Exposure-adjusted fatality rates for cycling and walking in European countries

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On behalf of the HEAT core group

http://www.heatwalkingcycling.org/#acknowl
Outline

- Background: PASTA and HEAT projects
- Introduction: Why are exposure-adjusted crash risk estimates needed?
- Methods: How did we estimate fatality rates across Europe?
- Results: What did we find (and not)?
- Discussion: outlook

Glossary

exposure = «amount of cycling»
exposure-adjusted = «taking into account the underlying amount of cycling»
Background
What are the determinants of active travel?
What are effective measures to promote active travel?

What is the interrelation between active travel, physical activity and injury risk?

What are the health impacts of active travel?

<table>
<thead>
<tr>
<th>Context</th>
<th>Individual</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical environment</td>
<td>Socio-geographical factors</td>
<td>Health benefits from PA</td>
</tr>
<tr>
<td>Transport options</td>
<td>Neighborhood perceptions</td>
<td>Environmental impacts</td>
</tr>
<tr>
<td>Built environment</td>
<td>Perception of travel choices</td>
<td>Health risks from AP</td>
</tr>
<tr>
<td>Natural environment</td>
<td>Trips</td>
<td>Injury risks from travel</td>
</tr>
<tr>
<td>Social Environment</td>
<td>Safety incidents</td>
<td>Net health impacts</td>
</tr>
<tr>
<td>Planning practice</td>
<td>Travel behaviour</td>
<td></td>
</tr>
</tbody>
</table>

Individual characteristics
Socio-demographics
Home and work location

Extended theory of planned behaviour

Physical activity

PASTA was funded by the European Union’s Seventh Framework Program under EC-GA No. 602624-2
Health Benefits of Active Travel Outweigh Risks
Health Economic Assessment Tool for walking and cycling (HEAT) by WHO

“For a given volume of walking or cycling within a defined population what is the economic value of the health benefits?”

- Online tool www.heatwalkingcycling.org
- Target audience “non-experts”
- Simple and quick “order of magnitude assessments”
- Focus on Europe (53 WHO member states)
- Approach based on core principles:
  - scientific evidence, transparent, conservative
- Development process:
  - iterative, modular, consensus-based
HEAT update 2017 (version 4.0) (as part of PASTA)

Required user inputs

- What do you want to assess?
  - Data inputs
    - Adjustment of data inputs
      - Review of calculation parameters
        - Physical activity benefit calculation
        - Air pollution risk calculation
        - Crash risk calculation
        - Carbon emissions calculation
          - Reduced mortality, carbon emissions
            - Monetization
Introduction (the research challenge)
Impact assessment of traffic safety with HEAT tool in mind

- Fatalities
- Injuries
- Cycling
- Walking
- E-biking
- Bike share
- Motorized traffic
- Risk factors
- National level
- City level
- Project scale, Infrastructures
Impact assessment of traffic safety
a research agenda (with HEAT in mind)

Modes
- Walking
- Cycling
- Motorized traffic
- E-biking
- Bike share

Outcomes
- Fatalities
- Injuries

Scale
- National
- Cities
- Project scale, Infrastructures

Increasing effort

Risk factors

Data collection

Research/modelling
Key challenge: «exposure-adjusted risk estimates»

1. Impact assessment is always also about «comparing» (just like policy evaluation)
2. Comparisons are only valid if adjusted for major determinants (of crashes)
3. Exposure (volume of cycling) is the main determinant of number of crashes.
4. Only exposure-adjusted crash risk estimates allow for valid comparisons.

Figure 4. Conceptual framework of safety of cycling (adapted from Schepers et al., 2014).
Conceptual framework of safety of cycling. Crash risk is conceptualized as a crash rate, such as the ratio between adverse events and an exposure measure. Impacts refer to the number of adverse events occurring in a specific population over a defined period of time. Diagonal arrows indicate “feedback” mechanisms: “perceived safety”, in large parts determined by absolute numbers of (severe) crashes, affects cycling behavior, and “exposure levels”, such as the number of cyclists, affect determinants of crashes (safety), such as behavior of other road users, an effect known as safety in numbers. (adapted from Schepers, Hagenzieker et al. 2014).

