The cost of lost productivity due to premature cancer-related mortality: an alternative measure of the cancer burden

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Introduction

- There are a variety of different measures of the cancer burden
- Most take a population health perspective
Introduction

• Cancer also places an economic burden on society

**HEALTH SERVICE COSTS**
- diagnosis & work-up
- treatment
- follow-up

**PATIENT COSTS**
- appointments, tests, procedures
- medications
- treatment-related travel

**FAMILY & CAREGIVER COSTS**
- out-of-pocket costs
- time forgone

**EMPLOYER & SOCIETY COSTS**
- lost productivity due to cancer

**Aims**

• To estimate
  - years of potential productive life lost (YPPLL) due to cancer
  - costs of lost productivity due to cancer-related premature mortality

• To compare these indicators with “conventional” measures to illustrate how each provides a different perspective on the cancer burden on society
Methods: cancer sites

Cancer deaths, Ireland, 2005-2009
- all cancer deaths (C00-97)
- top 10 most common causes of cancer death in adult males and females

<table>
<thead>
<tr>
<th>males</th>
<th>females</th>
</tr>
</thead>
<tbody>
<tr>
<td>oesophagus (C15)</td>
<td>oesophagus (C15)</td>
</tr>
<tr>
<td>stomach (C16)</td>
<td>stomach (C16)</td>
</tr>
<tr>
<td>colorectal (C18-21)</td>
<td>colorectal (C18-20)</td>
</tr>
<tr>
<td>pancreas (C25)</td>
<td>pancreas (C25)</td>
</tr>
<tr>
<td>lung (C33 &amp; 34)</td>
<td>lung (C33 &amp; 34)</td>
</tr>
<tr>
<td>prostate (C61)</td>
<td>breast (C50)</td>
</tr>
<tr>
<td>bladder (C67)</td>
<td>uterus (C53-55)</td>
</tr>
<tr>
<td>brain &amp; central nervous system (CNS) (C70-72)</td>
<td>ovary (C56)</td>
</tr>
<tr>
<td>non-Hodgkin's lymphoma (C82-85, 96)</td>
<td>brain &amp; central nervous system (CNS) (C70-72)</td>
</tr>
<tr>
<td>leukaemia (C91-95)</td>
<td>non-Hodgkin's lymphoma (C82-85, 96)</td>
</tr>
</tbody>
</table>

Measuring lost productivity

Human Capital Approach
- Treats individuals as human capital – humans have a stock of productive ability
- Individuals produce a stream of output over their lifetime (valued by the wage rate)
- Illness (cancer) interrupts the productive flow and results in production loss
- The human capital approach measures this lost productivity
Methods

For all cancers combined and each site separately:

1. Calculate years of potential productive life lost (YPPLL) for each person who died from cancer
   - years of potential life lost (YPLL), truncated to “working age” (adults below retirement age i.e. 15-64 years)

     e.g. death in 50-54 age-group, assume 52.5 years old at death:
     YPPLL = 64-52.5 = 11.5

2. Value YPPLL for each person who died from cancer
   - multiply YPPLL by age and gender specific wages, from age of death until 64
     - adjust wages for workforce participation and unemployment
       e.g. woman died at age 40 in 2009; average wage = €37,140; 0.69 probability of workforce participation; 0.93 probability of being employed if participating
       wage rate = €37,140*0.69*0.93
     - wage growth – inflate wages by 2.6% per annum
     - present value of forgone earnings – apply 4% discount rate

3. Sum across all people who died from cancer
   - express as total cost overall and per cancer (€2009), total cost for males & females; average cost per cancer death (15-64 years)
## Results: all cancers, males & females

<table>
<thead>
<tr>
<th>Measure of cancer burden, per annum</th>
<th>Total number of deaths: all ages</th>
<th>15-64 years</th>
<th>Total YPPLL (years of potential productive life lost)</th>
<th>Total cost of lost productivity due to cancer-related premature mortality</th>
<th>Average lost productivity cost per cancer death*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of deaths: all ages</td>
<td>8,067</td>
<td>2,276</td>
<td>22,992</td>
<td>€593.6 million</td>
<td>€260,821</td>
</tr>
<tr>
<td>15-64 years</td>
<td></td>
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<td></td>
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<td></td>
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<td>Total YPPLL (years of potential productive life lost)</td>
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<td>Average lost productivity cost per cancer death*</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* total cost/no. of deaths aged 15-64

