Gender Gap in Life Expectancy in India, 1970–2006

Vladimir Canudas-Romo
Nandita Saikia

सत्यमेव परमो धर्मः
IEG Working Paper No. 322

2013

सत्यमेव परमो धर्मः
Institute of Economic Growth
University Enclave, University of Delhi
Delhi 110007, India
Tel: 27667101/288/424; Fax: 27667410
Website: www.iegindia.org

RECENT WORKING PAPERS

Title	Author (s) Name	Paper No.
Nagaland's Demographic Somersault	Ankush Agrawal Vikas Kumar	E/311/2012
Does Access to Secondary Education Affect Primary Schooling? Evidence from India	Abhiroop Mukhopadhyay Soham Sahoo	E/312/2012
Reexamining the Finance–Growth Relationship for a Developing Economy: A time series analysis of post–reform India	Sabyasachi Kar Kumarjit Mandal	E/313/2012
Fiscal Consolidation in India	Sanhita Sucharita	E/314/2012
The Impact of Carbon Taxes on Growth Emissions and Welfare in India: A CGE analysis	Basanta K. Pradhan Joydeep Ghosh	E/315/2012
An Investigation into Changes in Nagaland's Population between 1971 and 2011	Ankush Agrawal Vikas Kumar	E/316/2012
Carbon Taxes vs Productivity Shocks: A comparative analysis of the costs in a CGE framework for India	Basanta K. Pradhan Joydeep Ghosh	E/317/2012
Food Price Inflation in India: Causes and Cures	Pradeep Agrawal Durairaj Kumarasamy	E/318/2012
India's Petroleum Demand: Empirical Estimations and Projections for the Future	Pradeep Agrawal	E/319/2012
Food Security, Productivity, and Gender Inequality	Bina Agarwal	E/320/2012
Productivity and Efficiency Impacts of Zero Tillage Wheat in Northwest Indo-Gangetic Plains	Prakashan Chellattan Veettil Vijesh V. Krishna	E/321/2013

Gender Gap in Life Expectancy in India, 1970–2006

Vladimir Canudas-Romo
Nandita Saikia

सत्यमेव परमो धर्मः IEG Working Paper No. 322 2013

ACKNOWLEDGEMENTS

The authors are grateful to Dr Domantas Jasilionis, Research Scientist, Max Planck Institute for Demographic Research, Germany for his comments and suggestions in the first draft of this paper. Dr Vladimir Canudas-Romo is grateful to the Institute of Economic Growth for awarding him a travel grant.

Vladimir Canudas-Romo is Assistant Professor at Johns Hopkins Bloomberg School of Public Health, USA.
email: vcanudas@jhsph.edu

Nandita Saikia is Assistant Professor at the Institute of Economic Growth, New Delhi.
email: nandita@iegindia.org

Gender Gap in Life Expectancy in India, 1970–2006

ABSTRACT

In this paper, we assess the changing age pattern of mortality in India and bigger states during 1970–2006 by applying a two-dimensional flexible mortality model. Using survey data from India, we provide further evidence of changes in country and state-level patterns of mortality differentials by sex, and assess the potential role of the major causes of death to this differential. We also study the contribution of major causes of death to the female–male mortality gap. The findings confirm that the health advantage of Indian females over males has been growing since the 1980s. This occurred despite persistent disadvantages among females below age 5. The biggest contribution to the life expectancy gap between females and males—in the second half of the 1990s—came from non-communicable diseases and external causes of death. We also found a notable geographical variation in sex-specific mortality patterns. While more advanced states showed female longevity advantages in the 1970s, laggard states displayed similar mortality levels for males and females even recently. It is necessary to consider changing sex-specific mortality patterns in India and their geographical diversity to understand the path and timing of health transition and its determinants.

Keywords: Mortality, gender, India, life expectancy at birth, causes of death

1. INTRODUCTION

Worldwide, women enjoyed longer life expectancy at birth than men for the first time in human history in the mid-2000s (Barford 2006). In India, both genders have experienced a continuous rise in life expectancy since the 1970s, and the transition to female dominance in life expectancy also occurred around 2000 (Registrar General of India 2004, 2007). Nevertheless, the pace of mortality stagnated in the 1990s and 2000s (Saikia et al 2011; Claeson et al. 2000). This calls for a close examination of the age patterns of mortality and of the question of possible reversals in mortality—particularly, a retrocession to times when female mortality was greater than male mortality. There is a strong north–south gradient across Indian states, with great differentials in the level and pace of mortality reduction over time (Dyson & Moore 1983; Bhat 1987; Saikia et al. 2011). In this paper, we assess the female–male gap down to the state and place of residence (rural and urban) to capture the possible existent heterogeneity in the country, which is not captured by a single life expectancy female–male gap for the entire country.

A study of the age pattern of mortality and causes of death can determine the most susceptible population groups and thereby provide policy makers valuable insights. However, few systematic attempts have been made to understand the age patterns of mortality in India (Singh & Ram 2004). In particular, applications of mortality models to understand age patterns of mortality in India are limited (Visaria 1969; Ram 1984; Roy & Lahiri 1987; Parasuraman 1990; Bhat 1998). Thus, our aim is to assess the changing age pattern of mortality by sex in India and its bigger states by applying the two-dimensional model by Wilmoth et al. (2012) on data from the Sample Registration System (SRS). We provide further evidence of peculiar patterns of mortality differentials by sex by systematically exploring patterns of cause-specific contributions into the female–male life expectancy gap in the late 1990s using data from the National Family Health Survey (NFHS) (IIPS & Macro International 2000).

