Age-specific and sex-specific adult mortality risk in India in 2014: analysis of 0·27 million nationally surveyed deaths and demographic estimates from 597 districts

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Summary

Background As child mortality decreases rapidly worldwide, premature adult mortality is becoming an increasingly important contributor to global mortality. Any possible worldwide reduction of premature adult mortality before the age of 70 years will depend on progress in India. Indian districts increasingly have responsibility for implementing public health programmes. We aimed to assess age-specific and sex-specific adult mortality risks in India at the district level.

Methods We analysed data from five national surveys of 0·27 million adult deaths at an age of 15–69 years together with 2014 demographic data to estimate age-specific and sex-specific adult mortality risks for 597 districts. Cause of death data were drawn from the verbal autopsies in the Registrar General of India's ongoing Million Death Study.

Findings In 2014, about two-fifths of India's men aged 15–69 years lived in the 253 districts where the conditional probability of a man dying at these ages exceeded 50%, and more than a third of India's women aged 15–69 years lived in the 222 districts where the conditional probability of a woman dying exceeded 40%. The probabilities of a man or woman dying by the age of 70 years in high-mortality districts was 62% and 54%, respectively, whereas the probability of a man or woman dying by the age of 70 years in low-mortality districts was 40% and 30%, respectively. The roughly 10-year survival gap between high-mortality and low-mortality districts was nearly as extreme as the survival gap between the entire Indian population and people living in high-income countries. Adult mortality risks at ages 15–69 years was highest in east India and lowest in west India, by contrast with the north–south divide for child mortality. Vascular disease, tuberculosis, malaria and other infections, and respiratory diseases accounted for about 60% of the absolute gap in adult mortality risk at ages 15–69 years between high-mortality and low-mortality districts. Most of the variation in adult mortality could not be explained by known determinants or risk factors for premature mortality.

Interpretation India's large variation in adult mortality by district, notably the higher death rates in eastern India, requires further aetiological research, particularly to explore whether high levels of adult mortality risks from infections and non-communicable diseases are a result of historical childhood malnutrition and infection. Such research can be complemented by an expanded coverage of known effective interventions to reduce adult mortality, especially in high-mortality districts.

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Introduction

In 2014, about two-thirds of India's 10 million deaths per year occurred before age 70 years. About 1·4 million of these deaths were in children younger than 5 years of age, 0·6 million deaths were in young people aged 15–29 years, and 4·4 million were in adults aged 30–69 years.[1] As child death rates decrease[2] and the effects of smoking[3] and other major risk factors increase, adults will form a greater proportion of the overall decreasing death rates. If 2010 deaths rates were to persist, more than 9 million people in India could die prematurely before the age of 70 years annually by 2030, the most of any country[4] and most of whom would be adults. The Indian Government has committed to introducing universal health coverage and has endorsed WHO's call for a 25% reduction in the death rates of adults aged 30–69 years from selected non-communicable diseases between 2008 and 2025.[5]

As with global progress in the reduction of child mortality, any future global progress in the reduction of adult mortality will depend largely on progress in India. Indian districts (small administrative areas each with about 2 million people) increasingly bear responsibility for implementing public health programmes. We have earlier described the widespread variability in child mortality rates between Indian districts[2] and in the age-specific adult mortality risks from cancer and heart disease between Indian states.[6–8] Epidemiological and demographic studies of adult mortality at subnational levels in India are scarce. The absence of reliable evidence of the levels, variation, and trends in adult mortality in India's districts restricts the adoption of evidence-based policies and does not allow measurement of the effect of introducing universal health coverage or of specific disease-control programmes.

We have combined data from five national mortality surveys with 2014 demographic data to estimate adult mortality by sex and age for 597 districts. We focus in particular on the large geographical variation in adult mortality and the contribution of specific diseases or determinants of premature mortality to these differences.

