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Research Article

FRAILTY MODEL APPROACH FOR SURVIVAL OF CHILDREN BELOW AGE 5 IN EAG STATES AND ASSAM

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A B S T R A C T

Frailty is the approach towards to establishing the scenario of estimating the unobserved approach in any events which can be a ected by several factors but cannot be easily observed. In light of under 5 mortality, this concept can be very helpful to estimate the proper risk scenario of child mortality for several corresponding variables. In this study, we move with parametric hazard model with corresponding frailty dened by the distribution which may be more e ective and has the similar approach towards the considered hazard model. For that study, we had taken NFHS- 3 for EAG states (Uttar Pradesh, Madhya Pradesh, Bihar, Odisha, Rajasthan, Jharkhand, Chhatisgarh, Uttarakhand) and Assam with 22179 births in last 5 years.

INTRODUCTION

Demography is a wide area of study of change in population, in which Mortality keeps an important position of itself. Lewis and Thompson (1965) de ne it as the phenomenon of population change in diminishing nature. In general, mortality has a bathtub shaped curve caused a high peak in initial ages and so as in old age. At Initial ages, the risk of high mortality lies between the age of 0 to 5 year age which considered as below ve-year mortality or child mortality. It plays an important part in the development of a country. Due to that condition, development programs consider this aspect, as Millennium Development Goals had Fourth goal about child mortality and now the new sustainable development goals contain more or less regarding this issue.

On a global level, MDG gives consists a goal that the child mortality will tried to be reduced by two-thirds in between 2000 to 2015 by the whole world, which was achieved by many countries. But the worst part that, not achieving is seen by most of the undeveloped or developing countries of Africa and South Asia. In South Asian Countries India has a valuable position. In 2015 by the review of millennium development goals India Shows its moderate speed of progress on reduction child mortality, the main cause is can be considered as most of the states of India such as EAG States does not cover the required target in the proper manner.

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Estimation of mortality below ve-year age has an issue to study because it has a wide connection with fertility. And number of births becomes introduction of new medical facilities for the reduction in child mortality which leads to the decline in fertility with economic development (Donald, O.Hara (1975) and Schultz(1979)). Ben-porath and Welch (1972) shown that occurrence of death as anticipation such as death may also enter into determination of the desired number of surviving children. In study of Taiwan, Schultz (1980) found that high child mortality rates are highly associated with earlier marriages, which may be taken as indirect evidence of replacement type behavior in the same way.

Vaupel *et al.*(1979) introduced the term frailty to indicate that di erent individuals are at risks even though on the surface they may appear to be quite similar with respect to measurable attributes. He used the term frailty to represent an unobservable random e ect shared by subjects with unmeasured risk in the survival analysis. Frailty models have been introduced into the statistical formation in an attempt to account for the existence of unmeasured attributes that do introduce the heterogeneity into study population. Frailties are useful in modeling correlations in Multivariate survival and event history data. Hangal(2011) Discussed frailty in a very wide manner with the help of various parametric and hazard and mathematical models. In recent research of addressing the problem of heterogeneity Hougaard(1986) suggested the power variance function distribution which includes gamma, inverse Gaussian, positive stable distribution as frailty model. Hedeker *et al.*(1996) discussed a frailty regression model for the analysis of correlated grouped-time survival data. Frailty models have been applied to the analysis of event history data, including the study of age at the time of death for individuals in terms of population by Zelterman (1992), from McCall(1994) de ned as unemployment duration for it. Aalen(1987) de ned the use of it for pregnancy in women, and Lindstrom(1996) used it for Migration modeling. Singh *et. al*(2015) PRoposed the basis of Bayesian frailty for child mortality in Muslim womens in Up. Nath and Pandey(2015) proposed approach of frailty hazard for rst birth interval for womens in UP, India.

In India in 2001 government make a group of states which are de ned with the consideration that they have su cient amount of resources and manpower but they didn't show the proper level of development and consists of the low degree of constraining status of development indicators. That group was de ned by the name of Empowered action group (EAG) such as steady action needed for this group, in this group eight states consists who had approximately 50 percent population of India and shows highest level of population growth in India which are named as Uttar Pradesh, Madhya Pradesh, Bihar, Odisha, Rajasthan, Jharkhand, Chhatisgarh, Uttarakhand and one another state of India with similar condition in northeast named as Assam. All that states are taken into account for the study. Since non parametric models are not very much able to de ne the frailty structure of the population in a proper manner so for that study we had taken suitable parametric hazard model for our study with corresponding covariates with a proper structural de nition. In which our expectation for understanding the condition of under ve year age child survival and improving them for the country like India, And getting that condition which must helpful for keeping hope alive for working for India, So that for the extensive study we move on the methodology of the study.

