HEALTH ECONOMIC ASSESSMENT TOOL FOR WALKING & CYCLING

Luc Int Panis, Michelle Laeremans, Evi Dons & Jurgen Buekers
INTRO

PASTA Physical Activity Through Sustainable Transport Approaches

European project, FP7, 7 cities
https://www.researchgate.net/project/PASTA-project

Objectives:
- Promotion & evaluation of active mobility
- Reduce health impact of sedentary behaviour
- Integration of physical activity in daily routine
- Update WHO HEAT tool

Longitudinal study: online survey on (active) mobility, PM, accidents etc.

Experiments & Top Measure analysis
Toxic cities mock 'health' capes

CYCLING to work, the healthy option has shown that cities inhale toxic nanoparticles, the least toxic, as fine as dust.

The research, in cyclers with dust, counted the particles emitted by car fumes. It showed that there are concentrations of particles, which measure 10,000 nanometers, which reach several hundred in a cubic centimeter.

The particles, which have been linked to disease and respiratory problems.

Because they are inhaled, cyclists inhale a higher percentage of air than other road users. The study showed that 10% of particles inhaled by cyclists were inhaled by the cyclists, and 90% were inhaled by the other road users.

"This is the first time anyone has counted the particles," said the research institute in Hasselt University in Belgium, which led the study.
Inactivity: a global health hazard
Health Economic Assessment for walking & cycling
  • Why?
  • What do we need?
  • Relative risks & dose-response functions
  • Monetary values for health

Case studies & available models
- The Health Economic Assessment Tool (HEAT) for walking & cycling
- Flemish model (CWIcalc)

Summary & conclusions
PHYSICAL INACTIVITY: A GLOBAL HEALTH HAZARD
4th most important cause of premature mortality

🚨 Active mobility

▶️ 😊 More physical activity
(better health)
→ 😞 Increases exposure to air pollution
→ 😞 Increases accident risk
Physical inactivity: a risk factor comparable to smoking

### PHYSICAL INACTIVITY: A GLOBAL HEALTH HAZARD

**Impacts on health in Flanders**

<table>
<thead>
<tr>
<th>Risk</th>
<th>DALYs (avg/year)</th>
<th>Healthy life years lost (per capita)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>144687</td>
<td>1.9</td>
</tr>
<tr>
<td>Obesity</td>
<td>94750</td>
<td>1.3</td>
</tr>
<tr>
<td>Air pollution (PM)</td>
<td>79000</td>
<td>1.1</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>54134</td>
<td>0.7</td>
</tr>
<tr>
<td>Hypertension</td>
<td>53690</td>
<td>0.7</td>
</tr>
<tr>
<td>Traffic accidents*</td>
<td>36476</td>
<td>0.5</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>27930</td>
<td>0.4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>10113</td>
<td>0.1</td>
</tr>
<tr>
<td>Passive smoking</td>
<td>6600</td>
<td>0.1</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>&lt;1000</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>&lt;1000</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
PHYSICAL INACTIVITY: A GLOBAL HEALTH HAZARD

Health expenditures, high & rising (but not for prevention)

Source: De maatschappelijke betekenis van de gezondheidszorg; Karel Van den Bosch, Peter Willemé; januari 2014
THE HEALTH ECONOMIC ASSESSMENT TOOL FOR WALKING & CYCLING (HEAT)
HEALTH ECONOMIC ASSESSMENT TOOL (HEAT) FOR WALKING & CYCLING:
A COLLABORATIVE PROJECT

Harry Rutter, Francesca Racioppi, Sonja Kahlmeier, Nick Cavill, Pekka Oja, Heini Sommer, Hywell Dinsdale, Charlie Foster, Paul Kelly, Thomas Götschi, Christian Schweizer
Karim Abu-Omar, Lars Bo Andersen, Finn Berggren, Tegan Boehmer, Nils-Axel Braathen, Dushy Clarke, Andy Cope, Audrey de Nazelle, Mark Fenton, Jonas Finger, Richard Fordham, Eszter Füzeki, Frank George, Regine Gerike, Mark Hamer, Max Henry, Marie-Eve Heroux, Michal Krzyzanowski, I-Min Lee, Christoph Lieb, Brian Martin, Markus Maybach, Christoph Schreyer, Marie Murphy, Nanette Mutrie, Luc Int Panis, Laura Perez, Gabe Rousseau, David Rojas Rueda, Candace Rutt, Tom Schmid, Elin Sandberg, Mulugeta Yilma, Daniel Sauter, Peter Schantz, Peter Schnohr, Dave Stone, Jan Sørensen, Gregor Starc, James Woodcock, Wanda Wendel Vos, Paul Wilkinson
HEAT FOR WALKING & CYCLING: WHY & HOW?

