Social disadvantage and life expectancy in India

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United Nations Expert Group Meeting on Innovative methods to measure the impact of COVID-19 on mortality through surveys and censuses

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Motivation

- Indian society rigidly stratified along multiple axes, but life expectancy disparities not quantified
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- Widespread public and academic debate on human development outcomes of marginalized social groups
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- Widespread public and academic debate on human development outcomes of marginalized social groups
- Improving empirical measurement of mortality is an urgent population science research priority
Approaches to calculate life tables

- Counts of deaths (civil registration) and people (census)
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- Survey estimates in a subset of the population
  - Demographic and Health Surveys
  - Health and Retirement Surveys (and sister studies)
  - Health and Demographic Surveillance Sites
  - Sample Registration System
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  - Health and Demographic Surveillance Sites
  - Sample Registration System
- Indirect approaches
  - Inter-censal approaches
  - Sibling survival or orphanhood
  - Model age-patterns of mortality
For example, in the 4th round of NFHS (2015-16):
- “Did any usual member of this household die since January 2012?”
- Follow-up questions: sex, age, month/year of death
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- An under-current of criticisms of indirect approaches:
  - “Demographers have been part of the problem, because we have helped to put band-aids on this for 60 years. We’ve developed all sorts of techniques to estimate demographic rates in the absence of hard data” – Andrew Noymer, Nature (2022)
Methods: Estimating deaths and person years

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- For ages 5 and above
  - For dead household members
    - Observed in the question on recent deaths of household members
    - Create life-lines, starting at observation window, until age at death
- For usual household members
  - Observed in the household roster (age, sex)
  - Create life-lines starting at age at beginning of observation window, or age 5
- For ages below 5 (children)
  - Use birth history module
  - Observed from birth / beginning of observation window
  - Followed until age 5, death, or interview date

Bottom-line: obtain age-specific mortality rates
Follow the approach developed in Gupta and Sudharsanan (2022)

For ages 5 and above
- For dead household members
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**Bottom-line**: obtain age-specific mortality rates
Methods (cont.): Weights, $n_a x$, and Standard Errors

- Weights: national survey weights


Repeatedly sample primary sampling units, with replacement for each sex and sample, maintaining the distribution of PSUs within strata.

Draw $100$ bootstrap samples, $Z^*_{1} \ldots Z^*_{100}$, and $100$ estimates: $\hat{e}^*_1 x \ldots \hat{e}^*_100$

Then standard errors can be calculated as:

$$SE(\hat{e}_x) = \sqrt{1/n - 1/100 \sum_{b=1}^{100} (\hat{e}^*_b x - \frac{1}{100} \sum_{r=1}^{100} e^*_b x)^2}$$

Calculate 95% CIs as $e_x \pm 1.96 \times SE(\hat{e}_x)$.
Weights: national survey weights

\( n_a_x \): Borrow from the Sample Registration Survey
Methods (cont.): Weights, $n_a_x$, and Standard Errors

- **Weights**: national survey weights
- **$n_a_x$**: Borrow from the Sample Registration Survey
  - Repeatedly sample primary sampling units, with replacement
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\text{SE}(\hat{e}_x) = \sqrt{\frac{1}{100} - \frac{1}{100} \sum_{b=1}^{100} (\hat{e}_{bx} - \frac{1}{100} \sum_{r=1}^{100} e_{bx})^2}
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95% CIs calculated as $e_x \pm 1.96 \times \text{SE}(\hat{e}_x)$
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- **Weights**: national survey weights
- **$n_{a_x}$**: Borrow from the Sample Registration Survey
  - Repeatedly sample primary sampling units, with replacement
  - for each sex and sample, maintaining the distribution of PSUs within strata
  - draw 100 bootstrap samples, $Z^*_1 \ldots Z^*_100$ and 100 estimates: $\hat{e}_x^*_1 \ldots \hat{e}_x^*_100$

Then standard errors can be calculated as

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95% CIs calculated as $e_x \pm 1.96 \times \text{SE}(\hat{e}_x)$
Methods (cont.): Weights, \( n_{a_x} \), and Standard Errors

- **Weights:** national survey weights
- \( n_{a_x} \): Borrow from the Sample Registration Survey
- **Cluster-bootstrap SEs:** following Fishman (2015) & Vyas et al (2022)
  - Repeatedly sample primary sampling units, with replacement
  - for each sex and sample, maintaining the distribution of PSUs within strata
  - draw 100 bootstrap samples, \( Z^*1 \) ... \( Z^{*100} \) and 100 estimates: \( \hat{e}_x^*1 \) ... \( \hat{e}_x^{*100} \)
  - Then standard errors can be calculated as

\[
SE(\hat{e}_x) = \sqrt{\frac{1}{100 - 1} \sum_{b=1}^{100} \left( \hat{e}_x^*b - \frac{1}{100} \sum_{r=1}^{100} e_x^*b \right)^2}
\]  

