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Adult male mortality in India: An application of widowhood method

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Abstract
Accurate knowledge of adult mortality levels and trends in the developing world is hampered by widespread lack of complete vital registration system. It has been observed that very little research work has been carried out to study the levels, trends and differentials in adult mortality in India, in spite of the fact that health and survival of adult are crucial for wellbeing of house. In this paper, adult mortality level is summarized by the probability of dying between the ages of 15 and 60, or ($^{45}q_{15}$) in a standard life table notation using the Sample Registration System (SRS) abridged life table for the recent period (ie. for 2006-10). This has been done particularly for Madhya Pradesh and its 45 districts as well as for Kerala and India as a whole. The range of values is wide, from minimum of 77 per 1000 females to a maximum of 265 per 1000 for males in Andhra Pradesh, followed by Karnataka (252). Females have lower probability of dying in all the 16 major states, though the differences are small in West Bengal, Tamil Nadu and Punjab. We also tried to compute survivorship probabilities from age 20 to age n=25, 30, 60 from the widowhood data of census and these probabilities are converted to estimate expectation of life at age 20 (e^0_{20}) using South Asian Model Life Table for selected Indian states, Madhya Pradesh and 45 districts of Madhya Pradesh. Mortality derived from data on women of age 45-49 (and also 50-54) appear to be better than those based on other age groups, but these too underestimate adult mortality in comparison to the SRS estimate. It was found from the widowhood method, the expectation of life at age 20 (i.e. $e^0_{20}{}^{(m)}$) obtained from young mothers were much higher than those obtained from old widows. Widowhood estimates of e^0_{20} from all age groups were higher than the official SRS estimate of e^0_{20}, which indicates considerably high rates of widow remarriage and of that information about the survival status of their first husband were missing. While comparing the adult mortality trends between 1980 and 1990, e^0_{20} showed consistent increasing until 1980 and after that the estimate showed declining. It was also noted that except for a few states such as Bihar, Rajasthan, Uttar Pradesh and West Bengal, the differences in $e^0_{20}{}^{(m)}$ between widowhood and SRS is even less than one year. District level analysis of Madhya Pradesh shows that there is a differences of five years (Maxi-Mini= 52.8-47.5) of life expectancy at age 20. The same value of all over Madhya Pradesh is 50.6 taking September 1989 as the reference date. Thus this leads to the conclusions that the mortality level of Madhya Pradesh is not equally distributed among districts. The Pearson Ian correlation coefficient was found to be negative (-0.115).

Keywords: Adult mortality levels and trends, vital registration system

Introduction
India still focuses largely on infant and child mortality (Arokiasamy 2004; Bang, Reddy and Deshmukh 2002; Claeson *et al.* 2000; Kravdol 2004; Singh, Hazra and Ram 2007; Singh, Mahapatra and Dutta 2008; Whitworth and Stephenson 2002) [26, 27, 31, 32, 33, 34]. This focus is obviously due to considerably high levels of overall mortality during infancy and childhood. The infant mortality rate in India is 57 per 1000 live births with huge variations across the different states from 73 per 1000 live births in Uttar Pradesh to 15 per 1000 live births in Kerala. Similarly, under five mortality within India ranges between 96 per 1000 live births in Uttar Pradesh and 16 per 1000 live births in Kerala (IIPS and ORC Macro 2007).
Unlike infant and child mortality, adult mortality has not received appropriate attention in India, but there is an urgent need for research in this area for numerous reasons. Firstly, the adult population aged 1559 in India is very large in both its absolute as well as its relative size. According to the 2001 Indian census, with a population of 585 million, the adult

population aged 1559 years constitutes 57% of India's total population. Calculations based on life tables derived from the Sample Registration System for the most recent period suggest that 89% of new born are likely to survive to age 15, but only 72% of children aged 15 years are likely to survive to age 65 (Registrar General of India 2008). In addition, the maternal mortality rate is very high in India (Hogan *et al*. 2010) [35] at 212 maternal deaths per 100,000 live births for the period 200709 (Registrar General of India 2011).