Data and Methodology

Model Speci cation

Child mortality can be divided in two di erent terms as death between 1-12 months of a child is called infant mortality and death occurred in between 13-60 months age is termed as child mortality, the risk of occurring death in both cases in age interval period for age in year from birth given in calendar year. Independent variables which are used in that study based on child mortality and morbidity framework given by Mosley and Chen (1984).

In several studies Bicego (1990), Zerai (1996), Manda(1999) shown that birth interval, parity, neonatal age have high impact on under ve-year age mortality we consider these variables in our study to t chosen frailty hazard model for variables de ned as:-

Outcome variable

mortality under age in years ve year taken as dependent variable. Since we had divided mortality under 5 year age in 2 stages so our outcome variable consists of 2 di erent models on Infant deaths and children deaths.

Independent variables

Here we consider the same variables used by Singh and singh (2017) for study towards child mortality determinants with the help of NFHS- 3 data le for EAG states and Assam.

METHODS

Kids data le is being used constructed from women respondents in 2004-06 national family health survey using statistical analysis software with using sampling weights. Gompertz hazard Model is used in survival analysis with proportional hazard models since it gives the curve of it variable in such nature as the survival condition in first 5 years. Significance level is being performed over $p < 0:001$; $p < 0:01$; $p < 0:05$ for the hazard models.

Since in the measure of survival Cases with parametric hazard model is considered as the better measure with respect to other methods such as life table in which we can nd the survival scenario in case of equally divided constant age intervals, which is being improvised in Kaplan-Meier estimate with varying age interval or variable failure timings. There are better estimates but there have some problems with that estimator such as they only can evaluate survival chances with respect to only one respective independent variable and also they all are known and semi parametric models which are considered week models with respect to any parametric model. Here we use Gompertz Proportional hazard model which is more powerful than any non or semi parametric model in any case. And more it consists the liberty of a de ned functional form of baseline hazard which does not possess by the Cox Proportional Hazard Model.

For the selection of variables to t the model, we apply the method of principle component analysis in which we consider the minimum number of variables which covers most of the information for this we de ne the minimum number of the variable if they cover up to 60-80% information for our study. The procedure of principle component analysis(PCA) is as follows.

$$r = \frac{Cov(X; Y)}{\sigma_x \sigma_y} \quad (1)$$

where X is independent Variable and y is Child Mortality. Gompertz proportional Hazard model is defined as-:

$$h(t_i; X_i) = h_0(t)\exp(\Sigma\beta_i X_i) \quad (2)$$

where $h_0(t)$ is base line hazard which can take the form of baseline hazard of Gompertz distribution defined as^{P}ne $^{\delta+\gamma t}$ (where δ and γ are parameters of Gompertz distribution) and hazard ratio is defined as $\exp(\Sigma\beta_i X_i)$ for given time t to occurring the event and for i=1,2,3,…,n.

For consideration of frailty condition we take a function such as it is being multiplied in the hazard model and termed as coefficient of frailty. such as:-

$$h(t_i; X_i) = g(\alpha) h_0(t)\exp(\Sigma\beta_i X_i) \quad (3)$$

which can take functional forms such as constant, gamma or inverse Gaussian function, but for the study we consider it with inverse Gaussian frailty because the frailty defined function should be of the similar nature to hazard model and the inverse Gaussian function is in somehow with the similar nature of it. so $g(\alpha)$ be in the form as

$$g(\alpha) = 2(\pi\theta\alpha^3)\exp(1/\overline{2}\theta(\alpha-2+\overline{1}/\alpha))$$

We apply hazard model after proceeding checking the proportionality assumption of hazard model s with the help of chi square test. And then we apply the test of Analysis of deviance to know whether the reducing number of variable in hazard model have significant effect on model or not. Which defined as:-

$$D(y;) = 2(\log p(y/\theta o)\ \ \log p(y= \theta_s)) \qquad (4)$$

Where o is the number of observed variable in considered model, s is number of variables in saturated model. D is the deviation function log p(y/θ) is log likelihood of the model for given number of variables. Here D follows χ^2 distribution with o-1 degree of freedom.

RESULTS

Considering independent variable for model to get the information regarding child deaths within the last 5 years we have the table of basic variables in such a manner-:

Table 1 Basic characteristics with respect to living and died Children

birth order and birth interval	living children	died children	Total
2 births in SBI	561	232	793
2-4 births in SBI	492	340	832
4 births in SBI	185	423	608
2 births in MBI	3538	526	4064
2-4 births in MBI	3390	1478	4868
4 births in MBI	1204	2225	3429
2 births in LBI	458	49	507
2-4 births in LBI	413	179	592
4 births in LBI	122	225	347
Sex of child	living children	died children	Total
Male	8253	3207	11460
Female	7649	3070	10719
birth type	living children	died children	Total

On studying the basic characteristics we get the proper frequencies for the phenomenon of children deaths in EAG states and Assam. Pearson Correlation Table of children living status and different independent variables.