The remaining sections of this paper are divided as follows. Section 2 describes the data and methods used in the study. Section 3 presents the results, which show the applicability of the mortality model used in the context of India, trends in male and female life expectancy at birth and the findings on the causes of death analysis. Finally, Section 4 offers the conclusions of this study.

2. DATA AND METHODS

The present study is based on two datasets: the SRS, 1970-2006, and the second round of the NFHS 1998–99. A detailed description of SRS data and its quality on mortality information is available in a recent study (Saikia et al. 2011). Under-five and adult mortality indicators are taken from the published SRS life tables for 1970–2006 (Office of Registrar General 1984, 1985a, 1989; Registrar General of India 1994a, 1998, 2004 2007, 2008). For the 2000–2004 and 2002–2006 periods, the original SRS abridged life table estimates show increasing child mortality rate for India and its states. This finding is inconsistent with the SRS annual reports and NFHS information on child mortality (Saikia, Singh, & Ram 2010). Therefore, for the period 2000–04 and 2002–06, we used data corrected by Saikia, Singh, & Ram (2010).

The data on causes of death in India come from NFHS 2. Various national-and state-level reports describe the NFHS design and findings in detail (IIPS & Macro International 1995, 2000, 2007). The household head reported the cause of death, which was recorded if a household member had died of a disease. The question was whether any usual household resident had died since January 1996. If there was any such death, the interviewer recorded more information—sex of the dead person, age at death, month and year of death, and the cause of death. A list of 52 causes of deaths was available with the interviewer describing symptoms of each disease. As adult members of the dead person's household provided information on the cause of death, the chance of rudimentary classification of cause of death is high in this dataset. This limitation has been minimised by classifying deaths into broad categories according to the global burden of disease study (Murray & Lopez 1996). Six broad groups of causes of death were used: (1) communicable diseases; (2) non-communicable diseases; (3) external causes; (4) senility; (5) other causes; and (6) mis-classified.

Considering the potential weaknesses of the age-specific SRS data (especially at older ages), a two-dimensional system of model life table (log-quadratic model) approach was applied to estimate age-specific mortality rates (Saikia et al. 2011; Wilmoth et al. 2012). These two inputs in the model are the probability of death from birth to age 5, denoted 5q0, and the probability of death between ages 15 and 60, 45q15. The model uses the existent correlation between mortality levels at different ages to predict mortality levels for all ages using the information available on child and adult mortality. The model outperforms the Coale-Demeny (1966, 1983) and UN model life tables (UN 1982) and returns results similar to those produced by the modified Brass logit model (Murray et al. 2003).

The death rate at age x, denoted as m_x, is estimated from the input parameters probability of dying between birth and age five, ${}_5q_0$, and between ages 15 and 60, ${}_{45}q_{15}$, as:

$$\log (m_x) = a_x + b_x h + c_x h^2 + v_x k, \quad (1)$$

where $h = \log({}_5q_0)$ 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, and v_x) calculated from the Human Mortality Database and presented in Wilmoth et al. (2012). Finally, given a value of ${}_5q_0$, the model chooses a value of k in order to reproduce the observed value of ${}_{45}q_{15}$ exactly.

The calculated coefficients log-quadratic model is based on populations with a majority population of European origin, except for Japan and Taiwan. Although not the optimal data for an Asian population, this is the most accurate existent information about the age pattern of mortality—historical and present. Furthermore, adding extra information on life tables from developing countries has almost no impact on the fitted model (Wilmoth et al. 2012).

Decomposition techniques are standard methods for comparing life expectancy across populations and time, and analysing the contribution of age and cause to the differences (Preston, Heuveline, & Guillot 2001). We extracted age-specific death rates, numbers of survivors, and person-years from the life tables described above. These values, together with the proportion of deaths for each cause in every age group, were used to obtain age- and cause-specific death rates and contributions that make up the difference in life expectancy between females and males.

