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Factors Influencing Under - Five Child Survival in Odisha: Insights from the National Family Health Survey (NFHS - 4 & 5)

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Abstract: ***The study investigates the determinants of under - five child survival in Odisha, utilizing data from both NFHS - 4 and NFHS - 5. Through logistic regression models, the analysis identifies several key factors influencing child survival. Maternal education emerges as a crucial determinant, with primary, secondary, and higher education levels associated with improved odds of child survival, emphasizing the significance of education in child welfare. Gender disparities are observed, with male children exhibiting slightly lower odds of survival compared to females, revealing nuanced gender - related impacts on child survival. While urban residency does not significantly impact survival odds, rural areas and specific regions exhibit varying influences, indicating geographical disparities. Caste and religion display mixed associations with child survival, highlighting the intricate interplay of socio - cultural factors. Economic status, as measured by the wealth index, consistently correlates with higher odds of survival, underscoring the importance of economic well - being. Moreover, variables related to basic amenities and maternal health practices, including breastfeeding and contraceptive use, significantly influence child survival. Overall, the analysis underscores the multifaceted nature of child survival outcomes, emphasizing the need for comprehensive strategies addressing socio - economic, demographic, and health - related determinants effectively.***

Keywords: Under five, Socio - economic, Demography, Health, Odisha

1. Introduction

With a decrease in infant death rates over the previous few years, Odisha's under - five child survival rates have improved (Das & Mohanty., 2021). The government's implementation of different health treatments and programmes, along with the expansion of healthcare services' accessibility in rural areas, should be credited for this progress (Saraceno et. al., 2007). Notwithstanding these encouraging advancements, issues like hunger and a lack of sanitary facilities continue to exist, underscoring the necessity of ongoing measures to guarantee the welfare of the state's children (Watkins, 2016).

To successfully address and overcome these obstacles, it is essential to comprehend the factors that impact child survival (Raphael, 2016). Children's health outcomes are greatly influenced by a number of factors, including maternal education, healthcare infrastructure, socioeconomic level, and access to clean water and sanitary facilities (Quansah et. al., 2016). Policymakers and healthcare professionals can carry out focused measures that will raise child survival rates and enhance Odisha's general well - being by recognising and addressing these variables (Pradhan, 2023). Furthermore, fostering community involvement and awareness, investing in women's education and empowerment, and raising community awareness can all help to create an atmosphere where children can flourish and realise their full potential (Marston, 2016).

Objectives:

- To study investigates social determinants of health impacting child survival rates in Odisha, India.
- It aims to provide evidence - based recommendations for policymakers and healthcare providers to improve child health outcomes.

2. Review of Literature

Under - five child survival is a major indicator of the health and development of a country. It is influenced by various factors, such as socioeconomic status, maternal and child health, birth spacing, environmental conditions, and health service utilization. Here are some key findings from previous research on this topic:

A study based on the National Family Health Survey 2015–16 in India showed that preceding child survival status, maternal age, birth interval, mother's education, and household wealth were significant predictors of infant and child mortality. (Srivastava. Et. al., 2021). A study conducted in high mortality regions of Ethiopia revealed that maternal age, maternal education, place of delivery, antenatal care visits, tetanus toxoid vaccination, birth order, and preceding birth interval were associated with under - five mortality (Shifa et. al., 2018). A survival analysis of under - five mortality in Ethiopia using Cox proportional hazards model found that maternal age, maternal education, birth weight, birth order, preceding birth interval, and breastfeeding duration were significant risk factors for child death (Hailu & Gulte, 2016). The study explores the impact of development - induced displacement on the livelihoods of tribal and non - tribal communities in Odisha, focusing on POSCO's mega project in Jagatsinghpur district. It highlights challenges faced by affected communities, including income loss, food insecurity, and psychological trauma (Jaysawal & Saha.,

2018). This report presents three studies and a guest article on seasonal labor migration from Odisha. The first explores migration trends in Coastal and Western regions, highlighting migrants' origin, destination, occupation, and socio - economic profile. The second examines the working conditions of migrant workers in Surat, Gujarat, highlighting issues like low wages, poor health, occupational hazards, and social discrimination. The third explores the impact on families (Sharma, 2014). This study assesses the growth and performance of Odisha's tourism sector, including eco - tourism, rural tourism, and agri - tourism, from 2001 to 2011, identifying its strengths, weaknesses, opportunities, and threats, and suggesting strategies for its economic growth and development (Das, 2013).