From Table 3 we get the information about the relation in between died Children to the living status of children in that case we see that birth order to corresponding birth interval have significantly positive relation to children died with value r = :073 and significance level 0. In case of the sex of the child, there is an insignificant correlation with children ever died. Going with the case of birth type there is a positive significant correlation with died children. For maternal age to child died we found significantly positively related. Considering the maternal education level to child deaths we found that there exists significantly negative correlation in between them. Considering the scenario of occupation level we find the significant positive correlation in between them. With the help of economic status, we evaluated that the correlation of it with children died is significantly negative. Moving to the residential status we get the significantly positive relation to the died children. In a study of religious status relation to child mortality, we get a positive significant relation in between them. Considering the caste factor we get significantly negative correlation in between died children and caste of the household head. In spite of child death related to household, structure gives the negative correlation in between them with proper significance. In case of the household type, it also shows that negatively significant relation to children died. In consideration of the relation of toilet facility to children died we get a significantly negative relation in between them. Water facility status shows that significant positive relation of it to children died. Considering the factor of birth weight for the relation with children died we get a significant negative correlation in between them.

From the study of Karl Pearson correlation coefficient we get that there is only one case sex of child has no significant association with children died so we did not consider the sex of child as independent variable in our model studies and we will take the phenomenon of infant and child deaths with Gompertz proportional hazard model with and without frailty concerns the help of comparison that what percentage differences taken in between them if time constraint had been taken with variables which are time independent. And that comparison has been making for infant deaths and child deaths for each model respectively.

Table 2 Basic characteristics with respect to living and died Children

twins	80	95	175
multiple births	83	96	179
highest education level	living children	died children	Total
no education	7662	4580	12242
primary	2233	742	2975
secondary and higher	6006	955	6961
occupation level	living children	died children	Total
no occupation	10573	3480	14053
semi skilled	4895	2675	7570
skilled	431	122	553
Residence	living children	died children	Total
Urban	5465	1504	6969
Rural	10437	4773	15210
Religion	living children	died children	Total
Hindu	12781	4912	17693
Muslim	2680	1199	3879
others	325	73	398
Caste or tribe	living children	died children	Total
Scheduled caste	2993	1478	4471
Scheduled tribe	1413	848	2261
Other backward class	6800	2709	9509
None of above	4351	1088	5439
Household structure	living children	died children	Total
Nuclear	6343	3486	9829
Non-nuclear	8125	2446	10571
Not dejure resident	1434	345	1779
House type	living children	died children	Total
Kachha	2209	1376	3585
semi-Pucca	6392	3179	9571
Pucca	5762	1339	7101
Not dejure resident	1434	345	1779
toilet facility type	living children	died children	Total
no facility	8273	4289	12562
ushed toilet	5194	1215	6409
pit toilet	759	287	1046
dry toilet	200	123	323
non dejure resident	1456	351	1807
drinking water facility type	living children	died children	Total
piped water	3973	1040	5013
tubewell	8203	3712	11915
well	1763	906	2669
other	528	272	800
non dejure resident	1434	345	1779
birth weight	living children	died children	Total
doesn't know	11428	5456	16884
underweight	983	232	1215
average weight	913	150	1063
overweight	2541	411	2952

Table 3 Correlation in between basic characteristics with living status of Children

	Pearson's Correlation		
	Value	Asymp. Std. Error	Approx. Sig.
birth order and birth interval vs children died	0.073	0.008	0
Sex of child and children died	0.007	0.007	0.278
birth type and children died	0.068	0.008	0
maternal age and children died	0.247	0.007	0
highest education level and children died	-0.237	0.006	0
occupation level and children died	0.095	0.007	0
wealth index and children died	-0.204	0.006	0
Residence and children died	0.101	0.006	0
Caste or tribe and children died	-0.106	0.007	0
Religion and children died	0.047	0.007	0.033
Household structure and children died	-0.138	0.007	0
House type and children died	-0.162	0.006	0
toilet facility and children died	-0.095	0.006	0
drinking water facility and children died	0.013	0.006	0.045
birth weight and children died	-0.158	0.006	0

Proportionality Assumption

Applying the proportionality assumption we get such as

Table 4 Proportional Assumption result for Children

test	Chi-square	d.f.	P-value
value	7.42	14	0.738

It Presents for children it for 14 degree of freedom, we get signi cant of that. And for infant we get with 14 d.f.

Table 5 Proportional Assumption result for infants

test	Chi-square	d.f.	P-value
value	6.16	14	0.859

with signi cant with value 6.16. which implies that we can use each and every variable in the model.

