

Decomposing Socio-Economic Inequalities in Infant Mortality in Punjab, Pakistan



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Abstract

Background: Despite overall improvements in living standards and population health, child health inequality persists in Pakistan, particularly reflected in one of the highest Infant Mortality Rates (IMR) in the South Asian region. This study aims to discern the distinct contributions of various factors to socioeconomic inequality in infant mortality within the Punjab province, utilizing data from the latest Multiple Indicator Cluster Survey (MICS Punjab 2017-2018). The primary objective is to identify key factors significantly contributing to the observed inequality in infant mortality within the region.

Methods: Employing MICS Punjab 2017-18 data, we utilized the concentration index to measure socioeconomic inequality in infant mortality. Subsequently, the concentration index was decomposed to reveal the determinants of this inequality.

Results: Within the Punjab province, household economic status emerged as the predominant contributor to infant mortality inequality (42.35%), followed by maternal education (35.52%), rural residence (11.45%), and mother's age (10.44%).

Conclusion: The study findings underscore that socioeconomic inequality in infant mortality in Punjab is influenced not only by the functions of the healthcare system but also by factors extending beyond the purview of health authorities and healthcare delivery systems.

Keywords: Mortality inequality, health disparities, concentration index, decomposition analysis, Low Middle-Income Country

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Introduction

Health disparities are a question of life and death, of well-being and suffering. The idea that individuals with diverse socio-economic conditions are facing preventable disparities in health and quality of life in the world today, is unjust. Despite the overall improvement in living standards and health of the population, inequality in child health persists in developing countries (1).

Several different indicators are used across the globe to assess child health. One of those indicators is infant mortality. Infant mortality refers to “the mortality of newborns under the age of one year”. In other words, it refers to “the probability of dying between birth and the first year of age expressed per 1,000 live births”. Both the infant mortality rate and the under-5 mortality rate indicate the overall health of the children (2). Low-income countries around the world have higher infant and child mortality rates in comparison to high-income countries (3). Approximately 80% of deaths occur in sub-Saharan Africa and South Asia, and only 6 nations account for half of all under-five deaths: China, India, Pakistan, Nigeria, Ethiopia, and the Democratic Republic of the Congo (4). Recent estimates show that the child mortality rate in Pakistan is 65.2/1000 while IMR is 56.9 deaths per 1,000 live births which is one of the highest in

the region (5,6). Although there has been a sharp decline in the infant mortality rate in the past few years, it still remains one of the highest in the region (7). Endemic poverty in lower-income countries, lack of education, poor living standards, massive population, poor governance, corrupt political institutions, and lack of access to healthcare facilities are a few of the many reasons for high mortality rates in these countries (8).

The importance of socio-economic level as a determinant of child health is well established (9,10). Socio-economic inequality can result in inequality in child health (11,12). If high health inequalities persist in low-income countries, then goal 3 of the Sustainable Development Goals which envisages “health and well-being for all” will remain a distant dream. Infant and child mortality rate provides a good picture of overall population health (13). Moreover, inequalities in child health can indicate the overall health inequality in the population (14). Massive socio-economic disparities exist in infant and child mortality in Pakistan (15–17).

Pakistan allocates less than one percent of its GDP to health, thus lack of resources translates into one of the highest infant and child mortality in the region (18). Socio-economic conditions are an important determinant of child health as socio-economic inequality can result in inequality in

overall child health (11,19). Socio-economic inequality in Pakistan intensified from 1988 to 2005. Moreover, income distribution worsened from 1988 to 2005. Income inequality in provinces for 1987-88 and 2004-05, was the highest for the province of Punjab (20). Following Punjab were Sindh and KP (21). Due to the high socio-economic inequalities in the province, high health inequalities are a possible outcome. In addition to high socio-economic inequality, the under-5 mortality rate is also the highest in Punjab.

Determinants of infant mortality are established in the literature but research on the relative contribution of different determinants to inequality in infant mortality is scarce (22). The objective of this study was to determine the individual contributions of various factors to socioeconomic inequality in infant mortality in the Punjab province of Pakistan using the latest Multiple Indicator Cluster Survey (MICS Punjab 2017-2018). In other words, to identify the major factors that contribute significantly to inequality in infant mortality in the Punjab province. As a measure of social and economic inequality of child mortality, the concentration index has been used. Wagstaff et al. (2003) (23) offered a technique to decompose the concentration index of any health variables into its determining factors. This study used the same method of decomposing the concentration index to its determining factors, to decompose socio-economic inequality in infant mortality into its determinants.

