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RESEARCH ARTICLE

RELATIONSHIP OF HEALTH CARE PRACTICES AND SOCIAL STATUS OF MOTHERS WITH VARIOUS LEVELS OF CHILD MORTALITY: AN APPLICATION OF MULTINOMIAL REGRESSION MODEL

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ABSTRACT

Statistical Modelling is used in child mortality research since a long time in order to develop predictive models as well as to know the factors which affect the child mortality. There have been various socio-economic and biological variables identified from previous research which significantly effect child mortality, the role of these factors vary in case of child mortality in different ages of death of the child, so to find out such differences we classify the women according child mortality experience in four categories or levels i.e. Neo-natal mortality, Post neonatal mortality, toddler mortality and women who not experience child mortality in childhood period, further multinomial logistic regression model was applied to find out the effect of health care practises and social situation of mothers on various levels of child mortality. It was found that the colostrums feeding at birth protects from death at neonatal mortality and if a woman wants to have another child then the present child has risk to die in neonatal or post-neonatal period. The poor wealth index was came a risk factor for toddler mortality.

INTRODUCTION

Childhood mortality constitutes as a major public health problems and one of the major challenges to the health system in India. It is also broadly used as an indicator of the socioeconomic conditions of a country or region. The child mortality for India was 116 in 1990 which dropped by 69 in 2009 but as per UNICEF – India is in the list of high child mortality countries. The influencing factors of child mortality are mainly socio-economic factors, demographic factors and biological factors. Socio economic factors mainly result in the erogeneity of child deaths, like carelessness after birth which is often closely related with the socio-economic and cultural conditions. Demographic factors affect both of the endogenous and exogenous deaths; Endogenous child deaths mean deaths caused by the congenital malformations, genetic diseases and childbirth-related problems, which is difficult to prevent and control. Exogenous child deaths are caused by the illness or accident due to the infection after the child's birth, malnutrition, carelessness, and the other external causes. It has a close relationship with social, economic and cultural factors and can be prevented and controlled by public health measures, immunization, and antibiotic treatment. Biological factors mainly refer to the mother's fertility information and the total number of children born which are concerned at the family level rather than children level. The factors associated with variations in infant and child mortality are interrelated, so it is important to attempt to isolate the effects of individual variables. Multinomial logistic regression models allow us to estimate the adjusted effect of each variable while controlling the effect of other factors that are associated with infant and child mortality. While many cause or factors of child death differ substantially at different ages of childhood (Guo and Rodriguez, 1992; Sastry, 1997), so for the comparison of various factors which change its effect in various childhood periods (or at various levels of child mortality), a multinomial logistic regression model is used. It generates three equations separately for three age intervals or levels: the neonatal period (first month), the post-neonatal period (1–11months), and toddler (12–24 months).

Multinomial logistic regression models are a straightforward extension of logistic models for a dependent variable with more than two categories. Multinomial logistic regression is often considered as an attractive analysis because it does not assume normality, linearity, or homoscedasticity. Some fields of machine learning (e.g. natural language processing), when a classifier is implemented using a multinomial logit model as the classification rule, it is commonly known as a maximum entropy classifier, conditional maximum entropy model or MaxEnt model for short. Many authors contributed towards modeling of infant and child mortality (Cheo, 1981; Hobcraft, 1983; Krishanan and Jin, 1993; Singh *et al.,* 2008; Uddin

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et al., 2008 etc.). In recent studies Godson and Nnamedi (2012), examined the environmental determinants of child mortality in Nigeria using multiple regression for child mortality modelling in Nigeria. Estimation from the stepwise regression model showed that household environmental characteristics do have significant impact on mortality as lower mortality rates were experienced in households that had access to immunization, sanitation facilities, good and proper refuse and solid waste disposal facilities, good healthy roofing and flooring materials as well as those using low polluting fuels as their main source of cooking. Singh *et al.* (2013) examined the effect of socio-economic and bio-demographic variable on Neo-natal mortality in Uttar Pradesh, India using Cox-proportional hazard model. Estimated regression coefficient by model shows that parent's education, type of birth, birth order and wealth status of mother have significant effect on neo-natal survival. The various studies on child mortality perform taking neonatal death or infant death or child death, so here we take a new approach and trying to find out various factors which are affect child death in one month, one to twelve month and twelve month to twenty four month simultaneously by using multinomial regression model so that effect of various factor on different childhood ages can find and compare its variation in effecting child mortality in different ages in other words we say it various level of childhood mortality.