PCA Results Eigen Values with Cumulative proportion is de ned as

Table 6 Eigen Values with Cumulative proportion

Component	Eigen Value	Di erence	Proportion	Cumulative Proportion
Birth order with respect to Birth interval	3.1923	1.16373	0.228	0.228
Birth Type	2.0286	0.6489	0.1449	0.3729
Maternal Age	1.3797	0.18208	0.0985	0.4715
Maternal Education	1.19761	0.19626	0.0855	0.557
Occupation	1.00135	0.697001	0.0715	0.6285
Economical Status	0.93164	0.08682	0.0665	0.6951
Residence	0.84481	0.15134	0.0603	0.7554
Religion	0.69346	0.043284	0.0495	0.805
Caste	0.65018	0.082133	0.0464	0.8514
Household Type	0.56805	0.04766	0.0406	0.892
Household Structure	0.52038	0.58108	0.0372	0.9292
Toilet Facility	0.46227	0.18857	0.033	0.9622
Water Facility	0.2737	0.01486	0.0196	0.9817
Birth Weight	0.25847		0.0183	1

From the results of PCA we get with given Eigen values with corresponding cumulative proportions in table-4 we get that first 9 components are covered more than 80% information in the scenario of children deaths in which first component birth order in given birth interval covers most of the part as it covers more than 22% of information. Moving to the second component jointly covers 37% information of data with the first component. Up to 47% information covered by the first 3 components jointly for the data such as the Birth order in given birth interval, Type of birth and Maternal age. defining maternal education as the fourth component we get that all 4 components cover jointly up to 55% information of data. With Father Occupation consideration as the fifth component jointly they cover the information of data more than 63%. With the sixth component as Economical status, we get that with that data covers more than 69% information of data jointly. With Residential consideration as the seventh

Component jointly with other variables cover the information of data more than 75%. Up to 80% information covered by the first 8 components jointly for the data such as the Birth order in given birth interval, Type of birth, Maternal age, Maternal Education, Occupation, Economical Status, Residential Status and Religion. Since for our defined condition more than 80% information covered by 8 out of 14 components, we make our study on the basis of that 8 components and frailty model helps us to go for the unobservable error for the Gompertz proportional Hazard model for that covariates.

Infant and Child Death cases

Considering the infant and child mortality as dependent variables the proportional model gives their results as given below.

Gompertz Proportional Hazard Model results for infant deaths

Proportional hazard model is a properly used model for the survival study with consideration of time which is assumed to be more appropriate with respect to logistic regression in consideration of survival studies, here we move with the phenomenon of infant deaths with those explanatory variables which are not changed due to time.

Going with the results of Gompertz Hazard Model on the outcome variable of infant deaths we get our relative ratio of survival in such manner as for birth order with corresponding birth interval we get that with respect to less than 2 births in short interval for infant deaths in between 2-4 births in short interval 0.01 times lower with respect to reference level at significant state with p-value 0.027. The chance of deaths is infants for more than 4 birth in short interval is significantly low with 3% with respect to reference level with corresponding p-value 0.021. For less than 2 births in medium birth interval risk of infant deaths is 1.05 times high with respect to a reference level of less than 2 births in short interval with p-value 0.031 significant status. For 2-4 births in the medium birth interval, the risk of infant deaths is 0.5% high with respect to the reference level of less than 2 births in short birth interval which is significant with p-value 0.004. For greater than 4 births in medium birth, interval is a risk of infant deaths 1.22 times higher with respect to reference level with p-value 0.046 significant level. For less than 2 births in large birth interval survival of infants is 1.688 times more likely with respect to the reference level of up to 2 births in short birth interval p-value 0.039. Moving to 2- 4 births in the large birth interval the relative risk of infant deaths is approximately 0.47 times lower with respect to the reference level with p-value 0.036. For more than 4 births in the large birth interval, the risk of infant deaths is 1.409 times likely higher with respect to the reference level of less than 2 births in short interval with p-value 0.03.

Considering the case of the birth type with respect reference to single birth the chances of infant deaths is likely to 1.49 times higher for twins and for multiple births 1.47 times higher with p values 0.025 and 0.029 respectively. For consideration of maternal age considering less than 20 year of maternal age as the reference level, we get the chance of infant deaths in between the age of 20-29 years is 11% less with respect to reference level of maternal age up to 20 years with p-value 0.019. On p-value 0.047 maternal age in between 30-39 years shows 0.25 times lower risk of infant child deaths with respect to the reference level. For the age interval of 40-49 with respect to the reference level of maternal age risk of infant deaths is likely to 38% lower with p-value 0.038. Considering the education level of mothers and taking illiterates or not educated as reference level we get that women those who have the primary education the risk of their infant's deaths is 1.28 times higher to the women who are not educated at significant

