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Determinants of Adult Mortality in India

Abstract: *This study attempts to evaluate the factors affecting adult mortality with special emphasis on the life style factors using NFHS 1998-99. The sample size N in this analysis is 3,30, 267 in age 15 to 59 of which 2.6 percent persons died during adulthood. In Poisson regression model, the independent variables used are age, sex, place of residence, life style factors of other members of the family, standard of living, literacy composition, caste, religion, mass media exposure, household type, fuel for cooking, region of residence etc. This analysis has been adjusted for the clustering of deaths at family level. The findings clearly suggest that there exists strong positive relationship between the life style factors and premature mortality even after controlling other back ground characteristics of the dead person. Further, age, SLI, literacy composition, religion, household type, region of residence are some important determinants of adult mortality in India.*(250 words)

Key words: adult, mortality, socio-economic, India, health, age, death, smoking, life style, Poisson, cluster.

Introduction

Living long is a much desired aspiration by everyone. A long life is universally valued and valued very strongly. This is not only because living as a state of being is itself valued, but also because it is a necessary requirement for carrying our plans and projects that we have reason to value (Sen, 1995). Mortality statistics can be helpful in the formulation of economic policy decisions over a large field, covering overall performances as well as distributional concerns regarding class, gender and race. As far as infant and child mortality in India are concerned, there has been much discussion with respect to class, gender, race and other background characteristics. However, little attention has been paid to the different aspects of mortality among adults in India despite the being the most productive section of society. Any impairment to this section through disease or untimely death will inevitably lead to a decline in national efficiency and a slowdown in overall national development. Additionally, determinants of adult mortality are not necessarily the same as that of infant and child mortality. In the determination of child mortality where the infectious and parasitic diseases predominate, the impact of environmental contamination is pre-eminent whereas in the case of adult mortality, where chronic diseases predominate, the likelihood of death from individual's health behavior is higher than the environmental contamination (Lopez et al. 1995). Lack of research on adult mortality in India may be due to lack of good quality data and also insufficient use of the information that have already been collected without considering the quality (Saikia and Bhat, 2006; WHO, 2008). The

study of health and survival of adults, knowing the chances of dying at each age for either sex, how the risk factors have changed over time, and understanding the factors behind the premature mortality are as important as that of under five mortality especially when a country like India passes through the epidemiologic transition period. The epidemiologic transition, as Omran, pointed out, is characterized principally by a decline in infectious diseases, which strike disproportionately at young children, and a corresponding rise in the proportion of deaths and of morbid episodes that occur among adults (Omran, 1971; Rogers and Hackenberg, 1987). Adult mortality, in particular, deserves special attention in any society as death during the most productive years of life leads subsequent economic and psychological losses to the other living members of the family and society. According to WHO report, India ranks third, next to only Myanmar and Nepal, among all South Asian countries ordered by adult death rate in 2001 (WHO, 2008). In addition, as table A depicts, the probability of survival from age fifteen to sixty in India is far lower than that of other developed & developing countries like USA, Japan & Sri Lanka (table A) which indicates that there is still scope for improving life expectancy during adulthood in India.

table A Survival probability from age 15 to 60 by country, (As reported in National and other sources)

		Survival Probability			Survival Probability	
Country	Period	Male	female	Period	Male	female
India	1970-1975	0.66	0.68	2000-2004	0.75	0.82
China	1973-1975	0.78	0.81	-	-	-
Bangladesh	1974	0.60	0.60	1994	0.75	0.73
Sri Lanka	1967	0.80	0.85	-	-	-
United Kingdom	1970-1972	0.82	0.89	2001-2003	0.89	0.93
Australia	1970-1972	0.80	0.89	2001-2003	0.91	0.95
Japan	1970	0.83	0.90	2003	0.90	0.96
USA	1971	0.77	0.87	2002	0.86	0.92

Source: World Mortality Report, 2005 & SRS, 2000-2004

Since coverage by the Vital Registration system is very poor in India, we get relatively reliable estimates of adult mortality only from the early seventies provided by Sample Registration System at the national and state level, although it has been criticized for undercounting adult mortality (Bhat, 2001). Thus prior to SRS the only way to estimate adult mortality was application of indirect techniques on Census data on age and growth rate of population. There is no doubt that Census data suffers from limitations such as changing enumeration completeness, age misreporting and migration; nevertheless comparison of e_5^0 from Census data using variable r-methodology with that of SRS demonstrates a fairly good level of

agreement (Table B) which further permits use of this method on Census data before the existence of SRS. Table B shows a continuous rise of life expectancy at age five; highest and lowest increase during 1961-1971 and 1951-1961 respectively. Sex differential in mortality during adulthood is not very high but it has been increasing continuously over time since the pace of declining mortality of females is faster than that of males.

Table B. Levels and Trends of Adult Mortality measured by e_5^0 derived from different Indirect Techniques and Sample Registration System, India, 1941-2008

Decade	variable-r method		Other Estimates		Source
	Male	Female	Male	Female	
1931-1941					
Adjusted for immigration and over count in 1941	42.9	44.1	44	41.7	Davis (1951)
1941-1951					
Adjusted for immigration and over count in 1941	47.1	46.6	45.6	45.2	Visaria (1969)
1951-1961					
Adjusted for immigration	47.2	46.8	48.2	47.9	Visaria (1969)
1961-1971					
Adjusted for undercount in 1971	53.8	53.3	50.2	55.4	Bhat, Preston & Dyson(1984)
1971-1981					
Adjusted for undercount in 1971	57.6	58.3	57.9	59	Official SRS L.T.
1981-1991					
Adjusted for undercount in 1991	60.1	61.7	60.5	62.1	Official SRS L.T.
1991-2001	-	-	63.3	62.3	Official SRS L.T.