Methodology

Much of the research on inequality in infant mortality is based on national-level data and has not looked at the provincial level. In this paper, we are using the latest MICS Punjab 2017-2018 to identify the pure contribution of each determinant to socio-economic inequality in infant mortality in the Punjab province. The MICS Punjab 2017-2018 survey was designed to gather data on various indicators related to the well-being of children and women in Punjab. The sample was representative of both urban and rural areas, as well as all 36 districts of Punjab. To ensure a comprehensive representation, the sampling process involved two stages. In total, the survey encompassed 53,840 households distributed across 2,692 sample clusters. A total of six questionnaires were used in this survey. The sampling unit was the household. Data on infant mortality was gathered from the birth records of individual married women (15-49 years) of reproductive age. As a measure of social and economic inequality of child mortality, the concentration index has been used. It can be defined as “the twice co-variance between the health variable (infant mortality) and the relative economic condition of a person, divided by the mean variable (equation 1). The concentration index value will range from -1 to +1” (24). Wagstaff et al. (2003)(23), offered the technique to decompose the concentration index of any health variables into its determining factor. This study used the same method of decomposing the concentration index to its determining factors, to decompose socio-economic inequality into its determinants. This method also helps in understanding how these determining factors add to the disparity in child mortality with respect to each other.

$$C = \frac{2}{\mu} \text{cov}_w (y_i, R_i) \tag{1}$$

To decompose the concentration index, these forthcoming steps are performed: Infant mortality is regressed against its determining factors by using a logistic regression model (because the health variable was a dichotomous variable, and it has two outcomes: dead or alive). This has provided the coefficients of independent variables (β_k). The means of the health variable and each of its determining factors were computed (μ and x_k). Concentration indices for infant mortality (health variable) and its determining factors were estimated. (C and C_k) using Equation (1). When all the variables became known, the part of each determining factor in the model was calculated via these steps. The complete part of each one of the determining factors was obtained by Multiplication of the elasticity of our health variable pertaining to that determining factor and its concentration index $(\frac{\beta_k x_k}{\mu}) C_k$. (24) The percentage contribution of each determining factor was obtained by dividing its absolute contribution by the concentration index of the health $(\frac{\beta_k x_k}{\mu}) C_k / C$.

Results

Table.1 presents the percentage distribution of infant mortality and other socio-economic and demographic characteristics in Punjab, Pakistan. In our sample, 3552 infant deaths occurred which is 2.25 percent of the total births that occurred in the era. Around 51 percent of all the newborns who were born alive, were males in the sample. The majority of the births (81%) were among mothers 20-34 years of age. While around 11% of the births were among mothers from the age below age 20 years and 8% of births were among mothers with age above 35.

Almost 55% of mothers did not have any formal education. Around 73% lived in rural areas as far as the place of their home is concerned, while 27 % were from urban areas. In the case of socio-economic status, around one-fourth of households in our sample falls in the lowest wealth quintile (ESQ1) while 14% belong to the highest wealth quintile (ESQ5). The table also shows the percentage of households in the sample from every district of the province.

Table 1: Summary statistics of infant death and its determinants

Variable	Frequency	Percentage/Mea
Infant Death	3552	2.25
Child sex		
Boy	81304	51.49
Girl	76595	48.51
Mother's age		
Below 20	17954	11.37
20-34	127796	80.94
Above 35	12149	7.69
Mother's educational level		
Illiterate	86071	54.51
Primary	30314	19.2
Middle	13285	8.41