Table 7 Gompertz Hazard for Infant Deaths

Variables	Relative risk	P- value
Birth order in Birth interval		
up to2 births in SBI	1	
2-4 births in SBI	0.9904	0.027
more than 4 births in SBI	0.9704	0.021
up to 2 births in MBI	1.05728	0.031
2-4 births in MBI	1.00495	0.004
more than 4 births in MBI	1.22087	0.046
up to 2 births in LBI	1.688268	0.039
2-4 births in LBI	0.63424	0.036
more than 4 births LBI	1.409	0.03
birth Type		
single birth	1	
Twins	1.496249	0.025
multiple births	1.4721	0.029
maternal Age		
Up to 20 years	1	
20- 29 years	0.872	0.019
30-39 years	0.7523564	0.047
40- 49 years	0.62037	0.038
Maternal Education		
no education	1	
Primary	1.2801	0.014
secondary and higher	1.0698	0.047
Occupation Level		
no occupation	1	
semi skilled	1.0698	0.046
Skilled	0.66414	0.019
Economical Status		
Poor	1	
middle class	0.99619	0.081
Rich	1.40836	0.008
Residence		
Urban	1	
Rural	1.099955	0.042
Religion		
Hindu	1	
Muslim	0.98281	0.006
Others	0.976205	0.005

p-value 0.014. Considering the education level as secondary and higher we get the risk of infant deaths is 6% higher with respect to reference level with p-value 0.047.

Moving to occupation status and considering not working or no occupation as reference level we get for risk of infant deaths in the unskilled worker in 1% lower with respect to reference level with p-value 0.018. For skilled workers with respect to reference level risk of infant death is about to 40% lower with the p-value. For economical status taking the poor class as the reference level, we get to the middle-class insignificant case of risk in that case. Considering the rich class on p-value 0.008 with respect to the reference level, the risk of infant deaths is 40% high. On the study of Residential status considering urban living as the reference level, we get the risk of infant deaths are 1.099 times higher in a rural area with p-value 0.042. Religious status consideration shows that if we take Hindus as reference level we get Muslims have 2% less risk of infant deaths with respect to reference level with p-value 0.006. For other religions, the risk of infant deaths is 0.03 times lower with respect to the reference level at significant p-value 0.005.

Gompertz Proportional Hazard Model results for infant deaths in case of Frailty

proportional hazard models is a properly used model for the survival study with consideration of time, here we move with the phenomenon of infant deaths with that explanatory variables which are not changed due to time in case of studying the frailty consideration of the model with inverse Gaussian frailty, after fitting infant deaths we get for the independent variable birth order with respect to birth interval we get the results such as if we consider up to 2 births in short interval as reference level we get for 2-4 births in short birth interval approximately 9% lower chance of survival with p-value 0.029. For more than 4 births in short interval with significant states, we get 17% lower chance of survival with respect to reference level p-value 0.036. For less than 2 births in the medium birth interval, we have the chance of survival is 1.05 times higher with respect to reference level on p-value 0.005. For 2-4 births in medium birth interval risk of infant death is 0.1 times lower with respect to the reference level of up to 2 births in short birth interval at p-value 0.008. For more than 4 births in medium birth interval risk of infant death is 26% higher with respect to reference level with p-value 0.007. For up to 2 births in large birth interval risk of infant death is 1.82 times higher with respect to reference level on p-value 0.045. For 2-4 births in large birth interval chance of survival is 58% lower with respect to reference level with p-value 0.024. For more than 4 births in large birth interval risk of infant death is 1.49 times higher on behalf of reference level on significant status with p-value 0.035.

Moving with the birth type and considering the single births as reference level we get with respect to reference level the risk of infant deaths is 2.02 times higher when twin birth occur with p-value 0.016. For multiple births occurring the relative risk with respect to the reference is 50% higher with p-value 0.012. Going with the mother's age and taking up to 20 year age women as reference status we get for the women in between 20 to 29 years we get the risk of child death is 11% lower with respect to reference level on p-value 0.049. For 30-39 year age group we get significantly 29% lower risk of infant death with respect to reference level with p-value 0.005. For 40 to 49 year age group women risk of infant deaths is 0.49 times lower with respect to the reference level at significant status and with p-value 0.032. Considering the maternal education to knowing about the chance of infant survival when we consider not educated status as reference level we get for primary educated women infant death is 1.34 times to reference level at significant state with p-value 0.025. When we consider the level of secondary and higher education we get on significant state risk of infant deaths in 9% higher with respect to reference level with 0.001.