Need for integration between different policy domains
(transport, urban planning, health, etc.)

HEAT:
User friendly tool to estimate economic value of health benefits of cycling & walking

Answer the question:

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

Inputs:
• Data on ‘volume’ of walking or cycling
• How many people?
• Which people?
• How far/often?
Volume of walking/cycling per person duration/distance/trips/steps (entered by user)

Protective benefit (reduction in mortality as a result of walking/cycling) = 

\[(1 - RR^\dagger) \times \left( \frac{\text{User's volume of walking/cycling}}{\text{Reference volume of walking/cycling}^{\dagger\dagger}} \right)\]

Population that stands to benefit (entered by user or calculated from return journeys)

General parameters
Intervention effect, build-up period, mortality rate, timeframe (changeable default values)

Estimate of economic savings using VSL (changeable default value)

\[\text{RR} = \text{relative risk of death in underlying studies (walking: 0.89 and cycling: 0.90)} \text{.}\]

\[\text{Volume of cycling per person calculated based on 100 minutes per week for 52 weeks per year at an estimated speed of 14 km/hour. Volume of walking based on 168 minutes per week at 4.8 km/hour.}\]
HEAT FOR WALKING & CYCLING: RELATIVE RISKS & DOSE-RESPONSE

1st HEAT for cycling version: based on Copenhagen only:
• Dose: 3h cycling; 36 weeks/year
• Response: RR ‘all-cause mortality’ = 0.72
• Corrected for leisure time PA
  → Lots of criticisms
  → But nevertheless very conservative

2nd HEAT version: Meta-analysis (7 studies):
• Dose: 11.25 MET.hours/week or 100 minutes cycling/week; 52 weeks/year (cycling = 6.8 METs)
• Response: RR ‘all-cause mortality’ = 0.90
• Corrected for leisure time PA
  → Even more conservative
  → Maximum ‘protective benefit’ (cycling = 45%)

New HEAT version 2018 (Beta version currently being tested, Manual also in German & French)

https://www.researchgate.net/publication/275219139_Health_impact_assessment_of_active_transportation_A_systematic_review/stats
Information on bicycling as transportation to work was available for 783 women and 6171 men. Among these 6954 subjects, 2291 died during follow-up. The same tendencies were found in men and women when mortality rates were compared between those who cycled to work and those who did not, but the estimates were not significant in women. The average time spent cycling in those who did cycle to work was 3 hours per week. The analyses are presented for the whole group, with adjustment for sex. Bicycling to work was inversely related to years of education. Among the less educated subjects (<8 years of school), 27.8% used the bicycle to work, in the middle group (8–12 years of school) 24.9% cycled, and in the most educated group (≥12 years of school) 20.3% cycled. After adjustment for age, sex, and educational level, the relative risk in those who cycled was 0.70 (95% CI, 0.33–0.89). After additional adjustment for leisure time physical activity, body mass index, blood lipid levels, smoking, and blood pressure, the relative risk was 0.72 (95% CI, 0.57–0.91).
‘Value of a Statistical Life’ (VSL)
• ‘willingness to pay’ to reduce mortality risk e.g. from 3/10000 to 2/10000?
• Different for each country

<table>
<thead>
<tr>
<th>Country</th>
<th>Value (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO European region average</td>
<td>2 587 175</td>
</tr>
<tr>
<td>België</td>
<td>4 380 597</td>
</tr>
<tr>
<td>Hongarije</td>
<td>1 576 768</td>
</tr>
</tbody>
</table>

Should be discounted
• Interaction between transport related PA & air pollution
• Accidents/crashes
• Morbidity
• Climate
• Noise
• Social
• ...

