Most research on mortality differentials by sex in India focuses on disparities among children under 5 years of age. In this paper, we assess the changing age and cause patterns of mortality by sex in India and selected States using survey data and including mortality trends over the life span. Since the 1970s, the gap between female and male mortality in India has increased to females' advantage. This occurred despite persisting higher female mortality below age 5, a disadvantage masked by the large gap favoring women at adult and older ages. This paper finds that the life expectancy gap between females and males in the second half of the 1990s can be attributed mainly to non-communicable diseases and external causes of death. While more developed States (primarily in the South) showed higher female longevity already in the 1970s, the States that lagged behind displayed similar mortality levels for females and males up until the turn of the century.

By Vladimir Canudas-Romo, Nandita Saikia and Nadia Diamond-Smith

Keywords: sex gap, mortality, India, causes of death, log-quadratic model, life expectancy, age-decomposition.

1. Vladimir Canudas-Romo, Max Planck Odense Center on the Biodemography of Aging, University of Southern Denmark, Department of Epidemiology, Biostatistics and Biodemography, Odense C, Denmark, and Johns Hopkins Bloomberg School of Public Health, Department of Population, Family and Reproductive Health, Baltimore MD 21205, United States of America, e-mail: vcanudas@health.sdu.dk; Nandita Saikia, Center for the Study of Regional Development, School of Social Science, Jawaharlal Nehru University, New Delhi, India; Nadia Diamond-Smith, Global Health Science, University of California, San Francisco, United States of America.

2. The authors would like to thank Abhishek Singh, Domantas Jasilionis, as well as colleagues at the Institute of Economic Growth, India, and Johns Hopkins Bloomberg School of Public Health (JHBSPH), USA, for their useful and constructive comments. The first authors' work was supported by the European Research Council - ERC Starting Grant number 240795. The first and third authors are thankful to the Institute of Economic Growth, India, and the Global Health Established Field Placement Research/Practice Experience Agreement, JHBSPH, USA, respectively for their travel grants.
Introduction

Today, in most countries in the world, women have a longer life expectancy at birth than men (Barford and others, 2006). India has experienced a continuous rise in life expectancy since the 1970s for both sexes, and the transition to a female advantage in life expectancy occurred around the turn of the century (India, Registrar General, 2004 and 2007). Nevertheless, the pace of mortality improvements stagnated in the 1990s and 2000s, especially for female child mortality and infant mortality for both sexes (Claeson and others, 2000; Saikia and others, 2011). This calls for a close examination of age patterns of mortality to answer questions related to slower mortality declines, with a specific focus on differences in mortality between females and males.

In developed countries, female mortality rates are lower than male mortality rates at most ages, and female life expectancy is greater than male life expectancy (Glei and Horiuchi, 2007; Oksuzyan and others, 2008). Past research in developed countries has found that men have higher mortality risks than women at practically all ages, and that since the 1950s disparity increased, especially for men in their middle ages, and then decreased in the last few decades (Oksuzyan and others, 2008). Other work looking at sex-based mortality differentials by age group found that disparities in children and adolescents decreased over time (Conti and others, 2003). The mortality gap in the working-age population also decreased over time, and mortality patterns at age 60 and older were the primary contributor to maintaining sex-based differentials in life expectancy (Conti and others, 2003). The increasing contribution of mortality at older ages is partially a consequence of the shifting of mortality towards older ages (Canudas-Romo, 2010; Oeppen and Vaupel, 2002).

There is a substantial body of literature that shows that, for most populations, male infants have higher rates of mortality than female infants, especially in the neonatal period (Wells, 2000). Work by Hill and Upchurch (1995) used Demographic and Health Survey data from developing countries to look at sex differences in child mortality. They found that female mortality disadvantage was greatest in childhood (ages 1 to 4) due to care-giving behavior, which is the main risk factor for mortality in childhood (Hill and Upchurch, 1995).
Mortality differentials in India: age, sex and cause

A large body of literature describes child mortality disparity by sex in India, a topic which has received much attention since the description made by Nobel Prize winner Amartya Sen of “100 million missing women” in Asia (Sen, 1990). Sen brought attention to the fact that there are a lot fewer women in India and China than there should naturally be, due to a strong cultural preference for sons and discrimination against daughters. Despite increased public attention, the situation worsened in the following decades. According to various rounds of Census, the sex ratio of children under the age of 5 in India has fallen from 945 girls to 1,000 boys in 1991 to 914 girls to 1,000 boys in 2011.

