International Journal of Recent Trends in Science And Technology, P-ISSN 2277-2812 E-ISSN 2249-8109
Special Issue, ACAEE: 2018 pp 66-72

Original Research Article

Estimation of infant mortality in budgam district of Jammu and Kashmir by curve fitting analysis.

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Abstract

Mortality is a continuous force of erosion, tending to reduce populations. Infant Mortality rate refers to deaths of young children, typically those less than one year of age. It is measured by the infant mortality rate (IMR), which is the number of deaths of children under one year of age per 1000 live births. Mortality Rate is one of the important indexes of economic development and social health status of the country. The infant mortality rate generally reflects the health of a population and has great significance for statistical measurements in public health. The Research paper devises some various curve fitting techniques for the estimation of Infant Mortality of District Budgam of Jammu And Kashmir. The Data are taken from Civil Registration system for the Fitting of Such standard curves. These Standard curves are fitted on the maternal mortality and infant mortality as there is an association between the same. The Results provided by such Curves revels that infant Mortality of District has downward trend and further decreases in Near Future. So the paper explains practical utility of Curve Fitting Technique to predict the infant mortality of district.

Key Words: Maternal Mortality, Infant Mortality, Curve Fitting Techniques, District Budgam Jammu and Kashmir.

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Access this article online	
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	Accessed Date: 26 March 2018

INTRODUCTION

Mortality or death of individuals are described by World health organization as "All live born infants should be registered and counted as such irrespective of the period of gestation and if they die at any time following birth they should also be register and counted as death" and is consider as Mortality. Mortality is one of the basic components of population change and the related data is essential for demographic studies and public health administration. Mortality is a continuous force of erosion, tending to reduce populations. Mortality is also an excellent indicator of economic, social status and well being of peoples of a region or to be precise, a pointer of development[1]. The levels of mortality define fitness, survival and growth of a population. It is the other intrinsic component of the demographic transition theory. Infant mortality refers to deaths of young children, typically those less than one year of age. It is measured by the infant mortality rate (IMR), which is the number of deaths of children under one year of age per 1000 live births. The Under-Five Mortality Rate is also an important statistic, considering the Infant Mortality Rate focuses only on children under one year of age[2]. Premature birth is the biggest contributor to the IMR[3]. Neonatal infection, diarrhoea, malaria, measles and malnutrition[4]. One of the most common preventable causes of infant mortality is smoking during pregnancy[5]. Infant Mortality Rate is one of the important indexes of economic development and social health status of the country. It is considered as the most sensitive measures of mortality. Children are important assets of a nation, therefore reduction in infant and child mortality is likely the most important objective of the Millennium Development Goals (MDG). Infant mortality is a leading public health problem in developing countries. Of the estimated 130 million infants born each year worldwide,4 million die in the first 28 days of life. Three quarters of neonatal deaths occur in the first week and more than one-quarter occur in the first 24 hours[6-7]. Mortality has played a very important role in the analysis of demographic situation of any country and determines the prospects of a potential change in future. World Population Prospects[8] noted that high level of infant and child mortality exists in the developing countries in Africa, Asia and, Latin America (85, 56,and 42 per 1.000 live birth) respectively, while low level mortality exists in the developed countries, especially in Europe and North America (9,and 7) per 1.000 live birth respectively.

Countries with low level of infant and child mortality were previously known as areas of high mortality then they gradually witnessed a drop in infant and child mortality. The latest IMR figures for India are 50 per 1000 live births. There are several intra state and intraregional differences in IMR with rural areas for the country reporting around 55 per 1000[9]. According to the United Nations estimate, 10 million infant deaths occur annually in the world. India accounts for a quarter of those. Thus any study of Indian infant mortality has global significance. Over the years, India has attained impressive achievements in child survival. The IMR has dropped by an average rate of 4.56% per year over last five years[13]. India could reduce it only by 53% in 1990[10]. Of the 19 million infants in the developing world who have low birth (less than 2,500 gram), 8.3 million are in India. The level of infant and child mortality is high among Scheduled Tribes particularly those living in rural areas.[11] Although infant mortality in India has declined dramatically over the past four decades, tremendous variations still persist across population sub-groups and geographical areas. The 2009 infant mortality rates (IMR) ranged from a low of 10 in urban Goa to a high of 72 in rural Madhya Pradesh[12]. In Jammu and Kashmir 1 in 15 children die in the first year of life and 1 in 12 die before reaching age 5.

