University Grants Commission, New Delhi Recognized Journal No. 41311
ISSN: Print: 2347-5021 www.research-chronicler.com ISSN: Online: 2347-503X

Statistical Analysis of Infant Mortality Rate of 20 Bigger States of India

Sugyanta Priyadarshini

Research Scholar Kiit Deemed To Be University (India)

Abstract

The concept of Infant Mortality rate (IMR) is gradually entering into mainstream in the recent years as an index of Millennium Development goals (MDG). As a result, reducing IMR in developing nation like India has become a key global issue. To achieve a target of MDG 4, India has to bring down the IMR to 39 per 1000 live births by the year 2015. The work focuses on exploring thinkable determinants of infant mortality rate in India. Using the data of IMR of 20 bigger states of India in 2012, an econometric analysis has been conducted to judge the relationship between IMR and socio-economic factors like total fertility rate, per capita income and female gross enrolment ratio under tertiary education. The result establishes a direct relationship between the fertility rate and IMR and an inverse relationship of per capita income (PCI) and female gross enrolment ratio with IMR.

Key Words*:* Infant mortality rate, Total fertility rate, Per-capita income, Female gross enrolment ratio (FGER).

Introduction

Health is one of the most important modules for safeguarding the improved quality of life. A large number of the Indian poor continue to fight a hopeless battle against existence and wellbeing. The struggle for existence begins even before birth due to the malnourishment of the mother which condenses the life probabilities of the fetus. The grim battle continues into later life, with a minute or no access to health care until risky existence once again broods a new cycle of birth and struggle. However, in the recent years, the concept of healthcare is gaining greater importance globally and this very concept of health care has become one of the major key parameters to measure economic growth of a nation. Infant mortality rate is one of the indicators of population wellbeing, which deals with the count of infant demise per 1000 live births under one year. However the health of the mother, suitable medical conduct, socio-economic scenario, fertility rate, women in labor force, quality of the environment, female literacy rate, national income are the various factors that affect IMR. However, the factors, as well as the causes of IMR, also influence the health status of the population in a distinguished manner. It has been statistically interpreted that there is a strong negative correlation between infant mortality rate and improved health condition of the population in general.

According to UNICEF, Infant mortality rate is considered as one of the major indicators of population wellbeing but the statement was criticized as IMR is collected from a very small section of population which makes it narrowly based while most wide-ranging

measure like DALE(disability-adjusted life expectancy) has been chosen as a better parameter but is not empirically tested. According to D D Reidpath1and P Allotey findings, the relationship between DALE and Infant mortality rate is linearly associated (r=0.91).It was tested that the countries whose IMR is high have definitely low DALE. Even if, infant mortality rate is criticized, it is one of the pithy measures of population wellbeing.

The objective of this paper is to examine different factors affecting IMR in 20 bigger states of India (Bihar, Himachal Pradesh, Andhra Pradesh ,Jammu & Kashmir, Jharkhand, Madhya Pradesh, Odisha, Rajasthan, Maharashtra, Uttar Pradesh, Assam, Gujarat, Karnataka, Kerala, , Haryana , Punjab, Chhattisgarh ,West Bengal, Tamil Nadu, and Delhi) specifically total fertility rate, per capita income, and female gross enrollment ratio under tertiary education. It is examined that low total fertility rate, high per capita income, and female education lowers the infant mortality rate significantly.

Literature Review:-

Improvement in female education has been considered as one of the epoch developmental aims to attend lower infant mortality rate.. Papageorgiou and Stoytcheva (2008) proposed the hypothesis that the reason behind higher infant mortality is higher inequality in education among women. This is because less educated mothers lack necessary skills for adequate care of infants. By putting primary focus on average years of women education, the relationship between female human capital inequality and infant mortality was examined. The data set of cross-country average female education for 108 countries was taken into account and it concluded "higher female education inequality, measured by Gini coefficient leads to substantially higher infant mortality." Monica Das Gupta's work has been an important influence in this sphere where behavioral determinants of child mortality were brought under lime-light. One of the behavioral factors which make for continuing high level of child mortality in rural Punjab is examined to be suppressed women's autonomy and her education. The statistics used in this research work were obtained by resurveying 11 villages in Ludhiana District of Punjab. The research indicated that maternal education is not significantly related to infant survivorship (r = - .023) until the infant care variables like BCG immunization and prenatal tetanus immunization are omitted which shows that maternal education improves child care resulting in low infant mortality. Thus, this paper concluded that clustering of deaths of infants is due to the deprived basic education of mothers. Caldwell and McDonald (1982) used the data from World Fertility Survey in ten Third World countries based on Nigerian study, to test whether mother's education is significant in reducing child mortality. The Nigerian study has put limelight on the fact "educated mothers are open to a worldwide culture of Westernize thoughts which slackens their ties to traditional values that make them not to differentiate between genders and reduce infant mortality, especially female infant mortality." Jiajian Chen et al. conducted a study on birth cohort in the province of Quebec in 1990-1991 to examine the differences in infant and fetal mortality by