Discrimination against girls in India does not only occur before birth through sex-selective abortion — there are also noted sex differences in infant and child mortality. The under-5 mortality rate for the country as a whole was 60/1,000 for males and 69/1,000 for females in 2009, and the infant mortality rate was 49/1,000 for males and 52/1,000 for females (India, Office of Registrar General, 2011). Oster (2009) looked at the impact of specific types of biases on mortality, and found that uneven vaccination rates explain about 20 to 30 per cent of the sex imbalance, malnutrition explains 20 per cent, respiratory infections and diarrhoea combined explain 5 per cent, and the remaining roughly 50 per cent is unexplained by these factors (Oster, 2009).

Cause-of-death data in India is scarce and problematic (The Million Death Study Collaborators, 2010). Given the paucity of data on causes of death among children in India, a detailed study of mortality in children under age 5 was undertaken in India from 2001 to 2003 (The Million Death Study Collaborators, 2010). This study found that prematurity/low birth weight, neonatal infections and birth asphyxia/trauma accounted for 78 per cent of neonatal deaths. Diarrhoea and pneumonia accounted for 50 per cent of deaths in children from 1 month to 5 years of age. Contrary to what is observed in developed countries but in line with what has been observed in India in previous studies, female disadvantage in mortality starts in India as early as 1 month after birth. As suggested in The Million Death Study, girls under 5 years of age have a higher mortality risk than boys in every region of India, and in some regions, girls have four to five times higher death rates for the same causes compared to boys.
There is less research on sex-based mortality differentials in other age groups in India. Understanding the age pattern of mortality and causes of death can help policymakers recognize the most vulnerable groups of the population to target interventions. Despite its potential value, there exist very few systematic attempts to understand the age patterns of mortality in India (Singh and Ram, 2004). In particular, applications of mortality models to understand age patterns of mortality in India are limited (Bhat, 1998; Parasuraman, 1990; Ram, 1984; Roy and Lahiri, 1987; Visaria, 1969). While research so far has focused on disparities in children under 5 years of age, understanding mortality differentials at all ages and their contribution to longevity is important, especially when considering how sex differentials in child and old-age mortality may be related or cancel each other out.

Work by Anderson and Ray (2012) decomposed the missing women in India into age categories, and found that 12 per cent were missing at birth, 25 per cent missing in childhood, 18 per cent in reproductive ages and 45 per cent in older ages (Anderson and Ray, 2012). This suggests that sex-based mortality differentials exist across all ages for women in India. Other work by the same authors suggests that similar numbers of women were missing in the United States of America a century ago, and that rates of missing women are actually higher in sub-Saharan Africa than in India or China (Anderson and Ray, 2010). Available data suggests that the largest share of deaths in India are due to non-communicable diseases (42 per cent), with the leading cause of death being cardio-vascular disease (favouring women), followed by respiratory diseases, diarrhoea, prenatal conditions, respiratory infections and tuberculosis (Anderson and Ray, 2012). Cardiovascular disease is responsible for more female deaths in India than sex-selective abortion, and “injuries” account for more female deaths than maternal mortality, which is not the case in sub-Saharan Africa or China (Anderson and Ray, 2010). Differences exist in cause of death by sex, rural/urban status and age (India, Office of the Registrar General, 2003). For example, non-communicable diseases contribute to a greater proportion of the mortality burden in urban areas than in rural areas, and are mostly concentrated in older-aged individuals (Yadav and Arokiasamy, 2014).