REVIEW OF LITERATURE

Oestergaard MZ, *et al*. (2011), researched on the the Neo natal mortality rate by Curve Fitting analysis by Using the statistical model $\log(NMR/1000) = \alpha 0 + \beta 1 * \log(U5MR/1000) + \beta 2 * ([\log(U5MR/1000)]^2)$. With additional random effect intercept parameters for both country and region. For countries with good vital registration data covering the period 1990-2010, they added random effects parameters for slope or trend parameters as well. Based on predictive performance evaluation using ten-fold cross-validation, the statistical model was fitted to data point for 1990 onwards were retained and included the most recent data point from each survey. To obtain the number of neonatal deaths, live births were applied to neonatal mortality rates[13]. United Nations, (2013). The absolute number of deaths among infants and children in a given year and country is calculated using the central death rates of age groups 0 and 1-4 years, M0 and M1, computed from the estimated U5MR and IMR as follows. First, the probability of dying between exact ages 1 and 5 is derived as follows: 4q1 = (U5MR - IMR/(1000-IMR). Then: M0 = IMR /[1000 - (1-a)* IMR] M1 = 4*4q1 / 4*[1-(1-0.4)*4q1] where a is the fraction of year lived by an infant = 0.1 for low mortality country and a= 0.3 for high mortality country[14]. Ssewanyana S. *et al* 2005). used the following relationship to estimate the infant mortality rate for Uganda $y_j = X_{i,j}\beta_i + X_{h,j}\beta_h + X_{d,j}\beta_d + X_{n,j}\beta_n + e_j$ where yj is a 0/1 indicator of whether child j died before his/her first birthday; Xi,jis a vector of individual-specific variables; Xh,jis a vector of household-specific variables; Xd,jis a vector of district-specific variables; Xn,jis a vector of national variables; and ej is a normally distributed error term[15]. Ansley J. Coale and Paul Demeny(1966), developed for their influential series of the regional model life tables an algorithm for calculating, the average age of death in age interval [0,1) for infants who died in the interval[16] This important parameter is necessary for beginning the life table. The number of person-years lived at in the interval from birth to exact age 1,, is related to, the number of survivors to age 1 and, the hypothetical number of births, by the actuarial relation a01 $L_{0=}1a_{0.1l0}$ $_{+}(1\text{-}1a_0).l1$, which leads in turn to the following formula for deriving the infant mortality rate,, from the death rate observed in the age interval from 0 to 1,$1q0 = \frac{1m0}{1+(1-q0)1m0}$. Ahmad.P.J.*et al* (2017) estimated the infant mortality of central Kashmir in December 2017 by using the regression analysis method. They consider the crude death rate as independent variable and infant mortality rate as dependent variable and fit a regression line by using least square estimation. These estimated values are very close to the observed values of the central Kashmir. The data they used for research taken from census which is very registered data in India [17]. Benfeng Du,Yu Zhang (2011).estimated the infant mortality rate by different methods and find some differences in different methods these mathematical techniques are as given IMR Statistic Method IMR = (D(t, 0)/Bt) × 1000‰ = (D(t–1, t, 0) + D(t, t, 0)/Bt) × 1000‰ (1) D(t–1, t, 0) is the number of babies born in the year of (t – 1) and die in the year of t, D(t, t, 0) is the number of babies born in the year of t and die in the year of t IMR = (D(t–1, t, 0)/Bt–1 + D(t, t, 0)/Bt) × 1000‰[18]

MATERIAL AND METHODS

The Authors Devised Various methods used for the estimation of infant mortality rate the methods by which we have estimated the Parameter are discussed below. The methodology of estimation of infant mortality rate followed by[19-20] is very applicable method. Taking IMR as dependent variable and CDR in their study as there is strong linear relationship between the two parameters. Following the same methodology, we take Maternal Mortality as Independent variable and IMR as dependent variable these variables are also strongly associated