maternal education, where the rates are among the lowest in Canada. Both hazard ratios (using survival analysis) and crude and adjusted odd ratios (using logistic regression) were calculated to examine the relationship between mother's education and fetal and infant mortality rate. The analysis concluded that after adjusting maternal age, infant's sex and marital status the progenies of mothers with less than 12 years of education the fetal and infant mortality rates were greater in contrast with the mothers with at least 14 years of education. The vital outcome acquired from the analysis was " if all the educational groups had been able to attain the low rates of the higher education group, the number of fetal and infant deaths would have been reduced by approximately 20%". Erdogan (2008) gathered data from 25 high-income OECD countries on yearly basis from 1970 to 2007 and concluded that a negative relationship persists between real per capita GDP and infant mortality in selected countries. Unit root test and Two way fixed effect model was used to draw the conclusion. However, Erodgan found that with 10% increase in per capita GDP, the IMR decreases in the ratio of 28.9% resulting in the conclusion that IMR of countries decreases as countries turn wealthier. R.Tresserras et al. tested the ecological association between Infant mortality rate (IMR) and Per capita income (PCI) in presence of Adult illiteracy. Required data for Infant mortality and Adult illiteracy was collected from 103 countries and for per capita income data were obtained from 82 countries. In order to determine the ecological association the weighted logistic regression was put into use. A negative association between IMR and PCI was observed in 1960 and 1982. (r =- .625 and r =-.729 respectively, with P less than 0.5). The association shows a light but not significant progress between 1960 and 1982. A study by J.Knodel in three parishes in Bavaria was conducted to determine the relationship between IMR and fertility at a period before the nuptial fertility began its transitional decline. An interesting thing that could be noted was fertility appeared to influence IMR even where the practice of deliberate family limitation is negligible. Infants who were born after short intervals were subject to higher mortality risk in comparison to those infants following longer intervals.

It can be noted that factors that significantly affect IMR may change over time with the influence of modern ideas and technology and new perceptions. However, due to the limited access to data for per capita income, education and fertility rate, the outcomes of the previous data has been outdated. This paper aims at focusing to test the above-mentioned factors in an accurate manner limited to 20 bigger states of India in order to validate the results and correct possible conclusions.

Variables and Descriptions

The data is examined by taking into account univariate and multivariate regression to efficiently study the relationship between IMR and predicted factors that highly affect IMR. Here regression is run on all the figures which included 20 bigger states of India. In this regression model, IMR is dependent on 3 variables: total fertility rate (children born per 1000 women), Female gross enrolment ratio

under tertiary education and per capita income (2012) as an economic tool to measure. The variables are summarized in Table 1.

TABLE 1: Variables and description

Variables	Descriptions
IMR: infant mortality rate	Count of infant deaths per 1000 live births under one year
fert: total fertility rate	A number of children born per 1000 women. Calculated by a total number of children by a number of female population.
pci: per capita income	Total income earned per person in a given year (2012) in a specific area.
educ	Gross enrolment ratio (female) under tertiary education.

The relationship between IMF and fat is found to be a strongly positive linear connotation(fig1).At the same time, the association between IMF and Female Gross enrolment ratio under tertiary education is found to be negatively linear(fig2). Further, the relationship between IMF and PCI is a negative linear association. But the association of IMF with edu and PCI is relatively weak than fer but is significant at 95% and 90% level respectively.

In order to discover the relationship of dependent variable IMF with each independent variable, following equations are projected below.

$IMR=\alpha_1 + \beta_1 \text{ fert} + \mu_1$ (1)

$IMR=\alpha 2 + \beta 2 \text{ PCI} + \mu 2$ (2)

$IMR=\alpha_3 + \beta_3 \text{ edu} + \mu_3$ (3)

Further, with the addition of more forecaster, the correlation between IMR and socio-economic factors is established using following equations.

