	cons	0.026***	0.023***	0.275***	0.147***
Random part	State	0.104	0.068	0.035	0.053
	Cluster	0.178	0.253	0.144	0.191

Table 3 Under-five mortality rate (1000 live births) in India and states/UTs by type of residences during 1991-95 and 2011-15.

States/Union Territories	1991-95		2011-15	
State	Rural	Urban	Rural	Urban
India	120.21	70.03	56.60	30.87
Jammu & Kashmir			47.46	33.53
Himachal Pradesh	79.75	47.93	45.89	30.63
Punjab	81.53	51.19	36.25	22.27
Uttarakhand			33.78	27.86
Haryana	103.95	80.46	53.94	38.96
Delhi			34.45	22.71
Rajasthan	135.54	89.53	68.88	41.53
Uttar Pradesh	147.35	106.42	79.16	57.83
Bihar	123.65	90.04	50.50	36.22
Assam	126.04	81.62	73.92	26.79
Jharkhand			50.95	28.14
Odisha	144.78	91.17	64.78	31.07
Chhattisgarh			55.98	38.27
Madhya Pradesh	164.30	91.39	81.43	42.00
Gujarat	106.99	72.11	63.94	33.28
Maharashtra	85.68	47.28	27.96	15.52
Andhra Pradesh,	88.35	56.63	43.50	28.76
Karnataka	99.28	55.41	40.06	27.83
Kerala	19.11	19.17	13.64	10.95
Tamil Nadu	67.76	50.64	26.09	19.32
West Bengal	95.23	58.69	37.01	22.37

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