Y =a+bX+e

Where Y=IMR (per 1000 Live births); X=MMR,e is random error component; and aand b are parameters to b estimated, the parameters a, bare estimated by using the least square method ofestimation which is based on minimizing the sum of squares of error from mean. The method used for fitting the exponential curve to the data is of the form $Y=e^{ax+b}$ where a and b are constants to be estimated after taking log on both bases 10 and base e than following same regression producure as followed by[18-21]. The data has been taken from reports of civil Registration system from the year 2004 to 2012 which is available there in SRS for District Budam Jammu and Kashmir. For the data of maternal mortality and infant mortality of district Budgam from year 2013 to 2016, a simple random sample of 88 Health Sub Centres has been taken randomly by using simple random number table and information regarding the infant mortality and maternal mortility yearly has been obtained and for the test of significance we set up null hypothesis. H_0: The fitting of regression curve for the data of budgam is not considered as best fit for the data as compared to exponential curve fit for the same data. Against The alternative hypothesis H_1: The fitting of regression curve for the data of Budgam is considered as best fit for the data as compared to exponential curve fit for the same data.

RESULTS

The Normal Equation for estimating the constants a and b are;

$\sum Y = a\sum X + nb$ and

$\sum XY = a\sum X2 + b\sum X.$

Substituting the values in above normal equations we have

1296$= 96a + 13b and\ 10215 = 796a + 96b$

on solving these two linear equations for constants $a and b$ we have

$a = 13.34\ and b = -4.19$ the fitted regression line becomes

$\mathbf{Y = 13.43X - 4.19}$

Put X=1.08 for the year 2017, The value of maternal mortility of budgam for the year 2017 has been forecasted by spss 16.0 version we get the estimated value of Infant Mortility of District Budgam for the Year 2017 is 10.31 i.e. $\mathbf{Y}^{\wedge}$=10.31 infant deaths per thousand. Exponential curve fitting method is another method for fitting the standard curve to any data. The general form of Fitting the exponential curve to the data is $Y = e^{aX+b}$Where a and b are constants to be estimated. For the estimation of a and b we taking the logarithm of Y for estimating the normal equations for calculation of a and b, both natural logarithm and common logarithm are used for estimation $\log_e Y = \log_e e^{aX+b}$ $\log_e Y = aX + b,$ $\bar{Y} = aX + b$,Where $\bar{Y}$ =$\log_e Y$ The normal equations for estimating the values a, b are $\sum\bar{Y}$=$a\sum X + nb$ and $\sum X\bar{Y}$=$a\sum X2 + b\sum X$ The values of the these quantities form above table we have the values of a and b as shown below $96a + 13b = 56.30$ and $796a + 96b = 435.70$ on solving these two linear equations for the values of a and b we have $a = 0.237, b = 2.574$ so the value of

$\bar{Y} = 0.237X + 2.574, \log_e Y = 0.237X + 2.574$

$\boldsymbol{Y = e^{0.23X+2.574}}$is the required equation of the curve for the data of district budgam. Using the forecasted value of maternal mortility of Budgam i.e. X=1.08 in exponential curve$\boldsymbol{Y = e^{0.23X+2.574}}$we have$\mathbf{Y}^{\wedge}$=**16.81**deaths per thousands. The Exponential Curve to the base 10 i.e. Common Logarithm is another curve fitted to above data. This curve is slightly different from the above exponential curve

The general form of equation of this curve is $Y = e^{aX+b}$

$\log_{10} Y = \log_{10} aX + b$

$\log_{10} Y = \log_{10} e^{aX+b}$ $\log_{10} Y = (aX + b)\log_{10} e$

$\log_{10} Y = (aX\log_{10} e + b\log_{10} e$ $\bar{\bar{Y}}$=$\bar{\bar{a}}$X+$\bar{\bar{b}}$ where $\bar{\bar{a}}$= $(a\log_{10} e)$ $\bar{\bar{b}}$= $b\log_{10} e$

