McNay, Kirsty : Fertility and Frailty : Demographic Change and Health and Status of Indian Women. Economic and Political Weekly. Oct 1995. 30(43). P. Ws-81-Ws-86.
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# Fertility and Frailty : Demographic Change and Health and Status of Indian Women

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*While it has become common to infer the social status of women from their demographic characteristics, it is not easy to read demographic progress in terms of declines in mortality, and fertility to make unambiguous judgments about trends in women's social standing. This paper attempts to distinguish the comparative contributions of fertility decline and relative status improvement to trends in maternal mortality in India and presents evidence showing that advancement in women's demographic attainment may not necessarily involve improvement in their health and status.*

It is now common practice to infer the social status of women from their demographic characteristics. Yet it is not so easy to read through demographic progress, in terms of declines in mortality and fertility, to make unambiguous judgments about trends in women's social standing. This paper investigates some of the issues involved in the context of maternal mortality, an important but as yet relatively neglected component of female mortality. Declines in maternal mortality may occur in the absence of any change in women's relative social standing or health status simply as the mechanical counterpart of fertility decline. This paper attempts to distinguish the comparative contributions of fertility decline and relative status improvement to trends in maternal mortality in India. Evidence is presented which supports the hypothesis that advancement in women's demographic attainment may, not necessarily involve improvement in, their health and status.

It is well established that throughout the 20th century the Indian sex ratio has been both masculine and characterised by a process of increasing masculinisation. This has been argued to demonstrate female mortality disadvantage which is claimed to operate via influences associated with poor female social status.

Successive censuses have revealed an overall decline in mortality accompanied by an increase in the population male: female ratio. This may suggest that as the absolute mortality position of both sexes has improved, the relative longevity of women has worsened. Census estimates show a sex ratio (the population ratio of males to females) of 1.047 in 1921, 1.058 in 1941, 1.075 in 1971, 1.070 in 1981 and

1.077 in 1991 [Dyson 1987]. The decline of the ratio between 1971 and 1981 is important since although partly attributed to the deficient 1971 Census coverage which disproportionately underenumerated women so biasing the 1971 sex ratio upwards, many demographers also take it to convey some moderation of the long-term trend of increasing masculinisation. Similarly, demographers point to particularly deficient 1991 Census coverage in certain states as partially responsible for inflating the 1991 sex ratio [Dyson 1992].

In addition to a significant regionalisation of mortality differentials [i] the age-specificity of differential mortality is also distinct. In 1975, Dandekar (1975), using census-based estimates for all-India, indicated the maintenance of a biologically determined female mortality advantage during the neonatal period throughout 1901-61. However, within the age groups 1-4, 5-14, and 35-49 years, he detected a notable deterioration in female relative longevity together with the continuation of greatest mortality vulnerability within the 15-34 years group. These observations signify the prominence of female mortality disadvantage among children and women of reproductive age. In contrast, Mari Bhat (1989) speaks of a decline in excess early age mortality from the end of the 19th century. This he partly attributes to the greater extent of female benefit relative to that of male benefit within this age group derived from the diminished incidence of famine. The diminished incidence of female infanticide is also important. To account for the simultaneous increasing trend of population masculinity. Mari Bhat points to historically modest improvements in female adult mortality.

More recently, Dyson's (1987)work shows that levels of early age female mortality still exceed those of males at the national level. However, his 1981 Census-based derivations of sex-specific estimates of q[21, the probability of dying before the age of two, indicate a markedly faster rate of post-1960 mortality improvement for females than for males. Dyson also points to the slow convergence of sex-specific early age mortality indicated from India's Sample Registration System (SRS) data. Both census and SRS data suggest that the differential in $e_0$, life expectancy at birth, is now small and its direction largely dependent upon the assessment of the magnitude of excess female early age mortality. With regard to mortality at later ages, SRS data reveals a lateral S pattern to male:female age-specific death rates at both the national level and in nearly every state. The female death rate exceeds the male death rate at all age groups below 35-39 years, but the reverse is true for older age groups. The upwards shitting of the age specific curve of male to female death rates from the 1970s onwards can be taken to indicate greater mortality gains for females than for males and a progressive lowering of the age at which excess male mortality begins. Dyson's indices of $e_5$, life expectancy from age five, demonstrate that from the 1970s onwards, females now outlive males beyond the age of five, whereas in the 1960s this was probably not the case. This is despite the continuation of pronounced, yet diminishing female mortality disadvantage during the reproductive years. Thereafter, female mortality gains relative to those of males seem to be decisive. These are attributed principally to the earlier deterioration of male mortality relative to female mortality rather than to any rapid progression in female mortality.