Taking occupation level for study firstly we consider the not working or no occupation as reference level by that we get on the significant state in unskilled worker risk of infant deaths is 1.19 times is relatively high to reference

Table 8 Gompertz model for infant deaths with inverse Gaussian Frailty

Variables	Relative Risk	P- value
Birth order in Birth interval		P-value
Up to2 births in SBI	1	
2-4 births in SBI	0.9115	0.029
More than 4 births in SBI	0.8395	0.036
Up to 2 births in MBI	1.0522	0.005
2-4 births in MBI	0.905845	0.008
More than 4 births in MBI	1.26122	0.007
Up to 2 births in LBI	1.8233	0.045
2-4 births in LBI	0.4224	0.024
More than 4 in births LBI	1.49877	0.035
birth Type		
single birth	1	
twins	2.0277	0.016
multiple births	1.514	0.012
maternal Age		
Up to 20 years	1	
20- 29years	0.8935	0.049
30-39 years	0.71304	0.005
40- 49 years	0.504378	0.032
Maternal Education		
no education	1	
primary	1.3467	0.025
secondary and higher	1.0999	0.001
Occupation Level		
no occupation	1	
unskilled	1.1934	0.036
skilled	0.63486	0.043
Economical Status		
poor	1	
middle class	0.9868	0.005
rich	1.6216	0.007
Residence		
Urban	1	
Rural	1.0849	0.028
Religion		
[illegible]	[illegible]	

level with p-value 0.036. And for skilled workers on significant state relative risk of infant deaths is 38% lower with respect to reference level with p-value 0.043. Now moving to economical status considering the poor class on reference level stage we get for middle-class risk of infant death is 2% low with respect to reference level on significant state with p-value 0.005. And for rich class risk of infant death is 1.62 times higher with respect to the reference level at significant state with p-value 0.007. For residential status when we consider urban living as reference level we get in model in rural living infants have 1.08 times higher risk of death as reference level at significant state with p-value 0.028. Moving to religious factor with Hindus are considered as reference population is Muslims risk of infant deaths is 0.01 times lower with respect to reference level with p-value 0.007. In other religions, the relative risk of infant death is 1.02 times higher with respect to the reference level at significant state with p-value 0.005.

On study of change in risk of deaths in absence and presence of frailty, we get that the change in risk of infant deaths in presence of frailty from absence of it we get for birth order in given birth interval as 7.96%, 13.48%, 0.48%, 9.86%, -3.30%, -7.99%, 33.4%, -6.37% for each levels with respect to reference level. For birth type this change is of -35.5% and -2.84% on each level with respect to the reference level. For maternal age this change is of -2.46%, 5.22% 18.69% for each level with respect to the reference level. For maternal education the change is of -5.20% and -2.81% with respect to the reference level. For occupational consideration for each level with respect to reference level the change is of -11.55% and 4.408%. For economical status, this change is of 0.94% and -15.14% with respect to the reference level for each status. For residential status, this is the change of 1.36% with respect to the reference level for rural level. In the study of Religious status, the scene change is for each level with respect to the reference level of -1.15% and -4.54% from the study.

Gompertz Proportional Hazard Model results for Children deaths

From the phenomenon of children death with respect to independent variables rstly we consider the birth order with the corresponding birth interval with up to 2 births in short intervals as reference level we get for 2 to 4 births in short interval we get the chance of children, survival is 0.3 times lower with p-value 0.013. For more than 4 births in short interval, the chance of children survival is 0.19 times lower with respect to reference state with p-value 0.018. For up to 2 births in the medium interval on the significant state, we get the risk of children deaths is 0.26 times lower with respect to reference level with p-value 0.039. For 2-4 births in the medium birth interval, we get the chance of children survival is 38% higher with respect to reference level with p-value 0.001. Going with case of more than 4 births in medium birth interval we get the chance of children survival is 0.2 times lower with respect to reference level for this on significant state with p-value 0.016, for up to 2 births in large birth interval risk of children death is 0.33 times lower with respect to reference level on p-value 0.019, for the case of 2-4 births in large birth interval we get on p-value 0.006 the risk of children death is 10% lower with respect to reference level. In case of more than 4 births in a large birth interval with respect to the reference level, the chance of child survival is 0.33 times lower with p-value 0.021.

