Why do children die?

Using administrative linked data to inform policy priorities

Dr Ania Zylbersztejn
Data Science for Child Health - Inaugural Symposium
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What do administrative data tell us about child mortality in England?
Newborn baby deaths may be on rise among poorest in England

Exclusive: MP Frank Field calls on government to investigate "extraordinary" increase in baby deaths

An ‘extraordinary’ increase in baby death in England linked to poverty

Harrowing statistics show another rise in infant mortality in England and Wales and the highest rate of baby deaths are in the most deprived areas.
Are infant mortality rates increasing in England?

Data sources

- Live births linked to deaths in infancy
- Aggregate data, publically available

Socioeconomic status
(Index of Multiple Deprivation)

Gestational age

ONS Birth Records

NHS Birth Notification

Age at death

Death

ONS Mortality Records
Results: trends in infant mortality in 2006-2016

Fig 1. Infant mortality rates per 1000 live births during 2006 – 2016 in England*

Are infant mortality rates increasing in England?

Results: trends in infant mortality in 2006-2016

Fig 1. Infant mortality rates per 1000 live births during 2006 – 2016 in England*

*Decline of 0.15 infant deaths per 1000 live births

Results: trends in infant mortality in 2006-2016

Fig 2. Early neonatal mortality rates per 1000 live births during 2006 – 2016 in England & Wales*

Are infant mortality rates increasing in England?

*Data from ONS Child and infant mortality in England and Wales Statistical bulletins
https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/childhoodinfantandperinatalmortalityinenglandandwales/previousReleases
Results: impact of extremely premature births

Differences in legal requirements for birth registration:
- Live birth: birth showing any signs of life
- Stillbirths: pregnancy loss at or after 24 weeks’ gestation
Are infant mortality rates increasing in England?

**Results:** impact of extremely premature births

Fig 3. Infant mortality rates per 1000 live births during 2006 – 2016 in England Excluding births with gestational age < 24 weeks or missing*

Are infant mortality rates increasing in England?

Implications

Increase in infant mortality in England since 2014 can be explained by rise in number of early deaths in babies born at < 24 weeks’ gestation

Why do we see a change in how births of extremely premature babies are registered?

– Better hospital care for very premature babies?
– Changes in how high risk pregnancies are managed by doctors?
– Other?

Trends in infant mortality need to be interpreted with caution
International comparisons of child mortality

The UK has one of the highest child mortality rates in Western Europe…

Fig 1. Under 5 (0–4 years) mortality rates per 1000 live births by age at death in Western Europe in 2013 [1]

For the International comparisons of child mortality, while Sweden has some of the lowest rates in the world.

Fig 1. Under 5 (0–4 years) mortality rates per 1000 live births by age at death in Western Europe in 2013 [1]

Multiple risk factors affect the risk of child death

**Before pregnancy**
- BMI
- Chronic health conditions

**During pregnancy**
- Age, Nutrition, Stress, Smoking, Alcohol/ drug use

**At birth**
- Low birth weight
- Preterm birth
- Congenital anomalies
- Sex

**After birth**
- Family environment e.g. housing conditions, crowding breastfeeding
- Welfare support
- Family policies
- Healthcare

Socio-economic disadvantage / Education

Why do more children die in England vs Sweden?
Why do more children die in England vs Sweden?

Multiple risk factors affect the risk of child death

<table>
<thead>
<tr>
<th>% of mothers in 2010 who:</th>
<th>England &amp; Wales</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were &lt;20 years old</td>
<td>5.7%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Smoked during pregnancy</td>
<td>12% (during)</td>
<td>6.5% (3rd Trimester)</td>
</tr>
<tr>
<td>Were obese</td>
<td>20%*</td>
<td>12.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% of babies born:</th>
<th>England &amp; Wales</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurely (&lt;37 weeks)</td>
<td>7.1%</td>
<td>5.3%</td>
</tr>
<tr>
<td>With low birth weight (&lt;2500g)</td>
<td>7.0%</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

Why do more children die in England vs Sweden?

**National birth cohorts**: singleton live births 2003-2012

**Sweden**
- Medical Birth Register
  - N=1,017,606

**England**
- Hospital Episode Statistics
  - N = 4,329,985 (71.0%)
  - Validated vs external data

**Exclusions**:
- Deaths at 0-1 days after birth
- Gestational age <24 weeks
- Birth weight <500g
- Missing information on any risk factor

**Hospitalisation Details**
- National Discharge Register
- Cause of Death Register
- Hospital Episode Statistics
- Office for National Statistics Mortality Records

**Death Records**
Why do more children die in England vs Sweden?

National birth cohorts: singleton live births 2003-2012

Birth and maternal details

- Birth weight
- Gestational age
- Sex
- Maternal age
- Socioeconomic status

Hospitalisation Details

- Congenital anomalies
- Chronic conditions

Death Records

- Death by age
- Death by cause

Cox Proportional Hazard Models

1. Unadjusted (including only country indicator)
2. Adjusted for birth characteristics
3. Adjusted for birth characteristics and socio-economic factors

Relative risk of death in England vs Sweden
Why do more children die in England vs Sweden?