The Normal equation for estimating$\bar{\bar{a}}$ and$\bar{\bar{b}}$ are as $\sum\bar{\bar{Y}}$ =$\bar{\bar{a}}\sum X + n\bar{\bar{b}}$ and

$$\sum X\bar{\bar{Y}} = \bar{\bar{a}}\sum X2 + \bar{\bar{b}}\sum X$$

From the above calculated normal equations by least Square method we have

$96\bar{\bar{a}} + 13\bar{\bar{b}} = 24.45$ and $796\bar{\bar{a}} + 96\bar{\bar{b}} = 189.22$ on solving these equations for $\bar{\bar{a}}$ and $\bar{\bar{b}}$ we have $\bar{\bar{a}} = -0.098$ and $\bar{\bar{b}} = 1.149$

Also we have $\bar{\bar{a}} = a\log_{10} e$ $a = \frac{\bar{\bar{a}}}{\log_{10} e}$ $a = -\frac{0.098}{0.4342}$ $a = -0.226$

$$\bar{\bar{b}} = b\log_{10} e\ b = \frac{\bar{\bar{b}}}{\log_{10} e} b = \frac{1.149}{0.4342} b = 2.645$$

The original equation becomes

$\bar{\bar{Y}} = -0.226X + 2.645, \log_{10} Y = 0.226X + 2.645$ $\mathbf{Y = e^{-0.226X+2.645}}$Is the fitted exponential curve to the mortality data for district Budgam. Using the for casted value of Maternal Mortility of budgam for estimating the infant mortility from the exponential curve $\mathbf{Y = e^{-0.226X+2.645}}$i.e.Put X=1.08 we have we have $Y^{\wedge}$=**0.07** infant deaths per thousand

DISCUSSION

The equations of the various fitted curves between maternal mortality and infant mortality of district budgam in Jammu and Kashmir and the results obtained above from various equations of the curves between infant mortality and maternal mortality Can be summarised as, the fitted regression equation for the data is $\mathbf{Y = 13.43X - 4.19}$,Which shows there is linear relationship between infant mortality and maternal deaths from above calculation the regression coefficient$a = 13.34$. and$constant b = -4.19$ are obtained form given data. Infant mortality of the budgam for any year can easily be estimated. Similarly different the values of a and b for exponential curves fitted for the same data I,e. the curve,$\mathbf{Y = e^{-0.226X+2.645}}$and $\boldsymbol{Y = e^{0.236+2.574}}$shows infant deaths varies exponentially with maternal deaths. From these two exponential equations infant mortality can easily be estimated for the district budgam for any year. The infant death per thousand for the year 2017 from these two curves are respect ally are 0.007 and 16.81 both these estimates can be considered as extremes when compared with the corresponding estimate predicated by regression curve for the same year 2017 which is 10.31 deaths per thousand. The research work done by[17] estimated the infant mortility rate of central Kashmir is 7.6 for the same year 2017, so our estimated value for separate budgam from central Kashmir could be around 10.31 The Graph between the Infant Mortality and maternal mortality shows that as the maternal mortality decreases accordingly but the rate of decrease is different. Also the graph depicts that the infant mortality and maternal mortality of the budgam district decrease rapidly from last decade. The results obtained from regression analysis between two parameters shows Coefficient of determination $R^2 = 0.5234$ which indicates Moderate relationship between the two variables. Exponential graph between maternal mortality and infant deaths is zig zag shaped graph indicates that there is sharp decline in infant mortility from 2004 to 2014, and corresponding maternal mortality rate is almost a horizontal line along the axis shows that there is gradual decline in maternal mortality in district budgam as compared to infant mortality. Life expectancy is also related with infant mortility[22] so in district budgam the results could be because of life expectancy also. As can be seen from these tables, the fit is extremely good as the calculated value of F(1,12) d.f is 12.082 and tabulated value of F for F(1,12) d.f at 5% level of Signifince is 3.11 value of F which is highly significant we reject the null hypothesis and conclude that Fitting of regression is considered as best than exponential fitting for the given data of district budgam and the model explains about 52.34 % percent of the variance. Regression model is appropriate to estimate the level of IMR for different levels of MMR.