Estimation of premature adult deaths for small geographical units in a diverse country like India can be particularly beneficial for monitoring the achievement of different population and health related policies such as the National Population Policy of 2000, the National Health Policy of 2003, and the Millennium Development Goals. Such analysis gains special significance in the light of Millennium Development Goals 5 and 6, which attempt to reduce maternal mortality and mortality due to HIV/AIDS, tuberculosis, and malaria. District Level Household Survey round 3). This evidence clearly underscores the need for mortality estimation at local levels to correctly estimate the impact of infections that are at times highly localized in nature. Such an exercise is also likely to help local policymakers and programme managers formulate evidence based interventions.

Need for the Study

A small of amount of research has been under taken about the adult mortality in India. While a great deal has now been discovered about infant and child mortality, about their causes and could underlying determinants, and about the ways to prevent child death, not much is known about level, trend and differences in adult mortality. Hence, an attempt is made to find out the level and trend of adult mortality in India and some selected states.

Objectives of the paper

i) To examine the changes in adult mortality level summarised by the probability of dying between the ages 15 and 60 or $_{45}q_{15}$ in a standard life table notation using the recent SRS abridged life table (i.e. from 1995-99to 2006-10).
ii) To examine the level and trend in adult mortality using the census marital status data in Madhya Pradesh, all India and some selected states of India.
iii) To compare the level and trend obtained by widowhood data with SRS based estimates.
iv) To examine at the district level variation for adult mortality in Madhya Pradesh.

Methodology

The widowhood method for estimating adult mortality from information about the death of husbands and wives was first proposed by Hill in 1977. Techniques were derived from estimating male adult mortality from reports of female respondents and vice-versa. The original method was subsequently revised by Hill and Truessell (1977) in order to remove the confounding effects of remarriage. Information used here is the survival of the first spouse as it is an indicator of the adult mortality since the exposure to the risk of the target person begins in adulthood i.e., at the marriage of the respondent. The exact question in any survey should be "is your first husband still alive? This method seeks to estimate probabilities of survival of males from the age 20 to age n (n=25, 30, 55, 60). Experience suggests that the most reliable information about the survival of the first spouse is provided by women and also remarriage rate is lower among female widow than that of male widow in India, a fairly good means of estimating male mortality.

Data Required

a) The proportion of ever married women in each five year age group whose first husband was alive at the time of census (interview)

b) Proportion of ever married males and females in each five year age group to compute singulate mean age at marriage for men ($SMAM_m$) and women ($SMAM_f$).

Steps of the Computational Procedure:

Step-I

The proportion of female respondents not widowed in the age group from age n to n+5, denoted by $NW_f(n)$, is equal to the ratio of the female respondents aged from n to n+5 whose first husband were alive at the time of interview and the total number of ever married female respondents aged from n to n+5 who declared survivorship status of their first husband.

Step-II

Calculation of Singulate Mean Age at Marriage (SMAM) for both males and females with the Hajnal method

$$SMAM_m = \frac{15+5\sum_5 S_x - k^* S_k}{1- S_k}$$

Where $_5S_x$ is the proportion single in the age group x to x+5
K is the maximum age up to which marriage occurs (in the present study k is taken as 50)

$$sk = \frac{5sk-5 + 5Sk}{2}$$

Step-III

Calculation of survivorship probabilities. The regression model proposed for calculating survivorship probability is:

$l_m^{(n)} / l_m^{(20)} = a(n) + b(n) * SMAM_f + c(n)*SMAM_m + d(n) * NW_f(n-5).....(1)$

Where a (n), b (n), c (n), and d (n) are coefficients and NW* (n-5), the proportion of ever married females aged n to n+4 not widowhood.

Neff (n-5) is considered because it has been mentioned that wives are five years younger to husbands.

Step-IV

Calculation of number of years before the census/survey to which survivorship probabilities refer; in case where mortality has been changing regularly during the 15 or 20 years proceedings, the survey estimates of time, t(n) will be;

$Tm(n) = (n – 2.5\ SMAM_f)(1.0 – u_m(n))/2.0$
Where $u_m(n) = 0.33333 \ln NW_f(n-5) + Z$

$(SMAM_m + n - 2.5 - SMSM_f) + 0.0037 * (27.0 - SMAM_m)$
Where Z values are given in Table 88 in UN Manual X.