Gaps:

Under - five child survival in Odisha is a crucial issue that requires more attention and research. Odisha has made significant progress in reducing under - five mortality, but it still lags behind the national average and faces wide disparities across districts and socio - economic groups. Some of the gaps in the literature of under - five child survival in Odisha are:

Lack of recent and reliable data on the causes and determinants of under - five deaths in Odisha. Most of the studies use data from the National Family Health Survey (NFHS), which is conducted every five years and does not capture the variations and trends at the district level or below. There is a need for more frequent and comprehensive surveys and vital registration systems to monitor and evaluate the under - five mortality situation in Odisha (Das, 2020). Lack of studies on the impact of various interventions and policies on under - five survival in Odisha. There is limited evidence on the effectiveness and cost - effectiveness of different strategies and programs to improve maternal and child health and reduce under - five mortality in Odisha. There is a need for more rigorous and robust evaluations of the existing and new interventions and policies, such as the Janani Suraksha Yojana (JSY), the Rashtriya Bal Swasthya Karyakram (RBSK), the Integrated Child Development Services (ICDS), and the Mamata scheme, among others (Kumar et. al., 2022). Lack of studies on the role of social and environmental factors on under - five survival in Odisha. There is scarce research on how factors such as poverty, gender, caste, religion, migration, climate change, natural disasters, and violence affect the health and survival of children under five in Odisha. There is a need for more interdisciplinary and holistic studies that examine the complex and interrelated influences of these factors on under - five mortality and morbidity in Odisha (Paul et. al., 2021).

3. Methodology

The data for this analysis was sourced from the National Family Health Survey (NFHS), specifically from NFHS - 4 & 5. NFHS is a large - scale survey conducted in India that provides comprehensive information on population, health, and nutrition indicators, making it a valuable resource for research on maternal and child health.

In this study, logistic regression is employed to examine the relationship between various independent variables and the likelihood of under - five child survival in Odisha. Logistic regression is a statistical method used to model binary outcomes, such as survival or death in this context.

Each independent variable, such as maternal education, sex, place of residence, caste, religion, and wealth index, is included in the regression model to assess its impact on the probability of child survival. The dependent variable is the binary outcome indicating whether a child survived or not. The logistic regression model estimates the odds ratios for each independent variable, which represent the change in the odds of child survival associated with a one - unit change in the independent variable, holding all other variables constant. These odds ratios indicate the strength and direction of the association between each independent variable and child survival.

The significance of each independent variable is assessed based on the probability values (p - values) associated with their coefficients in the logistic regression model. Variables with low p - values (<0.05) are considered statistically significant and are deemed to have a significant impact on child survival. Additionally, different models are constructed to explore the impact of each variable while controlling for potential confounding factors. Sensitivity analyses are also conducted to test the stability of the results under different model specifications, ensuring the robustness of the findings.

Overall, logistic regression allows the researchers to identify the key determinants of under - five child survival in Odisha and understand how various socio - economic, demographic, and health - related factors influence child survival outcomes in the region.

Binary Logistic Regression Model

David Cox introduced binary logistic regression in 1958 as a ground - breaking method for predicting the success or failure of events and identifying associated risk factors (Yin, 2012). This model, tailored for events with binary outcomes, such as "yes vs. no" or "survival vs. fatality, " has become instrumental in various fields. The versatility of binary logistic regression allows for the inclusion of both metric and non - metric predictor variables, offering flexibility in modelling. Researchers can assess the impact of individual predictors while accounting for the predictive power of other variables in the model (Wisz et al., 2008).

In this study, we employed the binary logistic model to investigate and forecast the likelihood of under - five mortality in Odisha. By examining a range of proximate and underlying characteristics, we aimed to discern their potential influence on mortality rates (Mosley & Chen 1984). In the context of child mortality, the outcome variable of the model indicates whether the event (i. e., the child's death) occurred, denoted as "1, " or if the child survived, denoted as "0. "

It's crucial to note that the probability distribution of events in binary logistic regression is constrained within the interval of zero to one. This limitation stems from the inherent nature of probabilities, where the likelihood of an event happening or not happening cannot exceed these bounds (Wondie et al., 2011). By adhering to this principle, the model provides

insightful predictions while respecting the fundamental laws of probability.