**Results:** mortality at 2-27 days

Unadjusted mortality rates:
England: 15 deaths /1000 child-years
Sweden: 9.2/1000

<table>
<thead>
<tr>
<th>Model adjusted for:</th>
<th>Hazard ratio for England vs Sweden at 2-27 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>1.66 (1.53, 1.81)</td>
</tr>
<tr>
<td>Country + birth characteristics</td>
<td>1.15 (1.06, 1.25)</td>
</tr>
<tr>
<td>Country + birth characteristics + socio-economic factors</td>
<td>1.13 (1.04, 1.23)</td>
</tr>
</tbody>
</table>

Relative risk reduced by 77%

No significant change

### Results: mortality at 28-364 days

Unadjusted mortality rates:
- **England**: 1.4 deaths /1000 child-years
- **Sweden**: 0.9/1000

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<th>Hazard ratio for England vs Sweden at 28-364 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>1·66 (1·53, 1·81)</td>
<td>1·59 (1·47, 1·71)</td>
</tr>
<tr>
<td>Country + birth characteristics</td>
<td>1·15 (1·06, 1·25)</td>
<td>1·19 (1·10, 1·28)</td>
</tr>
<tr>
<td>Country + birth characteristics + socio-economic factors</td>
<td>1·13 (1·04, 1·23)</td>
<td>1·12 (1·04, 1·21)</td>
</tr>
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</table>

Relative risk reduced by 68%
Further reduction of 11%

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### Results: mortality at 1-4 years

**Unadjusted mortality rates:**
- England: 0.19 deaths /1000 child-years
- Sweden: 0.15/1000

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<th>Hazard ratio for England vs Sweden at 28-364 days</th>
<th>Hazard ratio for England vs Sweden at 1-4 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>1.66 (1.53, 1.81)</td>
<td>1.59 (1.47, 1.71)</td>
<td>1.27 (1.15–1.40)</td>
</tr>
<tr>
<td>Country + birth characteristics</td>
<td>1.15 (1.06, 1.25)</td>
<td>1.19 (1.10, 1.28)</td>
<td>1.10 (1.00–1.22)</td>
</tr>
<tr>
<td>Country + birth characteristics + socio-economic factors</td>
<td>1.13 (1.04, 1.23)</td>
<td>1.12 (1.04, 1.21)</td>
<td>1.06 (0.96–1.18)</td>
</tr>
</tbody>
</table>

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Cause-specific mortality

Sudden Unexpected Deaths in Infancy (SUDI)
amenable to public health interventions, e.g.:
• advice on safe sleeping practices
• smoking cessation programs

SUDI includes:
• Unexplained deaths
  (e.g. Sudden Infant Death Syndrome)
• Explained but sudden/unexpected deaths

Respiratory Tract Infections (RTI)
amenable to healthcare interventions e.g.:
• vaccination
• antibiotics treatment
# SUDI mortality at 31-364 days

<table>
<thead>
<tr>
<th>Country</th>
<th>England</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>32 deaths / 100,000 child-years</td>
<td>20 deaths / 100,000 child-years</td>
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</thead>
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<tr>
<td>Country</td>
<td>1.59 (1.36, 1.85)</td>
</tr>
<tr>
<td>Country + birth characteristics</td>
<td>1.40 (1.20-1.63)</td>
</tr>
<tr>
<td>Country + birth characteristics + socio-economic factors</td>
<td>1.19 (1.02-1.39)</td>
</tr>
</tbody>
</table>

Relative risk reduced by \( \frac{1}{3} \)

Further reduction by \( \frac{1}{3} \)

**Key risk factors:**
- Young maternal age (<25 years HR=2.5-4.5)
- Low birth weight (<2500g: HR=3-7)
## RTI-related mortality at 31-364 days

<table>
<thead>
<tr>
<th>Country</th>
<th>England</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 deaths / 100,000 child-years</td>
<td>14 deaths / 100,000 child-years</td>
</tr>
</tbody>
</table>

### Model adjusted for:

<table>
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<th>Hazard ratio for England vs Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>1.52 (1.26, 1.82)</td>
</tr>
<tr>
<td>+ birth characteristics</td>
<td>1.16 (0.96, 1.40)</td>
</tr>
<tr>
<td>Country</td>
<td>1.11 (0.92, 1.34)</td>
</tr>
</tbody>
</table>

Key risk factors:

- Congenital anomaly (HR=26) & low birth weight (HR=5)
Why do more children die in England vs Sweden?

Policy implications

The largest reductions in infant mortality in England relative to Sweden could be achieved by reducing the prevalence of low birth weight, prematurity and congenital anomalies.

- Socio-economic disadvantage:
  - Is associated with prevalence of adverse birth characteristics,
  - Independently led to a further 10% reduction in mortality at 28-364 days

Policy focus:
- the health of women, to improve birth outcomes
- reducing health inequalities before and during pregnancy
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Contact: ania.zylbersztejn@ucl.ac.uk or sejjamz@ucl.ac.uk