Objective

To study the relationship between Independent variables (health care practices and social status of women) and dependent variables (child mortality at various levels or childhood period) using multinomial regression model and to observe the changing behaviour of factors which effect child mortality at various levels by using the regression coefficient generated by multinomial logistic model.

METHODOLOGY

If the dependent variable is discrete with more than two categories, in other words follow a multinomial distribution as here child mortality have four categories Neo-natal death, Post –neonatal death, Toddler death and death not experience in childhood period (survive child). A logit link function is made in GLM (generalised linear Model) to relate multinomial response to independent variables or covariates.

Let us consider the child mortality for investigating the effects of health practices and social status of mothers on child mortality experience. The child mortality variable

$$Y = \begin{cases} 1, \text{ Neo-natal death, level first} \\ 2, \text{ Post Neo-natal death, level second} \\ 3, \text{ Toddler death, level third} \\ 4, \text{ Survive child, reference level} \end{cases}$$

Or the dependent variable , (i= 1,2 ,3,4) each takes value 1 if any case belongs to ith category or takes value 0 if does not belong to ith category. If for any case or trial or child the probability to going into ith category is and this probability is constant for any no. of case or trial or child then Σ =1. Then this situation is taken as multinomial situation.

If total n (j=1,2….n) number of case taken in study then Σ (over j)=

Then ΣΣ = + + + = n

Then according to GLM 3 logits are defined by ln — (— say odd), because last category is taken as reference category. This means that the logits relate the ratio of two probabilities to independent variables. For m independent variables or covariates the general multinomial logistic regression model becomes

ln — = + + ...+ , i=1,2,3

Where = Intercept for the category i

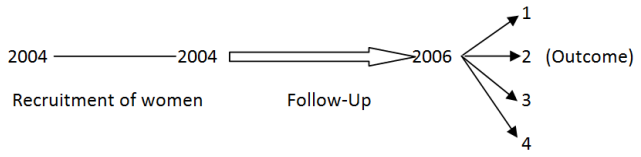
= Regression coefficient of variable for category i.

The above model provides 3 equations for 4 categories and that we have one regression coefficient for each equation. Any of the categories can be chosen to be the baseline (reference). The model will fit equally well, only the values and interpretation of the regression coefficients will change. The generated regression coefficient (β) for a covariate can be interpreted as: the increase in log-odd of falling into category i versus category 4 resulting from one-unit increase in the corresponding continuous covariate, holding the other covariates constant. But in case of categorical covariates the generated regression coefficient for a covariate can be interpreted as the increase in log-odds of falling into category i versus category 4 resulting from particular attribute in covariate is present or we can say that the exp(β) say that how many times odds of i category is high when particular attribute present in covariate with comparison to its absent holding the other covariates constant. This measure (exp(β)) called as odds ratio. In present study nine independent variables or covariates are taken for analysis. At first cross tabulation analysis was performed for dependent and independent variables, further association is checked with child mortality with all independent variables by use of chi-square test at 5% level of significance and the variables found significant associated (P value<0.05) to child mortality were taken for the multinomial logistic regression model to find out the adjusted effect of each independent variable on child mortality holding other independent variable constant. All the analysis was performed in SPSS 16.0 software.

Data and Covariates

The Data was taken from the DLHS-3 survey of women 15-49 years age –group with recent live birth in 2004 for the Empowered Action Group (EAG) States namely Uttar Pradesh, Uttarakhand, Rajasthan, Madhya Pradesh, Orissa, Chhattisgarh, Bihar and Jharkhand, The selected states have poor level of health indicators (report-2012) and less developed comparison to other part of country. The women taken here followed up to 2006 and find out of total no. of women to going each category of child mortality describe in Fig.1. The District Level Household and Facility Survey (DLHS-3) is a nationwide survey covering 601 districts from 34 states and union territories of India. It provides estimates on maternal and child health, family planning and other reproductive health

indicators. DLHS-3 adopted a multi-stage stratified probability proportion to size sampling design Fig.1.



The International Institute for Population Sciences (IIPS) was designated as the nodal agency for carrying out the survey. The selected women characteristics are defined in Table-1 and 2.