The justification for using Binary Logistic Regression

Building upon Fisher's linear discriminant analysis of 1936, the 1940s saw the emergence of binary logistic regression, offering a non - linear approach to modeling categorical outcomes (Tuffery, 2011). One notable advantage of logistic regression is its adaptability to various measurement scales, including nominal, ordinal, ratio, and interval, making it a versatile tool in statistical analysis.

Unlike traditional statistical models, logistic regression does not rely on normalcy assumptions for independent variables, setting it apart and enhancing its reliability (Kleinbaum & Klein, 2010). This flexibility allows logistic regression to excel in scenarios where there are two possible outcomes, rendering it preferable over structural equation models like two - stage least squares regression or conventional linear regression.

At the core of logistic regression lies the transformation of the dependent variable through the logit, or natural logarithm, of the exponential of the unknown outcome variable, creating the link function (Menard, 2010). This transformation results in a continuous criterion that accommodates the binary nature of the projected values (i. e., 0 and 1), a feature not readily handled by alternative regression models (Ramalho et al., 2011).

Moreover, while other regression models often assume normality, binary logistic regression is uniquely suited for variables following a binomial distribution or a single peak distribution (Menard, 2010). Through the concept of odds ratio, the logistic model effectively contrasts the likelihood of event occurrence (assigned a value of 1) with non - occurrence (assigned a value of 0), offering a robust solution (Allison, 2012).

In summary, binary logistic regression stands as a powerful tool in statistical analysis, offering adaptability, reliability, and efficacy in modelling categorical outcomes, particularly in scenarios with binary event possibilities.

Consider the situation where *b* represents the likelihood that an event "*X*" will take place and *c* represents the likelihood that it will not. By applying the logistic model to a set of independent variables and the "log odds" or "logit"—the natural logarithm of the odds ratio—we can derive the following type of regression equation:

$$\log\left[\frac{P}{I-P}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots \ldots \ldots \ldots \ldots + \beta_k X_k + \mu$$

Under five mortality rates are displayed by the model. P is the chance that deaths among children younger than five will occur in this research, and (1 - P) is the chance that deaths among children younger than five will not occur. A constant α determines the under - five mortality rate when all independent factors are removed from the model, $X1 \ldots Xn$ denote the independent variables, and $\beta 1 \ldots \beta k$ are the regression parameters. μ stands for the residual or random error term (Akinyemiju et al., 2017).

Log $\left(\frac{P}{1-P}\right)$ stands for the logistic transformation of the event's probability (here, the under - five death rate). This study employed a binary regression model to forecast the likelihood of under - five mortality in Odisha based on the underlying causes, with or without considering the proximal drivers (Mani et al., 2012).

Combination of Independent Variables in the Models using Logistic Regression

1) Model - 1: Study of under - five survival using Socio Economic Characteristics
2) Model - 2: Inclusion of Household level variables in Model - 1 for the study of under - five survival
3) Model - 3: Inclusion of Biological variables in Model - 2 for the study of Under - five survival
4) Model - 4: Inclusion of Children care Variables in Model - 3 for the study of under - five survival
5) Model - 5: Inclusion of Health care access variables in Model - 4 for the study of Under - five survival

4. Results

Logistic Regression result for the study of under five child survival using NFHS - 5 Data

Table - 1 presents, the analysis of Mother's Education reveals that mothers with primary education exhibit a slightly elevated likelihood of under - five child survival compared to those with no education, as indicated by an odds ratio of 1.109 ($p = 0.052$). Furthermore, the odds of survival increase notably as the level of education rises, with odds ratios of 1.905 for secondary education and 3.668 for higher education (both $p < 0.001$). This underscores the significant impact of maternal education on child survival rates.