3. RESULTS

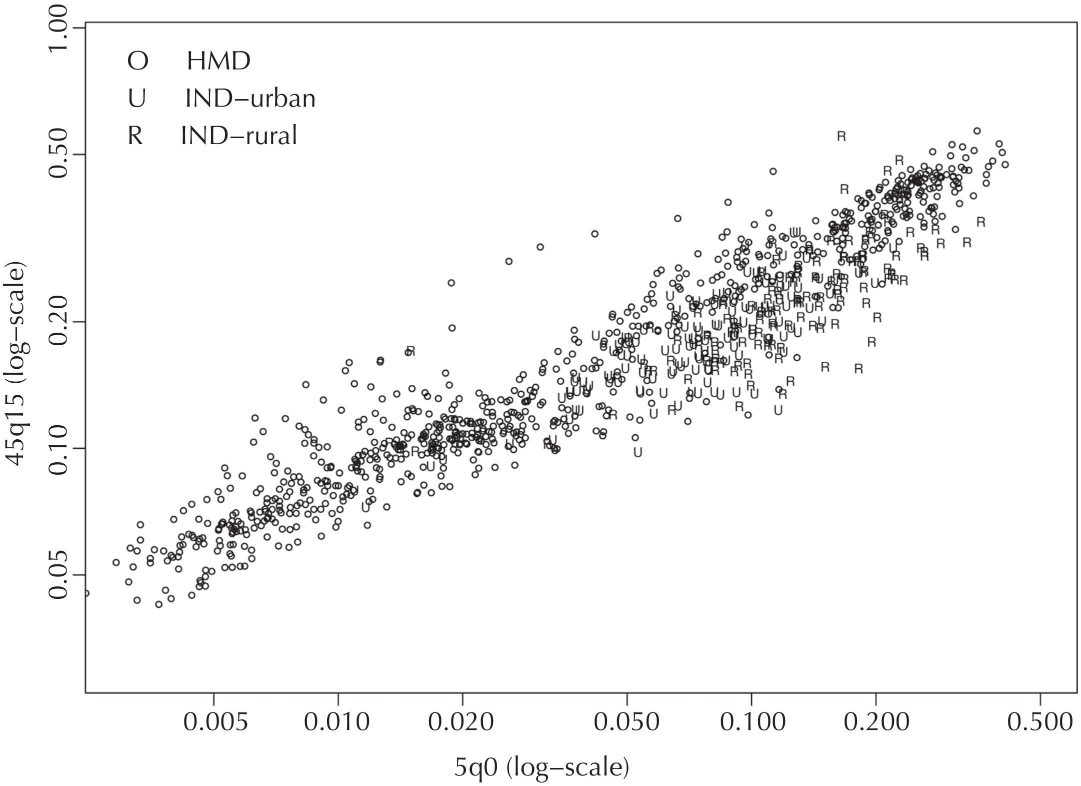
3.1 Validation of the Modeling Approach

First, an assessment of the applicability of the log-quadratic model in an Indian context was conducted. Information on child mortality (probability of death from birth to age 5, 5q0) and adult mortality (probability of death between ages 15 and 60, 45q15) were taken from the Human Mortality Database (HMD, www.mortality.org), and plotted and compared with the same values for the Indian population by place of residence. Figures 1A and 1B include the female and male plots, respectively. Since both figures use the same scale, it is also possible to see that male values of child mortality go in the same range as for females; however, adult mortality is much higher for the male population.

There is a strong correlation between the values of child and adult mortality for both HMD and Indian populations; that is, low child mortality is associated with low adult mortality and high child mortality with high adult mortality. The log-quadratic model used in this paper is based on the HMD data, and this figure proves that the model can be applied in the Indian context.

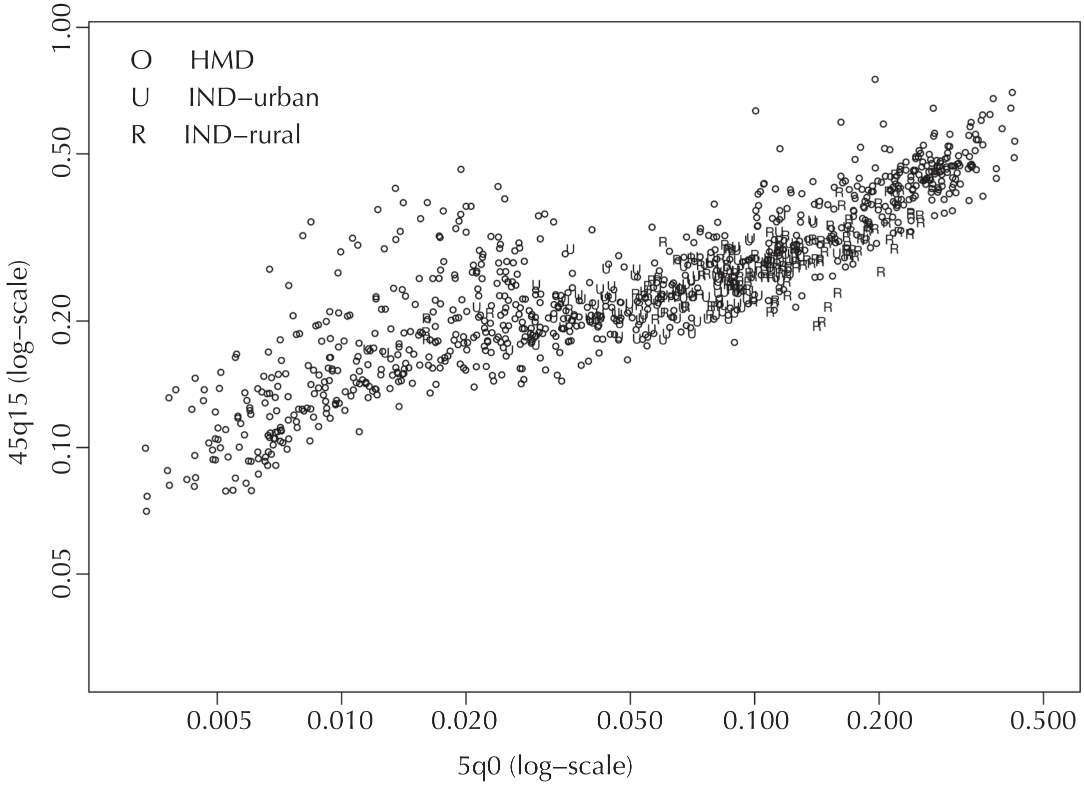
It should be noted that there seems to be a shifting of the urban residence towards lower values despite the strong clustering around high levels of child and adult mortality for the Indian values.

Figure 1A: Female child mortality (5q0) versus adult mortality (45q15), for 5–year period life tables from HMD 1751–2010, and urban and rural Indian life tables from 1970–2006



Source: HMD and Indian SRS.

Figure 1B: Male child mortality (5q0) versus adult mortality (45q15), for 5–year period life tables from HMD 1751–2010, and urban and rural Indian life tables from 1970–2006



Source: HMD and Indian SRS.