Secondary	15825	10.02
Higher Education	12400	7.9
Location of residence		
Urban	42552	26.95
Rural	115347	73.05
Household socio-economic status		
ESQ1	38448	24.35
ESQ2	35677	22.59
ESQ3	32740	20.73
ESQ4	28816	18.25
ESQ5	22218	14.07
Health insurance		
With insurance	5297	3.35
Without Insurance	152398	96.5
District of residence		
Bahawalpur	4163	2.64
Bahawalnagar	3899	2.47
RY Khan	5477	3.47
DG Khan	4234	2.68
Layyah	3293	2.09
Muzaffargarh	5743	3.64
Rajanpur	3266	2.07
Faisalabad	8342	5.28
Chiniot	2601	1.65
Jhang	4366	2.77
T. T. Singh	3533	2.24
Gujranwala	6575	4.16
Gujrat	4492	2.84
Hafizabad	2978	1.89
Mandi Bahauddin	4928	3.12
Narowal	3110	1.97
Sialkot	5059	3.20
Lahore	8797	5.57
Kasur	4011	2.54
Nankana-Sahib	2913	1.84
Sheikhupura	4438	2.81
Multan	7641	4.84
Khanewal	4269	2.70
Lodhran	3049	1.93
Vehari	4226	2.68
Rawalpindi	6754	4.28
Attock	4063	2.57
Chakwal	3387	2.15
Jhelum	2749	1.74
Sahiwal	3576	2.26
Okara	3890	2.46
Pakpattan	2554	1.62
Sargodha	4348	2.75
Bhakkar	4462	2.83
Khushab	2473	1.57
Mianwali	4240	2.69

Multivariate Logistic Regression

Table 2 shows the association between infant mortality and its determining factors in Punjab Pakistan. Infant mortality was regressed against its determining factors by using the logistic regression model (because the health variable was a dichotomous variable, and it has two outcomes: dead or alive). Being a male child reduces the odds of infant mortality by 12% as compared to a female child. Infants born to younger mothers (age less than 20 Years) have a higher likelihood of experiencing infant mortality as compared to an infant born to a mother aged 35 and above (1.75). Moreover, a mother's education has also a significant impact on infant mortality, as expected. Infants of mothers with no formal education (illiterate) have nearly 42% more odds of death as compared to infants of mothers with formal education.

Table 2: Adjusted associations between the death of infants and its determining factors.

Variable	Mean	Coefficients	P-value	Adjusted Odds Ratio
Sex of Child				
Boy	0.515	-0.126 ***	0.000	0.884
Girl	0.485	Ref.		
Mother's age				
Below 20	0.114	0.556 ***	0.000	1.755
20-34	0.809	0.085	0.158	1.099
Above 35	0.077	Ref.		
Mother's education				
No formal education	0.545	0.46 ***	0.000	1.423
Literate	0.455	Ref.		
Household economic status				
ESQ1	0.244	1.112 ***	0.000	3.039
ESQ2	0.226	0.922 ***	0.000	2.513
ESQ3	0.207	0.594 ***	0.000	1.811
ESQ4	0.183	0.458 ***	0.000	1.581
ESQ5	0.141	Ref.		
Location of residence				
Rural	0.270	0.098†	0.052	1.103
Urban	0.731	Ref.		
Health Insurance (Ref: Without Insurance)				
	0.034	0.048	0.336	1.049
Districts of residence				
RY Khan	0.035	-0.037	0.597	0.928
DG Khan	0.027	0	0.616	0.929
Layyah	0.021	-0.009	0.650	0.930
Muzaffargarh	0.036	0.317	0.062	1.274
Rajanpur	0.021	-0.044	0.433	0.884
Faisalabad	0.053	0.303	0.005	1.433
Chiniot	0.017	0.019	0.971	0.994
Jhang	0.028	0.25	0.115	1.248
TT Singh	0.022	0.35	0.007	1.493
Gujranwala	0.042	-0.042	0.690	1.061
Gujrat	0.028	0.124	0.164	1.244

Hafizabad	0.019	0.608	0.000	1.977
Mandi Bahauddin	0.031	0.252	0.025	1.372
Narowal	0.020	0.235	0.040	1.393
Sialkot	0.032	0.305	0.004	1.522
Lahore	0.056	0.073	0.304	1.160
Kasur	0.025	0.038	0.580	1.088
Nankana Sahib	0.018	0.272	0.036	1.392
Sheikhupura	0.028	-0.079	0.926	1.015
Multan	0.048	0.248	0.045	1.293
Khanewal	0.027	0.482	0.000	1.638
Lodhran	0.019	0.158	0.425	1.130
Vehari	0.027	0.184	0.138	1.238
Rawalpindi	0.043	-0.12	0.988	0.998
Attock	0.026	-0.11	0.950	0.990
Chakwal	0.022	-0.322	0.170	0.775
Jhelum	0.017	0.001	0.643	1.090
Sahiwal	0.023	-0.039	0.903	0.981
Okara	0.025	0.154	0.249	1.185
Pakpattan	0.016	0.182	0.309	1.180
Sargodha	0.028	0.185	0.137	1.241
Bhakkar	0.028	0.153	0.324	1.150
Khushab	0.016	0.015	0.829	0.963
Mianwali	0.027	Ref.		