In terms of Sex, male children demonstrate slightly diminished odds of survival in contrast to females, with odds ratios ranging from 0.878 to 0.705 across various models (all $p < 0.05$). Although this effect is statistically significant, its magnitude appears relatively modest, highlighting a nuanced gender - related aspect to child survival. When examining Place of Residence and Region, while no significant disparities in survival odds are observed between urban and rural areas, regional differences emerge. Notably, certain regions exhibit varied odds ratios compared to tribal districts, with odds ratios spanning from 0.906 to 1.543 across different models, signifying distinct regional influences on child survival.

Concerning Caste and Religion, odds ratios for different caste categories fluctuate between 0.947 and 1.415, without a consistent pattern of significance. Similarly, odds ratios for religion range from 0.889 to 1.049, indicating a lack of significant association with child survival, underscoring the multifaceted nature of socio - cultural factors. In examining Wealth Index, a clear trend emerges wherein increased wealth correlates with higher odds of under - five child survival. Odds ratios range from 1.219 to 2.192 across wealth index categories, with all comparisons showing statistical significance, except for one.

Furthermore, factors related to basic amenities and maternal health exhibit varied associations with child survival.

Notably, currently breastfeeding significantly enhances the odds of survival (odds ratios around 6.083, $p < 0.001$), while the use of any contraceptive method also shows a significant positive association with higher odds of survival (odds ratios around 1.977, $p < 0.001$). In conclusion, this logistic regression analysis underscores the intricate interplay of socio - economic, demographic, and health - related factors in shaping under - five child survival. While some variables exhibit stronger associations than others, the findings emphasize the multifactorial nature of child survival outcomes.

Table 1: Logistic Regression Result of NFHS - 5 Data

		Model - 1		Model - 2		Model - 3		Model - 4		Model - 5	
Variables	Specification	Odd Ratio	Prob. Value	Odd Ratio	Prob. Value	Odd Ratio	Prob. Value	Odd Ratio	Prob. Value	Odd Ratio	Prob. Value
Mothers Education	No Education (Ref)	1.000		1.000		1.000		1.000		1.000	
	primary	1.109	0.052	1.102*	0.069	1.117**	0.040	1.232	0.347	1.218	0.376
	secondary	1.905***	0.000	1.894***	0.000	1.940***	0.000	1.313	0.163	1.287	0.200
	higher	3.668***	0.000	3.643***	0.000	3.571***	0.000	2.375*	0.058	2.344*	0.062
Sex	Female (Ref)	1.000		1.000		1.000		1.000		1.000	
	male	0.878**	0.001	0.877**	0.001	0.877**	0.001	0.707**	0.014	0.705**	0.014
Place of Residence	Urban	1.000		1.000		1.000		1.000		1.000	
rural	Rural (Ref)	1.014	0.837	1.012	0.856	1.004	0.955	1.245	0.363	1.234	0.385
Region	Tribal District (Ref)	1.000		1.000		1.000		1.000		1.000	
	partly tribal district	1.079	0.233	1.076	0.250	1.077	0.249	1.540**	0.040	1.543**	0.039
	Non - tribal districts	0.916	0.105	0.919	0.117	0.906**	0.069	1.534**	0.017	1.530**	0.018
caste	Schedule Caste (Ref)	1.000		1.000		1.000		1.000		1.000	
	Scheduled tribe	0.957	0.466	0.956	0.450	0.947	0.365	1.026	0.901	1.040	0.849
	other caste	1.074	0.181	1.076	0.171	1.069	0.211	1.399*	0.089	1.415*	0.080
Religion	Hindu (Ref)	1.000		1.000							
	other religion	1.040	0.662	1.049	0.593	1.039	0.664	0.889	0.638	0.899	0.669
Wealth Index	Poor (Ref)	1.000	1.000	1.000	1.000	1.000		1.000		1.000	
	poorer	1.009	0.861	1.059	0.349	1.068	0.283	0.826	0.377	0.768	0.258
	middle	1.219**	0.003	1.297**	0.003	1.311**	0.002	1.774*	0.092	1.606	0.189
	richer	1.367	0.001	1.453**	0.001	1.460**	0.001	1.002	0.996	0.882	0.762
	richest	2.065	0.000	2.192***	0.000	2.188***	0.000	1.731	0.318	1.511	0.472
Toilet Facility	Unimproved (Ref)			1.000		1.000		1.000		1.000	
	Improved			0.992	0.849	0.994	0.897	1.057	0.724	1.060	0.709
Cooking fuel	Unsafe (Ref)			1.000		1.000		1.000		1.000	
	safe			1.014	0.815	1.020	0.743	1.366	0.174	1.390	0.153
Floor Material	Unsafe (Ref)			1.000		1.000		1.000		1.000	
	safe			0.984	0.811	0.979	0.750	0.933	0.716	0.945	0.769
Source of Drinking Water	Unimproved source (Ref)			1.000		1.000		1.000		1.000	
	Improved source			0.918	0.127	0.917	0.122	1.332	0.181	1.327	0.188
Age of mother at the time of Birth	Less than 20 years (Ref)					1.000		1.000		1.000	
	20 - 29 years					1.245***	0.000	0.934	0.636	0.931	0.621
	30 years and above					1.410**	0.048	1.089	0.840	1.095	0.829
Birth Order	1st order (Ref)					1.000		1.000		1.000	
	2 - 3 order					1.345***	0.000	1.209	0.215	1.201	0.233
	4 - 6 order					1.377***	0.000	1.177	0.552	1.181	0.546
	7 and above					0.969	0.891	1.137	0.870	1.146	0.862
Place of Delivery	Home (Ref)							1.000		1.000	
	Institutional							1.138	0.569	1.130	0.590
Currently Breastfeeding	No (Ref)							1.000		1.000	
	yes							6.082***	0.000	6.083***	0.000
Contraceptive use	No (Ref)							1.000		1.000	
	using any method of contraceptive							1.981***	0.000	1.977***	0.000
Birthweight	less than 2500gm (Ref)							1.000		1.000	
	2500 - 3500 grams							3.996***	0.000	4.000***	0.000
	above 3500grams							0.805	0.284	0.812	0.305
Media Exposure	No (Ref)									1.000	
	Yes									1.159	0.416
Covered Health Insurance	No (Ref)									1.000	
	yes									1.050	0.766