Figure 1C: Changes in male and female life expectancy at birth, 1970-75 to 2002-06

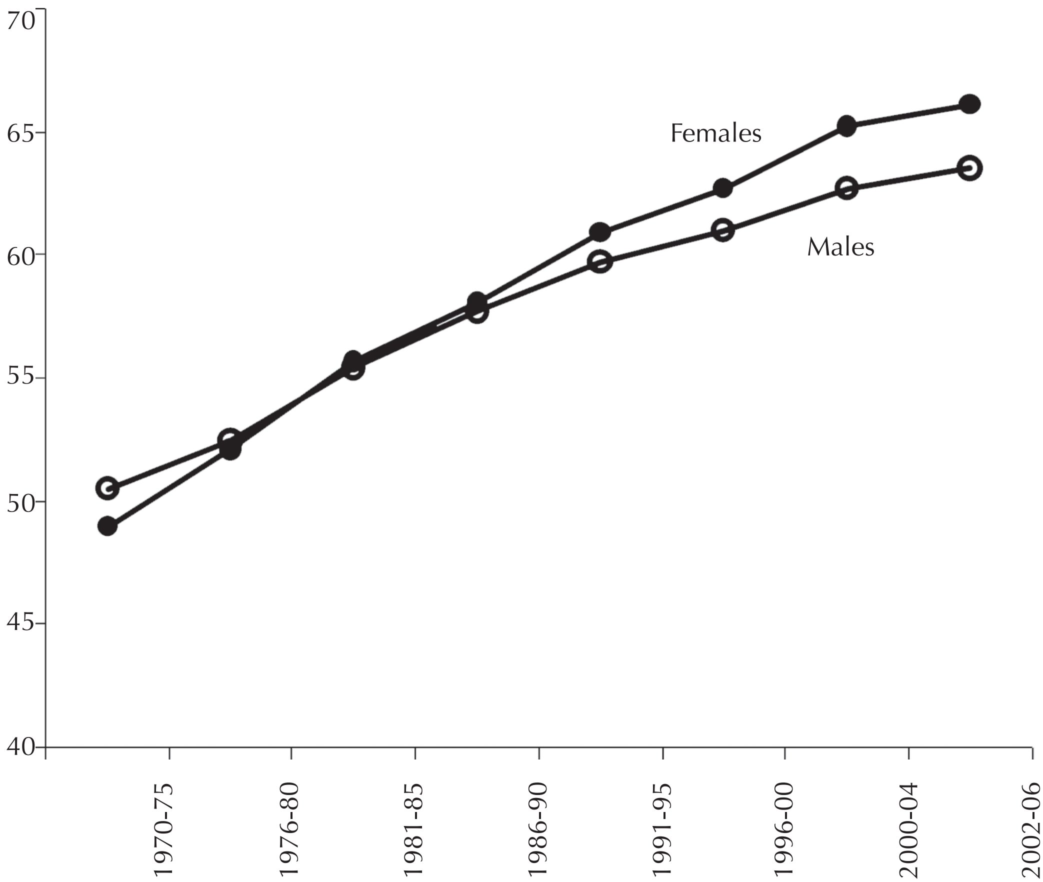


Figure 1C shows changes in male and female life expectancy at birth from the early 1970s to the mid-2000s. It can be seen that although the male life expectancy advantage was about one year in the early 1970s, females caught up in the 1980s. In the mid-2000s, female life expectancy was almost three years greater than male life expectancy, because female life expectancy improved faster in the beginning of the 1990s and 2000s.

Table 1 ranks the life expectancy of Indian females and males by state in 1970–75 and 2002–04 and indicates the change in ranking from one year to another. Kerala is at the top throughout the studied period. Gujarat, Tamil Nadu and Maharashtra improve their ranking; Haryana and Karnataka's rankings decline. However, these apparent changes hide the stronger sex differentials in life expectancy in the 1970s and their transition in the 2000s.

Table 1: Changes in life expectancy rankings (India and bigger states, 1970 and 2002)

FEMALES

RANK	STATE	LE(1970)	STATE	LE(2002)
1-High	KERALA	60.34	KERALA	70.37
2	HARYANA	59.11	MAHARASHTRA	65.65
3	PUNJAB	57.87	PUNJAB	64.94
4	HIMACHAL H	54.14	HIMACHAL	64.89
5	KARNATAKA	53.78	TAMIL	64.89
6	MAHARASHTRA	52.66	HARYANA	63.03
7	INDIA	49.80	GUJARAT	62.84
8	TAMIL	49.16	KARNATAKA	62.76
9	RAJASTHAN	47.85	INDIA	62.34
10	ANDHRA	47.74	RAJASTHAN	61.65
11	GUJARAT	47.43	ANDHRA	61.56
12	MADHYA	46.62	UTTAR	59.88
13	ORISSA	45.80	ORISSA	59.03
14	ASSAM	45.23	MADHYA	58.81
15-Low	UTTAR	44.33	ASSAM	57.71

