Average life expectancy and life years lost in people with mental disorders

Vladimir Canudas-Romo

School of Demography
Research School of Social Sciences
Lancet Psychiatry

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Cause-specific life-years lost in people with mental disorders: a nationwide, register-based cohort study

Annette Erlangsen, Per Kragh Andersen, Anita Toender, Thomas Munk Laursen, Merete Nordentoft, Vladimir Canudas-Romo
• Introduction & Aim

• Method: “Average life expectancy”… What? Why? When?

• Illustration using Danish population with mental disorders

• Can we use it in other settings?
Life expectancy

- “average age at death”

Source: HMD(2017)
Life expectancy

- “average survival time”

Source: HMD(2017)
Life expectancy

- “average survival time”

Source: HMD(2017)
Google scholar hits on:

“life expectancy”: 643.000
Google scholar hits on:

“life expectancy”: 643.000

“average life expectancy”: 53.400
3 state Markov health-disease model

0: No mental disorders

1: Mental disorders

2: Death

\[ \alpha_{01}(x) \]

\[ \alpha_{02}(x) \]

\[ \alpha_{12}(x) \]
To define “average life expectancy”

and “average life years lost”
Data and method
Record linkage

Register data on all persons aged 15+ living in Denmark during 1995-2014 (N=6,107,234).

Extracts from:
Centralised Civil Register
Register of Causes of Death
Psychiatric Centralized Registry (since 1969)
Cohort design


Truncation at:
- Date of death
- Turning 15 years
- In and out migration

Exposure: Mental disorders
3 state Markov health-disease model

0: No mental disorders

1: Mental disorders

2: Death

\[ \alpha_{01}(x) \]

\[ \alpha_{02}(x) \]

\[ \alpha_{12}(x) \]
Probability of surviving between 15 and 94, Denmark, 1995-2014
Life expectancies

**with** mental disorders

\[ e(a_1, \tau) \quad \tau > a_1 \]

**without** mental disorders

\[ e^*(a_1, \tau) \quad \tau > a_1 \]

\(a_1\) is the mental disorder diagnostic age
Probability of surviving between 15 and 94, Denmark, 1995-2014
Life years lost

with mental disorders

\[ \vartheta(a_1, \tau) \quad \tau > a_1 \]

without mental disorders

\[ \vartheta^*(a_1, \tau) \quad \tau > a_1 \]
Life years lost, Danish men without mental disorders, 1995-2014
Life years lost

**with mental disorders**

\[ \varpi(a_1, \tau) = \int_{a_1}^{\tau} F(x) \, dx \]
with mental disorders

\[ \varrho(a_1, \tau) = \int_{a_1}^{\tau} F(x) \, dx \]

by causes of death

\[ \varrho_j(a_1, \tau) = \int_{a_1}^{\tau} F_j(x) \, dx \]

\( F_j \) cause j cumulative incidence function
Life years lost by causes of death, Danish men without mental disorders, 1995-2014

- Neoplasm
- Heart disease
- Respiratory diseases
- Digestive diseases
- Alcohol misuse
- Suicide
- Accidents
- Other causes
with mental disorders

$$(\tau - a_1) = e(a_1, \tau) + \varnothing(a_1, \tau)$$

without mental disorders

$$(\tau - a_1) = e^*(a_1, \tau) + \varnothing^*(a_1, \tau)$$
Life years lost by causes of death
ages 15-94, Denmark, 1995-2014

Men with no mental disorders

Men with mental disorders

Women with no mental disorders

Women with mental disorders

- Neoplasm
- Heart disease
- Respiratory diseases
- Digestive diseases
- Alcohol misuse
- Suicide
- Accidents
- Other causes
3 state Markov health-disease model

0: No mental disorders

1: Mental disorders

2: Death

\[ \alpha_{01}(x) \]

\[ \alpha_{02}(x) \]

\[ \alpha_{12}(x) \]
with mental disorders

$$\frac{1}{n} \sum_{i=1}^{n} (\tau - a_{1i}) = \frac{1}{n} \sum_{i=1}^{n} [e(a_{1i}, \tau) + \varnothing(a_{1i}, \tau)]$$

without mental disorders

$$\frac{1}{n} \sum_{i=1}^{n} (\tau - a_{1i}) = \frac{1}{n} \sum_{i=1}^{n} [e^*(a_{1i}, \tau) + \varnothing^*(a_{1i}, \tau)]$$
## Average life expectancy and life years lost, 15-94, Denmark, 1995-2014