HEAT FOR WALKING & CYCLING: WHAT IS/WAS MISSING?
HIGH AIR POLLUTION CONCENTRATION ON CYCLE LANES

Average UFP number in Brussels

- Near “park” (Louisa Square, KDG avenue)
- “Busy street canyon” rue de la Loi
- “Quiet street” (rue Jozef II)
ACCIDENTS/CRASHES
Do the Health Benefits of Cycling Outweigh the Risks?

Jeroen Johan de Hartog,1 Hanna Boogaard,1 Hans Nijland,2 and Gerard Hoek1

1University of Utrecht, Institute for Risk Assessment Sciences, Utrecht, the Netherlands; 2Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands

BACKGROUND: Although from a societal point of view a modal shift from car to bicycle may have beneficial health effects due to decreased air pollution emissions, decreased greenhouse gas emissions, and increased levels of physical activity, shifts in individual adverse health effects such as higher exposure to air pollution and risk of a traffic accident may prevail.

OBJECTIVE: We describe whether the health benefits from the increased physical activity of a modal shift for urban commutes outweigh the health risks.

DATA SOURCES AND EXTRACTION: We have summarized the literature for air pollution, traffic accidents, and physical activity using systematic reviews supplemented with recent key studies.

DATA SYNTHESIS: We quantified the impact on all-cause mortality when 500,000 people would make a transition from car to bicycle for short trips on a daily basis in the Netherlands. We have expressed mortality impacts in life-years gained or lost, using life table calculations. For individuals who shift from car to bicycle, we estimated that beneficial effects of increased physical activity are substantially larger (3–14 months gained) than the potential mortality effect of increased inhaled air pollution doses (0.8–40 days lost) and the increase in traffic accidents (5–9 days lost). Societal benefits are even larger because of a modest reduction in air pollution and greenhouse gas emissions and traffic accidents.

CONCLUSIONS: On average, the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting their mode of transport.

Cycling: Health Benefits and Risks

doi:10.1289/ehp.1003227

de Hartog et al. (2010) quantified the balance between physical activity and air pollution and accident risks of cycling and concluded that the benefits outweigh the risks by an order of magnitude. This is the most comprehensive and quantitative comparison to date, based on recently published data available at the time. In the weeks after publication of the article, two new relevant studies were published; this illustrates that a scientific answer to this question is urgent from the societal perspective. In many places cyclists are perceived to have a higher exposure to air pollution and an accident risk. Do the new data tilt the balance between the risks and benefits of cycling?

de Hartog et al. (2010) used a ventilation rate that is twice as high for cyclists as for both drivers. In a recent study in Belgium (Int Panis et al. 2010), we found that both the ventilation rate and the tidal volume were increased and that minute ventilation was 43% higher in cyclists compared with car passengers (similar to the ratio of metabolic rates). The difference can further be explained by differences in cycling speeds and lung deposition resulting in a dose that is up to 9 times higher in cyclists.

The life expectancy (LE) loss estimated from substituting this ratio into the calculation by de Hartog et al. (2010) may thus offset most of the expected LE gain. However, this is unlikely because some studies have observed an LE gain in the presence of air pollution (Andersen et al. 2000). To resolve this conflict, it is important to consider the implicit assumptions in the comparison.

First, the higher dose ratios apply only to situations without route choice, although cyclists prefer to avoid motorized traffic, which represents an important limitation. Second, de Hartog et al. (2010) did not consider the costs associated with cycling, i.e., weather, time, and LE loss or those in which many people have a small loss (Rabl 2003). Cyclists are generally young and in excellent health and therefore less vulnerable, implying that the relative risk used by de Hartog et al. (2010) is too high for application to this specific population.

In addition, accidents remain an important cause for concern. Aertssens et al. (2010) recently estimated the costs of minor bicycle accidents at an astonishing 0.126/km cycled. Including the more serious accidents in the equation would yield a cost that could easily offset the value of the LE benefit calculated by de Hartog et al. (2010).

If the higher LE observed in present day cyclists can be transferred to people now taking up cycling, the benefits will probably be higher than the risks. However, it will be crucial to demonstrate that cycling increases physical activity. Without increased physical activity there are only risks, but reducing those risks may yield larger benefits than anticipated.