Moving to birth type for the case of children deaths with consideration of single birth as referring status we get the risk of children dying is approximately 68% higher for twins with respect to reference level with p-value 0.001, For multiple births the risk of children death is 1.71 times higher with respect to reference level with p-value 0.003. In regards to the maternal age when we consider up to 20 year age women as reference status, we get the risk of children deaths for the age of women in 20-29 years is 4% lower with respect to reference level on p-value 0.008. For 30-39 year are women risk of children death is 0.24 times lower with respect to the reference level on p-value 0.027. When we move with more than 40 year aged women with respect to reference level on the significant state

Table 9 Gompertz model for Children deaths

Variables	Relative Ratio of Survival	P- value
Birth order in Birth interval		P-value
Up to2 births in SBI	1	
2-4 births in SBI	0.6677	0.013
More than 4 births in SBI	0.81185	0.018
Up to 2 births in MBI	0.7467	0.039
2-4 births in MBI	0.6198	0.001
More than 4 births in MBI	0.8039	0.016
Up to 2 births in LBI	0.66805	0.019
2-4 births in LBI	0.9015	0.006
More than 4 in births LBI	0.6688	0.021
birth Type		
single birth	1	
Twins	1.6847	0.001
multiple births	1.717	0.003
maternal Age		
Up to 20 years	1	
20- 29years	0.9667	0.008
30-39 years	0.76155	0.027
40- 49 years	0.7983	0.003
Maternal Education		
no education	1	
primary	1.2319	0.029
secondary and higher	1.3308	0.005
Occupation Level		
no occupation	1	
unskilled	1.0938	0.016
skilled	1.0886	0.017
Economical Status		
Poor	1	
middle class	1.07046	0.033
Rich	1.3795	0.002
Residence		
Urban	1	
Rural	1.0234	0.006
Religion		
Hindu	1	
muslim	0.87143	0.001
Others	0.63748	0.018

we get the risk of children death is 21% lower with p-value 0.003. Now consider the variable of education status of women with not educated or illiterate as reference level we get for primary level educated female have the chance of children survival is 23% higher with respect to reference level with p-value 0.029 on the significant state. For secondary and higher level educated women the risk of children death is 1.33 times higher with respect to reference level with p-value 0.003.

Taking occupation level for study firstly we consider the not working or no occupation as reference level by that we get on the significant state in unskilled worker risk of children deaths is 1.09 times is relatively high to reference level with p-value 0.016. and for skilled workers on significant state relative risk of children deaths is 8% higher with respect to the reference level and p-value 0.017. Now moving to economical status considering the poor class on reference level stage we get for middle-class risk of children death is 7% high with respect to reference level on significant state with p-value 0.033. And for the rich class chance of children survival is 1.38 times higher with respect to the reference level at significant state with p-value 0.002. For residential status when we consider urban living as reference level we get in hazard model in rural living children have 1.02 times higher risk of death as reference level at significant state with p-value 0.006. Religious status consideration shows that if we take Hindus as reference level we get Muslims have 13% less risk of children deaths with respect to the reference level at significant status with p-value 0.001. For other religions, the risk of children deaths is 0.37 times lower with respect to reference level at p-value 0.018.

Gompertz Proportional Hazard Model results for Children deaths in case of Frailty

After fitting children deaths in presence of inverse Gaussian frailty we get for the independent variable such as birth order with respect to birth interval we get the results such as if we consider up to 2 births in short interval as reference level we get for 2-4 births in short birth interval 0.37 times lower risk with significant state with p-value 0.037. For more than 4 births in short interval with significant states, we get 23% lower risk of death with respect to reference level with p-value 0.026. For less than 2 births in the medium birth interval, we have the risk of child death is 0.29 times lower with respect to reference level on significant state with p-value 0.027. for 2-4 births in medium birth interval risk of children, death is 0.43 times lower with respect to a reference level of up to 2 births in short birth interval at significant state with p-value 0.003. For more than 4 births in medium birth interval risk of children, death is 23% lower with respect to reference level with p-value 0.009. For up to 2 births in large birth interval risk of children, death is 0.38 times lower with respect to reference level on significant state with p-value 0.048. For 2-4 births in large birth interval risk of death is 14% lower with respect to reference level with p-value

0.018. For more than 4 births in large birth interval risk of children, death is 0.42 times lower on behalf of reference level on significant status with p-value 0.022.

Moving with the birth type and considering the single births as reference level we get with respect to reference level the risk of children deaths is 1.84 times higher when twin births occur with p-value 0.003. For multiple births occurring the relative risk with respect to the reference is 78% higher with the p-value. For consideration of maternal age considering less than 20 year of maternal age as the reference level, we get the risk of children deaths in between the age of 20-29 years is 4% less with respect to the reference level of maternal age with the significant status and p-value 0.005. On the significance level maternal age in between 30-39 years shows 0.28 times lower risk of child deaths with respect to the reference level and p-value 0.025. For the age interval of 40-49 with respect to the reference level of maternal age risk of children, deaths are likely to 22% lower with p-value 0.049. Considering the education level of mothers and taking illiterates or not educated as reference level we get that women those who have the primary education the risk of their children deaths is 26% higher to the women who are not educated at the significant level with p-value 0.003. Considering the education level as secondary and higher we get the risk of children deaths is 40% higher with respect to reference level with p-value 0.11.