**Mortality Disadvantage and Women's Social Status**

Many scholars have asserted that important determinants of female mortality vulnerability may be found in intra-household sex biased allocations of basic resources, such as food and health care which discriminate against females. Such discrimination influences the extent of exposure to illness and the outcome of illness once it has occurred. Debate has taken place as to the relative significance of nutritional bias and differential use of health care to sex differences in mortality. Recently, it seems that authors have highlighted the impact of the latter. Basu (1992), in her study of contrasting cultural groups in a resettlement slum in Delhi, declares that differential access to curative health care may be one of the most important determinants of sex differences in mortality.

These determinants of female mortality disadvantage have been argued to reflect gender differences in social status. In this way female mortality experience and female social status are linked. Importantly, women's mortality disadvantage has largely, been taken to he indicative of their poor relative social status and has therefore been viewed as its proxy. Debate has occurred as to the relative importance of economic versus cultural factors in explaining female status. Geographical differences in status have been used to explain India's regional demography and the age-specific patterns discussed above. Some writers perceive demographic patterns as primarily the consequence of economic determinants of female social status, particularly the extent of female participation in the economy: Bardan (1982) and Miller (1981) look to differences in female labour demand in crop cultivation as the motivating factor in status determination. Dyson and Moore (1983) consider the primacy of culture rather than economic structure in determining female social status and they develop the concept of female autonomy. This is taken to define influence in decision-making and control over personal and household concerns and resources. They consider autonomy as operating primarily through kinship structure, marriage patterns, residential arrangements and property inheritance and focus on a north/south distinction within India in these variables. Most recently, Visaria (1993), rather than concentrating on the conventional measures of women's status, such as economic participation and educational attainment, has attempted to measure regional variations in female autonomy by questioning women with regard to the extent of their freedom to undertake specific tasks and their frequency of contact with natal kin. Situations resulting in female mortality vulnerability which may be associated with a lack of autonomy identified with any of these concepts could be termed status-determined mortality risk factors [ii]

It seems plausible to argue that the link between female mortality experience and social status may be extended to the dynamic situation in which India's demographic progress in the form of narrowing excess female mortality may be taken to reflect improvement in women's relative social status. If this is the case, mortality trends can be seen to represent status trends as declines in status-determined mortality risk factors are primarily responsible for improvements in female mortality. Also, women's morbidity patterns are likely to mirror mortality patterns as women's health improves as a result of declines in relative as well as absolute levels of sex-selective discriminatory behaviour. Fertility decline may also be seen as indirect evidence of women's status improvement so that once the demographic transition is underway, a virtuous circle is implied with respect to changes in women's status and fertility and mortality declines. Status improvement may be associated with diminishing fertility and mortality which then themselves feed into further status improvement. This may well impart some degree of complacency with regard to interventions aimed specifically at improving the social standing of women as it suggests automatic improvement merely as an outcome of demographic progress.

Despite the association between women's, status and their mortality vulnerability, Dyson has asserted that the recent trend away from excess female mortality may principally be a consequence of demographic transition rather than an advancement in the relative social position of women perse. Rather than looking to status-determined mortality risk factors, he focuses upon demograhically-determined risk factors. Dyson argues that a decline in the latter may have been associated with women's mortality improvement independently of trends in female status. In the face of fertility decline, excess female mortality may be diminished discriminatory behaviour remain unchanged as poor female status persists. As a decline in the number of children per couple enables an increase in the absolute levels of attention per child, such discriminatory practices are less likely to be translated into mortality, instead contributing to increases in the incidence and duration of morbidity. This implies that in more recent times, relative female status may be more accurately proxied by women's conditions of health than by their mortality performance [iii]. Females' relative morbidity trends may therefore break away from their mortality trends as the health status of women remains frail in the face of their mortality decline, and individuals who may not have survived in an earlier cohort live longer as ill-health replaces early death [iv].

**Maternal Mortality in India**

These competing hypotheses have been investigated in this study with particular reference to urban maternal mortality. Both urban mortality and maternal mortality seem to have been relatively neglected in the literature to date. However claimed that "maternal mortality would appear to be a primary contributor to the atypical pattern of higher female than male mortality among those aged 15-44 reported in many parts of south Asia" [Koenig et al 1988]. More recently, it has been asserted that a "decline in maternal mortality appears to be the prime reason for the steep fall in mortality observed among women of reproductive ages" [Irudaya Rajan et at 1992]. Nevertheless, India's 1990-91 maternal mortality level has been given as 460 maternal deaths per 1,00,000 live births. This compares with a level of 630 deaths per 1,00,000 live births in Africa and 26 deaths per 1,00,000 live births in developed countries [WHO 1994]. Clearly then maternal mortality is a significant risk facing Indian women and a key element in their demographic experience.