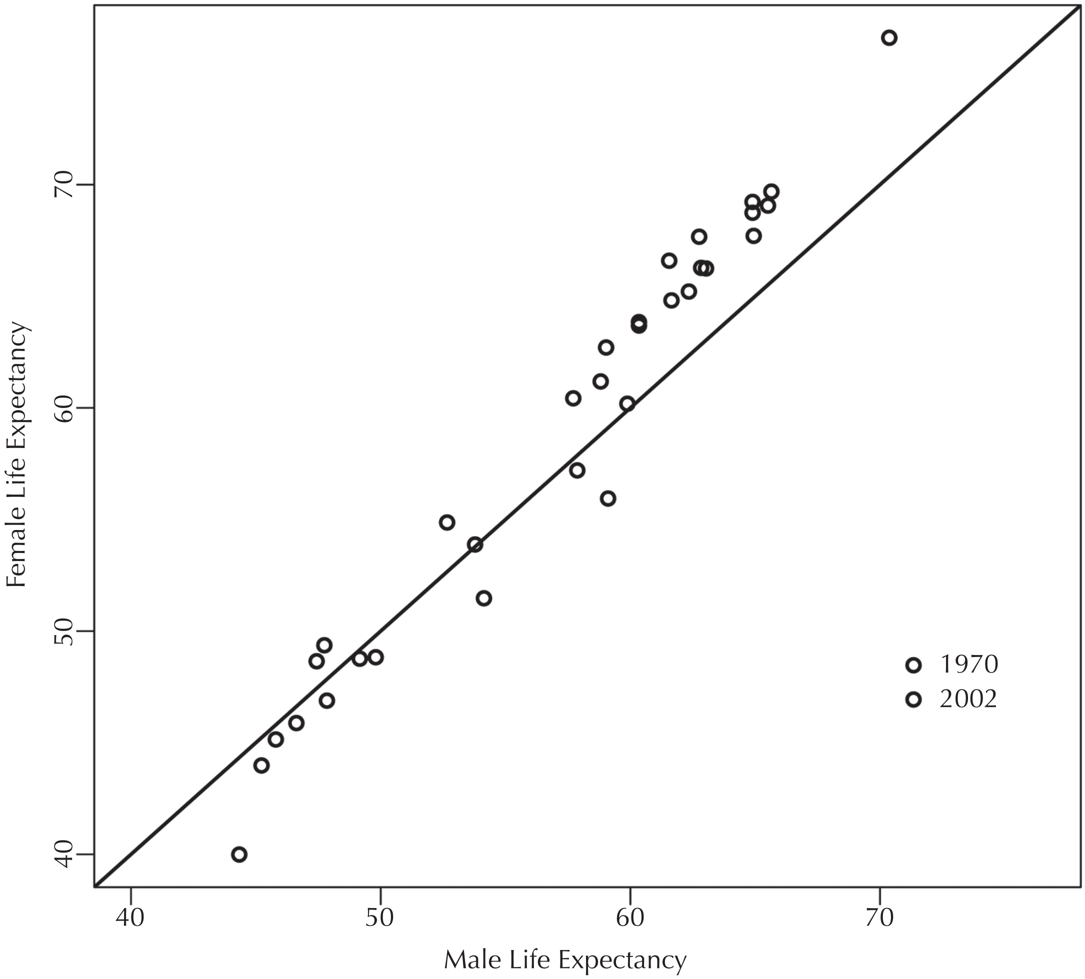
MALES

RANK	STATE	LE(1970)	STATE	LE(2002)
1-High	KERALA	63.69	KERALA	76.58
2	PUNJAB	57.20	MAHARASHTRA	69.69
3	HARYANA	55.94	HIMACHAL	69.23
4	MAHARASHTRA	54.87	TAMIL	68.74
5	KARNATAKA	53.88	PUNJAB	67.71
6	HIMACHAL	51.47	KARNATAKA	67.67
7	ANDHRA	49.37	ANDHRA	66.59
8	INDIA	48.83	GUJARAT	66.27
9	TAMIL	48.76	HARYANA	66.25
10	GUJARAT	48.65	INDIA	65.21
11	RAJASTHAN	46.88	RAJASTHAN	64.82
12	MADHYA	45.88	ORISSA	62.70
13	ORISSA	45.15	MADHYA	61.18
14	ASSAM	43.98	ASSAM	60.43
15-Low	UTTAR	39.99	UTTAR	60.19

Source: SRS India and own calculations.

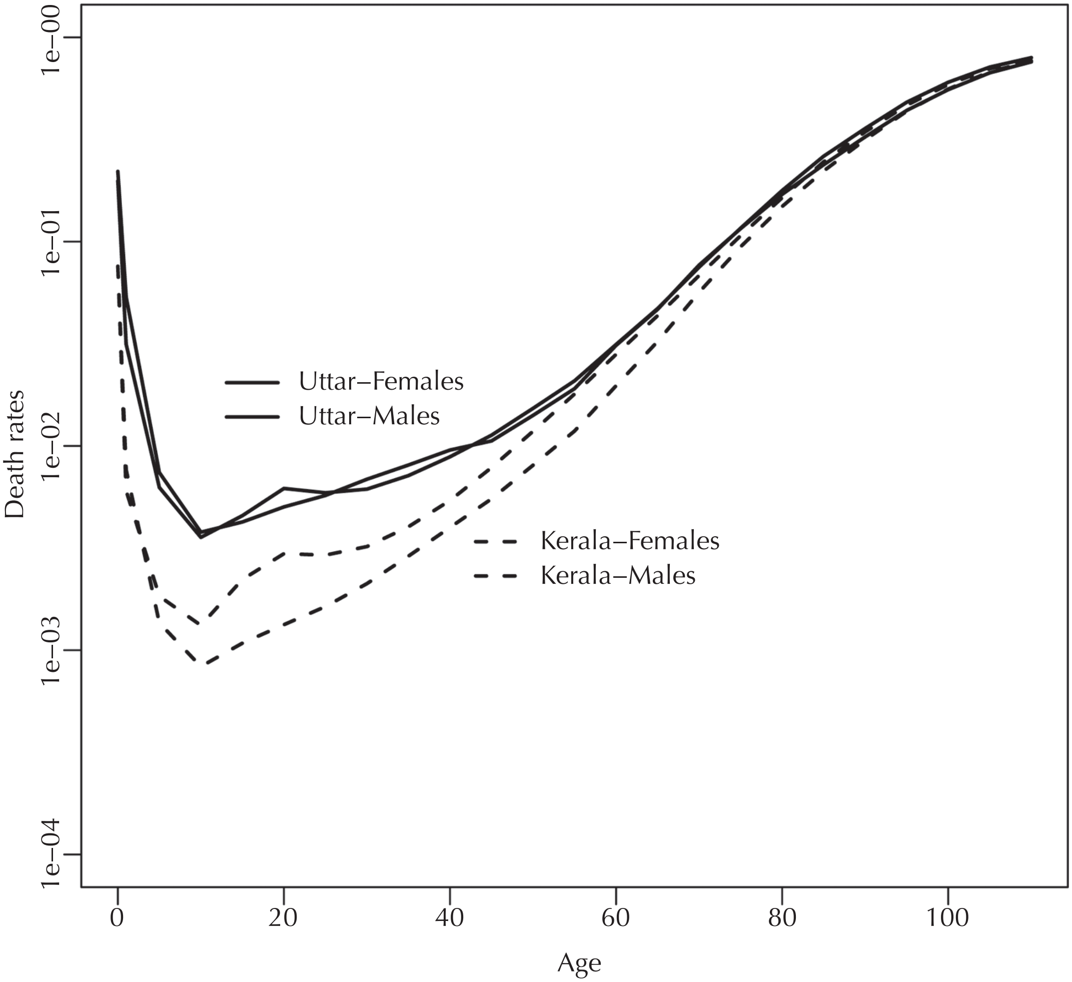
Note: The arrows indicate change in rank over time.