Step-V
Calculation of expectation of life at age 20, corresponding to $l_m^{(n)} / l_m^{(20)}$ using South Asian Life Table Pattern and 'West' model life table system (Coale and Demeny 1966, UNs 1982)

The estimated regression coefficients a (n), b (n), c (n) and d (n) in step-III have been estimated by regression of simulated data. The details of the computational procedure are given in United Nations Manual X
(United Nation, 1983).

Model Life Tables are the tabular representations of the age patterns of mortality and present all the life table functions for pupulations at a particular "level" of mortality (Preston, Hauveline, and Hillob, 2001), Studies have shown that the UN South Asian Model Life Table System and West Model Life Table System are most suitable for examining levels and trends in India (Bhat 1998, Parsuraman 1990, Ram 1984) [29, 36, 37]. It is to be mentioned here that,

1. The estimation of adult mortality using information on widowhood is applicable in populations in which marriage is almost universal,
2. Marriage is a clearly defined event.
3. Mortality does not vary significantly by marital status. In developed countries, a high risk of mortality among unmarried compared to married women was found by Humer *et al* (1998) [38].

Since there is no systematic and scientific evidence on differential mortality experience in India, we assume that the third assumption should not induce bias in the estimates presented here.

Levels and Trends of Adult Mortality
Table1 presents the adult mortality level summarized by ${}_{45}q_{15}$ using the SRS abridged life table for the recent period (2006-10) by sex and selected Indian states. The range of values is wide, from a minimum of 176 per 1000 males in the state of Kerala to a maximum of 292 for Assam, which as not only highest male mortality but it has also had highest female mortality (224). In general, ${}_{45}q^f_{15} < {}_{45}q^m_{15}$.

Table 2 shows the trend in adult mortality by sex rural, urban and total for Madhya Pradesh, Kerala and India. Madhya Pradesh reveals a considerably higher adult male mortality in rural as well as in urban areas, in both the time period (i.e., in 1995-99 and 2006-10). Even though adult mortality has declined during 1995-99 to 2006-10, but the decline is not much significant (both for male and female). The percentage of declinefor male and female in case of Madhya Pradesh being 12.1 and 28.8 percentage respectively as compared to corresponding figure of 10.7 and 18.08 for Kerala.

To assess the quality of NFHS-2 data on adult mortality for India and its major states, Saikia (2006) constructed life table for male and female separately using NFHS-2 data. The adult age specific death rates for the life table have been calculated by applying the technique of Lexis diagram to back project usual resident age-sex structure for two years ago to the date of survey. Table 3 (borrowed from Saikia and Ram 2010) presents ${}_{45}q_{15}$ obtained from NFHS -2 and SRS, indicates a high level of concordance of adult mortality between these two sources. The main findings from the above table is given below:

1. At the national level, ${}_{45}q_{15}$ (NFHS) > ${}_{45}q_{15}$ (SRS), both for males (12%) and females (20%).
2. Coverage of female deaths in NFHS seems to be better in almost all states.
3. Coverage of adult male mortality i.e. ${}_{45}q^m_{15}$ in Assam, Haryana, Kerala and Orissa in SRS is better than the NFHS.

One of the assumption of the widowhood method is that the information should be collected from the first spouse, but due to increasing rate of remarriage the estimate might be affected. As regards to adjustment for remarriages, some researchers such as Malaker (1986) [40] and Bhat (1998) [29] have made earlier attempt to estimate adult mortality in India. Malakar (1986) [40] first attempted to estimate adult mortality in India using the 1971 and 1981 census data. He further extended his study to examine district level variation in adult mortality in West Bengal (Malakar and Crook, 1989). It was found that the widowhood method gives consistent estimates of adult mortality for males. However, the female adult mortality were severely underestimated. There is a general agreement supported by social surveys that the incidence of remarriage among the widowed is higher among the Muslim population and generally higher for men than for women, men usually remarrying younger women. Bhat (1998) [29] further found that the estimates of male adult mortality using widowhood data from women below age 40 were less acceptable than those obtained from widowhood data from women over age 40, which is simply because of high rates of remarriage among young widows. Bhat and Kanbargi (1984) [28] estimated proportion of ever married population using adult mortality and age at marriage information by inverting the widowhood method. The difference between the estimated proportion of ever married and currently widowed directly obtained from the census demonstrates that the percentage of ever married among ever widowed in India was 34 in 1971. During the recent periods, the widow remarriage rates must have gone up significantly. Even though we do not have a clear evidence, the widow remarriages are likely to go up.