Across the States of India there is a strong North-South gradient, with great differences in the level and pace of mortality reduction over time (Bhat, 1987; Dyson and Moore, 1983; Saikia and others, 2011). For example, infant mortality in 2009 was as high as 67/1,000 in Madhya Pradesh, and as low as 12/1,000 in Kerala (India, Office of the Registrar General, 2011). Infant mortality has declined by as much as 40 per cent between 1990 and 2007 in Odisha, Maharashtra and West Bengal, while only by 20 to 30 per cent in Andhra Pradesh, Bihar and Rajasthan in that same time period (Lahariya and Paul, 2010). Therefore, it is essential to explore the female-male gap down to the State level to capture possible heterogeneity present in India masked by a single female-male life expectancy gap for the entire country. In this paper, we provide further evidence on patterns of mortality differentials by sex using data from the Sample Registration System (SRS), National Family Health Survey (NFHS), and a two-dimensional mortality model developed by Wilmoth and others (2012). We systematically explore
long-term trends in male and female life expectancy and cause-specific contributions to the life expectancy gap by sex from the late 1990s to the 2000s. Our aim is to understand the contribution of sex differentials in mortality through the entire life span in India, with the ultimate goal of providing an evidence base to better tailor policies.

Data and methods

Data

Mortality data and limitations

The present study uses data from the Sample Registration System (SRS) from 1970 to 2013, and the second round of National Family Health Survey (NFHS), 1998/99 (International Institute for Population Sciences (IIPS) and ORC Macro International, 2000). Indicators for mortality under 5 years of age and for adults are taken from the published SRS life tables for the period from 1970 to 2013 (India, Office of the Registrar General, 1984, 1985, 1989, 1994, 1998, 2004, 2007, 2013, 2015). For the years 2000 to 2004 and 2002 to 2006, the original SRS abridged life table estimates show increasing child mortality rates for India and its States, which is inconsistent with the SRS annual reports and NFHS information on child mortality (Saikia, Singh and Ram, 2010). The Office of the Registrar General and Census Commissioner therefore published revised life tables for this time period which had corrected child mortality estimates (India, Registrar General, 2013). These revised figures were used in our analysis for that time period. A more detailed description of the SRS procedure and the quality of its mortality information is available in the study by Saikia and others (2011). For the most recent period of 2009 to 2013, while a detailed analysis remains to be conducted, we applied the same methodology as for the other time periods.

Cause-of-death data and limitations

India’s Civil Registration System statistics on causes of death is far from complete or accurate (Mahapatra and others, 2007). For this analysis, we used the data on cause of death in India from the second round of National Family Health Survey (NFHS). Detailed descriptions of the NFHS survey design and findings are available in various reports at the national and State levels (IIPS and ORC Macro International, 2000; IIPS and ORC Macro International, 2007). The second round of NFHS (1998/99) provided details on 52 causes of death. The cause of death was reported by the head of household and recorded when a household member had died as a result of disease. Since information on the causes of death is only reported by the head of household (and may not be medically certified), we categorized it into five broad groups of causes of death to avoid misclassification as much as possible: communicable diseases, non-communicable diseases, external
causes, other causes, and misclassified. The specific causes of death in each of these groups are listed below and their International Classification of Diseases, ICD10, can be found in the publications of NFHS (IIPS and ORC Macro International, 2000; IIPS and ORC Macro International, 2007):

a) Communicable, maternal, perinatal and nutritional diseases: unclassified fevers, malaria, influenza, typhoid, not classifiable digestive disorders, gastroenteritis, cholera, tuberculosis of lungs, bronchitis, pneumonia, measles, leprosy, tetanus, poliomyelitis, prematurity, malposition, congenital malformation, birth injury, respiratory infection, diarrhoea, malnutrition, amoebic dysentery, other respiratory diseases;

b) Non-communicable diseases: anemia, peptic ulcer, acute abdominal pain, asthma, central nervous system diseases, paralysis or cerebral apoplexy, meningitis, congestive heart diseases, heart attack, cirrhosis of liver, jaundice, malignant neoplasm, mental diseases, diabetes;

c) External Causes: accidents and injuries, snake bite, scorpion and other insect bite, dog bite, drowning, fall, vehicular accidents, burns, suicide, homicide, food poisoning;

d) Others: other causes not accounted for by the above (i) to (iii);

e) Misclassified: misclassified and coded as “I don’t know”.