Source: Bhat, 1998 and SRS abridge life tables

Mortality studies of India are particularly focused on infant and child mortality. Previous research shows that the mortality burden among infant and child mortality varies from one region to another (Dyson and Moore, 1983; Subramanian et al. 2006). Infants or children belonging to households with the lowest wealth quintile and rural family, socially disadvantaged groups have higher risk of mortality than others (IIPS & ORC Macro, 2007). Available literature indicates that there are few studies addressing adult mortality in India other than estimating level and trend by applying different indirect techniques on Census data. In particular, there are very few studies about the determinants of premature mortality in India. As mentioned earlier, one important reason behind the dearth of knowledge about socio-economic determinants of adult mortality in India may be lack of data: as the SRS does not provide socio-economic information of adult deaths (Saikia and Bhat, 2006). Using SRS and Vital Registration data, Dyson (1984) focused on sex differentials in adult mortality in India and found that after age 35 men almost certainly experience much heavier death rates than women, and at these later ages male life expectation is significantly shorter than that of the females. He further remarked that male death

rates at later ages in India are surprisingly high by international standards. Krishnaji et al. (2002) emphasized urban rural mortality differential along with regional variation of death among adults. A very recent case-control study on smoking and death in India done by Jha et al. (2008) found that persons who died were older and less educated and had a higher prevalence of smoking, tobacco chewing and alcohol use than did living control subjects. In this study, mortality risk ratios comparing smokers with non-smokers were adjusted for age, educational level and use of alcohol. However, along with life style and demographic factors, adult mortality may be result of many other socio-economic factors which can be examined from cross sectional data from the National Family Health Survey which provides many other indicators influencing mortality. The earlier analysis have not provided a comprehensive picture of all the factors affecting adult mortality within a complete socio-economic and demographic framework. Hence the main objective of this paper is to put forth the factors affecting adult mortality in India all together under the following conceptual framework which is a derived from the framework originally provided by Rogers et al. (2002). Usually demographers continue to place a great deal of focus on demographic and social factors associated with adult mortality (Rogers et al. 2005). However this conceptual framework introduces proximate factors viz. health behavior, health condition, physiological influences etc. which mediate the effects of demographic and socio-economic factors on mortality. These factors are acquired throughout a person's lifetime and compared to demographic and social factors have a more direct impact on the risk of mortality at particular ages. The importance of these factors, in particular, health behavior factors have been increasing in developing countries in recent time due to a changing pattern of cause of death. According to Ezzati et al. (2006), Ischemic heart disease and Stroke are the top two diseases (attributing 11.8 and 9.5 percent of deaths to the total deaths) in low and middle income countries. Previous clinical studies shows that both of these diseases are influenced by active or