Table 4 presents the percentages of women married more than once by age group during the three rounds of NFHS for Madhya Pradesh, Kerala, Punjab and India. The state level trend in remarriage rates among women show very negligible fluctuations over time. The table clearly shows a slight variation in remarriages among women in India and selected states. The maximum change for all women aged 15-49 among states under study is in Punjab with an increase of 1.3% (from 0.90 to 2.21 percent).

Levels and Trends of Male Adult Mortality
Table 5 shows the estimated probabilities from age 20 to age n. These probabilities are further converted into life expectancy at age 20 by using 'South Asian Model Life Table System' (UN 1983). Studies have shown that the UN South Asian Model Life Table System and Coale and Demeny (1966) West Model Life Table Systems are most suitable for examining mortality levels and trends (Bhat 1998, Parasuraman 1990 and Ram 1984) [29]. We present the survivorship probabilities ($l_m^{(n)}/l_m^{(20)}$) as well as life

expectancy at age 20 in Table 5. However in Table 6 and 7 we give only e^0_{20}(m) instead of male survivorship probabilities ($l_m^{(20)}/l_m^{(n)}$) for better understanding as life expectancy is a more often used indicator of mortality than the survivorship function. Estimates obtained from young widows aged 20-24 were close to recent periods. Estimates of life expectancy at age 20 (e^0_{20}(m)) obtained from young widows were much higher than those obtained from old widows. For example, in Rural Madhya Pradesh, e_{20} obtained from widows aged 25-29 was 51.7 in 1997, whereas the same from widows aged 50-54 was 48.9.

While estimating the proportion of widowed in 1991 by fitting regression on propoertion widowed in 1961, 1971, 1981 and 2001 data, Saikia (2010) found that the new estimate from the estimated 1991 census are consistent with e^0_{20} from other censuses, and the trends obtained from age group 30-34, 35-39 and 40-44 show very close patterns to the SRS trend of e^0_{20}. The trend obtained from 45-49 concurs with the SRS trend of e^0_{20} during 1970-75 to 1986-90. Mortality estimates derived from age group 45-49 and 50-54 appear to be best for application of widowhood method. In view of this, we present estimate of e^0_{20} from age groups 45-49 for rest of the two tables (i.e. Table 6 and 7).

Tables 6 and 7 presents the male e^0_{20} from widowhood method and their comparison with the SRS estimates for India and major states. The SRS estimates refer to 1983 and 1993 whereas widowhood estimate refer to 1978 and 1990. It is evident from Table 6 that the widowhood estimates e^0_{20} for male were higher than the official SRS estimates of e^0_{20} and the maximum difference was found in Bihar (5.0) followed by Uttar Pradesh (4.7), and Rajasthan (3.5). In these states, there may be various reasons for a different patterns, such as possibility of under enumeration of widows beyond age 45-49 in censuses, high digit preference at age 50 among the widows and choice of remarriage rate among the widows. The actual widow remarriage rates in these states may be higher than the marriage rates assumed. In Maharashtra, both the sources are close to each other. Except Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh, widowhood estimates of e^0_{20} either coincides or very close to SRS for the recent periods. These are the states which are marked by highest levels of remarriages. Agarwala (1967) [39] in a study of Rural Northern India found that the widow remarriage is about 80 to 90% among widows under age 19 and the remarriage rates ranged between 19% in Mathura district of Uttar Pradesh to 38% in Delhi in early Sixtees. Driver's (1963) study reveals that among the states, the remarriage rate varied between 9% in Orissa to 38% in Central India.

In Table 7 we have compared the estimates of male adult mortality with and without adjustment for remarriage (Columns (1) & (2) which refers to 1990 whereas in column (3) and (4) we have compared SRS estimates (1978) to those of widowhood estimates derived after adjusting for remarriage and which refers to 1983. The table clearly shows that in general, the life expectancy at age 20 i.e. e^0_{20} is generally lower for population where there is adjustment for remarriage than e^0_{20} when the data is not adjusted for remarriage. When we compare the e^0_{20} values at two points of time (refer to column 1 and 3), we found that at national level male life expectancy at age 20 increased by 1.5 years during 1980-90, and the maximum gain in e^0_{20} was found in Gujarat (3 years) and the least among Andhra Pradesh followed by Kerala.