According to the 9th Revision of the International Classification of Diseases, a maternal death is defined as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes" [Abouzahr and Royston 1991]. The possibility of suffering a maternal death is a function of two distinct components. These can be related to the different mortality risk factors described above. First is the probability of being pregnant or having delivered within the last 42 days. This probability will largely, be associated with demographically-determined mortality risk factors established by the level of fertility. The maternal mortality, rate the number of maternal deaths per 1,000 women of reproductive age, will capture this component. Second is the probability of dying of pregnancy-related causes once pregnant or recently delivered. The maternal mortality ratio, the number of maternal deaths per 1,000 live births, will capture this component as it is a measure of mortality risk per birth. The key point here is that the magnitude of this risk per birth may be largely associated with status-determined risk factors especially women's pre-existing health conditions and their access to adequate medical care. However, it is important to note that risk per birth also has a demographically-determined component as a high fertility regime is likely to exhibit high risk births among very young women and older, multiparous women: studies have indicated a J-shaped relationship between maternal mortality associated with various clinical factors and both maternal age and maternal parity.

Fertility decline will operate to reduce maternal mortality via a reduction in the maternal mortality rate by reducing the average number of children born to each woman (i e. by reducing the incidence of exposure to demographically-determined risk factors). Fertility, decline may also operate to reduce maternal mortality via reduction in the maternal mortality ratio by reducing risk per birth as childbearing is concentrated into lower risk age and parity groups [v] (ie, by reducing the demographically-determined component of risk per birth). The latter however may even increase as fertility declines as the proportion of high risk primiparous pregnancies to total pregnancies rises [London 1992],

Support for Dyson's hypothesis may be found in the conjunction of a significant decline in the maternal mortality rate with an insignificant decline in the maternal mortality ratio. This would imply that a decline in the average number of children born to each woman had been more important in reducing maternal mortality than a decline in risk per birth. Risk per birth would remain high as status-determined risk factors remain unaffected. These may continue to elevate both direct and indirect maternal mortalities. Specifically, anaemic women may face significant mortality risk from haemorrhage. Also, pre-existing health complaints such as anaemia may be exacerbated by pregnancy and delivery, so that a pregnant woman who died from such a cause may not have died had she not been pregnant. These observations suggest that, in addition to generalised malnutrition, adverse food allocation practices within the Indian household may become critical in resulting in high levels of risk per birth. Similarly women's lack of autonomy in seeking early access to health care is likely, to apply to maternal care and is therefore liable to further augment maternal mortality.

Conversely, the conventional wisdom would find support from evidence showing a significant decline in the maternal mortality ratio. This would imply that a decline in risk per birth brought about by declines in status determined risk factors associated with improvements in women's relative status had been important in reducing maternal mortality. This effect is assumed to be additional to and independent of any improvement in the demographically determined component of risk per birth brought about by fertility decline [vi]. A comparison of the trend significance of these two distinct measures of maternal mortality therefore discriminates between the two competing hypotheses of mortality decline.

**Maternal Mortality in Urban Gujarat**

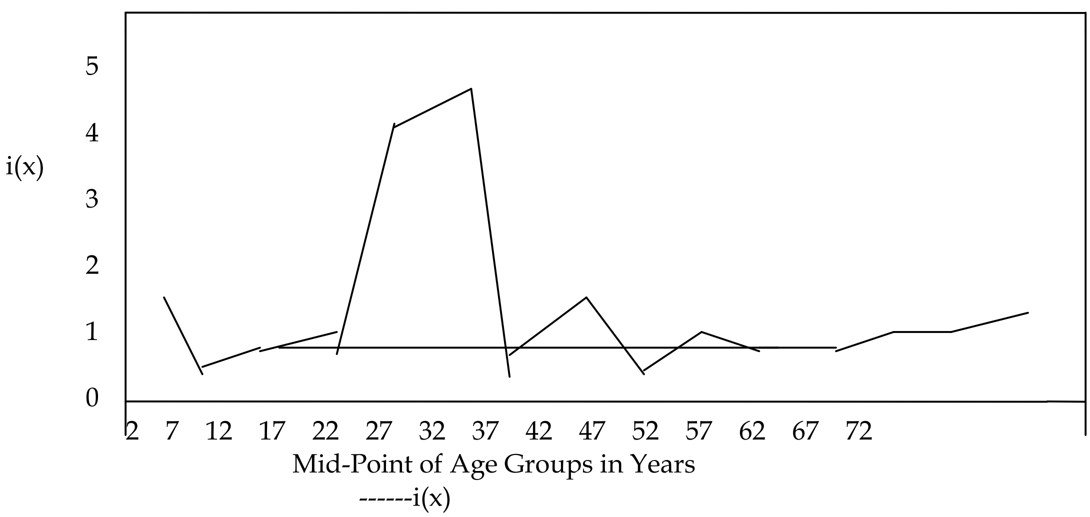
Maternal mortality trends have been estimated for urban Gujarat for the period 1970-90 [vii]. The need to estimate levels of maternal mortality arises from the gap in India's registration data concerning maternal deaths. Although data on live births and maternal deaths was collected for the years 1970. 1971 and 1972 as part of the registrar general's survey on cause of death in rural areas, for years since 1974 publication of this data has been abandoned. Since then, studies have attempted to measure maternal mortality by undertaking field investigations and by using hospital data [viii]. Such studies have indicated varying levels of maternal mortality for India.