Methods

Data sources

We derived estimates for all 640 districts in the 2011 census but classified 12 smaller states and union territories (containing 39 districts) as districts themselves, for a total of 597 districts. From the 2015 revision of the UN World Population Prospects,[1] we derived annual estimates for 2014 of the age-specific and sex-specific death totals for India (appendix). Each 5-year age group and sex-specific national mortality total was divided into state totals and further into district totals using ratios reported in five national mortality surveys done between 1996 and 2008: the District Level Household Surveys of 2002–04[9] and 2007–08,[10] and three surveys by the Registrar General of India (the Special Fertility and Mortality Survey [1998],[11] Sample Registration System data [1998–2003],[7] and the ongoing Million Death Study [2001–06]).[7,8] This method, similar to that already published for child mortality trends in India,[2] is transparent in that it relies only on demographic totals and survey proportions and produces internally consistent estimates—for each age and sex, district death totals sum to state totals, which in turn sum to the 2014 UN estimates for India. All surveys were nationally representative (providing a true snapshot) and totalled 20 million surveyed population, including 142 634 deaths at ages 0–14 years and 265 393 deaths at ages 15–69 years (157 742 men and 107 651 women). Comparison of the district proportional mortality for men and women aged 15–69 years in different surveys with a linear growth curve showed stable proportions, suggesting that the surveys were consistent in their measurement of proportional mortality (data not shown).

See Online for appendix

Estimation of national, state, and district totals

To estimate deaths for each of India's 35 states and union territories on the basis of the 2011 census, we derived age-specific and sex-specific death rates from the weighted averages of relative mortality rates from the Registrar General of India's 2011–13 annual Sample Registration System data.[12] We applied the state proportional mortality to the 2014 UN national death totals for each sex and adjusted them (by no more than 0·03%) to ensure that the sum of states matched the age-specific and sex-specific national totals. We derived district mortality totals by calculating each district's death totals for each of the 11 5-year age groups (15–19 years, 20–24 years, etc, until 65–69 years) from the five national mortality surveys. We then applied the age-specific and sex-specific proportions of district mortality to the 2014 state totals. We derived the age-specific and sex-specific district population by extrapolating the recorded annual growth rate for each district between the 2001 and 2011 censuses to the 2014 population; to these we applied the 2011 district–age distribution. Division of the district deaths by population yielded age-specific death rates. We used the 10·3 million total deaths estimated by the UN for 2014 to correct for the slight undercounts in the Sample Registration System death rates.[13,14]

Statistical analysis

We calculated the conditional probability that an individual aged 15 years would die before reaching the age of 70 years. This calculation assumed constant mortality within each of the 11 5-year age intervals from ages 15 to 69 years, or within the relevant intervals in each of the smaller age groupings (15–29 years, 30–69 years, etc).[15] Standard life-table methods were used to generate probabilities of dying from birth to age 100 years. Age-standardised rates were based on the WHO's standard world population.[16]

Geospatial maps for each district used smoothed interpolation or so-called kriging.[17] Data of causes of death, based on household collections of verbal autopsies,[18] were available for 2001–06 from the Million Death Study.[7,8] Causes of death were apportioned into the three district-level mortality categories after applying the survey weights.[19] We compared high-mortality to medium-mortality or low-mortality districts by logistic regression analysis of 47 possible district-level social, economic, demographic, and health indicators that were grouped into 22 variables from a principal components analysis (appendix). For all analyses, use of tertiles of conditional probability of dying at an age of 15–69 years yielded similar results to our deliberate classifications. The main source of statistical uncertainty arises from the district-specific inputs of deaths tabulated from five mortality surveys. Thus, for each district we summed deaths in the five surveys to provide a 99% CI (a relative SE of 2·58) for lower and upper limits of the conditional probability of dying at an age of 15–69 years. The male-to-female gap in conditional probability of dying at these ages is computed as the difference in conditional probability of men and women dying at these ages divided by the conditional probability for women.

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The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.