Results from Districts of Madhya Pradesh

District level analysis shows that there is a range of five years (Max-Min = 52.8-47.5) of life expectancy at age 20. The same value of all over Madhya Pradesh is 50.6 taking September 1989 as the reference date, which leads to the conclusion that the mortality pattern of Madhya Pradesh is not equally distributed among different districts but this may not be true because if we closely examine the geographical position, then it is possible to see that more equal level of mortality estimates are obtained for geographically and culturally adjacent districts.

In order to see whether child mortality is an indicator of adult mortality, we calculated Pearsonian Correlation Coefficient between q^m_5 and e^0_{20}(m), and the same is found to be negative (-0.115) and insignificant. Existing literature proves that child mortality and adult mortality can vary independently so that e^0_0 and IMR may not be significant indicator of adult mortality since the determinants of these two types of mortality are different. For example, in determinants of child mortality, where infections and parasitic diseases are predominant, the impact of environmental contamination is very high. But in case of adult mortality where chronic diseases predominate, the likelihood of death from environmental contamination is minimal. While medical innovations may lead to lower levels of adult mortality, their influence on infant and child mortality will be limited in the absence of significant socio-economic development, especially rising living standards and adult literacy (Woods 1933).

Summary and Conclusions

According to World Health Organization (WHO) report that orders adult death rate in 2001, India ranked third highest among all South Asian countries, next only to Myanmar and Nepal. The probability of survival from exact age 15 to 60 in India is for lower than that of developed countries like United States, Japan and also well below that of Sri Lanka. Research in adult mortality in India is scare than those of infant and child mortality due to pan city of data. The present paper presents in the first section, the estimates of adult mortality level summarized by the probability of dying between the exact ages 15 and 60, i.e. $_{45}q_{15}$ during 1995-99 to 2006-10 by sex and residence of Madhya Pradesh and selected states of India. The range of values is wide, from a minimum of 77 per 1000 for females in Kerala in 2006-10 to a maximum of 292 per 1000 for males in Assam. The corresponding expectation of life at age 10, i.e. e_{10} are 68.1 and 59.5 respectively. (SRS, 2010)

In the second section, the paper describes the application of widowhood method of estimation of male adult mortality only to 1991 census data for Madhya Pradesh and selected states of India with and without adjustment for remarriage data. Mortality derived from data on women of age 45.49 and also 50-54 appear to be better than those based on other age groups, but these too underestimates adult mortality in comparison to the SRS estimates of e^0_{20} which indicates considerably high rates of widow remarriage. It was observed that except for a few states such as Bihar, Rajasthan, Uttar Pradesh and West Bengal, the difference in e^0_{20}(m) between widowhood and SRS is even less than one year. According to widowhood estimate, Assam experience highest adult mortality (e^0_{20} is 45.9 years) whereas Bihar experience least adult mortality (i.e. $e^{0(m)}_{20}$ is 51.8 years). Estimates obtained from this method reliably depict the changes in mortality differential over time and place.

In the last part, an attempt is made to study the district-wide variation of adult mortality in Madhya Pradesh, which shows that there is a range of five years of life expectancy at age 20. The same value of all over Madhya Pradesh is 50.6 taking September 1989 as the reference data which leads to the conclusion that the mortality level of Madhya Pradesh is not equally distributed among districts. The Pearsonian Correlation Coefficient between q^m_5 and e^0_{20}(m) was found to be negative (-0.115) and insignificant.

It is worthwhile considering quantification effect on our estimate using the widowhood method for degree of remarriage. Remarriage imparts an upward bias on survival if the respondent reports her widowhood status in relation to the most recent marriage. For the sake of illustration let us assume that in the age group 30-34, 20 percent of the widowed women have remarried and reported as "married" rather than as 'widowed'. As a result, suppose 97% of the women in this age group are recorded as not widowed, rather than the true 96%. Using the Princeton West Model Life Tables (Coale & Demeny 1966, 1983) we would estimate the survival level to be 19.7 when in fact the true level is 18.5. That is to say, we overestimate the male survival level by 1.2 levels. If, however, remarriage rates were 10 percent in this age group at this level of mortality, the overestimation would be 0.6 level. This type of simulation, is however, sensitive to the model life table used. The details of the simulation exercise have been presented in the appendix.