The methods used here for estimating maternal mortality trends for urban Gujarat are those developed by Blum and Fargues (1990). These are indirect methods of estimation which employ sex-age-specific mortality rates to project female mortality in the non-childbearing ages over the childbearing ages and then compare these estimated rates with the actual rates. The methods do not therefore require data on cause of death. SRS data, considered to be very nearly complete with respect to the coverage of vital events, has been used.

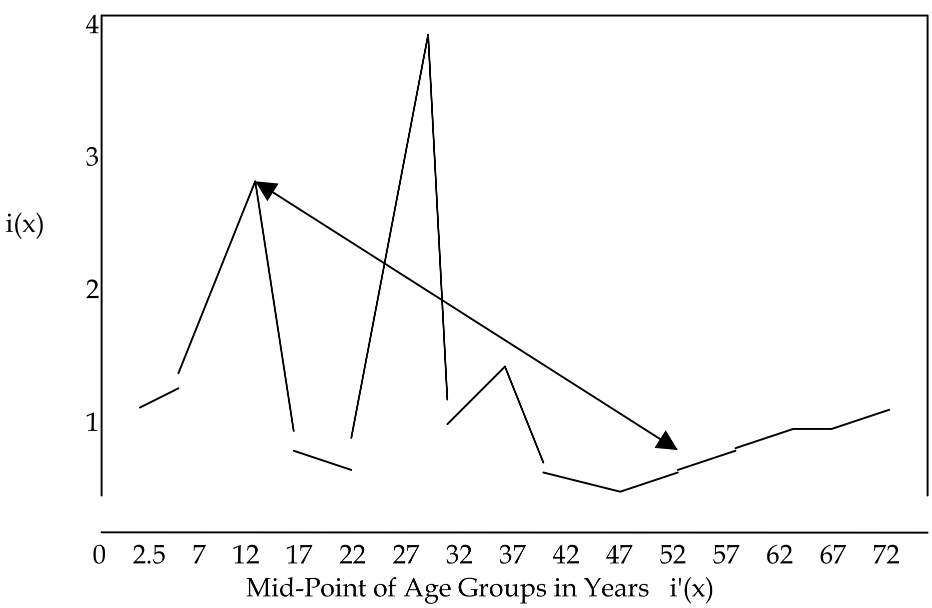
The first method (method 1) utilises differences in observed and expected ratios in female: male age-specific mortality. These ratios are denoted by i(x) and i'(x), where x is the mid-point of the age group, respectively. The method presupposes that the change in the observed ratio over the life span will typically follow a particular pattern so that when graphed, an anticipated shape is obtained. For India, this pattern seems broadly consistent with the differences in female:male age-specific mortality outlined above. A ratio greater than unity is expected at young age groups and at childbearing ages, where female mortality disadvantage is experienced. Elsewhere, in consequence of excess male mortality, the ratio is expected to be less than unity. Graphically therefore a shape similar to that exhibited by Graph 1 is expected where a peak is seen within the childbearing ages. Making the important assumption that maternal causes predominate among causes of death specific to women aged between 15 and 50, the deviation of the observed age-specific female:male mortality ratio, i(x), from the expected ratio, i'(x) can be taken as a measure of maternal mortality. i'(x) is estimated by linear interpolation between the values of i(x) observed just before (10-14 years) and just after (50-54 years) the childbearing period. This assumes that in the absence of maternal deaths, the ratio of female to male mortality changes linearly. To estimate total maternal mortality, each age-specific value has been weighted against the proportion of women in that age group and summed [ix].