<table>
<thead>
<tr>
<th></th>
<th>with mental disorders</th>
<th>without mental disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{1}{n} \sum_{i=1}^{n} (\tau - a_{1i})$</td>
<td>55.6</td>
<td>55.6</td>
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<tr>
<td>Life expectancy</td>
<td>29.3</td>
<td>39.5</td>
</tr>
<tr>
<td>Life years lost</td>
<td>26.3</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td></td>
<td>55.6</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td>34.6</td>
<td>41.9</td>
</tr>
<tr>
<td></td>
<td>19.6</td>
<td>12.3</td>
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</table>
Excess life years lost

$$\sum_{j=1}^{m} \left[ \frac{1}{n} \sum_{i=1}^{n} (\varnothing_j(a_{1i}, \tau) - \varnothing_j^*(a_{1i}, \tau)) \right]$$
Results
### Life expectancy at age 15

<table>
<thead>
<tr>
<th></th>
<th>Denmark</th>
<th>Sweden</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious mental ill</td>
<td>39.0</td>
<td>41.9</td>
<td>43.3</td>
</tr>
<tr>
<td>General population</td>
<td>60.9</td>
<td>60.8</td>
<td>63.6</td>
</tr>
<tr>
<td>Difference</td>
<td>21.9</td>
<td>18.9</td>
<td>20.3</td>
</tr>
</tbody>
</table>

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Serious mental ill</td>
<td>48.3</td>
<td>54.1</td>
<td>53.1</td>
</tr>
<tr>
<td>General population</td>
<td>65.4</td>
<td>67.6</td>
<td>68.0</td>
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<tr>
<td>Difference</td>
<td>17.1</td>
<td>13.6</td>
<td>14.9</td>
</tr>
</tbody>
</table>

Wahlbeck et al, 2011
People with mental disorders have 3 to 4-fold higher mortality rates than people without mental disorders.

Higher mortality rate ratios by: suicides, accidents, and homicides.

Also elevated rate ratios for cardiovascular disease, malignant neoplasms, respiratory diseases, as well as endocrine and metabolic conditions.

Laursen et al., 2007; Joukamaa et al., 2001; Lawrence et al., 2013
## Mortality Rate Ratio

<table>
<thead>
<tr>
<th>Cause</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious diseases</td>
<td>3.1 [2.9 - 3.3]</td>
<td>2.2 [2 - 2.3]</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>1.5 [1.4 - 1.5]</td>
<td>1.3 [1.3 - 1.4]</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.5 [2.4 - 2.7]</td>
<td>2.0 [1.9 - 2.1]</td>
</tr>
<tr>
<td>Heart diseases</td>
<td>1.9 [1.8 - 1.9]</td>
<td>1.7 [1.7 - 1.7]</td>
</tr>
<tr>
<td>Respiratory diseases</td>
<td>2.6 [2.5 - 2.7]</td>
<td>2.5 [2.4 - 2.5]</td>
</tr>
<tr>
<td>Digestive diseases</td>
<td>2.7 [2.6 - 2.8]</td>
<td>2.0 [2 - 2.1]</td>
</tr>
<tr>
<td>Alcohol misuse</td>
<td>8.3 [8.1 - 8.5]</td>
<td>8.9 [8.6 - 9.2]</td>
</tr>
<tr>
<td>Suicide</td>
<td>10.7 [10.4 - 11]</td>
<td>18.7 [17.9 - 19.5]</td>
</tr>
<tr>
<td>Accidents</td>
<td>5.0 [4.9 - 5.2]</td>
<td>3.3 [3.2 - 3.5]</td>
</tr>
<tr>
<td>Other causes of death</td>
<td>2.7 [2.7 - 2.8]</td>
<td>2.2 [2.2 - 2.3]</td>
</tr>
</tbody>
</table>
Heart disease – life years lost

**Men**

- **Mental disorders**
- **No Mental disorders**

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental</td>
<td>7.0</td>
<td>6.0</td>
<td>5.0</td>
<td>4.0</td>
</tr>
<tr>
<td>disorders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6.0</td>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Mental</td>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>No</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Women**

- **Mental disorders**
- **No Mental disorders**

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental</td>
<td>7.0</td>
<td>6.0</td>
<td>5.0</td>
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<td>2.0</td>
<td>1.0</td>
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</table>
A difference of 10.2 and 7.3 life years lost was noted between men and women with and without mental disorders, respectively.

Most excess LYL for alcohol misuse for men and respiratory diseases for women.

Over time, a decrease in excess LYL for suicide and accidents among people with mental disorders.
Conclusion

Average life expectancy is a suitable measure for multistate demographic models where people enter states at different ages.
3 state Markov health-disease model
4 state Markov marriage model

1: Single

2: Marriage

3: out of marriage

4: Death

\[ \alpha_{12}(x) \]

\[ \alpha_{14}(x) \]

\[ \alpha_{23}(x) \]

\[ \alpha_{24}(x) \]

\[ \alpha_{34}(x) \]