How HEAT Looks at Crash Risk (for now)

- Nature of crash risk
- HEAT tool
- HEAT application

Crash Risk (Crash rate)

- Crashes (Numerators)
  - Fatalities

Exposure (Denominators)

- Bicycle traffic
  - Volume (Distance)

Impacts

- Fatalities
- Time period
- Population

Conceptual framework of safety of cycling. Crash risk is conceptualized as a crash rate, such as the ratio between adverse events and an exposure measure. Impacts refer to the number of adverse events occurring in a specific population over a defined period of time. Diagonal arrows indicate “feedback” mechanisms: “perceived safety”, in large parts determined by absolute numbers of (severe) crashes, affects cycling behavior, and “exposure levels”, such as the number of cyclists, affect determinants of crashes (safety), such as behavior of other road users, an effect known as safety in numbers. (adapted from Schepers, Hagenzieker et al. 2014).
Fatality Rates for HEAT Crash Module
Basic Implementation in HEAT Crash Module

Crash risk estimate \times \text{Volume of cycling} = \text{Bike crashes}

From where?
Fatalities data

1. Average number of fatalities (2011-2015) were primarily calculated based on data from the ITF-IRTAD data set
2. For countries not included in this data set, 1-year data from the WHO-GHO were used

<table>
<thead>
<tr>
<th>Source</th>
<th>Year of data</th>
<th>Number of countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Transport Forum (ITF) -</td>
<td>2005-2015</td>
<td>32</td>
</tr>
<tr>
<td>International Traffic Safety Data and</td>
<td>Time series</td>
<td></td>
</tr>
<tr>
<td>Analysis Group (IRTAD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>World Health Organization (WHO) -</td>
<td>2013</td>
<td>142</td>
</tr>
<tr>
<td>Global Health Observatory (GHO)</td>
<td>One-year data</td>
<td></td>
</tr>
</tbody>
</table>
Exposure Data (total km, km/person*day)

1. National **travel survey**
2. *if no travel survey*, estimation based on:
   - **Mode share**:
     - Crude estimates by world regions produced by ITDP-ITS report (16% for Nordic countries, 7% European OECD countries, 2% for non-OECD countries and 3% for Middle Eastern countries)
   - **Number of trips**:
     - 3 trips by all-modes per person and day (assumption based on the WALCYNG report as well as PASTA data)
   - **Trip length**:
     - 4 km per bicycle trip and 1 km per walking trip (based on UK, NL, and PASTA)

\[
TD = AMS \times TT \times TL \times Pop
\]

- **TD** = Yearly travel distance by active mode (kilometres)
- **AMS** = Active mode share (active mode trips / trips by all modes)
- **TT** = Total number of trips by all modes (trips per person and day)
- **TL** = Average trip length (km per active mode trip)
- **Pop** = Population (inhabitants)
Data Quality

- Distinction of some data quality criteria results in **six reliability levels**
- Main contrast is availability of **travel survey vs. mode share estimate**

<table>
<thead>
<tr>
<th>Exposure data</th>
<th>Fatality data</th>
<th>Fatality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Original data</strong></td>
<td><strong>Used data</strong></td>
<td><strong>Original data</strong></td>
</tr>
<tr>
<td>National data</td>
<td>Original data (or combination thereof) without assumptions</td>
<td>Observed deaths</td>
</tr>
<tr>
<td></td>
<td>Estimation with assumption(^{(a)})</td>
<td>Single year</td>
</tr>
<tr>
<td><strong>Mode share estimate for world region based on selected cities</strong></td>
<td>Model estimation</td>
<td>5-year average</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single year</td>
</tr>
</tbody>
</table>

\(^{(a)}\) Assumption of mode share for different world regions.
Availability of High Quality Data

- 13 countries for cycling
- 11 for walking

<table>
<thead>
<tr>
<th>Reliability level of fatality rate</th>
<th>Countries for cycling</th>
<th>Countries for walking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high (1)</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>High (2)</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Moderate (3)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Low (4-6)</td>
<td>33</td>
<td>n.a.(a)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