For most years, the data yields relationships of the expected shape. However, for certain years a peak in the observed ratio occurs at the 10-14 years age group, rather than in the later childbearing years. An example is shown in Graph 2. This has implications for the magnitude of the maternal mortality estimates for these years and therefore affects the estimated trends in both measures of maternal mortality. Such patterns bias downwards the estimates because i'(x) is greater than i(x) in many age groups following the high value of i(x) at the 10-14 years age group at which the linear interpolation is started. For these age groups, the mortality estimates therefore have to be assumed to be zero. In these cases, the method was repeated with the linear interpolation beginning at the age group 5-9 years. Estimation of maternal mortality was started from the value of the deviation between i(x) and i'(x) at age mid-point 17 as before, because the deviation before this age group cannot be classified as maternal mortality. This modification shifts downwards the gradient of the linear interpolation so that more of any excess female mortality indicated during the childbearing ages is captured as maternal mortality.

**GRAPH 1**: Estimation of Maternal Mortality, Method 1, Urban Gujarat, 1983.

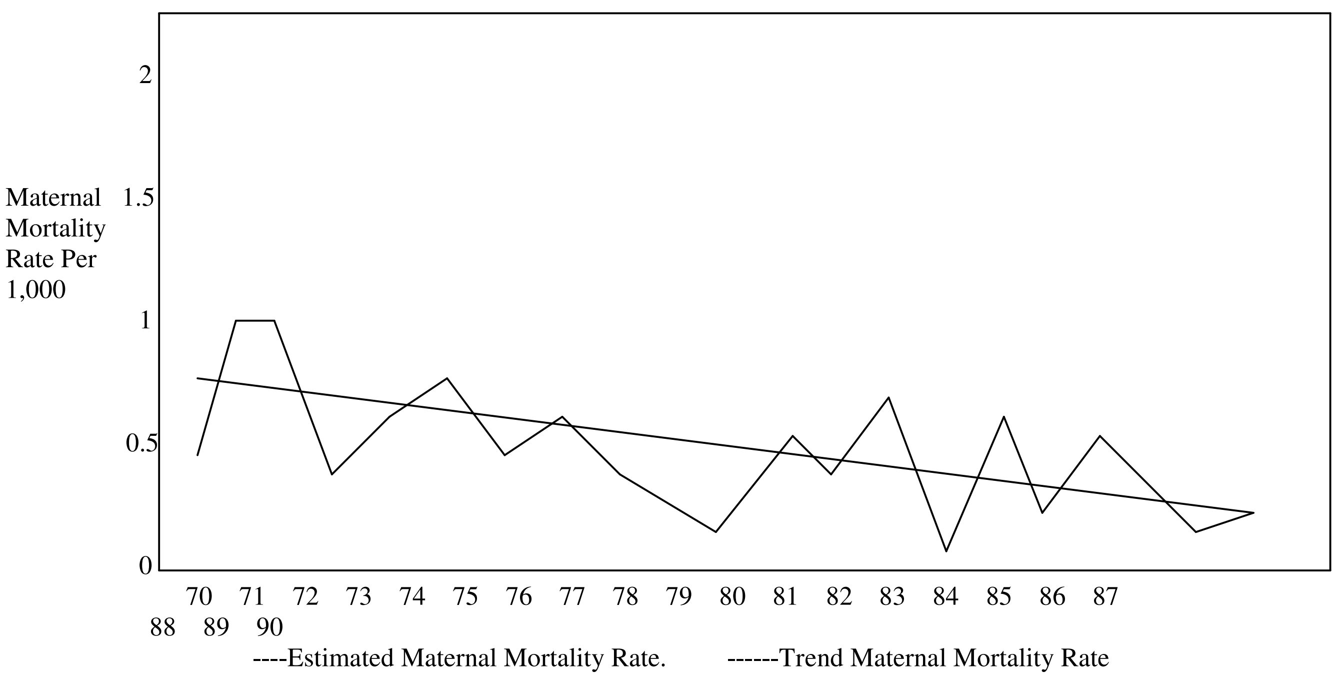



**GRAPH 2 :** Estimation of Maternal, Mortality, Method I, Urban Gujarat, 1976



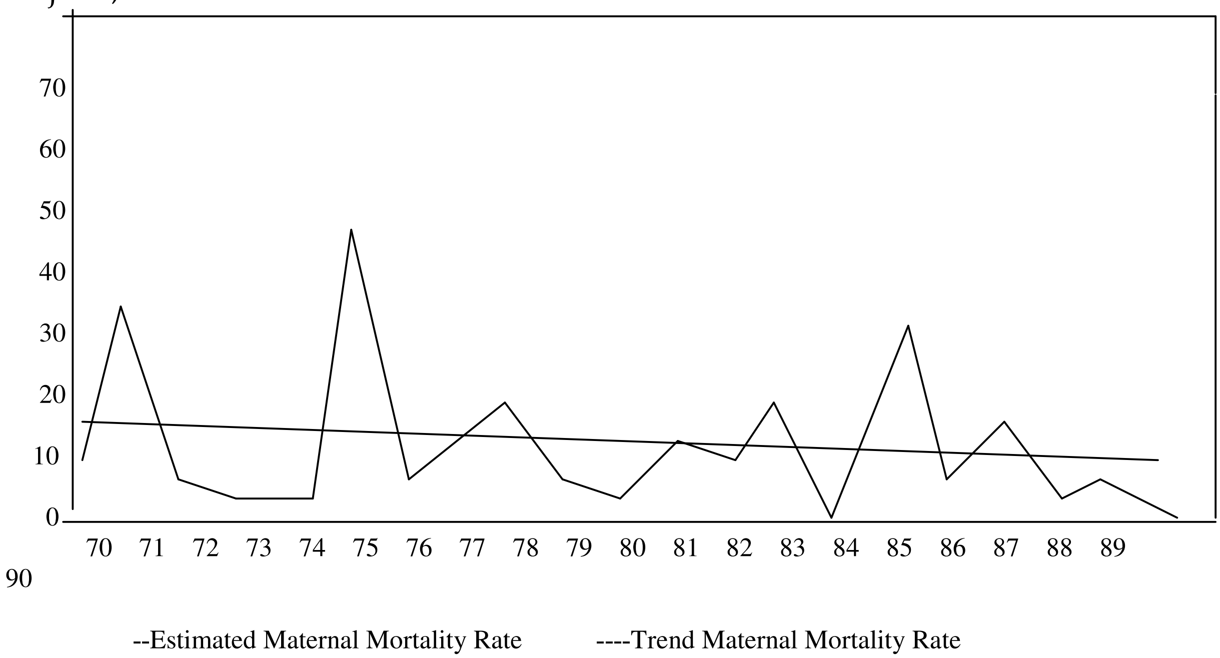
Both the trend in the maternal mortality rate and the maternal mortality ratio with and without the modification are negative. Those values obtained with the modification have been plotted as Graph 3 and Graph 4. Regression analysis indicates that in the modified case, the trend in the maternal mortality rate is statistically significant (t-statistic = -3.375), whereas the trend in the maternal mortality ratio is statistically insignificant (t-statistic = 1.071). For the unmodified case, the mortality ratio trend remains insignificant (t-statistic = -0.732) and the mortality rate trend is also insignificant (t-statistic = -1.545). It seems therefore that the alternative use of age midpoint seven in this method does transform a statistically insignificant trend into a significant one in the case of the maternal mortality rate. The results therefore demonstrate some degree of sensitivity to the modification. Examination of the statistical values obtained from the second method of estimation will shed some light upon the comparability of the trend significance of the mortality rate obtained using the modification.