Table 1. Distribution of selected women in study according States

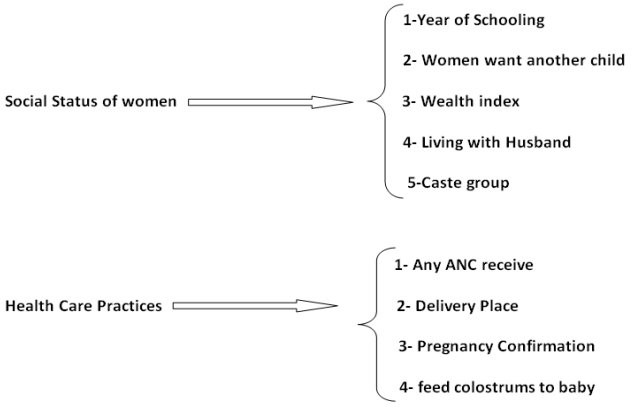
State	Number	Percentage
Uttarakhand	327	2.50
Rajasthan	1459	11.15
Uttar Pradesh	4429	33.84
Bihar	2139	16.34
Jharkhand	1352	10.33
Orissa	880	6.72
Chhattisgarh	853	6.52
Madhya Pradesh	1650	12.61
Total	13089	100.00

Table 2. Distribution of selected women in study according baseline characteristics

Variable	Number	Percentage
Age-group(At birth)		
15-25	5446	41.6
25-35	6584	50.3
>35	1059	8.1
Place of Residence		
Rural	11143	85.1
Urban	1946	14.9
Women education		
Illiterate	8199	62.6
Literate	4890	37.4
Caste		
SC/ST	4155	31.7
Others	8934	68.3
Religion		
Hindu	11191	85.5
Non Hindu	1898	14.5
Wealth index		
Poor	3767	28.8
Middle	5589	42.7
Rich	3733	28.5

The total nine independent variables which represent the social status as well as health care practices of mothers were taken to observe the effect of these variables on various levels of child mortality. The independent variables or covariates are described in Fig.2.

In past research it was found that year of schooling is a variable which significant influences the child mortality as well as it is a confounding variable (Report-2012) to other social and health related variable which effect the child mortality, in many research studies year of schooling was taken as categorical variable taken as confounding variable so here taken also, Wealth index quintile defined economic status of female or household so here Wealth index quintile was taken as wealth measure in study. In general women having higher social status tend to produce lesser no. of child or put reasonable gap into two consecutive child (Report-2012) so "women want another child" variable was taken as to determine the social status. Living with husband for a female in middle and higher social status is more common while in low status society husband is often migrated to earn livelihood Fig.2.



Due to caste bifurcation in social setting of selected states caste group defined as a key element to determine social status of women. Any ANC (Ante-natal checkup) was defined by checkup in pregnancy period of female, the question arise here only for at least one ANC visit for female. ANC visit of pregnant lady shows her utilization status of health care for own and her outcome baby, the ANC visit is essential because it plays important role in determining child mortality as well as maternal mortality. Delivery in hospital is safer as compared to home because equipment and medical health workers are involved in monitoring the delivery. Pregnancy confirmation is essential for a woman because when pregnancy is confirmed they become conscious about their nutritional supplements during pregnancy and ANC checkups during delivery. When mother delivers a baby then first milk produced by mother just after delivery is known as colostrums, feeding colostrums to child protects from various types of infection and develops the immunity in new born.

RESULTS

The results of cross tabulation analysis are shown in Table -1. From Table -1 it is clears that independent variables literacy, women want another child, wealth index were significantly associated with child mortality. Whereas living with husband, posses BPL card and delivery place were not associated with child mortality. Table-2 gives the outcome of multinomial regression analysis for each independent variable; three regression coefficients (β) were generated corresponding to neonatal level, post neonatal level and toddler level, whereas having survival child was taken as reference category in dependent variable. Table-2 also gives the standard error (S.E. (β)) of regression coefficients and odds ratio (OR) for each independent variable. Though level of literacy did not show significant relation to child mortality in multinomial regression but it shows the illiteracy increases risk of child mortality in neonatal to toddler level. If a woman wishes to have another child then it is a risk factor to neonatal and post neonatal mortality and significant behavior of risk going down from neonatal to toddler level in comparison to women who were undecided about further child. It was also found having poor

Table 3. Outcome of Cross tabulation Analysis between dependent and independent variable