CONCLUSION

From the above results and discussion we conclude that infant mortility of Jammu and Kashmir is declining from almost last decade, particularly in district budgam by fitting various standard curves. We also conclude that fitting of regression curve is considered as best fit as compared to exponential curve for such type of data. This Research paper checks the predicated infant mortility of budgam which is also satisfactory value. There is nothing to worry about regarding such parameter. There are various factors affecting mortility[7] the need of hour is to reduce the rate further by taking special consideration towards these major factors.. This Research paper is entirely based on the infant mortality figures of district budgam and would be helpful to district health authorities to identify the figures and try to reduce themfurther.

Table 1:
Dependent Variable (Y): IMR
Variable in the equation:

	Regression Coefficient (a)	SE(a)	R^2 (%)	Adjusted R^2 (%)	Value of F
Log 10 MMR X	0.226	0.49	0.07	0.07	0.85
(Loge MMR X)	0.237	0.53	0.59	0.56	15.90

Table 2:
Variable in the equation:

	Regression Coefficient (a)	SE(a)	R^2 (%)	Adjusted R^2 (%)	Value of F
MMR	13.43	35.89	0.523	0.480	12.082

Table 3:

	Model	Sum of Squares	df	Mean Square	F
	Regression	15491.968	1	15491.968	12.082
1	Residual	14104.801	11	1282.255	
	Total	**29596.769**	**12**		

Table 4:

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Infant Mortality Y	146	154	153	147	119	118	75	82	80	79	36	26	11	$\sum Y$ = 1226
Maternal mortality X	13	11	7	7	8	7	6	8	7	9	6	5	2	$\sum X$ = 96
X^2	169	121	49	49	64	49	46	64	49	81	36	25	4	$\sum X 2$ = 796
XY	1898	1694	1071	1029	952	826	450	656	560	711	216	130	22	$\sum XY$ =10215
$\bar{Y} = \log_e y$	4.98	5.03	5.03	4.99	4.77	4.76	4.31	4.40	4.38	4.36	3.58	3.25	2.39	$\sum \bar{Y}$ =56.30
$X\bar{Y}$	64.74	55.33	35.21	34.93	38.16	33.32	25.86	35.20	30.66	39.24	21.48	16.25	4.78	$\sum X \bar{Y}$ = 435.70
$\bar{\bar{Y}}=\log_{10} Y$	2.16	2.18	2.18	2.16	2.07	2.07	1.87	1.91	1.90	1.89	1.55	3.258	1.04	$\sum\bar{\bar{Y}}$=24.45
X $\bar{\bar{Y}}$	28.13	24.06	15.29	15.17	16.60	14.50	11.25	15.31	13.32	17.07	9.33	7.07	2.08	$\sum X\bar{\bar{Y}}$=189.22

Table 5:

Variable	Pearson Correlation	R Square	Adjusted R Square	Std. Error of the Estimate	Unstandardized Coefficients		Unstandardized Coefficients	Sign
					B	Std error	Beta	
X	0.723	0.523	0.480	35.89	-4.19	30.0		0.89
					13.3	3.83	. 723	0.05
Y	0.723	0.523	0.480	35.89				
N	13	13	13	13	13		13	

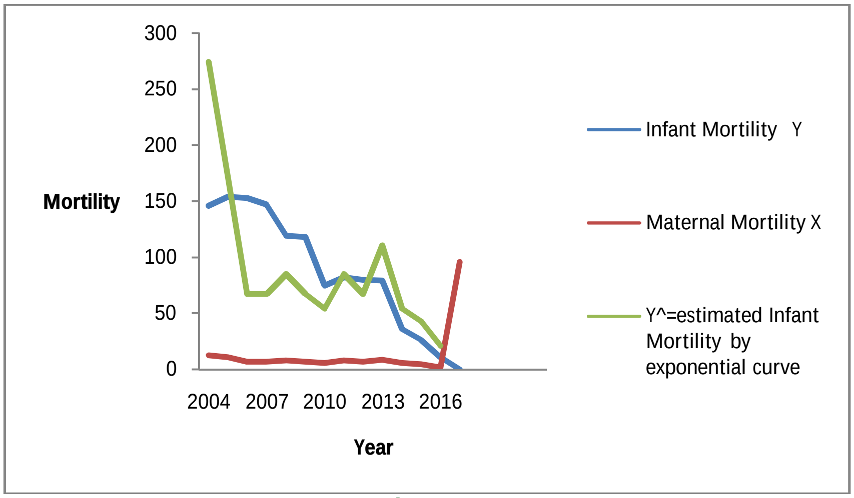

Figure 1:

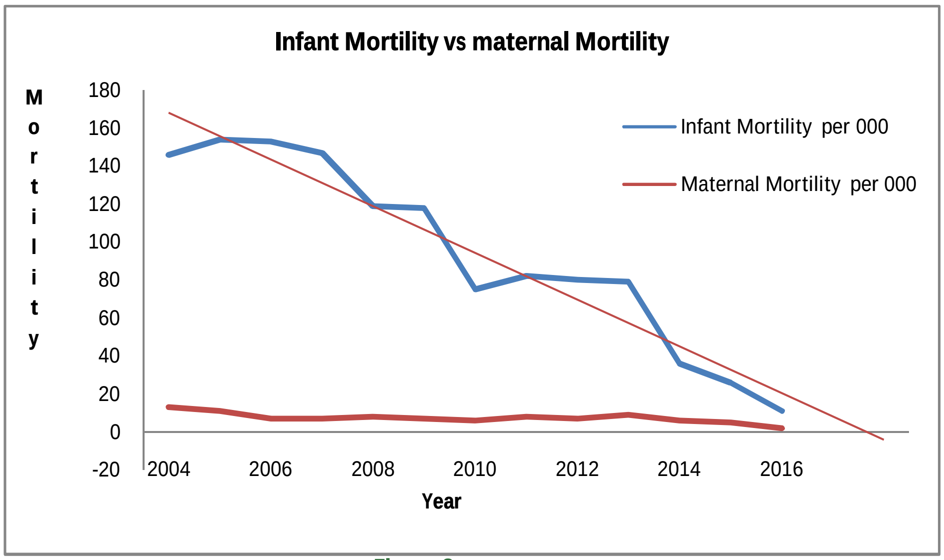

Figure 2:

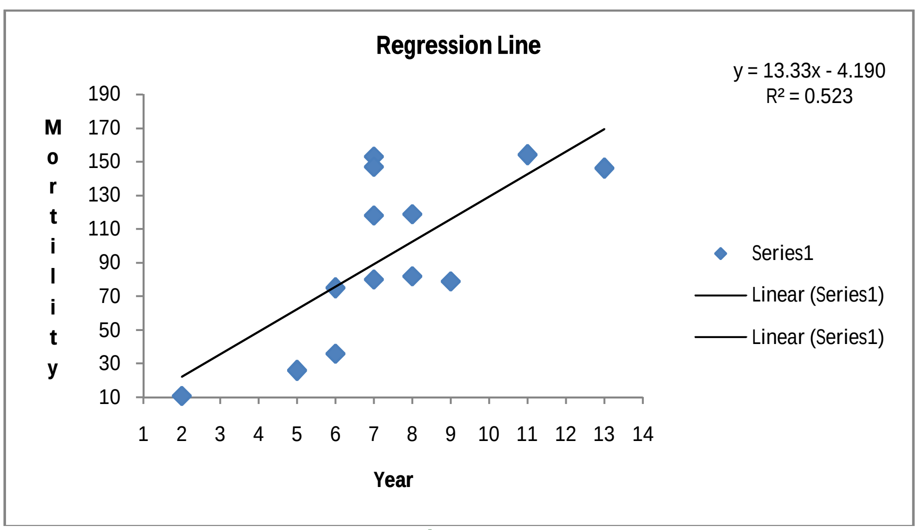

Figure 3:

ACKNOWLEDGEMENT

I feel very pleased to thank all the supporting hands, who helped me in my ambitions work. I want to show my gratitude to my respected supervisor Dr Sushma Jain for his guidance, help, support and encouragement. I am thankful to Prof. Shariwastoo, Head of the Department of Statistics Govt.M.V.M Bhopal for giving thoughtful suggestions during my work nobody has been more important to me in the pursuit of this Research work than the members of my family. I would like to thank my parents, whose love and guidance are with me in whatever I pursue. They are the ultimate role models.

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Source of Support: None Declared
Conflict of Interest: None Declared