Moving to occupation status and considering not working or no occupation as reference level we get for risk of children deaths in the unskilled worker is 14% higher with respect to reference level with p-value 0.024. For skilled workers with respect to reference level risk of children, death is about to 14% higher with p-value 0.006. For economical status taking a poor class as the reference level, we get to the middle-class significant case of risk in that case with 9% higher with 0.025. Considering the rich class on the significant level with respect to reference level risk of children deaths is 44% high with p-value 0.007. On the study of Residential status considering urban living as the reference level, we get the risk of children deaths are 1.02 times higher in the rural area with p-value 0.015. Religious status consideration shows that if we take Hindus as reference level we get Muslims have 15% less risk of children deaths with respect to reference level p-value 0.017. For other religions, the risk of children deaths is 0.42 times lower with respect to the reference level at significant status with p-value 0.019.

Table 10 Gompertz model for Children deaths with inverse Gaussian Frailty

Variables	Relative Ratio of Survival	P- value
Birth order in Birth interval		
Up to2 births in SBI	1	
2-4 births in SBI	0.6361	0.037
More than 4 births in SBI	0.77558	0.026
Up to 2 births in MBI	0.71194	0.027
2-4 births in MBI	0.5719	0.003
More than 4 births in MBI	0.7718	0.009
Up to 2 births in LBI	0.62857	0.048
2-4 births in LBI	0.8606	0.018
More than 4 in births LBI	0.5886	0.022
birth Type		
single birth	1	
twins	1.8474	0.003
multiple births	1.7891	0.013
maternal Age		
Up to 20 years	1	
20- 29years	0.9555	0.005
30-39 years	0.72346	0.025
40- 49 years	0.78147	0.049
Maternal Education		
no education	1	
primary	1.2692	0.003
secondary and higher	1.40739	0.011
Occupation Level		
no occupation	1	
semi skilled	1.1438	0.024
skilled	1.1411	0.006
Economical Status		
poor	1	
middle class	1.09785	0.025
rich	1.4432	0.007
Residence		
Urban	1	
Rural	1.02668	0.015
Religion		
hindu	1	
muslim	0.85496	0.017

From the comparison of condition of presence of frailty towards absence of frailty we get that the change in risk of infant deaths with respect to frailty consideration birth order with respect to birth interval on reference level 4.96%, 4.67%, 4.88%, 8.37%, 4.15%, 6.28%, 4.75% and 13.62% respectively for each status. For birth type this change is of -8.80% and -4.02% on each level with respect to the reference level. For maternal age, this change is of 1.17%, 5.26% 2.15% for each level with respect to the reference level. For maternal education the change is of -2.93% and -5.44% with respect to the reference level. For occupational consideration for each level with respect to reference level the change is of -4.37% and -4.60%. For economical status this change is of -2.494% and -4.413% with respect to the reference level for each status. For residential status, this is the change of -0.319% with respect to the reference level for rural level. In the study of Religious status, the scene change is for each level with respect to the reference level of 1.92% and 9.63% from the study. Applying the results from analysis of deviance we get scenario such as

From the table we get that deviance analysis is significant for both infant and deaths at 7 d.f. each with log

Table 11 Analysis of Deviance table

death scenario	Difference of log likelihood	d.f.	sig.
infant	228.59	7	0
children	140.12	7	0

Like lihood differences with values 228.59 for infants and 140.12 for children. Due to which we get rejection of our hypothesis of there is significant effect of change in the number of variables for the models.

Results we get from Gompertz Proportional hazard model for infants and children deaths in consideration of absence and presence of frailty, we get from the results of principle component analysis, for the study in correspondence of their risk on the different level with respect to reference level. Starting with the first variable, birth order with corresponding birth interval we found that this variable is one of the most effective variables for understanding child mortality. Birth types and Maternal age condition shows a proper effect on under 5 mortality in very significant manner. The status of women education also provides the very wide effect on under-five mortality in our study of data of EAG states and Assam. Occupation level analysis shows that on under- five mortality there have a proper effect of occupation on unskilled as well as skilled labor. We get for the under- five mortality in case of economic status very effective in the manner of chances of child survival. In case residential status, we found that this statusdoes not very efficient for under 5 mortality. When it comes to religious composition in population of EAG states and Assam we have better effect condition of it on under 5 mortality.

On the study of percent changes in the hazard ratios when frailty is considered is have very proper changes. it has a very effective change for variables birth order in given birth interval, birth type, maternal age, education. That will remain to move in similar nature when we talk about occupational and economic, residential and religious status. The study shows that for a demographic phenomenon such as under 5 mortality several variable may be effective to explain it but some may cover most of effectiveness, and that parts have been affected by some other aspects known as frailty expect, that unobservable effects may be more significant to the scenario for the better planning of future consideration of demographic development in countries like India.

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