Sig: level of significance, *p<.05 or **p<.01 or ***p<.001

Logistic Regression result for the study of under - five child survival using NFHS - 4 Data

The analysis of Table - 2 reveals several noteworthy associations between various factors and under - five child survival. Mother's Education: Mothers with primary education show significantly increased odds of child survival compared to those with no education, with odds ratios ranging from 1.326 to 1.091 across different models. Similarly, higher levels of education exhibit even higher odds ratios, underscoring the importance of maternal education in child welfare.

Sex: Male children consistently demonstrate slightly decreased odds of survival compared to females, with odds ratios ranging from 0.898 to 0.883 across different models. Although statistically significant, the effect size remains relatively modest.

Place of Residence and Region: While urban residence does not significantly affect child survival odds, rural areas exhibit varied odds ratios, ranging from 0.823 to 0.719 across models. Furthermore, regional differences are evident, with odds ratios differing significantly from tribal districts, particularly in partly tribal and non - tribal districts.

Caste and Religion: Odds ratios for different caste categories fluctuate between 1.116 and 1.134, while those for religion range from 1.339 to 1.544. These variations suggest a nuanced influence of social and cultural factors on child survival.

Wealth Index: Higher wealth index categories consistently demonstrate elevated odds of child survival, with odds ratios ranging from 1.082 to 1.805 across different wealth levels, highlighting the critical role of economic status in child welfare.

Other Factors: Variables related to basic amenities and maternal health also show significant associations with child survival. For instance, currently breastfeeding and contraceptive use are strongly associated with higher odds of survival, with odds ratios around 4.819 and 1.735, respectively, emphasizing the importance of maternal and child health practices. In summary, Table - 2 provides valuable insights into the complex interplay of socio - economic, demographic, and health - related factors in determining under - five child survival, with certain variables exerting stronger influences than others. These findings underscore the multifactorial nature of child welfare and the need for comprehensive approaches to address underlying determinants.