$IMR=\alpha_0 + \beta_p \text{ PCI} + \beta_f \text{ FER} + \mu$ (I)

$IMR=\alpha_0 + \beta_p \text{PCI} + \beta_e \text{EDU} + \mu$ (II)

$IMR=\alpha_0 + \beta_f \text{FER} + \beta_e \text{EDU} + \mu$ (III)

In order to have a complete analysis regarding the relationship between IMR and per capita income as economic strength factor, we first conjectured OLS model on all selected countries(Equation IV) and regression is run on data of countries stratified for lower and higher GDP countries (Equation V and VI).The hypothesized OLS models follow:-

$IMR=\alpha_0 + \beta_f \text{FER} + \beta_e \text{EDU} + \beta_p \text{PCI} + \mu$ (IV)

$IMR1 = \alpha 0,1 + \beta f,1 \text{ FER} + \beta e,1 \text{ EDU} + \beta p,1 \text{ PCI} + \mu 1$ (V)

$IMR2 = \alpha 0,2 + \beta f,2 \text{ FER} + \beta e,2 \text{ EDU} + \beta P,2 \text{ PCI} + \mu 2$ (VI)

Data are gathered from Directorate of Economics and Statistics of year 2012.A total of 20 bigger states of India are taken into account for complete analysis. Other states are excluded due to missing data regarding the predictors in the analysis. Table 2 presents a descriptive data regarding the study of the dependent variables.

Table 2: Descriptive statistics for selected variables

Variables	N	Mean	Std Dev	Min	Max
IMR	20	38.25	12.12598	12	56
Fert	20	2.25	.57720	1.70	3.50
Pci	20	74263.5500	37990.22637	27202.00	192587.00
Edu	20	21.1250	8.516600	11.60	40.80

Empirical Estimates

Table 3 shows the results of simple regression (Equation 1-3).The R-squared value of 0.36340 and0.38211 points out a weak relationship between per capita income and tertiary education of women education with IMR. The wealthy and highly educated families living in urban areas have complete access to ultrasound scans and can afford the price of abortion. Even if prenatal sex determination and sex-selective abortion are declared as illegal in our country still many clinics provide these services. Whereas in poorer communities, where there are not many ultrasound clinics and they are not that rich enough to afford abortions, they prefer throwing away or killing them after they are born. However, it can be said with a heavy heart that even if the IMR count of India is decreasing but the orphans number is increasing side by side. Even if the masses are educated now but the gloomy part is they have become practical now and stopped being emotional regarding their decisions. Thus, infants especially girls are starved let die of infections girls are buried alive, poisoned, crushed with stones, starved and even abandoned and aborted even if in a scenario where India is progressing towards modernization with welleducated and wealthy citizens. However, all the coefficients are significant at 1% level of significance. The results of simple regression can be established as follow:-For each additional infant birth per woman, IMR increases by 13.9734; one additional percent increase in female gross enrollment ratio of tertiary education results in -0.880131 percent decrease in IMR, each additional percentage point in per capita income reduces IMR by -0.00019. TABLE 3 Parameter estimates for simple regression on all data

Model	Regressor	df	Coef.	_cons	Std. Err.	T stat	P value	R-squared
1	Fert	18	13.97314	6.810427	3.697612	3.778965	0.001374	0.642389
2	Pci	18	-0.00019	52.53965	6.00259E-05	-3.20556	0.004902157	0.363409607

3	Edu	16	-0.880131	56.84278372	0.263796005	-3.33641	0.003673652	0.382115018

Multiple regression is run to explore the interaction among the variables as more predictors are added (Equation I-IV).OLS regression is conducted with all selected states. The results are listed in table 4-7.

In Model I (Table 4), fertility is added. The result shows that one percent decrease in fertility leads to a reduction of 9.985651 in IMR. The estimates are significant at 5% level of significance. The magnitude of the coefficient of fertility decreases from 13.97314 to 9.985651636.

Table 4 Parameter estimates for regression model I

Regressor	Coefficient	Std. Err.	T stat	P value	R-Square 0.513035815 Adj R- Square 0.455745911 Df=17
Pci	-0.000104249	6.63819E-05	-1.57044206	0.034737325	
Fert	9.985651636	4.369146688	2.28549242	0.035396424	
_cons	23.52418143	13.46369416	1.747230822	0.098636033	

In model II(Table 5), female tertiary education is added up and fertility is omitted. The estimates of per capita income and female education are negative. The result shows that one percent increase in education leads to a reduction of 0.538767564 in IMR. The magnitude of the coefficient of education has decreased when per capita income and female tertiary education has taken into account. However, R^2 decreases to 0.422467787 when fertility rate is omitted and education is taken into account.