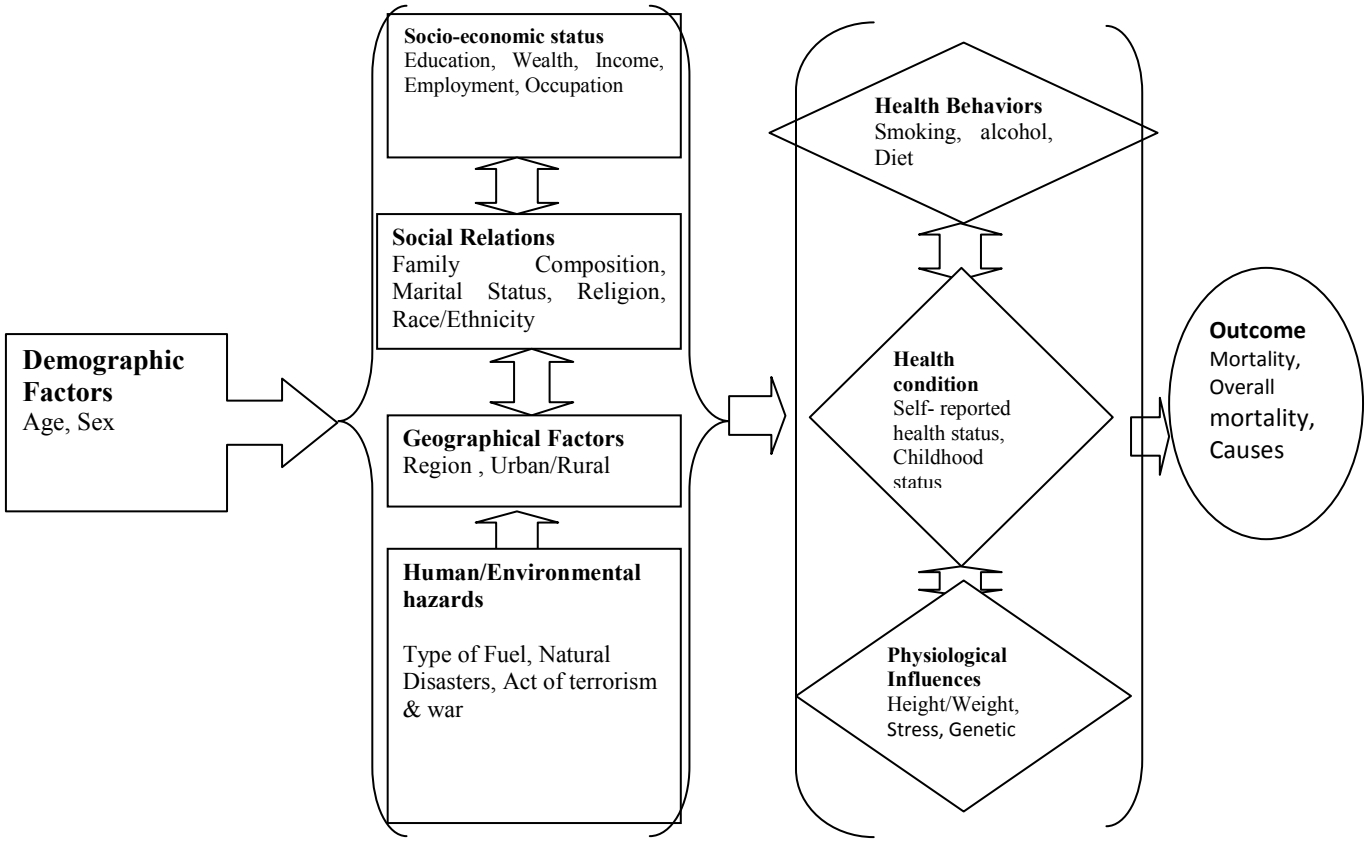

Figure1. Conceptual framework for factors affecting adult mortality in India

passive smoking of the individuals. (Meade et al. 1987; Barry et al. 1989; Yao He et al. 2008; Kelly et al. 2008). According to Medical Certification of Cause of Death report 2001[1], diseases of the circulatory system such as Pulmonary circulation, Ischemic heart disease and Cerebrovascular diseases, are the first leading major causes of fatality accounting 28 percent of male and 27 percent of female deaths in urban India during 1985-2001 and the prevalence of these diseases has been continuously increasing over time. The second leading major causes are certain infectious and parasitic diseases, among which tuberculosis is the highest reported cause of mortality. Similarly, disease of the respiratory system is another major leading cause of death

[1] The report for Medical certification of cause of death 2001 is the twenty-eighth in the series of the publication presenting statistics on causes of death obtained through the Civil Registration System under the Registration of Births and Deaths Act, 1969. Section 10(3) of the Act provides for issuing a certificate of cause of death by the medical practitioner who has attended on the deceased at the time of death. In the report, data on medically certified deaths received from 24 States/UTs has been tabulated in conformity with the International Classification of diseases (ICD) Tenth Revision (1993).

in India. A very recent study conducted in rural Andhra Pradesh has also found that diseases of the circulatory system were the leading causes of mortality (32 percent), with similar proportions of deaths attributable to ischemic heart disease and stroke. Infectious and parasitic diseases (12 percent) were the third important causes of death, tuberculosis and intestinal conditions each caused one-third of deaths within this category (Joshi et. al, 2006). All the above major groups of diseases have important correlation with health related behaviors. Although health related behaviors such as smoking tobacco or drinking alcohol are examined in the medical, public health and epidemiological literature (Gajalakshmi et al. 2003, Sankaranarayanan et al. 1990), because of their direct biological links to the mortality, it would be interesting to examine the effects of these factors on a particular age group after controlling the effect of socio-economic and demographic variables.

Data and Methodology

Data used in the study comes from the National Family and Health Survey carried out in India in 1998-1999 (IIPS & ORC Macro, 2000). The National Family Health Survey (NFHS) is a large-scale, multi-round survey conducted in a representative sample of households throughout India. The second National Family Health Survey (NFHS-2) conducted in 1998-99 is the outcome of collaborative efforts of many organizations like the International Institute for Population Sciences (IIPS), United States Agency for International Development (USAID) and United Nations International Children Fund (UNICEF). Responsibility for data collection was entrusted to 13 reputed organizations in India, including some Population Research Centers. The survey covered a representative sample of about 91,000 ever-married women aged 15-49 from 26 states in India who were covered in two phases, the first starting in November 1998 and the second in March 1999. A uniform sample design was adopted in all the states. In each state, the rural sample was selected in two stages: the selection of Primary Sampling Units (PSUs), which are villages, with probability proportional to population size (PPS) at the first stage, followed by the random selection of the households within each PSU in the second stage. Both for rural and urban areas, the 1991 Census list of villages and wards served as the sampling frame. The list was stratified by a number of variables; the first level of stratification was geographic, with districts being subdivided into contiguous regions. Within each of these regions, villages were

further stratified using selected variables from the following list: sub-regions, village size, percentage of males working in the nonagricultural sector, percentage of the population belonging to scheduled castes or scheduled tribes, and female literacy; however, these variables vary from one state to another state.

In every state, a mapping and household listing operation was carried out in each sample area. This listing provided the necessary frame for selecting households at the second stage; the households to be interviewed were selected with equal probability from the household list in each area using systematic sampling. The interval applied for the selection was determined to obtain a self-weighting sample of households. In urban areas, a three-stage procedure was followed. The procedure adopted for the first stage of the sample design in urban areas was similar to the one followed in rural areas. The 1991 Census list of wards was arranged according to districts and within districts by the level of female literacy, and a sample of wards was selected systematically with probability proportional to size. Next, one census enumeration block, consisting of approximately 150–200 households, was selected from each selected ward using the PPS method. Household selection procedure in the urban areas was the same as in the rural areas.