(1)
**Methods (cont.): Weights, na_x, and Standard Errors**

- **Weights**: national survey weights
- **na_x**: Borrow from the Sample Registration Survey
  - Repeatedly sample primary sampling units, with replacement
  - for each sex and sample, maintaining the distribution of PSUs within strata
  - draw 100 bootstrap samples, Z\(^*\)\(^1\) ... Z\(^*\)\(^{100}\) and 100 estimates: \(\hat{e}_x\)\(^{*1}\) ... \(\hat{e}_x\)\(^{*100}\)
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  \]  
  (1)

- 95% CIs calculated as \(e_x \pm 1.96 \times SE(\hat{e}_x)\)
Is this approach reliable?

Comparison of mortality rates, 1990-99

Comparison of mortality rates, 2012-16
What about NFHS-5?

Age-specific mortality rates, 2017-19

Female

Male

Mortality rates per 1,000 (nmx)

0 10 yrs 20 30 40 50 60 70 80 85+

NFHS

SRS
Disparities by social group (Gupta & Sudharsanan 2022)

Large and persistent disparities in life expectancy at birth in India

1997-2000, female

1997-2000, male

2013-2016, female

2013-2016, male

Life expectancy at birth \( (e_0) \), years

50 55 60 65 70 75

Scheduled Caste  Scheduled Tribe  Muslim  Other Backward Class  High Caste

58.0 57.0 62.2 60.7 64.3

58.3 54.5 62.6 60.2 62.9

67.8 68.0 69.4 69.4 72.2

63.3 62.4 66.8 66.0 69.4

Scheduled Caste  Scheduled Tribe  Muslim  Other Backward Class  high caste
Disparities across the life course

Note: 95% CIs calculated using a cluster-bootstrap approach. The number of bootstrap samples drawn was 100.
Measuring household wealth

- Standard approach of creating an asset index, based on durable goods and assets
  - Exclude assets with direct links to health (fuels, toilets)
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  - Exclude assets with direct links to health (fuels, toilets)
  - For each wealth category, $wc$, estimate age-specific mortality rates, $n m_{x}$, in abridged life-table ages $x$ to $x + n$, in period $t$, for sex $g$, sample $s$ (overall, rural, or urban sample)

\[ n m_{x}^{wc,s,t,g} = \frac{n d_{x}^{wc,s,t,g}}{n L_{x}^{wc,s,t,g}} \]  

**Disadvantages:** Measured at the time of interview; bi-directional relationship between wealth and mortality, relative measure

**Advantages:** Available for all individuals; for all ages; easier to collect in LMICs; a marker of social status; and less sensitive to shocks
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By finer categories (NFHS-4, for period 2013-2016)

The vertical height of each bar depicts the 95% confidence interval. CIs were estimated using a cluster bootstrap approach with 100 replications.
But caste and class intersect? (Vyas et al 2022)

Life expectancy at birth, $e_0$, (years)

Wealth decile

Female

Male

Adivasi

Dalit

Muslim

Higher-caste Hindu
Social disparities in life expectancy in India: 2017-2019

<table>
<thead>
<tr>
<th>Category</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled Caste</td>
<td>64.1</td>
<td>69.6</td>
</tr>
<tr>
<td>Scheduled Tribe</td>
<td>64.6</td>
<td>70.9</td>
</tr>
<tr>
<td>Muslim</td>
<td>67.3</td>
<td>70.4</td>
</tr>
<tr>
<td>Other Backward Class</td>
<td>67.4</td>
<td>72.1</td>
</tr>
<tr>
<td>High Caste</td>
<td>69.9</td>
<td>73.7</td>
</tr>
</tbody>
</table>

Life expectancy at birth ($e_0$), years
Implications

- Large, persistent, and consequential disparities, from an Indian as well as global perspective
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- Large, persistent, and consequential disparities, from an Indian as well as global perspective
- An urgent need to focus on mortality disparities across the life course
- Empirical approaches to measure mortality in large scale sample surveys quite valuable
Ongoing further work

- Mortality in 2020
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- Mortality by religion in India
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- New approaches to measure deaths in the household in phone surveys
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- Mortality in 2020
- Mortality by religion in India
- New approaches to measure deaths in the household in phone surveys
- The reliability of the ‘recent deaths in the household’ approach in India from all available surveys