Table5: Parameter estimates for regression model II

Regressor	Coefficient	Std. Err.	T stat	P value	R- Square 0.422467787 Adj R- Square 0.354522821 Df=17
Pci	-9.98372E-05	9.16051E-05	-1.089865799	0.290980534	
Edu	-0.538767564	0.408625118	-1.318488612	0.204828567	
_cons	57.04573195	5.959397152	9.572399775	2.92651E-08	

In model III (Table 6), total fertility rate along with education is taken into account and per capita income is omitted. In comparison to model II, it is noticed that the magnitude of female tertiary education decreases from 0.538767564 to 0.489773828. In comparison to model I, it is noticed that the magnitude of total fertility rate decreases from 9.985651636 to 9.667699108.However, the estimates on repressors all remain their signs and significance. TABLE 6 : Parameter estimates for regression model III

Regressor	Coefficient	Std. Err	T stat	P value	R -Square 0.518717461 Adj R-Square 0.462095986
Fert	9.667699108	4.401183588	2.19661346	0.042204821	

Edu	-0.489773828	0.298282803	-1.641978091	0.118962485	Df=17
_cons	26.84414912	14.6994571	1.826200039	0.085435533	

Table 7 shows the results of model IV which includes all the variables of all the states selected. The R^2 value (0.8547) indicates a moderately strong fit data. The estimates of PCI and Edu continue to be negative. The summary of the results of Model I-IV is presented in Table 8.The result implies a unit increase in PCI, fert, edu leads to -5.8942, 8.9190966, -0.318464 percent change in IMR respectively.

Table 7:Parameter estimates for regression Model IV

Regressor	Coefficient	Std. Err.	T stat	P value	R-Square 0.531963561 Adj R-Square 0.444206729 Df=16
Pci	-5.89424E-05	8.75919E-05	-0.672921154	0.510600508	
Fert	8.9190966	4.610011725	1.934723192	0.070906608	
Edu	-0.318464095	0.395904891	-0.804395455	0.432958952	
_cons	29.28686213	15.37651086	1.904649397	0.074963702	

Table 8:Parameter estimates for OLS regression on all 20 states selected

Model	I	II	III	IV
_cons	23.52418143	57.04573195	26.84414912	29.28686213
Pci	-0.000104249	-9.98372E-05	Xxxxxxxxxx	-5.89424E-05
Fert	9.985651636	Xxxxxxxxxxx	9.667699108	8.9190966
Edu	Xxxxxxxxxxx	-0.538767564	-0.489773828	-0.318464095
Adj R^2	0.455745911	0.354522821	0.462095986	0.444206729
Obs.	20	20	20	20

To further explore the impact of PCI, separate regression is run using data stratified for countries with higher PCI and lower PCI separately. The OLS regression was run with the independent variables like fertility and education in 50% countries with higher PCI and 50% countries with lower PCI separately. The results are as follow:-

Table 9:Parameter estimates for OLS regression on stratified data

Dependent variable	Specification estimation	Constant	Fert	edu	Adj.R^2	Obs.
IMR	V	1.326970388	18.89131709	-0.254657481	0.129274861	10
	VI	51.45460686	0.006932909	-0.215229858	0.298915094	10

The lower PCI states have higher R^2 in comparison higher PCI states. The estimates of fertility are significant at 5% level of significance and education is significant at 1% level of significance. The magnitudes of independent variables of specification (VI) is far greater than specification (V).

Robustness Analysis:-

Here Robustness analysis is run to approach the problem structurally and sequentially.

The Cook's distance test is used with cutoff 3/20. The result of the Robust analysis is shown in Table 10. In summary, the OLS results shown in Table 8 and 9 are fairly robust.

Table:-10 Robust regression

Dependant Variables	Specification Estimation	Constant	Tfr	Pci	Edu	F	Pro B>F	Obs
IMR	I	23.52418	9.985652	-.0001042		9.85	.0014	20
	II	57.04573		-.0000998	-.5387676	6.99	.0061	20
	III	26.84415	9.667699		-.4897738	11.16	.0008	20
	IV	29.28686	8.919097	-.0000589	-3.184641	6.44	.0046	20
	V	-3.232242	21.35328	-.0000364	-.118521	6.93	0.0224	10
	VI	31.16871	5.40548	-.0000158	.1233187	0.33	0.8042	10

However, here cook's and leverage test is used to find out the outliers. And it was marked that there are some outliers in the cook's distance versus centered leverage value chart. State 1which is high in cooks distance as well as leverage distance it is the first state for deletion.Taking all the 20 states into account, R^2 was .532 but if state 1 is not taken into account, then R^2 gets improved from .532 to .605.