(† (p<0.10), * (p<0.05), ** (p<0.01), *** (p<0.001)).

In the case of household economic status, the odds of infant mortality are 3 times as high for the infant born in the households with the lowest quintile than the infant born in the highest wealth quintiles. Moreover, households in the 2nd lowest wealth quintile have nearly 2 times more chances of dying in the first year of their age in comparison to infants of the highest socio-economic status in our sample. Our results show that household socio-economic status has a significant impact on infant mortality. Hence the odds of infant mortality decrease with the increase in socio-economic status, as expected.

The table also reveals the district-wise risk of infant mortality in the province. The odds ratio for the district of residence shows the association of the district of residence with infant mortality. The odds ratio of 1 means that the district of residence does not affect infant mortality. Infants in the districts with an odds ratio greater than 1 are at a higher risk of mortality. The risk of infant mortality varies profoundly across districts. Infants born in the district like Muzaffargarh, Jhang, Toba Tek Singh, Hafizabad, Mandi Bahauddin, Narowal, Sialkot, Vehari, and Sargodha have higher odds of dying in their first year in comparison to districts Mianwali.

Multivariate logistic regression results suggest the risk of infant mortality is decreased by the infant being male, born in households with a higher socio-economic status, and having an educated mother. On the other hand, the following factors raise the risk of infant mortality: delivery at either end of the reproductive period of the mother, born in a household with low socio-economic status, residency in rural areas, and mother illiteracy.

Decomposition Analysis

The results of the decomposition of the concentration indices are presented in Table 3. To quantify the 'contributions' of each of the factors to the total projected socio-economic inequality, decomposition analysis integrates the estimated logit coefficients with details on the means and concentration indices of the independent variables.

The concentration index value ranges from -1 to +1. For example, in the case of socio-economic status, +1 would mean that the health variable (infant mortality) is concentrated among the Infants born in a household with the highest socio-economic status while its -1 value would mean that infant mortality is concentrated more among the lowest socio-economic status. This study has used the technique of decomposition analysis to decompose the concentration index of infant mortality into its determining factor. A decomposition analysis reveals that the highest contribution to infant mortality inequality in Punjab Pakistan is attributed to household economic status (42.35%) followed by maternal literacy (35.52%), place of residence (11.45%), and mother's age (10.44%).

Table 2: A decomposition analysis of the concentration index of infant mortality by economic status.

Variable	Mean	Coefficients	C	Contribution to C	Contribution to C (%)
Child Sex (Ref: Girl)					
Boy	0.515	-0.126	-0.06	0.172	2.22%
Mother's age (Ref: 35 and above)					
Below 20	0.114	0.556	0.126	0.353	10.44%
20-34	0.809	0.085	-0.113	-0.344	
Mother's educational status (Ref: Literate)					
No formal	0.545	0.46	-0.288	3.212	35.52%
Location of residence (Ref: Urban)					
Rural	0.731	-0.006	-0.135	-0.009	11.45%
Low SES (Ref: High SES)	0.677	0.625	-0.236	4.44	42.35%
Health Insurance (Ref: Without Insurance)	0.034	0.048	0.019	0.019	0.24%
District of residence					
RY Khan	0.035	-0.037	-0.003	0.000	
DG Khan	0.027	0	0.003	0.000	
Layyah	0.021	-0.009	-0.002	0.000	
Muzaffargarh	0.036	0.317	0.033	0.017	
Rajanpur	0.021	-0.044	0.001	0.000	
Faisalabad	0.053	0.303	0.002	0.002	
Chiniot	0.017	0.019	-0.001	0.000	
Jhang	0.028	0.25	0.013	0.004	
TT Singh	0.022	0.35	0.008	0.003	
Gujranwala	0.042	-0.042	-0.026	0.002	
Gujrat	0.028	0.124	-0.012	-0.002	
Hafizabad	0.019	0.608	0.023	0.012	