It has been shown in some Western Countries, mortality among the widowed is higher than that of the general population. If this is so, we will again over estimate the survival level. We have, unfortunately no evidence in India to help us with this problem.

Appendix

Effect of Remarriage on Survival Levels and Life Expectancy in Estimation of Adult Mortality by Widowhood Method

Let T and R be the true and reported proportions never widowed out of ever married (considering the survival of the first spouse) in an age group; P = proportion of the widowed who remarry. Thus,

R = 1 – (1-T) (1-P)
T = (R-P) / (1-P)

In the following table calculations have been shown on widowhood for females from the 1981 census of Kerala with three different values of P namely, .1, 2 and.3

← Proportion Not Widowed: $NW_f(n-5)$

Age Group	R	T		
		P = 0.1	P = 0.2	P = 0.3
30-34	.9653	.9614	.9566	.9504
35-39	.9350	.9278	.9188	.9071
40-44	.8838	.8709	.8548	.8340

Mortality Levels (West Model)

Age n	T			
	R	P = 0.1	P = 0.2	P = 0.3
35	19.7	19.1	18.5	17.7
40	18.8	18.1	17.3	16.4
45	17.7	16.8	14.9	14.5
Average	18.7	18.0	16.9	16.2
e^0_0(m)	60.5	58.8	56.2	54.6

Note

1. The mortality levels are based on $l_m(n)/l_m(20)$ values.
2. If we allow for 10 to 20 percent of remarriage among widowhood females, the range of life expectancy at birth will be 56.2 to 58.8 years for the decade 1971-81

Table1: Probabilities of dying between ages 15 and 60 ($_{45}q_{15}$) by sex for sixteen major states of India, 2006-10

Name of the States	Male	Female
Andhra Pradesh	0.265	0.163
Assam	0.292	0.224
Bihar	0.198	0.172
Gujarat	0.232	0.140
Haryana	0.190	0.124
Himachal Pradesh	0.214	0.114
Karnataka	0.252	0.150
Kerala	0.176	0.077
Maharashtra	0.217	0.125
Madhya Pradesh	0.248	0.168
Orissa	0.240	0.189
Punjab	0.233	0.131
Rajasthan	0.203	0.121
Tamil Nadu	0.227	0.137
Uttar Pradesh	0.244	0.176
West Bengal	0.195	0.135
India	0.229	0.152

Source: SRS Based Abridged Life Tables 2003-07 to 2006-10 SRS Analytical Studies, Report No.1 of 2012.

Table 2: Probabilities of dying between ages 15 and 60 $_{45}q_{15}$ by sex, Rural, Urban and Total for the state of Kerala, Madhya Pradesh and India, 2001.

States	1995-99		2006-10	
	Male	Female	Male	Female
Madhya Pradesh T	0.282	0.236	0.248	0.168
R	0.285	0.239	0.238	0.162
U	0.226	0.222	0.207	0.106

Kerala T	0.197	0.094	0.176	0.077
R	0.202	0.099	0.180	0.080
U	0.182	0.079	0.162	0.068
India T	0.256	0.200	0.229	0.152
R	0.266	0.212	0.238	0.162
U	0.182	0.161	0.207	0.125

Table 3: Comparison of $_{45}q_{15}$ from NFHS-2 and SRS at national and sub-national level, India

State/Country	1998 Male			1998 Female		
	NFHS-2	SRS	Ratio = NFHS-2/SRS	NFHS-2	SRS	Ratio = NFHS-2/SRS
Andhra Pradesh	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
Madhya Pradesh	0.31	0.29	1.05	0.29	0.74	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
Tamil Nadu	0.35	0.26	1.31	0.20	0.18	1.08
Uttar Pradesh	0.32	0.27	1.25	0.24	0.22	1.07
West Bengal	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

Source: Nandita Saikia and Ram F. 2010, Determinants of Adult Mortality in India, Asian Population Studies, Vol. 6, No. 2, July 2010, p. 159.