The principal objective of NFHS-2 was to provide state and national estimates of fertility, the practice of family planning, infant and child mortality, maternal and child health and the utilization of health services provided to mothers and children. In addition, the survey includes information on the quality of health and family welfare services and provides indicators of the status of women, women's reproductive health, and domestic violence. The survey provides state-level estimates of demographic and health parameters as well as data on various socio-economic and program dimensions, which are critical for bringing about the desired change in demographic and health parameters. In addition, the survey questioned the head of the household or any other adult member on the number of deaths that had occurred in the household during the two years preceding the survey, the cause of death, age and sex of the deceased member. Since data on socio-economic conditions of the households are also collected, the data on deaths provide an opportunity to examine mortality by such factors. This is in contrast to the Sample Registration System (SRS) that does not provide tabulations by socio-economic factors in normal rounds. Thus, though the SRS estimates, based on dual recoding, are considered quiet reliable

and commonly used, the NFHS scores over the SRS in facilitating socio-economic differentials in mortality. However, adult mortality data obtained from a question asking a household member to report any deaths in the last one or two years may be subject to recall bias. Therefore before drawing any inference on the basis of above-mentioned data, it would be appropriate to evaluate the quality of data in order to ensure the accuracy of the conclusions drawn in further analysis. For this purpose we have constructed a life table on the basis of survey data for males and females separately for fifteen major States of India.

Table C Comparison of $_{45}q_{15}$ from NFHS II and SRS at national and sub national level, India

	C.1998 Male			C.1998 Female		
State/Country	**NFHSII**	**SRS II**	**Ratio=N/S**	**NFHS II**	**SRS II**	**Ratio=N/S**
A.P.	0.32	0.28	1.11	0.25	0.20	1.23
Assam	0.28	0.32	0.89	0.31	0.29	1.06
Bihar	0.31	0.25	1.25	0.31	0.25	1.23
Gujarat	0.27	0.25	1.09	0.23	0.17	1.34
Haryana	0.19	0.24	0.79	0.17	0.16	1.07
Karnataka	0.30	0.27	1.09	0.20	0.18	1.10
Kerala	0.14	0.20	0.71	0.09	0.09	0.96
MP	0.31	0.29	1.05	0.29	0.24	1.20
Maharashtra	0.25	0.24	1.02	0.22	0.16	1.35
Orissa	0.26	0.29	0.91	0.29	0.25	1.14
Punjab	0.23	0.24	0.95	0.17	0.17	0.98
Rajasthan	0.27	0.25	1.12	0.20	0.16	1.28
T.N.	0.35	0.26	1.31	0.20	0.18	1.08
UP	0.32	0.27	1.25	0.24	0.22	1.07
WB	0.24	0.23	1.04	0.19	0.19	0.97
India	**0.29**	**0.26**	**1.12**	**0.24**	**0.20**	**1.19**

The adult age specific death rate for the life table has been calculated by applying the technique of Lexi's diagram to back project usual resident age-sex structure two years ago to the date of survey (Saikia & Bhat, 2006). Table C presenting $_{45}q_{15}$ obtained from NFHS and SRS indicates a high level of concordance of adult mortality between these two sources. Further, it is observed that the probability of death during adulthood from NFHS data is higher than that of SRS data at national level for both sexes. The coverage of female deaths in NFHS seems to be better in almost all States. As far as male mortality is concerned, states like Assam, Haryana, Kerala and Orissa have better coverage in SRS than NFHS. At the all India level, NFHS estimates are higher for both male (12 percent) and female (20 percent) than that of SRS. This finding is supported by previous studies which show that completeness of death registration among adults in India is 86 to 87 percent during 1990-1997 (Bhat, 2001). In addition, NFHS estimates of crude death rate (CDR) and age specific death rates (ASDR) are higher than the SRS estimates

for both rural and urban areas (IIPS & ORC Macro, 2000). Hence one can assume that under registration of adult deaths does not pose a serious problem in analyzing these data further.

The household file of NFHS provides information of age of the usual residents at the time of survey and age along with the year of death for the dead persons. To get the age structure two years back for those persons who are living at the time of survey, we have simply subtracted two years from their age at the time of survey. On the other hand, to get the age structure two years back for those persons who had died two years proceeding to the survey, we first calculate their age at survey date if they would have lived up to the survey date. To get a dead person's age at survey if he/she would have lived, the interval between the survey date and the time of the death (month and year of death) has been calculated and this has been added to the age at death. From this age, two years have been subtracted to obtain what were the ages two years before the survey. Thus, people were exposed to the risk of death two years prior to the survey date. Since our main concern is only adult deaths, we consider persons of age group fifteen to fifty nine. For the multivariate analysis, we construct the dependent variable assigning zero to the persons who have lived up to survey date and one to the persons who had died two years prior to the survey. Smoking or chewing tobacco and drinking alcohol by any member of the household are taken as independent variables in the multivariate analysis. It is worthwhile to mention that data does not provide behavioral factors such as smoking, drinking and chewing tobacco of the dead person itself for which we take that of household members either as a proxy for the dead person's behavior or to examine the resultant impact of these behavior on the dead person . Question may arise how smoking behavior of surviving persons could have influenced the behavior of dead person. There are some previous studies which reveal that smoking behavior spreads through close and distant social ties; it depends on the smoking habit of spouse, siblings and friend (Christakis & Fowler, 2008). Several other studies showed that smoking initiation in adolescence is associated with sibling and parental smoking (Conrad et al., 1992; Tyas and Pedersson, 1998). Osler et al. (2001) found that there is a family resemblance in smoking behavior especially within the same generation. Further, examination of NFHS II and III data shows that (IIPS & ORC Macro, 2000 & 2007) smoking and drinking behavior is clustered within the family. For example, it is observed that the households of size 11 members have 3.0 percent persons as smokers and the households of size 12 members have 3.1 percent

persons as smokers and so on. It indicates possible clustering of life style factors at family level. Thus we can assume that lifestyle factors are highly clustered at the family level.