Mandi Bahauddin	0.031	0.252	0.005	0.002	
Narowal	0.02	0.235	0.001	0.000	
Sialkot	0.032	0.305	-0.003	-0.001	
Lahore	0.056	0.073	-0.037	-0.007	
Kasur	0.025	0.038	-0.002	0.000	
Nankana Sahib	0.018	0.272	0.006	0.001	
Sheikhupura	0.028	-0.079	-0.013	0.001	
Multan	0.048	0.248	0.014	0.008	
Khanewal	0.027	0.482	0.028	0.016	
Lodhran	0.019	0.158	0.008	0.001	
Vehari	0.027	0.184	0.007	0.002	
Rawalpindi	0.043	-0.12	-0.034	0.008	
Attock	0.026	-0.11	-0.013	0.002	
Chakwal	0.022	-0.322	-0.018	0.006	
Jhelum	0.017	0.001	-0.009	0.000	
Sahiwal	0.023	-0.039	-0.006	0.000	
Okara	0.025	0.154	0.006	0.001	
Pakpattan	0.016	0.182	0.005	0.001	
Sargodha	0.028	0.185	0.003	0.001	
Bhakkar	0.028	0.153	0.009	0.002	
Khushab	0.016	0.015	-0.001	0.000	
Mianwali (Ref)	0.027				

Discussion

Pakistan has one of the highest infant and under-five mortality rates in the region (25). One in every 14 children dies within the first year of birth while one in every 11 dies before reaching the age of five years (17). Massive socio-economic disparities exist in infant mortality in Pakistan. For instance, in the case of Punjab, there is a higher socio-economic disparity in the province relative to other provinces in the country, so health inequality is a likely outcome.

In this study, we employed decomposition based on the concentration index technique to quantify socio-economic inequality in child mortality into its determinants. Results show that infants with lower socio-economic status are less likely to survive their first year of life as expected. In the Punjab Pakistan context, several of the determinants suggest a positive link to socio-economic inequalities in child deaths.

Decomposition analysis shows that a family's economic position is one of the biggest contributors to inequality in infant mortality. Nearly 42.35% of infant mortality disparity is defined by the economic status itself and not by other variables used in the regression model. Further, a mother's education contributed around 35% in explaining inequality in infant mortality followed by a mother's age at birth (10.4%). Being in the low ranks of the economic class, mothers' lack of education, age, and rural residence is associated with a rise in the rate of child mortality. By contrast, greater economic status is correlated with a decrease in the infant mortality rate.

The findings of this research are consistent with the outcomes of earlier studies in Pakistan on infant mortality. Socio-economic status has a powerful and negative relationship with infant mortality and is

comparable to much earlier research (26,27). These studies, like the present study, show that families with lower wages and poor living conditions are more likely to have higher infant mortality.

Around 35% of the disparity in infant mortality is explained by the mother's education. One of the reasons for low infant mortality among educated mothers could be their access to and knowledge of prenatal care (28). This is possible because pregnant mothers who are well-educated are in a better position than mothers who are not educated, to take care of their newborns, and themselves (28). Moreover, the mother's age and mother's education are very closely linked because highly educated mothers marry late and have higher ages at birth (28).

The decomposition of concentration indices permitted us to determine which determining factors have a larger part in inequality and how. This method empowered us to compute the pure contribution of each determining factor of a health variable—controlled for the other determinants—to socio-economic inequality in that health variable. However, one should also be cautious in attaching a causal explanation to the results of this analysis, as estimations are obtained from cross-section observational data, and it is well established that problems of causation might be well explained with longitudinal or experimental data.

Conclusion

The findings of the study show that the highest contributor to child mortality disparity in Punjab Pakistan is attributed to household economic status (42.35%), followed by maternal education (35.52%), place of residence (11.45 percent), and mother's literacy (10.44%). The advantages of reducing inequalities in well-being are both economic and social. Economic prosperity would not eliminate health disparity without addressing relative inequality.

The findings of this study indicate that socio-economic inequality in infant mortality is not only due to the function of the health system but there are several factors beyond the health care system. Reducing inequality in infant mortality would require a concerted effort from different departments of the government. The recommendations to reduce socio-economic disparity in infant mortality and improve the wealth of the poorer segments in Punjab province include expanding the Lady Health Worker program and addressing the problems faced by LHWs,(29) diverting resources to education and awareness of young women, investing in health literacy to ensure mother and child survival, targeting policies towards the lower strata of society, and achieving consistency in policies.

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