Table 4: Percentage of women aged 45-49 who married more than once from NFHS-1, 2 and 3, Madhya Pradesh and selected states of India

Age Group	Madhya Pradesh			Kerala			Punjab			India		
	NFHS			NFHS			NFHS			NFHS		
	1	2	3	1	2	3	1	2	3	1	2	3
15-19	0.90	0.67	0.34	0.60	1.18	0.00	0.00	0.00	0.00	0.63	0.64	0.65
20-24	2.26	2.17	1.02	2.18	0.55	0.66	0.76	0.00	0.46	1.24	1.25	1.24
25-29	3.60	2.26	1.68	2.63	1.45	1.22	0.82	1.06	0.92	1.83	1.65	2.10
30-34	2.94	2.81	2.84	2.88	2.07	1.17	0.54	0.36	3.04	2.12	1.92	2.48
35-39	3.13	3.14	1.85	3.15	3.26	3.28	1.33	1.46	3.70	2.16	2.42	2.72
40-44	2.45	2.73	2.29	3.40	3.79	3.52	1.07	1.78	3.29	2.27	2.29	2.52
45-49	1.75	1.99	1.42	4.62	4.45	4.51	1.45	0.00	2.33	2.20	2.18	2.83
Total	2.54	2.28	1.77	2.95	2.53	2.38	0.90	0.00	2.21			

Table 5: Estimation of male survivorship probabilities and $\mathbf{e^0}_{20}^{(m)}$ derived from first husband, Madhya Pradesh, 2001.

Age Group	Age I	Total			Rural			Urban		
		$l_m^{(n)}/l_m^{(20)}$	$e^0{}_{20}^{(m)}$	Reference date	$l_m^{(n)}/l_m^{(20)}$	$e^0{}_{20}^{(m)}$	Reference date	$l_m^{(n)}/l_m^{(20)}$	$e^0{}_{20}^{(m)}$	Reference date
20-24	25	0.9911	48.4	Sep.99	0.9921	49.1	Apr. 99	0.9983	46.5	July 2000
25-29	30	0.9866	50.8	June97	0.9883	51.7	Feb.97	0.9816	48.9	April 98
30-34	35	0.9783	51.1	Mar.95	0.9807	51.8	Nov.94	0.9714	49.3	Jan 96
35-39	40	0.9628	50.5	Janu.93	0.9648	50.9	Sep.92	0.9558	49.4	Nov 93
40-44	45	0.9374	49.9	Mar.91	0.9399	50.2	Nov.90	0.9290	49.0	Dec 91
45-49	50	0.9129	50.6	Sep.89	0.9163	50.9	June 89	0.9011	49.6	Jun 90
50-54	55	0.8353	48.8	May88	0.8377	48.9	Janu.88	0.8234	48.1	Dec 88
55-59	60	0.8482	LT20.0	Janu.88	0.8541	LT20.0	Oct.870	0.8201	LT20.0	May 88
SMAM $_m$				23.00	SMAM $_m$		21.90	SMAM $_m$		25.40
SMAM $_f$				19.10	SMAM $_f$		18.30	SMAM $_f$		21.10

Note: Estimates are obtained using South Asian Model Life Table Pattern of Model Life Table

Table.6 Estimates of Male e^{20} from Widowhood Method * and their comparison with the SRS estimates, India, 1990.

Name of the States	Widowhood 1990	SRS 1993	Difference
	1	2	3 = (1) – (2)
Andhra Pradesh	47.7	47.1	0.6
Assam	46.6	45.4	1.2
Bihar	53.0	48.0	5.0

Gujarat	49.0	47.1	1.9
Kerala	49.1	50.9	-1.8
Maharashtra	48.8	48.8	0.0
Madhya Pradesh	50.6	47.2	3.4
Orissa	48.9	47.7	1.2
Rajasthan	50.7	47.2	3.5
Tamil Nadu	47.1	47.6	-0.5
Uttar Pradesh	52.0	47.3	4.7
West Bengal	47.9	48.7	-0.8
India	49.3	47.6	1.7

Note

*1. Widowhood estimates calculated from 45-49 age groups using South Asian Model Life Table and refers to 1990