The other explanatory variables used in this analysis are important socio-economic and demographic variables such as age, age square, sex, type of residence (rural & urban), standard of living of the household (low, medium and high), literacy composition (no literate & at least one literate), religion (Hindu, Muslim and Others), caste (General or OBC, ST and SC), Mass Media (No exposure and at least one exposure), Type of household (nuclear family, Type of fuel used for cooking (Electricity/LPG/Bio-gas, Wood, Crop residue/dung cake/Coal/Charcoal, Kerosene) joint and region (North, South, East, West, Central and North-East).

To examine the factors affecting adult mortality in India, bi variate and multivariate analysis have carried out. Poisson regression has been carried out as the predictor information is related to the rate of susceptibility of the response to increase or decrease in counts. Poisson regression is a regression model that assumes that the outcome variable follows a Poisson distribution (where occurrence of an event is rare in a large sample) and is appropriate when the dependent variable is a count, such as death, which can take only integer value.

A Poisson random variable Y has probability density function, $f(y) = P(Y = y)$ given as,

$$f(Y_i) = \frac{e^{-\mu}\mu^{Y}}{Y!}$$

Where $f(Y)$ denotes the probability that the variable Y takes non-negative integer values. The parameter μ is the mean value of the random variable Y, $E(Y) = \mu = V(Y)$. This random variable takes on values from zero to infinity, at integers.

The Poisson regression model may be written as

$$Y_i = E(Y_i) + u_i = \mu_i + u_i$$

Where the Y's are independently distributed as Poisson random variables with means μ_i for each individual expressed as $E(Y_i) = \mu_i = \{\beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + ... + \beta_k x_{ki}\}$. (Gujarati, 2006).

In this study the number of exposed person is 330267 of which only 8668 (2.6 percent) deaths had occurred. It is further assumed that events are independent in the sense that occurrence of one death will not make occurrence of another event more or less likely. However,

typical use of the Poisson regression may violate this assumption in the presence of death clustering at the family level. Previous studies on infant and child mortality indicates clustering of deaths at the family level indicating correlation of risk in family (Dasgupta, 1990; Omariba, 2008). There may be a number of reasons why deaths may cluster within family. During childhood, siblings share the same living conditions and economic and social resources. However, there are strong indications that differences in parental behavior are important. For example, Das Gupta emphasizes the importance of 'parental competence': 'Incompetent' parents give their children poorer care, are slower to recognize and respond effectively to their needs, and consequently lose children." (DasGupta, 1990). Sometime simple actions, like washing hands and utensils and avoiding polluted water or contaminated food, may have contributed to inter-family mortality differentials. There are, of course, few studies addressing clustering of deaths for adult mortality. Still, if lower mortality was due to types of personal behavior learned in childhood, it should carry over to mortality at older ages. If people learned good health habits as children, then those who grew up in homes with lower infant and child mortality should have had lower mortality in adulthood. Thus 'cluster' command has been used while running Poisson regression which specifies that observations are independent across the groups (Here group will be 'household'), but not necessarily within the groups (Stata, 2003). By doing so, we are adjusting standard error estimates and Variance-covariance matrix.

While including variables in the model, we conducted the Wald test to know whether the independent variables are really predictors or not. In case any variable is not really a predictor, we have dropped that variable. To check the appropriateness of Poisson regression, we have done Pearson goodness of fit test. The goodness of fit χ^2 tells us that, given the model, we accept the hypothesis that these data are Poisson distributed.

Since the demographic performance in India is different in different regions of residence, particular attention was paid to adjust the estimates for region of residence. For this purpose India was divided into six regions based on the geographical locations and cultural settings. The six regions include north (Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Delhi, and Uttaranchal), central (Uttar Pradesh, Madhya Pradesh and Chhattisgarh), east (Bihar, Jharkhand, West Bengal, and Orissa), northeast (Arunachal Pradesh, Assam, Manipur,

Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura), west (Gujarat, Maharashtra and Goa) and south (Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu).

Four different sets of models were constructed to examine the unadjusted and adjusted effects life style behaviors. This is done to understand the pathway through which different factors affect the outcome of interest. Model 1 gives the unadjusted effect of 'life style variables' on death. Model 2 includes 'life style variables' and demographic variables. Model 3 includes socio-economic variables along with the variables used in model 2. Region of residence is added in model 4 along with the variables used in model 3.

Results

Table 1 presents the frequencies of each category of the analyzed variables for the persons aged 15 to 59. Among all the life style variables, prevalence of chewing tobacco is highest (around 20 percent). Only 18 percent of the population age d 15-59 experienced smoking in their households by any member of the family. A majority of people are from joint families having at least two literate persons in their households, living in rural areas and belonged to Hindu religion. The percentage of people belonging to low or medium standard of living and socially disadvantaged groups is found to be higher. About 60 percent of the people are exposed to at least one mass media. The percentage of people using wood for cooking is highest among different kinds of fuel followed by clean fuel such as electricity, LPG and bio-gas. The distribution of sex and region of residence does not very much across different categories.

