Valuing mortality risk reductions in global benefit-cost analysis

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• Concept & terminology
• Review of direct estimates in LMICs
• Recommendations
  — Use direct high-quality estimates if available
  — Extrapolate from high-income country estimates, adjusting for income difference
    o As primary estimate, or sensitivity analysis
  — Extrapolation
    o 2 base values
    o 2 income elasticities
  — Sensitivity analysis for age
    o Value proportional to life expectancy
Concept

- Money value of reduction in mortality risk
  - Risk change in specified period
    - Usually short-term, e.g., current year
- Individual concept
  - Own risk
  - Own money (or household money)
- Rate of substitution (ratio of money to risk change)
  - Idealization: marginal rate (infinitesimal risk change)
  - Approximation: money value of small risk change
    - Change in wealth that has same effect on wellbeing as the risk change
      - Compensating or equivalent variation
Terminology

- Rate of substitution (ratio of money to risk change)
  - Rate = ratio = change in money / change in risk

- Value per statistical life (VSL) = $ per 1 unit change in risk (probability)

- Value per standardized mortality unit (VSMU) = $ per 1/10,000 change in risk
  - = VSL \cdot 1/10,000

- Value per micromort = $ per 1/million change in risk
  - = VSL \cdot 1/million

- EPA expected to propose a new term; we will evaluate & may recommend it (or an alternative)
VSL = slope

Indifference curve

Wealth

VSL

Survival probability ( = 1 - risk)

0 1
VSL = slope

\[ VSL \approx \frac{WTP}{\Delta r} \]

\( \Delta r = \text{SMU} \)

WTP = VSMU

Indifference curve

Wealth

VSL

Survival probability (\( = 1 - \text{risk} \))

0 \hspace{2cm} 1
Total value of a change in population risk
\[ = \text{sum of individual values} \]

- Total value = sum of (individual VSL x individual risk reduction)
  \[ = \sum_{i=1}^{n} (VSL_i \cdot \Delta r_i) \]

- \( \approx \) average VSL x sum of (individual risk reduction)
  \[ \approx \overline{VSL} \sum_{i=1}^{n} \Delta r_i \]
  Approximation is exact if individual VSLs and risk reductions are uncorrelated

- = average VSL x expected number of lives saved
  Lives saved = deaths avoided during period
  \[ = \overline{VSL} \cdot E(\text{lives saved}) \]
VSL depends on

- **Individual characteristics**
  - Wealth & income
    - We know something about how to adjust for this
  - Age & life expectancy
    - Conflicting evidence, we suggest crude adjustments
  - Health
  - Household size & composition

- **Social or cultural characteristics**
  - Preferences for allocating resources to self v. family or community

- **Risk characteristics**
  - Traumatic injury v. chronic disease

- **Other factors?**
Direct estimates in LMICs

• Searched for studies conducted in LMICs
  — General adult population
    o Probabilistic (not convenience) sample
    o WTP to reduce own risk
  — Data collected in past 20 years (1997 – present)
  — Written in English

• 25 studies
  — 8 revealed preference (wage differential)
  — 17 stated preference studies (18 estimates)
    o 9 of 18 tested whether willingness to pay increases with risk reduction
    o 5 of 9 found a statistically significant increase
25 studies, 15 countries
VSL / GNIpc vs. GNIpc (not adjusted to common year)
Recommendations

• If high-quality direct estimates exist, use them
  — Requires multiple high-quality studies
  — Government guidance exists for many high-income countries

• Otherwise (or as sensitivity analysis) extrapolate from high-quality estimates (in high-income country)
  — Adjust for income, using GNI per capita as measure
    o GNI per capita is broad measure, available for all countries
  — Base value (2)
    o VSL / GNI per capita = 170 & 80
  — Income elasticity (2)
    o Income elasticity = 1.0 & 1.4
  — Bound result to VSL / GNI per capita ≥ 20
Rationale: base value  
(expressed as VSL / GNI per capita; 2013 dollars)

• US government guidance (HHS)
  — Central value: $9 million → VSL/GNIpc = 170
    o Based on wage-differential estimates (with good risk data) & stated-preference estimates (that satisfy validity test)  
    o DOT (wage differential): $9.2 million  
      o EPA (old wage-differential and stated-preference): $9.7 million  
  — Low value: $4.2 million → VSL/GNIpc = 80

• Why US values?
  — Based on many high-quality studies, numerous reviews  
  — Larger than most other high-income countries  
    o Treat central US value as high estimate for high-income countries  
  — Proposed range covers central value from OECD meta-analysis: $3.0 million → VSL/GNIpc = 100
Rationale: income elasticity

• Ratio of VSL to income probably increasing with income
  — Share of income required for basic necessities lower at higher income
  — → income elasticity ≥ 1

• Well being from year of living probably greater than value of consumption of goods & services
  — VSLY ≥ consumption ≈ GNIpc
  — VSL ≥ present value of future consumption ≈ 20 x GNIpc

• Direct estimates (median GNIpc ~$9,400)
  — Exclude ratios > 170 and < 20
  — Of remaining 14, half are between 98 & 37 (median = 57)

<table>
<thead>
<tr>
<th>Extrapolate to GNIpc =</th>
<th>Base = 170 Elasticity = 1</th>
<th>Base = 80 Elasticity = 1</th>
<th>Base = 170 Elasticity = 1.4</th>
<th>Base = 80 Elasticity = 1.4</th>
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<tbody>
<tr>
<td>$10,000</td>
<td>170</td>
<td>80</td>
<td>87</td>
<td>41</td>
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<tr>
<td>$1,000</td>
<td>170</td>
<td>80</td>
<td>34</td>
<td>16 → 20</td>
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Adjustment for age

- Estimates suggest
  - VSL increases then decreases with age
  - May be ~ 2x higher for children than adults
- Recommendation: if policy disproportionately affects young or old, add sensitivity analysis using constant VSLY
- VSLY = VSL / life expectancy at mean adult age
  - Consistent with using VSL for mean-age adult
- Value of reducing mortality risk inversely proportional to life expectancy
  - Alternative (divide VSL by present value of discounted future life years) yields results between recommendation and using same VSL for all ages
- For children, newborns, fetal mortality
  - No special recommendation, conduct sensitivity analysis