Table 2: Logistic Regression Result of NFHS - 4 Data

Variables	Specification	Model - 1	Model - 2	Model - 3	Model - 4	Model - 5
		Odd ratio	Odd ratio	Odd ratio	Odd ratio	Odd Ratio
Mothers Education	No Education (Ref)	1.000	1.000	1.000	1.000	1.000
	primary	1.326***	1.323***	1.321***	1.108	1.091
	secondary	2.377***	2.362***	2.324***	1.131	1.102
	higher	4.491***	4.434***	4.050***	1.595	1.526
Sex	Female (Ref)	1.000	1.000	1.000	1.000	1.000
	male	0.898**	0.898**	0.901**	0.886	0.883
Place of Residence	Urban	1.000	1.000	1.000	1.000	1.000
rural	Rural (Ref)	0.823**	0.834**	0.825**	0.678*	0.719
Region	Tribal District (Ref)	1.000	1.000	1.000	1.000	1.000
	partly tribal district	1.139**	1.130	1.123**	1.451**	1.416*
	Non - tribal districts	1.065	1.064**	1.043	1.075	1.053
caste	Schedule Caste (Ref)	1.000	1.000	1.000	1.000	1.000
	Scheduled tribe	1.116**	1.120**	1.107**	0.915	0.928
	other caste	1.134**	1.137**	1.126**	0.920	0.921
Religion	Hindu (Ref)	1.000				
	other religion	1.339**	1.360***	1.361***	1.534	1.544
Wealth Index	Poor (Ref)	1.000	1.000	1.000	1.000	1.000
	poorer	1.082*	1.096*	1.113**	1.111	0.983
	middle	1.134**	1.150*	1.170**	1.272	1.050
	richer	1.342**	1.317**	1.334**	2.126*	1.667
	richest	1.459**	1.409**	1.414**	2.308	1.805
Toilet Facility	Unimproved (Ref)		1.000	1.000	1.000	1.000
	Improved		1.071	1.073	1.124	1.141
Cooking fuel	Unsafe (Ref)		1.000	1.000	1.000	1.000
	safe		1.024	1.029	0.939	0.932
Floor Material	Unsafe (Ref)		1.000	1.000	1.000	1.000
	safe		1.153**	1.149**	0.901	0.922
Source of Drinking Water	Unimproved source (Ref)		1.000	1.000	1.000	1.000
	Improved source		0.940	0.944	1.097	1.100
Age of mother at the time of Birth	Less than 20 years (Ref)			1.000	1.000	1.000
	20 - 29 years			1.304***	0.955	0.971
	30 years and above			1.245	0.486**	0.507**
Birth Order	1st order (Ref)			1.000	1.000	1.000
	2 - 3 order			1.227***	1.046	1.064
	4 - 6 order			1.070	0.993	1.025

	7 and above			1.020	1.181	1.187
Place of Delivery	Home (Ref)				1.000	1.000
	Institutional				0.794	0.804
Currently Breastfeeding	No (Ref)				1.000	1.000
	yes				4.822***	4.819***
Contraceptive use	No (Ref)				1.000	1.000
	using any method of contraceptive				1.669***	1.735***
Birthweight	less than 2500gm (Ref)				1.000	1.000
	2500 - 3500 grams				3.074***	3.130***
	above 3500grams				0.534***	0.534***
Media Exposure	No (Ref)					1.000
	Yes					1.268
Covered Health Insurance	No (Ref)					1.000
	Yes					0.721**

Sig: level of significance, *p<.05 or **p<.01 or ***p<.001

5. Conclusion and Recommendations

The findings highlight the importance of maternal education, gender equity, regional disparities, socio - cultural factors, and economic status in shaping under - five child survival outcomes. Policymakers should prioritize interventions aimed at improving maternal education and promoting gender equality to enhance child welfare. Addressing regional disparities in child survival requires targeted efforts tailored to specific geographical contexts. Socio - cultural factors like caste and religion should be carefully considered in intervention strategies to ensure inclusivity and equity in child welfare programs. Moreover, efforts to alleviate poverty and improve access to basic amenities are essential for improving child survival rates. Additionally, promoting maternal and child health practices, including breastfeeding and contraceptive use, can significantly contribute to reducing child mortality. Therefore, comprehensive and integrated approaches that address these multifactorial determinants are crucial for ensuring the well - being and survival of under - five children.

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