Premature death of the persons aged 15-59 by background characteristics is presented in table1. It is clear that the prevalence of death among the people who experience secondary smoking in their households is higher than those who do not experience (5.29 percent as against 2.05 percent). Similarly, the percentage of people dying in the households where at least one member either chews tobacco or drinks alcohol is higher than that of households where nobody chews or drinks. Despite the extra risk of death during their maternal period, percentage of adult women experiencing death in India is lower than their male counterparts. People who reside in rural areas experience higher prevalence of death than the people residing in the urban areas. As far as standard of living is concerned, the distinction is very clear among different categories,

such as, the prevalence of death among low SLI households is far higher than that of high SLI households(3.24 percent against 2.17 percent). Having at least one literate person at in the household does not make difference adult mortality as shown by the bi-variate analysis. Adult belonging Hindu religion experiences higher death rate than the adults from other religions (2.71 percent for Hindu against 2.32 & 2.38 percent for Muslim and Other religion). Similarly higher prevalence of death rate is observed among the socially disadvantaged groups of India. The proportion of death is highest among the people who use crop residue, dung cake, Coal, Charcoal etc. as their fuel for cooking food. People using clean fuels seem to be less vulnerable to death than people using other types of fuel. Regional differences in premature mortality are also observed in the bi-variate analysis. The Chi-square test shows that the association between the different background characteristics and adult deaths was statistically significant for almost all the characteristics at one percent level of significance.

The bi-variate analysis clearly suggests that life style variables have significant effects on mortality. To get the adjusted effects of these variables on the dependent variable we carried out multivariate Poisson regression. Table 3 presents the results of Poisson regression analysis of the relationship between death during adulthood and life style factors, adjusted with socio-economic and demographic characteristics. It is worth mentioning that the parameter estimates presented in table 3 are relative to the reference category "no death". All the life style factors have a strong positive relationship with mortality. A person belonging to the household where at least one member smokes has 2.08 times higher risk of death than a person belonging to a household where nobody smokes. Similar is the case for drinking alcohol or chewing tobacco (model 1). Except smoking, the results of life style factors do not change much when one moves from model 1 to model 4. The positive association between smoking or chewing tobacco and drinking alcohol holds even after adjusting for other important socio-economic and demographic characteristics.

Sex seems to have significance importance on mortality in model number 2 where we adjust life style and demographic variables. We get an almost similar result after introducing other important socio-economic variables in model 4; Female adults experience higher risk of death than their male counterparts. With a one unit of increase of age, incidence ratio rate increases by five percent. There exists an inverse and consistent relationship between household's economic status and mortality. People from the households with medium and high

standard of living experience 11 and 21 percent lower risk ratio of death than the people from low standard of living households (Model 4).

Educational composition of the household members, religion, and size of the household, type of household and region of residence were found to be significantly associated with the death of an adult person in the multivariate analysis as well. Caste and exposure to mass media do not have statistically significant relationship with death after controlling socio-economic and demographic variables. Among the environmental factors, type of fuel has been included in the analysis to observe the impact of indoor pollution in adult mortality. There exists a higher risk ratio of death (1.1 times higher) among persons using kerosene than the persons using electricity, LPG or biogas.

Tests of goodness of fit of the Poisson regression model shows that the model appears to fit the data well; the goodness of chi- square tells us that given the model, we can accept the hypothesis that these data are Poisson distributed at the 1.64 percent significance level.

Discussion

The results of this analysis reveal that both smoking or chewing tobacco and drinking alcohol are very important factors affecting premature death in India, even after controlling for other socio-economic and demographic variables. The chance of death during adulthood is significantly higher among the persons from those households where any member consumes tobacco or drinks alcohol compared to persons from households where nobody smokes or drinks. Results of this study support the previous findings that smoking or chewing tobacco is a major determinant of adult deaths in India (Jha et al. 2008; Gajalakshmi et al. 2003). Similarly, the findings about the consumption of alcohol are similar to other studies which prove mortality from all causes increased with heavier drinking, particularly among adults under age 60 with lower risk of cardiovascular disease (Thun et al. 1997). It is indeed very surprising to see that even if we consider the tobacco or alcohol consumption behavior of the other members of the family and not of the dead person's itself, it has very strong positive relationship with death of adults. There may be two basic reasons why it is so. Firstly, there is a high chance that health behavior of a dead person from a household is reflected by the health behavior of the surviving persons from that family. In other words, when one person is abstaining from smoking tobacco

in a household, there is a high chance that other persons of that household may also stay away from smoking tobacco and vice versa. Secondly, smoking tobacco does not affect only the smoker itself but also other persons surrounding smokers. Many previous studies within and outside the country indicate hazardous impact of smoking (Jha et al. 2008; Doll et al. 2004; Bonita et al. 1999). It is found that, smoking accounts for half the tuberculosis deaths in India and contributes to increased transmission of the infection (Gajalakshmi et al. 2003). Similarly, a case-control study conducted by Jha et al. (2008) reveals that during the 2010s, the annual number of deaths from smoking in India will be about 1 million, and of the million annual deaths from smoking in India, approximately 70 percent (100,000 among women and 600,000 among men) will occur in middle age, rather than old age.