Methods

Taking into account potential weaknesses of the age-specific data from the SRS, especially at older ages (Saikia and others, 2011), a two-dimensional system of the model life table (log-quadratic model) approach was applied to estimate age-specific mortality rates (Saikia and others, 2011; Wilmoth others, 2012). Several further reasons for applying the log-quadratic model to the Indian population are that it helps to obtain consistency across States, time, and sex, since the model only requires information on child and adult mortality to construct the life tables. Additionally, the SRS publishes life tables up to age 70+, while the log-quadratic model returns estimates up to advanced ages, facilitating the study of mortality at older ages in this population. Nevertheless, for consistency with some of the results on causes of death only available for ages 75 and above, we present all our results with this open-ended age group.

The two inputs in the model are the probability of death from birth to age 5, denoted $\text{a}_0$, and the probability of death between ages 15 and 60, $\text{a}_{15}$.

The model uses existing information on child and adult mortality to predict mortality levels for all ages. The model outperforms the Coale-Demeny (Coale and Demeny, 1966; Coale and Demeny, 1983) and UN model life tables (United Nations, 1982) and returns similar results as those produced by the modified Brass logit model (Murray and others, 2003).
The death rate at age \( x \), denoted as \( m_x \), is estimated from the input parameters probability of dying between birth and age 5, \( q_0 \), and between ages 15 and 60, \( q_{15} \), as:

\[
\log(m_x) = a_x + b_x h + c_x h^2 + v_x k, \tag{1}
\]

where \( h = \log(q_0) \) and \( k \) is a function of the adult mortality input. The estimated relationship between \( \log(m_x) \) and \( h \) is quadratic with the four age-specific coefficients \( (a_x, b_x, c_x, v_x) \) calculated from the Human Mortality Database and presented in Wilmoth and others (2012). Finally, given a value of \( q_0 \), the model chooses a value of \( k \) in order to reproduce the observed value of \( q_{15} \) exactly.

The calculated coefficients for the log-quadratic model are based on all countries in the Human Mortality Database, populations mainly of European origin, except for Japan and Taiwan, Province of China. Although it is not the optimal data for India’s population, this is the most accurate existing information on the age pattern of mortality to date. We conducted a validation of the modeling approach.

In order to estimate the contributions of age and causes of death to the female-male life expectancy gap, standard decomposition methods were used. (Preston, Heuveline and Guillot, 2001; Canudas-Romo, García-Guerrero and Echarri-Cánovas, 2014). The overall age-contribution between ages \( x \) and \( x+n \), \( n\Delta x \), to the difference in life expectancies between populations 1 and 2, \( e_i - e_j = \sum s\Lambda \), is obtained as:

\[
s\Lambda = \frac{1}{1 \times} \left( \frac{sL_1^2 - sL_2^1}{1 \times} \right) + \frac{T_1}{1 \times} \left( \frac{1}{1 \times} \frac{1}{1 \times} \right), \tag{2}
\]

where \( sL_i^1 \) and \( T_i^1 \) are the survival function at exact age \( x \), person-years lived between ages \( x \) to \( x+n \), and after age \( x \) respectively for a life table in population \( i \). Population \( i=1 \) corresponds to males and \( i=2 \) to females. This age decomposition can be further decomposed into causes of death as \( e_i^c - e_j^c = \sum s\Lambda \left( \sum s\Lambda^c \right) \), where \( s\Lambda^c \) is calculated from the proportion of deaths from cause \( c \) at that age (for more details see Preston, Heuveline and Guillot, 2001). We explore the female-male life expectancy gap from 1970 to 2013 in India using the log-quadratic model with Indian SRS data. For causes of death we explore the period from 1996 to 2000 with data from NFHS (a further analysis of causes of death for the period from 2001 to 2003 was carried out).
Results