Variables	Categories on the basis of child mortality					
	Neo-Natal(NN)	Post NN	Toddler	Survive	Total	P-value
	Variables represent social status of women					
Literacy						
literate	48(1.0)	29(0.6)	10(0.2)	4803(98.2)	4890(100)	
illiterate	94(1.1)	71(0.9)	35(0.4)	7999(97.6)	8199(100)	0.04
Woman want another child						
Yes	66(2.3)	32(1.1)	16(0.5)	2797(96.1)	2911(100)	
NO	37(0.7)	31(0.6)	14(0.3)	5399(98.5)	5481(100)	<0.01
Undecided	39	37	15	4606(98.1)	6697(100)	
Wealth index						
Poor	50(1.3)	31(0.8)	23(0.6)	3663(97.2)	3767(100)	
Middle	58(1.0)	45(0.8)	17(0.3)	5469(97.9)	5589(100)	0.008
Rich	34(0.9)	24(0.6)	5(0.1)	3670(98.3)	3733(100)	
Living with husband						
Yes	119(1.0)	86(0.7)	41(0.4)	11246(97.9)	11492(100)	
No	23(1.4)	14(0.9)	4(0.3)	1556(97.4)	1597(100)	0.41
Caste Group						
SC/ST	54(1.3)	36(0,8)	18(0.4)	4048(97.4)	4155(100)	
Others	88(1.0)	65(0.7)	27(0.3)	8754(98.0)	8934(100)	0.21
	Variables represent Health care practices of women					
Any ANC receive						
Yes	82(1.1)	45(0.6)	21(0.3)	7550(98.1)	7698(100)	
No	60(1.1)	55(1.0)	24(0.4)	5252(97.4)	539(100)	0.01
Delivery Place						
Hospital	36(1.2)	18(0.6)	7(0.2)	3028(98.0)	3089(100)	
Home	106(1.1)	82(0.8)	38(0.4)	9774(97.7)	10000(100)	0.31
Pregnancy confirmation						
Yes	35(0.9)	17(0.4)	7(0.2)	3927(98.5)	3986(100)	
No	107(1.2)	83(0.9)	38(0.4)	8875(97.5)	9103(100)	0.001
Feed -colostrums						
Yes	46(0.5)	63(0.7)	27(0.3)	9161(98.5)	9297(100)	
No	96(2.5)	37(1.0)	18(0.5)	3641(96.0)	3792(100)	<0.001
Total	142(1.1)	100(0.8)	45(0.3)	12802(97.8)	13089(100)	

R^c = Reference category in independent variable.
* = Significance at 5% level of significance.
$^{\#}$ = Significance at 10% level of significance.

Table 4. Outcome of Multinomial logistic regression analysis

	Neo-Natal level			Post neo natal level			Toddler level		
Variable	β	S.E.(β)	OR	β	S.E.(β)	OR	β	S.E.(β)	OR
Intercept	-3.58	0.30		-4.29	0.35		-6.07	0.62	
Literacy									
Illiterate	-0.129	0.211	0.88	0.142	0.25	1.15	0.13	0.40	1.14
literate	R^c								
Woman want another child									
Yes	1.04	0.21	2.84*	0.415	0.244	1.51$^{\#}$	0.580	0.36	1.79
No	-0.33	0.23	0.72	-0.37	0.246	0.69	-0.250	0.37	0.78
Undecided	R^c								
Wealth index									
Poor	0.25	0.26	1.283	-0.18	0.31	0.83	1.20	0.55	3.31*
Middle	0.03	0.24	1.025	-0.09	0.27	0.91	0.59	0.54	1.80
Rich	R^c								
Any ANC receive									
Yes	0.09	0.19	1.09	-0.35	0.23	0.71	-0.13	0.33	0.88
No	R^c								
Pregnancy Confirmation									
Yes	-0.13	0.23	0.878	-0.58	0.31	0.56$^{\#}$	-0.43	0.46	0.65
No	R^c								
Feed Colostrums									
Yes	-1.73	0.18	0.18*	-0.329	0.21	0.72	-0.45	0.31	0.64
No	R^c								

level of wealth index is risk for toddler mortality in comparison to rich wealth index. Any Ante Natal checkup (ANC) does not show any significant relation to any level of child mortality although it comes significant in cross tabulation analysis. Pregnancy confirmation was found as a protective factor for all levels of child mortality, but it shows significant relationship with only post-neonatal mortality. Feeding colostrums to baby was also found significantly protective for neonatal mortality.

Conclusion

The colostrums feeding practice saves the child from mortality so this practice should be propagated. The future fertility

behavior of women that they want another child shows a proxy for death of current child, so if a woman wants further children then she must take more care for the current child. It is also observed that some independent variables associated with child mortality by cross-tabulation analysis but are rejected as invalid when checked by those based on refined technique such as multinomial regression. Such a situation may be due to interrelationship between independent variables. The effect of variables ANC receive not found significant on child mortality after adjusting of social status of women. The effect of other health care practices variable effect on child mortality also became week after adjusting for social status of mothers. So it is clear that child mortality outcomes have relationship with social status of mothers in selected EAG states. In the results it was also found that the effect of various variables on child mortality varies with different levels so a proper emphasis should be given to act on these factors to reduce child mortality at various levels during planning by the government.

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