Since educational status of the dead person is not available directly from the available data, literacy composition of the household has been considered in this analysis. It is found that presence of at least one literate person in the household leads to a substantial reduction in death among adults. Previous findings suggest that education, being one of three basic indicators for measuring socio-economic status of an individual, has significance importance in mortality differential (Kitagawa and Hauser, 1973 & Schwarz, 2005). Education has a casual impact on adult mortality and it is found that this impact is larger than has been previously estimated in literature (Lleras-Muney, 2002). A very recent study of adult mortality reveals that the differences by educational levels are about two times between the highest and lowest educational groups in Brazil (Perez, 2008). Thus the findings of the present study further prove the importance of education in reducing adult mortality in the Indian context. A relationship between health and income has been documented for virtually all measures of health and health habits within many countries, and recent research suggests that the statistical correlation between income and mortality may have actually increased over the past 40 years (Feldman, et al, 1989; Preston and Elo, 1995; Deaton and Paxson, 1998). Observations in the developed countries suggest that this relationship is asymptotic; that there is a maximum life expectancy beyond which increase in income has no further effect. It is even possible that at very high incomes, diseconomies of excessive income might reduce life expectancy (Rodger, 1979). On the other hand, Preston and Taubman (1994) found that people with lower level of education, income and occupational status are poorly placed in most of the bio-medical and behavioral variables related with health. This is because high ranking social groups have, on average, more resources to

pursue better health and longer lives. Standard of living index (SLI) has been taken as a proxy indicator of the economic status. It has been made on the basis of a number of questions asked about the household properties or amenities to measure economic status of the household indirectly. There exists substantial mortality differential among the different categories of SLI, as SLI increases from low to high, mortality among adults decline. This result is consistent even after controlling the effect of other socio-economic variables.

Age, religion and type of household are found to be important determinant of premature mortality in India. With each unit increase of age, mortality incidence risk ratio also increases. People belonging to Muslim religion have lower incidence risk ratio than people belonging to the Hindu religion. This is consistent with the previous findings from NFHS I and NFHS II (Saikia & Bhat, 2008). Type of household has an important role in many demographic outcomes such as fertility behavior, infant and child mortality, maternal and child health care (Pakrasi & Chittaranjan, 1967; Prasad & Srivastava, 1977; Saikia & Singh, 2009). Previous studies reveal that there exists a close relationship between type of family and fertility behavior. Family composition may affect mortality in various ways. For example, the health behavior of a never married person living with other family members will be different from the health behavior of a never married person living alone. Living with other family members can promote compliance with group norms, encourage health practices and reduce stress through emotional reassurance or a helpful appraisal of difficult situation (Antonucci, 1990). In addition to this, family members can exercise some measure of social control, for example, by discouraging behaviors such as cigarette smoking, drug abuse, excessive alcohol consumption and promoting behaviors such as maintaining regular exercise, sufficient rest etc. In case of adult mortality, it is evident from the analysis that people belonging to joint family experience lesser risk ratio of death during their adulthood compared to their nuclear family counterparts. This may be due to the reasons discussed above since the number of caretakers in a joint family is higher than in a nuclear family. To control the impact of indoor pollution, type of fuel used for cooking has been included in the multivariate analysis. Persons using clean fuel have lower chance of death than persons using polluted fuel.

The region of residence in India has particular importance in the demographic behavior of the residents. With the exception of one or two states, north Indian states have less satisfactory

demographic indicators such as relatively high overall fertility, earlier age at first marriage, higher infant and child mortality and comparatively high ratios of female to male infant and child mortality compared to their southern counterparts (Dyson and Moore,1983; IIPS & ORC Macro, 2000) The same situation has been found by this study since there exists a higher incidence risk ratio of mortality in all other regions compared to South India.

Premature adult mortality in India is an important issue for further research as it has significant negative consequences on the economy as well as society of the country. There is ample scope to find out the correlates of adult deaths in future which could not be addressed here due to lack of detailed data. For example, previous studies in developed countries proves that early childhood socio-economic and health status have significant importance in adult ill health or mortality (Elo & Preston,1992). Similarly, nutritional status, diet, stress, workplace hazards, regular physical activity etc. are some other important factors which could not be addressed in this study. Traffic accident, a possible determinant of male mortality, cannot be directly accounted in the analysis. Secondly, the assumption that life style behavior of the living members of the family can be a good proxy for life style behavior of the dead person is a strong assumption particularly for women. Another limitation of this study is that NFHS survey was carried out in 1998-99 indicating lack of timeliness of data.

Conclusion

The present study has documented the determinants of adult mortality within a holistic framework of socio-economic, demographic and behavioral factors. It is found that one of the major determinants of adult mortality in India is people's health-related behavior. The impact of these proximate factors on adult mortality remains considerable even after controlling other socio-economic and demographic variables. To reduce premature death in India it is very urgent and important for the people to shift to healthier lifestyles from smoking or chewing tobacco, drinking alcohol etc. Analysis reveals that determinants of adult mortality are many and diverse in nature; mortality differential among adults by socio-economic and demographic characteristics is pertinent from this analysis. Socio-economic status measured by the wealth and educational composition of the household has a close association with adult deaths. Wealth is one of the paramount determinants of adult mortality in India as there is a strong negative correlation between mortality of adults and standard of livings of the households. Educational composition

of the household is a key factor influencing adult mortality; improvement of which can reduce substantially premature adult deaths in India. Among social factors, religion and family structure have an impact on adult mortality but there is no clear relationship between caste and premature death of adults. Further, indoor pollution has an association with adult deaths.