*(a) regional mode share estimates were not available for walking*
## Results

Tables with values, sources and meta information of

- fatality data,
- exposure data and
- fatality rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Fatalities (cycling fatalities per year)</th>
<th>Exposure (million km travelled by bicycle per year)</th>
<th>Fatality rate (cycling fatalities per hundred million km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Year</td>
<td>Data</td>
</tr>
<tr>
<td>Albania</td>
<td>20.0</td>
<td>2013</td>
<td>E, 1y</td>
</tr>
<tr>
<td>Armenia</td>
<td>2.0</td>
<td>2013</td>
<td>E, 1y</td>
</tr>
<tr>
<td>Austria</td>
<td>45.8</td>
<td>2011-2015</td>
<td>O, 5y</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>3.0</td>
<td>2013(^{(b)})</td>
<td>O(^{(e)}), 1y</td>
</tr>
<tr>
<td>Belarus</td>
<td>101.0</td>
<td>2013</td>
<td>O, 1y</td>
</tr>
<tr>
<td>Belgium</td>
<td>74.0</td>
<td>2011-2015</td>
<td>O, 5y</td>
</tr>
</tbody>
</table>
Fatality Rates for Cycling

- Fatality rates range from 0.8 to 5.1
- Fatality rates are lower in countries with high exposure (cycling volume)
Fatality Rates for Walking

- Fatality rates range from 0.6 to 5.3
- Fatality rates are lower in countries with high exposure (walking volume)
Fatality Rates for Cycling (incl. low reliability figures)

- Clustering due to
  - Regional mode share estimates
  - Common extrapolation assumptions
- Several low reliability rates seem inflated
Discussion
Strengths of HEAT crash module

- A rare effort of systematically compiling exposure-adjusted fatality risk data for active travel modes following a common methodology
- Comparisons of fatality risks across 12 European countries.
- Comparisons of crash risks vs. health benefits of cycling in assessments of multiple impact pathways as in HEAT, for approximately another 30 countries.
Limitations of HEAT crash module

- Simplified approach within **constraints and scope of HEAT**
  - No motorized modes
  - No injuries
  - No sub-national scale, etc.
- High reliability fatality rates: No **harmonization of travel surveys**
  - Survey methods
  - Inclusion criteria, etc.
- Low reliability fatality rates: extrapolation likely inflates exposure in some places
  - Mode share depends on local/national factors – world region too crude
  - Trip distance depends on mode share – not reflected
  - is “best available” “good enough”?
Limitations beyond HEAT

- Fatality rates provide an «incomplete picture»
  - Risk and exposure are self-regulating:
    «High levels of cycling» and «low fatality rates» both indicate «safety»
  - Injuries are a substantial (equal/larger) issue
  - National rates are of limited value to inform (sub-national) policy
    (understanding the “why?”)
Considerations for Cycling Safety Research (bigger picture)

- **Scope**
  - within HEAT fairly narrow and clear.
  - Do we understand **needs of policy and practice** more broadly, and how they align with safety research efforts?

- **Spatial scale**: city level, project level
  - This is **where (most) policy happens**
  - **Major research gap/challenge**

- **Data** collection vs. research and **models**:
  - Where can «**collection of existing data**» suffice geographical scope and diverse use cases?
  - Where can/should «**prediction models**» step in?
Considerations for Cycling Safety Research (specific topics)

- Travel surveys:
  - Is harmonization worth the hassle?
  - How about a publication standard for «indicators plus meta-data»?
  - What is plan B for countries without travel surveys?
    - can smartphones, internet etc. lead to supranational solutions?
- “Exposure to motorized modes”
  - Is it worth pursuing “data collection” at the national level?
  - Can we learn something about bicycling?
- “Safety-in-numbers-in-safety-…“: nice to see (again), but:
  - How to establish causality and produce policy inputs?
  - Is there an opportunity at the national level?
- Injuries:
  - Same approach, equal effort - or ten-fold?
Conclusions: “...from iceberg to white paper...”

- Before we rush to conclusions, let’s do some basic home work:
  - Identification/alignment of needs/gaps, objectives, and priorities
    «which questions should be answered, which ones are being addressed, and are we setting the right priorities»
  - Definition of roles for practitioners, agencies, (supra)(national) organizations, and research (disciplines)
    «who can we expect to contribute what?»
  - Alignment of methods and objectives
    «which methods/approaches are suited to address which questions?»
  - Produce more robust evidence
    «cycling safety research merits more attention and funding»
Thank you for your attention

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