**GRAPH 3 :** Estimated and Trend Maternal Mortality Rate, Method I, Urban Gujarat, 1970-90.




The second method of estimation uses logarithms of the age-specific female mortality rate. In this method, it is assumed that in the absence of maternal mortality, this mortality schedule follows a Gompertz distribution. In the case of women in high mortality regimes, a discontinuity can be observed at the end of the childbearing period, ie, at the age group 50-54 years. This discontinuity can be contrasted with a greater regularity of the age-specific male mortality schedule, which follows the Gompertz distribution from a younger age group, and from which deviations are more regular. It is therefore assumed that in the absence of maternal mortality there would be no deviation at the age group 50-54 years in the female mortality schedule. Estimates of female mortality rates in the absence of maternal mortality are therefore provided by backward extrapolation of the logarithms of the female mortality rates observed at the age group just beyond the childbearing period, ie, the 50-54 years age group, and above, back to the age group just before the childbearing period. i e. the 10-14years age group. Two different extrapolation rules have been used. Total maternal mortality has been estimated as before [x].

**GRAPH 4 :** Estimated and Trend Maternal Mortality Rate, Method I, Urban Gujarat, 1970-90




For the first extrapolation rule, regression analysis indicates that the trend in the maternal mortality rate is statistically significant (t-statistic =-2.889) and the trend in the maternal mortality ratio is statistically insignificant (t-statistic=-0.976). Similarly, the trend in the maternal mortality rate obtained from the second extrapolation rule yields a statistically significant t-statistic (=-3.111) while the t-statistic for the trend in the maternal mortality ratio is insignificant (=-1.262). Comparison with the statistical values obtained from method 1 suggests that the use of the of the modification in that method yields results that are consistent with those obtained from the logarithm methods. Its use may therefore be argued to improve the accuracy of the maternal mortality estimates derived from method 1.