## Results: all cancers, by sex

<table>
<thead>
<tr>
<th>Measure of cancer burden, per annum</th>
<th>Males</th>
<th>Females</th>
<th>M:F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of deaths: all ages</td>
<td>4,276</td>
<td>3,791</td>
<td>1.13</td>
</tr>
<tr>
<td>15-64 years</td>
<td>1,158</td>
<td>1,118</td>
<td>1.05</td>
</tr>
<tr>
<td>Total YPPLL (years of potential productive life lost)</td>
<td>10,873</td>
<td>12,119</td>
<td>0.90</td>
</tr>
<tr>
<td>Total cost of lost productivity due to cancer-related premature mortality</td>
<td>€369.2 m</td>
<td>€224.4 m</td>
<td>1.65</td>
</tr>
<tr>
<td>Average lost productivity cost per cancer death*</td>
<td>€322,488</td>
<td>€202,472</td>
<td>1.60</td>
</tr>
</tbody>
</table>

* total cost/no. of deaths aged 15-64
Results: all cancers, by sex

- Lower YPPLL in males than females (M:F=0.90)
  - due to gender differences in the distribution of age at death

![Distribution of cancer deaths by age group and sex, 2005-09, 15-64 years]

Results: all cancers, by sex

- Higher lost productivity costs in males than females (M:F=1.65)
  - due to gender differences in workforce participation and wages

![Average workforce participation, by sex, 15-64, 2009]

![Average wages, by sex, 15-64, 2009]
**Results: total lost productivity costs, by site**

- **lung, 17.3%, €102.7m**
- **breast, 10.8%, €64.1m**
- **colorectal, 9.9%, €58.8m**
- **brain & CNS, 7.7%, €45.7m**
- **pancreas, 4.8%, €28.5m**
- **stomach, 4.4%, €26.1m**
- **oesophagus, 4.2%, €24.9m**
- **leukaemia, 2.3%, €13.7m**
- **ovary, 2.8%, €16.8m**
- **NHL, 3.5%, €20.8m**
- **uterus, 3.7%, €22.0m**
- **bladder, 0.9%, €5.3m**
- **prostate, 1.2%, €7.1m**
- **other sites, 26.5%, €157.3m**

**Results: cost per death**

Lost productivity cost per death, males (average all cancers=€322,488)

1. **lung** - €262,459
2. **colorectal** - €318,811
3. **prostate** - €182,985
4. **oesophagus** - €316,875
5. **pancreas** - €311,849
6. **stomach** - €363,846
7. **leukaemia** - €386,157
8. **brain & CNS** - €443,054
9. **NHL** - €379,835
10. **bladder** - €289,399
Results: cost per death

Lost productivity cost per death, females (average all cancers=€202,472)

- 1 breast: €224,682
- 2 lung: €152,128
- 3 colorectal: €190,806
- 4 ovary: €180,673
- 5 pancreas: €140,091
- 6 uterus: €265,320
- 7 stomach: €225,797
- 8 oesophagus: €156,889
- 9 NHL: €193,828
- 10 brain & CNS: €237,723

Discussion 1

- Costs of lost productivity due to cancer-related premature mortality are significant in economic terms
  
  Ireland: €593.6 million per annum = 0.5% GDP
  
- Similar magnitude to other countries
  
  USA, $115.8 billion in 2000 = almost 1% of GDP
  (Bradley et al., 2008)
  
- Lost productivity cost per cancer death in Ireland (€260,821): 6-7 times the average wage
Discussion 2

- Premature mortality costs dwarf the direct medical costs associated with cancer

Colorectal cancer
premature mortality costs per death (€2009) = €269,551
diagnosis, treatment & 5-year follow-up costs per new case (€2008) = €39,607 (Tilson et al., 2012)

- Similar pattern seen in studies of other individual cancer sites in other countries (e.g. Lindgren et al., 2007; Morris et al., 2009; Tingstedt et al., 2011)

Discussion 3

- Premature mortality costs are not the only lost productivity costs due to cancer

"Total" lost productivity costs due to cancer will be greater than these estimates
Discussion 4

- As the retirement age increases, cancer-related lost productivity costs will rise (substantially)

Number of deaths by age group and sex

<table>
<thead>
<tr>
<th>Age-group</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-64</td>
<td>1,158</td>
<td>1,118</td>
</tr>
<tr>
<td>65-69</td>
<td>565</td>
<td>401</td>
</tr>
</tbody>
</table>

Colorectal cancer premature mortality costs per cancer diagnosed (€2008), by age at retirement

Hanly et al., 2013

Conclusions

- The costs of cancer-related lost productivity are significant (€593.6 million per annum; 0.5% GDP)
  - dwarf direct medical costs of diagnosing and treating cancer
  - lower bound on total lost productivity costs due to cancer
- Total cost and cost per death higher for men than women
  - gender differences in workforce participation and wages
- Cancers with high incidence - or early age at onset and poor survival - have relatively high lost productivity costs
  - different ranking of cancer sites compared to more “conventional” measures of cancer burden

Cost estimates such as these provide an alternative perspective on the cancer burden on society
Acknowledgements

• Information on cancer deaths was obtained from the WHO Cancer Mortality Database
• Wages, and labour force participation and unemployment rates, were obtained from the Central Statistics Office

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