Figure 2: Female and male life expectancies by Indian states in 1970 and 2002



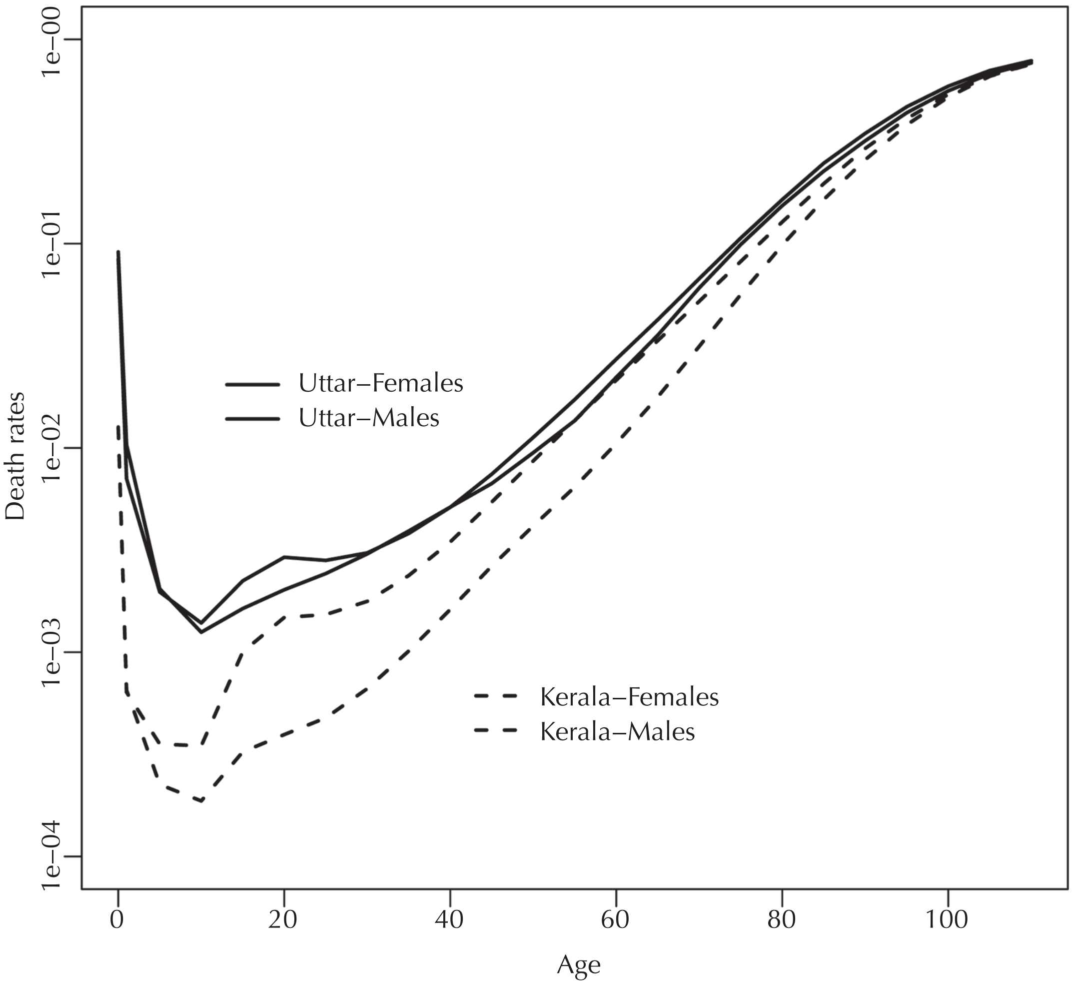
Source: Indian NSO and own calculations.

Figure 3A: Female and male age-specific death rates in Uttar Pradesh and Kerala, India in 1970



Source: Indian NSO and own calculations.

Figure 3B: Female and male age–specific death rates in Uttar Pradesh and Kerala, India in 2002



Source: Indian NSO and own calculations.