Both method suggest that the conjunction of a significant decline in the maternal mortality rate with an insignificant decline in the maternal mortality ratio has taken place for urban Gujarat. This allows some tentative propositions to be forwarded concerning the relative viability of the two competing hypotheses of female mortality decline to the Indian experience. The difference in trend significance of the two measures of maternal mortality implies that a decline in the average number of children born to each woman may have been more important in reducing maternal mortality than a decline in risk per birth. This observation seems more consistent with Dyson's hypothesis than with the alternative hypothesis of mortality decline. It is compatible with Dyson's arguments that more favourable mortality performance may occur independently of any advancement in the relative status of women. This takes place as status (as well as demographically) determined risk factors contributing to maternal mortality vulnerability fail to improve as fertility declines [xi].

**Conclusion**

The Dyson hypothesis of mortality decline is not the more optimistic of the two and the support for it found here reinforces the suspicion that the health status of Indian women may well have remained frail in the face of their mortality decline. Despite fewer household members, persistently poor female status dictates that girls and women continue to be less well fed and receive less timely medical attention than boys and men so that smaller family size alone mitigates against the grim association between longevity and poor status. For girls and women therefore, frailty may well replace early death. This assumes that the increase in the absolute share of resources allocated to girls and women within a smaller family is sufficient to exceed a threshold level at which the same level of relative discrimination within a larger family is translated into female mortality vulnerability. More females therefore remain alive in the declining fertility regime but they are more likely to suffer from health frailty.

For expectant mothers that frailty means that the risks of pregnancy and childbirth remain high, even if confronted less frequently. These observations suggest that in addition to fertility decline safe motherhood in India requires a strengthening of the health and well-being of Indian women long before they are exposed to maternity. Pregnancy and delivery themselves will thereby become safer events so that risk per birth, in addition to the frequency of exposure to that risk, is lessened. It may be that this can be achieved only through a more fundamental change in women's social position so that the discriminatory practices, currently serving to keep maternity hazardous, disappear at last.

**Notes**

[i]. Relative female scarcity shows much internal variation. High and increasing male:female ratios are concentrated in the north and west particularly in Uttar Pradesh. Gujarat and Madhya Pradesh. A pattern of masculinisation below the national mean predominates in the south, notably Kerala, Tamil Nadu and Andhra Pradesh.

[ii].The notion of mortality enhancing risk factors is taken from Alter and Riley's work on mortality decline in historical and contemporary developed countries [see Alter and Riley 1989].

[iii].Jeffery and Jeffery (1983) however note the increasing importance of family sex composition in determining the extent of intra household discrimination as desired family size declines within the context of continued on preference. They claim that the number of `surplus' daughters facing discrimination will increase as desired family size falls even though, as Dyson supposes, this discrimination may be less likely to translate into mortality.

[iv]. Importantly, Dyson does not regard the fertility decline itself to be a consequence of improvements in female social status. This view is in contrast to feminist perspectives which have traditionally called upon an improvement in the social status of women as being a necessary precondition of fertility decline. More recently emphasis upon the role of abortion following foetal sex testing to India's fertility decline has strengthened the Dyson perspective and implies thatfertilitv decline may to some extent in fact represent the continued prevalence of son preference in India.

[v]. Fertility decline is likely to contribute to these changing patterns of childbearing in two ways. First, it operates via increases in the age at marriage sufficient to increase the age at first birth so reducing the length of exposure to childbearing risk and the incidence of high risk births among very young women. Second, it is associated with increased contraceptive use among married women whose desired family size has been achieved, so reducing the incidence of high risk multiparous births and perhaps unwanted pregnancies among older women.

[vi]. It may be the case that a decline in this demographic component of risk per could alone be sufficient to result in a significant decline in the maternal mortality ratio. If this is the case a significant decline in the maternal mortality rate may also be expected as fertility is incorporated in this measure of maternal mortality.

[vii]. This state has been chose as although Gujarat's demographic characteristics fit more closely with India's northern demographic regime than with its southern regime, many of its characteristics are less `northern' than other states such as Uttar Pradesh. Many, such as the sex ratio and some fertility indicators, as well as certain indexes relating to women's status demonstrate a middle ranking compared with all other states and conform quite closely to all-India estimates [Dyson and Moore 1983]. Gujarat may therefore be viewed as a broadly representative state as far as much of its demography is concerned. The rest of my data collection took place in Ahmedabad, the largest urban area in Gujarat.

[viii]. An example, of a recent Field investigation is that of Bhatia's (1993) in which a high level of maternal mortality was found. The study estimated maternal mortality of 830 per 1,00,000 live births in rural Andhra Pradesh and 545 in urban areas.