The analysis presented in this paper shows mortality can be reduced substantially by intervening in certain socio-economic affects. Although there are some policies to combat mortality due to some major diseases such as malaria or HIV/AIDS or maternal mortality in India, a coherent policy is necessary to prevent premature death so that loss experienced by family or society due to early death of adult members can be minimized. In formulating health policies, the people living at the bottom of the socioeconomic strata of the society should get more importance in utilizing the health care facilities to reduce avoidable mortality.

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Table 1 Percentage distribution person of age 15-59 experiencing from death by selected life style, socio-economic & demographic characteristics, India, NFHS 1998-99*

Covariate & Category	% of Death	% Distribution	Sample (N)
Smoking			
No	**2.05**	**82.29**	**271776**
Yes	**5.29**	**17.71**	**58491**
Drinking			
No	**2.28**	**89.03**	**294032**
Yes	**5.41**	**10.97**	**36235**
Chewing			
No	**2.19**	**79.8**	**263563**
Yes	**4.36**	**20.2**	**66704**
Sex			
Male	2.87	51.21	169139
Female	2.37	48.79	161128
Place of residence			
Rural	2.82	66.59	219922
Urban	2.24	33.41	110345
Standard of living index			
Low	3.24	24.98	82489
Medium	2.56	47.95	158357
High	2.17	27.08	89421
Education composition of Household			
Non-literate	3.7	6.41	21181
At least one literate	2.55	93.59	309806
Religion			
Hindu	2.71	76.42	252401
Muslim	2.32	11.83	39067
Others	2.38	11.75	38799
Caste			
ST/SC	2.83	28.56	94333
OBC	2.73	56.21	91325
General	2.42	43.79	144609
Mass media exposure			
No exposure	3.02	39.24	129596
At least one exposure	2.37	60.76	200671
Type of Household			
Nuclear Family	2.68	36.88	121789
Joint family	2.59	63.12	208478
Type of Fuel			
Electricity/LPG/Bio-gas	2.17	23.96	79127
Wood	2.79	57.66	190,426
Crop residue/dung cake/Coal/Charcoal	3.05	10.9	35998
Kerosene	2.22	7.35	24284
Regions			
South	2.44	16.77	55377
West	2.34	12.2	40296
North-east	2.31	13.2	43584
East	3.16	16.99	56098
Central	2.83	17.01	56179
North	2.55	23.84	78733

Note: * Chi-square test significant at 1 percent level for all the variables.

Table 2 Poisson regression results (IRR) † showing the effect of life style , socio-economic and demographic variables on adult deaths, India, NFHS II

	Model 1	Model 2	Model 3	Model 4
Covariate & Category				
Smoking				
No				
Yes	2.08***(1.98,2.18)	1.54***(1.47,1.62)	1.36***(1.33,1.46)	1.44***(1.36,1.51)
Drinking				
No				
Yes	1.48***(1.39,1.56)	1.56***(1.49,1.64)	1.40***(1.33,1.47)	1.50***(1.42,1.58)
Chewing				
No				
Yes	1.57***(1.50,1.64)	1.26***(1.21,1.31)	1.18***(1.14,1.24)	1.18***(1.13 ,1.24)
Age		1.03***(1.03,1.03)	1.04***(1.04,1.05)	1.04***(1.03,1.04)
Age square		1.00***(1.00,1.00)	1.00***(1.00,1.00)	1.00***(1.00,100)
Sex				
Male				
Female		1.08***(1.01,1.12)	1.01(0.97,1.06)	1.07***(1.02,1.12)
Place of residence				
Rural				
Urban			1.02 (0.97,1.07)	0.98(0.92,1.04)
Standard of living index				
Low				
Medium			0.92**(0.87,0.97)	0.89***(0.84,0.94)
High			0.87***(0.81,0.94)	0.79***(0.73,0.86)
Education composition of Household				
Non-literate				
At least one literate			0.65***(0.60,0.70)	0.66***(0.61,0.72)
Religion				
Hindu				
Muslim			0.92**(0.86,0.98)	0.93*(0.87,1.00)
Others			0.91***(0.86,0.98)	0.98(0.91,1.05)
Caste				
ST/SC				
OBC			1.00(0.96,1.06)	1.00(0.95,1.06)
General			0.96(0.91,1.01)	0.96(0.91,1.00)
Mass media exposure				
No exposure				
At least one exposure			1.00(0.95,1.05)	1.02(0.96,1.07)
Type of Household				
Nuclear Family				
Joint family			0.66***(0.64,0.70)	0.65***(0.62,0.68)
Type of Fuel				
Electricity/LPG/Bio-gas				
Wood			0.99(0.92, 1.02)	0.99 (0.91, 1.06)
Crop residue/dung cake/Coal/Charcoal			1.06(0.97, 1.15)	1.00 (0.91, 1.01)
Kerosene			1.10**(1.00, 1.21)	1.10** (1.00, 1.21)
Regions				
South				
West				1.08**(1.01, 1.17)
North-east				1.01(0.92,1.08)
East				1.18***(1.10,1.27)
Central				1.13***(1.06,1.20)
North				1.11**(1.04,1.19)

Note1*** **p < 0.01, ** p < 0.05, * p < 0.10, † refers to Incidence Risk Ratio**
Note2: Standard. Error. Adjusted for correlated outcomes within the households.