3.2 The Role of Different Ages and Causes Of Death

Figure 4 shows that despite more rapid progress in life expectancy, excess child mortality among females remained very significant throughout the period covered. At the same time, male mortality above the age of five remained higher among males.

According to the data for the 1990s, this pattern 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 (Figure 5). If no child mortality gap had been observed, the overall female-to-male life expectancy gap would have been around three years!

Figure 4: Age contribution to the 1.93 years of difference in the gender gap in life expectancy between females (61.99) and males (60.06) from India

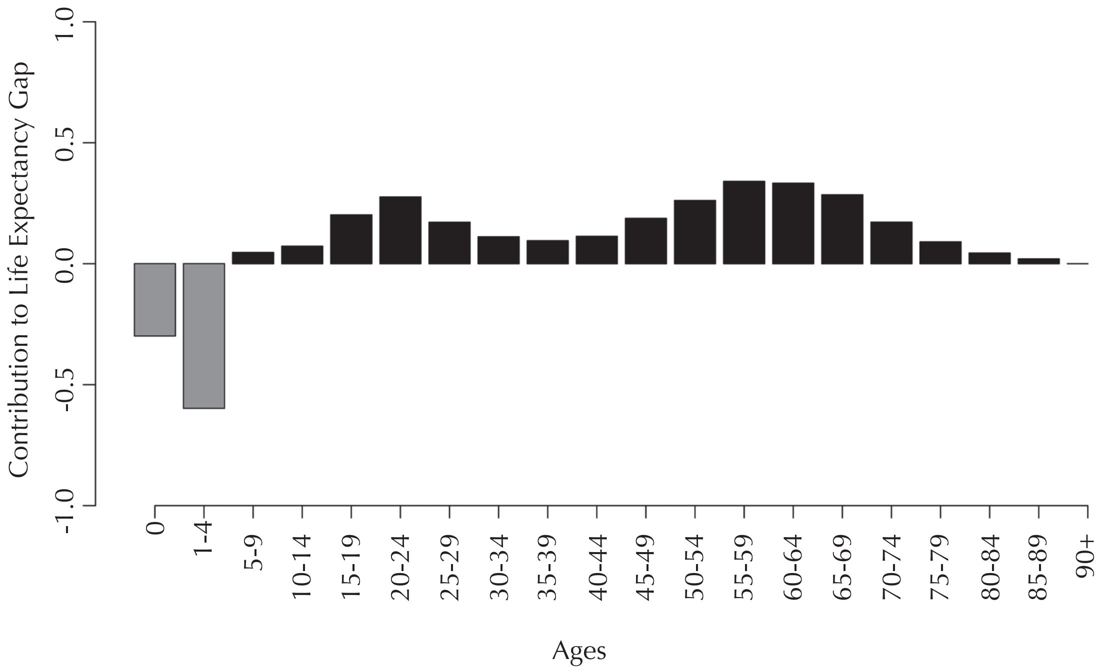
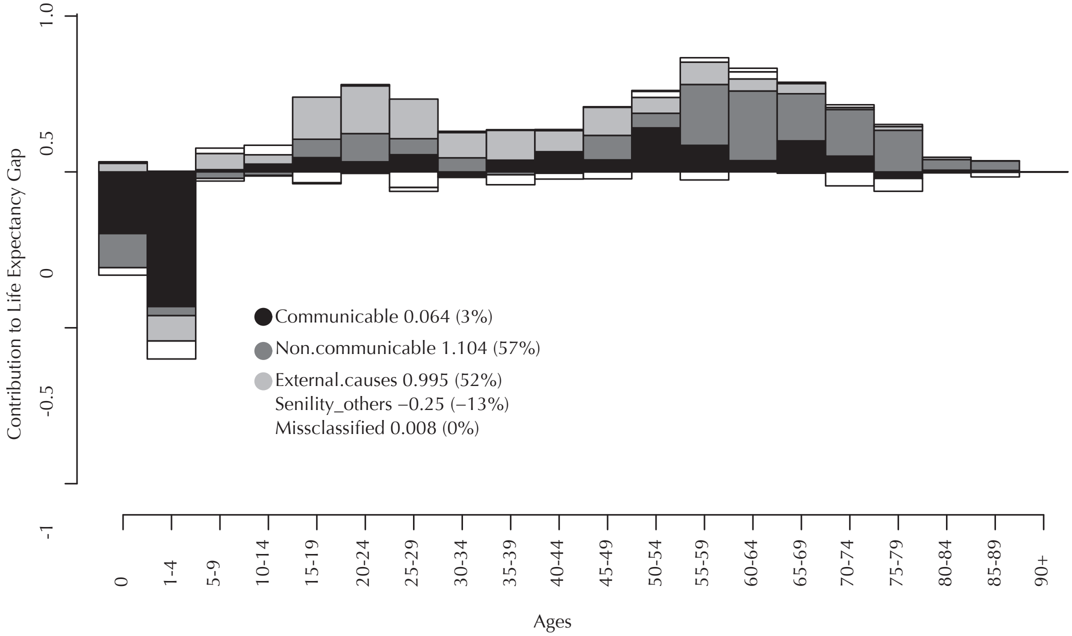


Figure 5: Age and cause contribution to the 1.93 year gap in life expectancy between females (61.99) and males (60.06) in India, 1996–2000



4. DISCUSSION AND CONCLUSION

The results of this analysis confirm that the health advantage for Indian females compared to males has been growing since the 1980s. This occurred despite persisting female disadvantage below the age of five. A balancing of sorts is occurring, where female disadvantage at young ages is balanced by female advantage at older ages. While more advanced states showed female longevity advantages already in the 1970s, the lagging states displayed similar mortality levels for males and females even during the most recent periods.