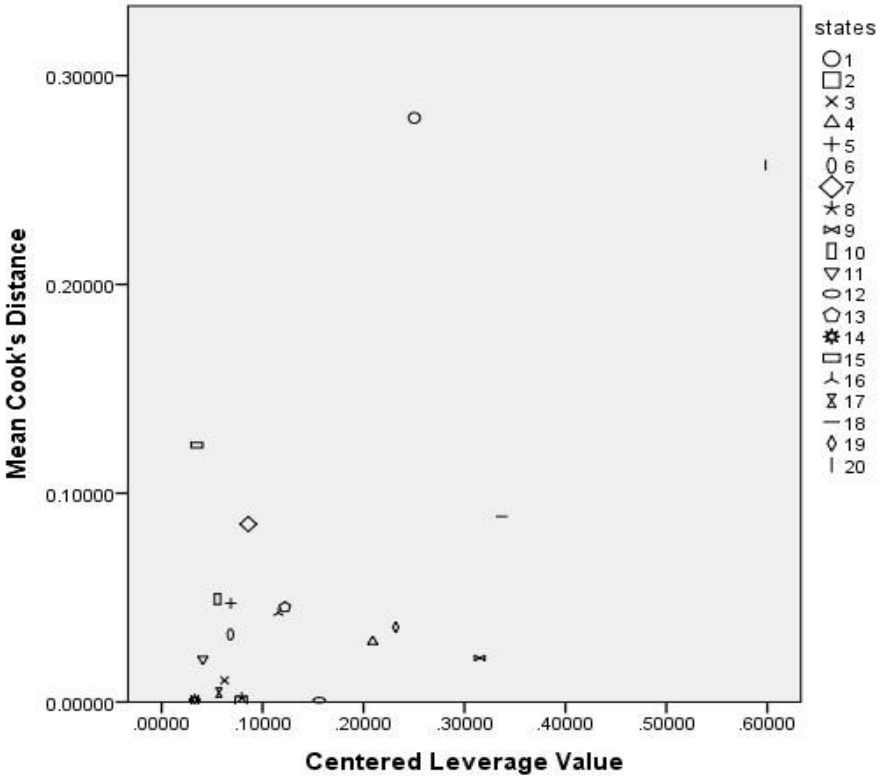

Figure 1: Outliers in Cook's distance verses centered leverage value chat

Conclusion:-

Infant mortality rate is one of the significant indicators of measuring wellbeing of a nation. In this very paper, the relationship between IMR and economic factor like Per capita income and socio-economic factors like female education and fertility rate is investigated. In order to conduct a detail study, univariate regression and then multivariate regression is run on all the accumulated data. The results attained suggested that IMR is positively associated with fertility and negatively related to female education and Per capita income. But when individual state's data were considered then an interesting fact was put into lime light. Some states like Haryana whose Per capita income is considerably high, its IMR was also higher i.e., a positive correlation between IMR and PCI in Haryana and the reason behind such a relationship is the economic inequality which points towards a vital conclusion that distribution of income is also a dynamic factor behind IMR.

References:-

Papageorgiou, C., & Stoytcheva, P. (2008). *Education Inequality among Women and Infant Mortality: A cross-country empirical investigation*.

Gupta, M. D. (1990). Death Clustering, Mothers' Education and the Determinants of Child Mortality in

Rural Punjab, India. *Population Studies*, *44*(3), 489–505. https://doi.org/10.1080/0032472031000144866

Caldwell, J., & McDonald, P. (1982). Influence of maternal education on infant and child mortality: Levels and causes. *Health Policy*, *2*(3), 251–267. https://doi.org/10.1016/0165-2281(82)90012-1

Chen, J., Fair, M., Wilkins, R., & Cyr, M. (1998). Maternal education and fetal and infant mortality in Quebec. Fetal and Infant Mortality Study Group of the Canadian Perinatal Surveillance System. *Health Reports*, *10*(2), 53-64 (Eng); 57-70 (Fre).

Erdoğan, E., Ener, M., &Arıca, F. (2013). The Strategic Role of Infant Mortality in the Process of Economic

Growth: An Application for High Income OECD Countries. *Procedia - Social and Behavioral Sciences*, *99*,

19–25. https://doi.org/10.1016/j.sbspro.2013.10.467

Knodel, J. (1968). Infant mortality and fertility in three Bavarian villages: An analysis of family histories

from the 19th century. *Population Studies*, *22*(3), 297–318. https://doi.org/10.1080/00324728.1968.10404941

Tresserras, R., Canela, J., Alvarez, J., Sentis, J., & Salleras, L. (1992). Infant mortality, per capita income, and adult illiteracy: an ecological approach. *American Journal of Public Health*, *82*(3), 435–438.

https://doi.org/10.2105/AJPH.82.3.435