[ix]. The details of all estimation methods are given in Blum and Fargues (1990). It can be seen that

$i(x) = Mf(x)/Mm(x)$ so, $Mf(x) = i(x). Mm(x)$ and

$i'(x) = Mf'(x)/Mm(x)$ so, $Mf'(x) = i'(x). Mm(x)$

Therefore, if the age-specific maternal mortality rate per 1,000 is given by Rl(x),

$Rl(x) = Mf(x) - Mf'(x)$

$= Mf(x) - i'(x). Mm(x)$ and,

if the age-specific maternal mortality ratio per 1,000 is given by R2(x),

$R2(x) = RI (x)/f(x). 1,000$ where,

$F(x)$ = fertility rate at age x.

[x].Again, details of the extrapolation rules are contained in Blum and Fargues (1990). The first rule is a linear combination of two adjustments, Uf1(x) and Uf2(x) is obtained by linear extrapolation of the logarithms of the mortality rates from age group mid-point 52 to mid-point 12 following the gradient of the mortality rate scheduled between the age group mid-points 52 ind 72. Similarly, Uf2(x) is obtained by linear interpolation between the logarithm's of the mortality rates observed at age mid-points 12 and 52. The estimation of the mortality scheduled in the absence of maternal mortality is then derived as

$$Uf3(x) = \frac{(x - 12)}{40} Uf1(x) + \frac{(52 - x)}{40} Uf2(x)$$

where 40 = distance between age mid-points 12 and 52 in X axis units (years). Therefore, if the age-specific maternal mortality rate per 1,000 is given by Sl(x), then,

$$S I (x) = Mf(x) - Uf3(x)$$

If the age-specific maternal mortality ratio per 1,000 is given by S2(x), then,
$S2(x) = S1 (x)/F(x) \times 1{,}000$.

The second extrapolation rule involves the fitting of a quadratic function.

$\log Uf4(x) = yx^2 + dx + v$ such hat the following constraints are met:

$$\log Uf4 (52) = y52^2 + d52 + v = \log Mf(52)$$

$$\log Uf4'(52) = 2y52 + d = a$$

$$\log Uf4 (12) = 144y + 12d + v = \log Mf(12)$$

where, a = gradient of linear interpolation of the logarithms of the mortality rates between age group mid-points 52 and 72. Then,

$$y = \underline{\log Mf(52) - \log Mf(12) - 40a}$$

$$d = a - 104y$$

$$v = \log Mf(i2) - 12d - 144y,$$

If the age-specific maternal mortality rate per 1,000 is given by Tl(x), then,

$$Tl(x) = Mf(x) - Uf4(x)$$

and if the age-specific maternal mortality, ratio per 1.000 is given by T2 (x), then,
$T2(x) = Tl(x)/F(x) \times 1{,}000$.

Sources of bias error in the estimation of maternal mortality by these methods should be noted. Specifically an abnormally high mortality for women from non-maternal causes at childbearing ages may lead to an overestimation of maternal mortality. For the case of India, deaths from external causes such as accidents and suicide may be a possible source of such a bias. [see Blum and Fargues 1990; Mari Bhat et al 1994].

[xi].The whole procedure has been repeated for all-India SRS data (rural and urban areas combined). The results produce a broader picture than those from a single urban region. Table 1 indicates that trends of similar statistical significance were obtained from all methods for the all-India data. Method I produced a significant trend in the maternal mortality rate without the use of the modification. The method was therefore not repeated for this data using the modification importantly, for all methods a statistically significant decline in the mortality rate can be observed to coincide with an insignificant trend in the mortality ratio. For the all-India data it is interesting to note that this insiginificant trend is upward. The all-India results do however, second the Gujarati analysis and make more forceful the inferences drawn.

**Table 1**

| | **Urban** | | | | **Gujarat** | | | |
|---|---|---|---|---|---|---|---|---|
| | Method 1 | | | | Method 2 | | | |
| | Un-modified | | Modified | | 1st Rule | | 2nd Rule | |
| | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio |
| X-coefficeint | -0.017 | -0.334 | -0.027 | -0.468 | -0.026 | -0.483 | -0.028 | -0.588 |
| Std. Error | 0.011 | 0.456 | 0.008 | 0.437 | 0.009 | 0.495 | 0.009 | 0.466 |
| T-statistic | -1.545 | -0.732 | -3.375 | -1.071 | -2.889 | -0.976 | -3.111 | -1.262 |
| **All India** | | | | | | | | |
| | Method 1 | | | | Method 2 | | | |
| | Un-modified | | Modified | | 1st Rule | | 2nd Rule | |
| | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio | Maternal Mortality Rate | Maternal Mortality Ratio |
| X-coefficient | -0.011 | -0.010 | - | - | -0.013 | 0.039 | -0.012 | 0.049 |
| Std. Error | 0.005 | 0.045 | - | - | 0.005 | 0.072 | 0.005 | 0.069 |
| T-statistic | -2.200 | 0.222 | - | - | -2.600 | 0.542 | -2.400 | 0.710 |

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