Interestingly, the biggest contribution to the life expectancy gap between the two sexes in the second half of the 1990s came from non-communicable diseases and external causes of death. This suggests the importance of these causes in the structure of causes of death. Finally, we found a notable geographical variation in sex-specific mortality patterns. It is very important to consider changing sex-specific mortality patterns and their geographical diversity to understand the path and timing of health transition and its determinants in India.

References

Barford A, Dorling D, Smith GD, and Shaw M. 2006. Life Expectancy: Women Now on Top Everywhere. BMJ (332):808.

Bhat, P.N.M. 1987. Mortality in India: Levels, Trends, and Patterns. A Dissertation in Demography. Ann Arbor, Michigan: UMI.

Bhat, P.N.M. 1998. Demographic estimates of post independence India: A new integration. Demography India 27(1):23-37.

Claeson, M, ER Bos, Tazim Mawji, Indra Pathmanathan. 2000. Reducing child mortality in India in the new millennium, Bulletin of the World Health Organization 78(10): 1192–1199.

Coale, AJ, and P Demeny. 1966, 1st ed.; 1983, 2nd ed. Regional Model Life Tables and Stable Populations. New York: Academic Press.

Coale, A. and P. Demeny (1983). Regional Model Life Tables and Stable Populations. New York: Academic Press.

Dyson, T and M Moore. 1983. On kinship structure, female autonomy, and demographic behavior in India, Population and Development Review 9(1): 35-60.

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on [07/09/2012]).

IIPS and ORC Macro International. 2007. National Family Health Survey 2005-2006, India. Mumbai: International Institute for Population Sciences.

IIPS and ORC Macro International. 1995. National Family Health Survey 1992-1993, India. Mumbai: International Institute for Population Sciences.

IIPS and ORC Macro International. 2000. National Family Health Survey 1998–99, India. Mumbai: International Institute for Population Sciences.

Murray, CJL.and A.D. Lopez. 1996. The Global Burden of Disease. USA: The Harvard School of Public Health.

Murray, CJL, BD Ferguson, AD Lopez, M Guillot, JA Salomon, and O Ahmad. 2003. Modified Logit Life Table System: Principles, Empirical Validation, and Application. Population Studies 57(2): 165-182.

ORG (Office of the Registrar General). 1984. SRS based abridged life tables 1970-75. Census of India 1981, Occasional Papers No. 1 of 1984. New Delhi: Office of the Registrar General.

ORG (Office of the Registrar General). 1985. SRS based abridged life tables 1976-80. Census of India 1981, Occasional Papers No. 1 of 1985. New Delhi: Office of the Registrar General.

ORG (Office of the Registrar General). 1989. SRS based abridged life tables 1981-85. Census of India 1981, Occasional Papers No. 1 of 1989. New Delhi: Office of the Registrar General.

Parasuraman, S. 1990. Age patterns of Mortality in India. In: Dynamics of population and family welfare 1989, edited by K.A.P.K.B. Srinivasan. Mumbai: Himalaya Publishing House.

Preston, S.H., M. Heuveline, and M. Guillot. 2001. Demography Measuring and Modeling Population Process. USA: Blackwell Publishers Inc.

Ram, F. 1984. Some contribution onwards the estimation of vital rates from incomplete data. Bombay: Bombay University.

RGI (Registrar General of India). 1994. SRS based abridged life tables 1986-90. SRS Analytical Studies Report Series, Occasional Papers No. 1 of 1994. New Delhi: Registrar General.

RGI (Registrar General of India). 1998. SRS based abridged life tables 1990-94 and 1991-95.SRS Analytical Studies Report No. 1 of 1998. New Delhi: Controller of Publications.

RGI (Registrar General of India). 2004. SRS based abridged life tables 1996-2000 and 1997-2001. SRS Analytical Studies Report No. 2 of 2004. New Delhi: Controller of Publications.

Registrar General of India. 2007. SRS-based abridged life tables 2000–2004: SRS Analytical Studies Report No. 1 of 2007. New Delhi: Controller of Publications.

Registrar General of India. 2008. SRS Based Abridged Life Tables 2002-2006. New Delhi: Registrar General.

Roy, TK and Lahiri, S. 1987. Recent levels and trends in mortality in India and its major states: an analysis based on SRS data. In: K. Srinivasan and S. Mukerji eds. Dynamics of population and family welfare 1987, Himalaya Publishing House, Bombay, pp 279-349.

Saikia, N, Jasilionis, D, Ram, F, and Shkolnikov, VM. 2011. Trends and geographic differentials in mortality under age 60 in India. Population Studies 65(1):73-89.

Saikia, N, Singh, Abhishek and Ram, F. 2010. Has child mortality really increased in last two years? Economic and Political Weekly XLV(51).

Singh, A and F, Ram. 2004. Forecasting mortality in India, in T.K. Roy, M. Guruswamy, and Arokiaswamy (eds.), Population, Health and Development in India: Changing Perspective. Mumbai, India: Rawat Publication, pp 73-100.

United Nations. 1982. Model Life Tables for Developing Countries. New York: United Nations (Sales No. E.81.XIII.7).

Visaria, P. 1969. Mortality and fertility in India, 1951-1961. Milbank Memorial Fund Quarterly 47(1):91-116.

Wilmoth, J, Zureick, S, Canudas-Romo, V, Inoue, M and Sawyer, C. 2012. A flexible two-dimensional mortality model for use in indirect estimation. Population Studies 66(2):219-21.