2. SRS estimates are obtained averaging SRS Abridged Life Tables for the period 1986-90 and 1991-95

Table 7: Estimates of Male Adult Mortality Measured by $e^{0}_{20(m)}$ with and without adjustment for remarriage data, India, 1980-1990

Name of the States	$e^{0}_{20(m)}$* 1990		$e^{0}_{20(m)}$ 1978	
	With Adjustment for Remarriage+	Without Adjustment for Remarriage*	With Adjustment for Remarriage+	SRS Without Adjustment for Remarriage*
Andhra Pradesh	47.5	47.7	45.4	44.9
Assam	45.9	46.6	45.0	43.1
Bihar	51.8	53.0	49.2	NA
Gujarat	46.0	49.0	44.9	45.5
Kerala**	49.4	49.1	47.8	49.2
Maharashtra	47.3	48.8	45.7	46.1
Madhya Pradesh	49.1	50.6	46.3	45.8
Orissa	47.6	48.9	45.6	44.1
Rajasthan	50.0	50.7	49.1	46.3
Tamil Nadu	46.6	47.1	44.6	46.0
Uttar Pradesh	50.6	52.0	49.7	46.0
West Bengal	46.2	47.9	43.8	NA
India	47.8	49.3	46.3	45.8

Note

* Calculated from age group 45-49 using south Asian Model Life Table

** For Kerala, remarriage data has not adjusted+ Nandita Saikia, 2010 "Adult Mortality in India: Levels, Trends, Determinants and Causes, "unpublished Ph. D. Thesis submitted to IIPS, 2010, p 180.

Table 8: Estimates of Mortality levels ($e^{0}_{20(m)}$) from Widowhood Method* for Districts of Madhya Pradesh, 2001

S. No	Name of the District	(e020(m)	Reference Date	$_5q_0$**
1.	Sheopur	51.0	April 1989	136
2.	Morena	52.1	June 1989	108
3.	Bhind	52.6	July 1989	84
4.	Gwalior	50.3	Feb. 1990	83
5.	Datia	51.2	July 1989	134
6.	Shivpuri	51.6	May 1989	143
7.	Guna	52.5	July1989	151
8.	Tikamgarh	52.8	April 1989	132
9.	Chhatarpur	48.8	Jun 1989	141
10.	Panna	51.9	July 1989	172
11.	Sagar	50.8	Oct. 1989	136
12.	Damoh	50.4	Aug. 1989	151
13.	Stna	51.1	June 1989	158
14.	Rewa	52.5	Jun. 1989	131
15.	Umaria	50.2	May 1989	160
16.	Shahdol	49.2	May 1989	146
17.	Sidhi	51.9	March 1989	128
18.	Neemuch	50.3	May 1989	107
19.	Mandsur	50.6	April 1989	114
20.	Ratlam	49.1	June 1989	140
21.	Ujain	50.0	June 1989	114
22.	Shajapur	51.1	Feb. 1989	111
23.	Dewas	51.6	June 1989	131
24.	Jhabua	50.3	Sept. 1989	149
25.	Dhar	50.3	Aug. 1989	113
26.	Indore	50.4	Feb. 1990	66

27.	West Nimar	50.9	Sept. 1989	115
28.	Barwani	50.8	July, 1989	138
29.	East Nimar	49.3	Nov. 1989	130
30.	Rajgarh	52.2	March 1989	134
31.	Vidisha	51.4	Oct. 1989	158
32.	Bhopal	50.3	July 1990	90
33.	Seore	51.7	Aug 1989	126
34.	Raisen	52.5	Dece.1989	121
35.	Betul	50.6	June 1990	127
36.	Harda	49.4	March 1990	153
37.	Housangabad	50.0	March 1990	146
38.	Katni	49.5	June 1989	187
39.	Jabalpur	49.3	July 1990	116
40.	Narsimhapur	51.1	Dec. 1989	115
41.	Dindori	48.7	July 1989	150
42.	Mandla	48.0	Oct. 1989	157
43.	Chhindwara	48.9	April 1989	121
44.	Seoni	48.6	Jun. 1990	116
45.	Balaghat	47.5	March 1990	131
46.	Madhya Pradesh	50.6	Sept. 1989	128

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