Trends in female and male life expectancy at birth

Table 1 presents the gap between Indian female and male life expectancies by State in the years 1970-1975, 1981-1985, 1991-1995, 2002-2006 and 2009-2013. As can be seen, by 2009-2013 females outlived males in all States, while this was only true for five States in 1970-1975. The progression of States with female life expectancy advantage goes from 5 in 1970-1975 to 14 in the 1980s, 15 in the 1990s, and all the States with available information from 2002 onwards. Kerala has the biggest female advantage in all time periods, and in Uttar Pradesh and Bihar females fared comparatively worse from 1970 to 2006, but better in recent years. States are divided into those with female disadvantage in mortality (negative gap), with advantage (positive gap), and where female and male life expectancy are about the same. As can be seen in table 1, for 1970-1975 there was a strong North-South divide in life expectancy gaps, with females having survival advantage in the South and disadvantage in the North. By 2009-2013 life expectancy differentials looked more homogeneous, with every State showing longer female than male longevity, although life expectancy was higher for females only by 1.5 years in Gujarat and 2.2 years in Jammu and Kashmir.


<table>
<thead>
<tr>
<th>Ranking</th>
<th>States</th>
<th>Female minus male life expectancy in given year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1970-75</td>
</tr>
<tr>
<td>1</td>
<td>Kerala</td>
<td>3.35</td>
</tr>
<tr>
<td>2</td>
<td>Maharashtra</td>
<td>2.21</td>
</tr>
<tr>
<td>3</td>
<td>Andhra Pradesh</td>
<td>1.63</td>
</tr>
<tr>
<td>4</td>
<td>Gujarat</td>
<td>1.22</td>
</tr>
<tr>
<td>5</td>
<td>Karnataka</td>
<td>0.10</td>
</tr>
<tr>
<td>6</td>
<td>Tamil Nadu</td>
<td>-0.40</td>
</tr>
<tr>
<td>7</td>
<td>Odisha</td>
<td>-0.65</td>
</tr>
<tr>
<td>8</td>
<td>Punjab</td>
<td>-0.67</td>
</tr>
<tr>
<td>9</td>
<td>Madhya Pradesh</td>
<td>-0.74</td>
</tr>
<tr>
<td></td>
<td><strong>India</strong></td>
<td><strong>-0.97</strong></td>
</tr>
<tr>
<td>10</td>
<td>Rajasthan</td>
<td>-0.97</td>
</tr>
<tr>
<td>11</td>
<td>Assam</td>
<td>-1.25</td>
</tr>
<tr>
<td>12</td>
<td>Himachal Pradesh</td>
<td>-2.67</td>
</tr>
<tr>
<td>13</td>
<td>Haryana</td>
<td>-3.17</td>
</tr>
<tr>
<td>14</td>
<td>Uttar Pradesh</td>
<td>-4.34</td>
</tr>
<tr>
<td>15</td>
<td>Bihar</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>West Bengal</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: SRS and author’s calculations.
Note: Rankings correspond to the values of 1970-75, when Bihar and West Bengal did not have data.
The role of different ages and causes of death

The contribution to the sex gap in life expectancy by age group has shifted over time, as can be seen in figure 1. In this figure, age groups contributing to female advantage in life expectancy are above zero, and below zero show female disadvantage. We observe a few notable changes in female-male life expectancy dynamics during the studied period. First, males had one year of advantage in life expectancy over their female counterparts, with particular disadvantage at ages below 30 in 1970-1975. The following four decades were of transition to female advantage: around 1 year in the 1980s, 2 years in 1990s, and almost 3 years in the early 2000s. By 2009-2013, there were 4.08 years of difference between female and male life expectancy, with females living longer. The female-male life expectancy gap in Indian States is therefore similar to what is found in East and South-East Asia today, where countries range from 1.29 years (Lao People’s Democratic Republic) to 4.98 years (Democratic People’s Republic of Korea) (Gu and others, 2013). Second, there is a clear change in the contribution of various age groups to sex differentials in life expectancy. For example, age group 0-4 always showed male advantage in life expectancy, but it decreased from two years in 1970-1976 to half a year in the 2000s. Although all age groups from 15 to 74 played a positive role in favoring female life expectancy, the role of age groups 45-74 substantially increased in this period. A reduction in excess female deaths in age groups 5-14 and 30-44 became visible in the mid-1980s. Finally, there is minimum change in the contribution of age group 75 and older during the studied period.

Figure 1. Contribution of mortality patterns by age group to sex differentials in life expectancy, India, 1970-2013
Different patterns in the effect of age-specific mortality on life expectancy gaps by sex are also observable among States. As can be seen in figures 2a, 2b, and 2c, 10 out of 17 big States in India showed substantial excess mortality of females under 5 years of age in 2009-2013. Therefore, the under-5 mortality rate negatively contributed to the female-male life expectancy in those States. Until the 1990s, in the two most populous, States namely Bihar and Uttar Pradesh, females experienced higher mortality rates than males. Particularly notorious is the mortality disadvantage in Bihar for females in the age groups 0-44. Thus, these two States stand out because women experience higher mortality rates outside of childhood. In all other States, except Assam, women have higher life expectancy than men after age 15. Indian States can be divided into three groups on the basis of differential age contribution to the female-male life expectancy gap in the last decades. The first group shows minor excess female mortality in the under-5 age group and women enjoy significantly higher life expectancy than men beyond age 15. These States belong to southern India (Kerala, Tamil Nadu, Karnataka and Andhra Pradesh) and in recent years also to eastern India (Odisha and West Bengal). The second group exhibits significant excess female mortality in the under-5 age group and women enjoy significantly higher life expectancy than men beyond age 15. The majority of these States (Gujarat, Haryana, Himachal Pradesh, Maharashtra and Punjab except for Rajasthan) are economically well-off States. The third group of States shows significant excess female deaths in the under-5 age group and a minimum advantage in life expectancy for women above age 15, particularly until the early 2000s. They are the most populous States of Central India: Bihar, Madhya Pradesh and Uttar Pradesh. Another noteworthy point in figure 2 is that women uniformly experience the highest life expectancy advantage in the age group 45-74 in most States.

Figure 2a. Contribution of mortality patterns by age group to sex differentials in life expectancy, India and selected States, 1970-1975
Figure 2b. Contribution of mortality patterns by age group to sex differentials in life expectancy, India and selected States, 1991-1996

Figure 2c. Contribution of mortality patterns by age group to sex differentials in life expectancy, India and selected States, 2009-2013
Figure 2c. Contribution of mortality patterns by age group to sex differentials in life expectancy, India and selected States, 2009-2013

Figure 3 illustrates the role of age and causes of death in the female-male life expectancy gap from 1996 to 2000. A distinct shift in the pattern of causes of death across the age spectrum is visible in this figure. While communicable diseases are the most prominent killer of females under 5 years of age, external causes of death are a major player for excess male deaths in the age group 15-50. Non-communicable causes, on the other hand, are responsible for excess male deaths beyond age 50. Thus, in the 1990s, disparities in mortality can be explained by higher female mortality due to communicable diseases at the youngest ages and excess male mortality due to external and non-communicable diseases at adult and older ages. The main causes of the female-male life expectancy gap in the second half of the 1990s were already non-communicable diseases and external causes of death, affecting mostly men. Communicable diseases made a minor overall contribution. However, this minor role results from the fact that disadvantages for females below age 5 and female advantages after this age cancel each other out when added together. Nevertheless, it can be noted that communicable diseases continue to be the main cause of excess mortality in females below age 5, but less information is available for the rest of the age groups and for causes of death from this supplementary figure.
Figure 3. Contribution of causes of death to sex differentials in life expectancy, India, 1996-2000

Conclusions

The results confirm that, in the past few decades, overall female life expectancy surpassed male life expectancy in India. This occurred despite persistent female disadvantage below age 5. A large positive gap favoring women at adult and older ages masks the disadvantage experienced by female children even in States at the later stages of the epidemiological transition. While States that were more advanced in this transition showed female longevity advantages already in the 1970s, States in earlier stages displayed similar mortality levels for males and females even during recent years. In comparison, every country in East and South-East Asia showed female advantage in life expectancy by 1980 (Gu and others, 2013).

The biggest contribution to the life expectancy gap by sex in the second half of the 1990s was made by non-communicable diseases and external causes of death, affecting men more starkly. However, for children under 5 years of age, most of the disparity was attributed to communicable diseases, with female infants and children more likely to die of communicable diseases than their male counterparts.

Although great progress has been made in reducing both male and female infant and child mortality in India, the female disadvantage in mortality below 5 years of age remains (India, Office of the Registrar General, 2009). Female children still face a serious disadvantage compared to male children. Much literature has documented discrimination against girl-children in India in the past; here we have added to the complexity of the current Indian mortality situation by showing that these behaviors co-exist today at the same time that women at older ages are experiencing advantage in mortality. Past literature has suggested that parents discriminate against their female children through sex-selective abortion before birth (Jha and other, 2011), and in care-taking, such as providing fewer vaccines, less nutritional diets, and taking them to health care facilities less often when they are ill (Barcellos, Carvalho and Lleras-Muney, 2012; Das Gupta, 1987; Mishra, Roy and Retherford, 2004). All of these types of behaviors could contribute to excess mortality from communicable diseases for female children.

Our results suggest that greater efforts are needed to reduce population mortality, specifically that of girls below 5, by eliminating discrimination at the individual, household and community levels. Policymakers need to strengthen their efforts to reduce discrimination against girls and subsequent sex-selective abortion and excess of mortality in the early years of childhood. This could include promoting gender equality and the value of girls broadly, specifically incentivizing families to bring their young daughters to health facilities for vaccinations or check-ups, or other programmes to ensure equal opportunities for girls and boys. Both programmes that encourage school attendance by girls and health-seeking behavior for
daughters by parents seem to play a role in reducing mortality disparities (Das Gupta and others, 2005; Pebley and Amin, 1991). Further research on effective policies to reduce discrimination and improve the health of girls is much needed (Sekher, 2012; Sekher, 2010).

At the other end of life, women are experiencing advantages in mortality at older ages. External causes of death and cardiovascular deaths, which affect predominantly men, are the explanatory factors in western countries, as well as in India as shown by past research (Anderson and Ray, 2010; Meslé, 2013). Behavioral factors, such as smoking and alcohol consumption, greatly increase males’ risk of mortality and partially explain the female to male gap in mortality in western societies (Glei, Meslé and Vallin, 2011; McCartney and others, 2010). India remains a very sex-divided society, and these behavioral patterns may also have contributed to creating a female advantage in survival at adult ages. For example, about 42 per cent of men in India smoke, compared to just over 4 per cent of women, and men in India are twelve times more likely to be current alcohol drinkers than women (John, Sung and Max, 2009; Wilsnack and others, 2009). There has been growing attention to the need for policies focused on reducing drinking and smoking behaviors in men in India, which could help men catch up to women in terms of life expectancy (Prasad, 2009). Obesity in India, which is growing despite the concurrent existence of extreme malnutrition, has also gained additional policy attention (Khandelwal and Reddy, 2013).

Substantial geographic variations in sex-specific mortality patterns persist in India. In order to better understand the path and timing of the health transition and its determinants in India and its States, it is important to consider changing sex-specific mortality patterns and their geographical diversity. It is also essential to think critically about using the life table estimates that come from the SRS. It appears that the log-quadratic model to estimate life expectancy is appropriate for the Indian population, and might provide a way of working around weaknesses in the data (Saikia and others, 2010). However, no model can replace the optimal situation of having accurate data, and India should strive to improve the accuracy of its data on mortality and causes of death. Having reliable data on causes of death is vital for understanding the changing nature of mortality in a population. We were limited by the lack of cause-of-death data after the 1990s because the National Family Health Survey stopped collecting data in its latest survey (2005-2006). In addition, the NFHS-2 data had more missing values and poorer quality data, such as more age heaping, than...
The contribution of age-specific mortality towards male and female life expectancy differentials in India and selected States, 1970-2013

NFSH-1 (Rajan and James, 2008). Hence, our results on overall mortality, and particularly on the cause-of-death data, should be taken with caution and further analysis should be carried out once appropriate data is available.

References