The views and opinions expressed in this article are those of the author and not necessarily those of his employer.

L.I.P. received financial support from the Science for Sustainable Development programme (2007–2010) of the Belgian Science Policy Office and strategic research funding from VITO (Flemish Institute for Technological Research) for the SHAPES (Systematic Analysis of Health Risks and Physical Activity Associated with Cycling Policies) project but has no competing financial interests. VITO is a public research institute of the Flemish regional government.

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REFERENCES

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REFERENCES

Cycling: de Hartog et al. Respond

doi:10.1289/ehp.1003227

We thank Int Panis for his thoughtful comments on our article (de Hartog et al. 2010), and we broadly agree with his comments. In fact, we discussed most of the issues—including the limitation to impact on mortality, sensitive subgroups, route choice, and activity substitution—in our paper.

The first issue discussed by Int Panis is whether we underestimated the difference in minute ventilation between cyclists and car drivers; however, his comment was based on a recent Belgian study (Int Panis et al. 2010) that was not published at the time of our study. In our analysis we used a ratio of 2.2 [the average of two Dutch studies that closely agreed (van Wijnen et al. 1993; Zuurber et al. 2009)], whereas the Belgian study (Int Panis et al. 2010) found a ratio of 4.3. The difference is probably explained in part by differences in cycling speed: 12 km/hr in the recent Dutch study (Zuurber et al. 2009) and >19 km/hr in the Belgian study (Int Panis et al. 2010). In urban areas, the average cycling speed is about 15 km/hr, including stop time. Rather than replacing the previous estimates by with the newer Belgian estimate, we believe that the best current estimate would be the average of the ratios of the three available studies. This would lead to a ratio of 2.9.

Use of this ratio based on more studies clearly would not tip the balance between cycling and car driving as Int Panis suggests. We think it is stretching the data too much to use deposition particle mass (actually 5.9–8.99 higher in the Belgian study) for the analysis, because the long-term epidemiological studies we used are based on concentrations measured in outdoor air. In the most likely estimate we provided for air pollution [based on black smoke, which better represents traffic exposures than PM2.5]...
What if:

500 000 people switch from car to bike for daily short trips?

• More air pollution exposure: 0.8-40 days lost
• Accidents: 5-9 days lost
• Increased physical activity: 3-14 months gained
• Benefits even larger if social benefits are included

No morbidity impacts included in most studies or models (increases complexity & uncertainty)
HEAT FOR WALKING & CYCLING: AIR POLLUTION IS HARD TO EXTRAPOLATE

<table>
<thead>
<tr>
<th>City</th>
<th>Average PM2.5 (μg/m³)</th>
<th>Gain in Life Expectancy (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bucharest</td>
<td>38.2</td>
<td>22.1</td>
</tr>
<tr>
<td>Budapest</td>
<td>33.7</td>
<td>21.6</td>
</tr>
<tr>
<td>Ljubljana</td>
<td>29.4</td>
<td>21.6</td>
</tr>
<tr>
<td>Barcelona</td>
<td>29.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Athens</td>
<td>27.0</td>
<td>14.5</td>
</tr>
<tr>
<td>Rome</td>
<td>22.0</td>
<td>11.6</td>
</tr>
<tr>
<td>Sevilla</td>
<td>21.4</td>
<td>10.2</td>
</tr>
<tr>
<td>Valencia</td>
<td>20.9</td>
<td>9.9</td>
</tr>
<tr>
<td>Granada</td>
<td>21.6</td>
<td>9.3</td>
</tr>
<tr>
<td>Vienna</td>
<td>18.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Marseille</td>
<td>18.0</td>
<td>9.3</td>
</tr>
<tr>
<td>Bruges</td>
<td>18.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Lille</td>
<td>16.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Paris</td>
<td>16.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Lyons</td>
<td>16.5</td>
<td>8.3</td>
</tr>
<tr>
<td>Strasbourg</td>
<td>16.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Bordeaux</td>
<td>15.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Nantes</td>
<td>16.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Rouen</td>
<td>15.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Le Havre</td>
<td>15.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Toulouse</td>
<td>14.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Toulon</td>
<td>13.1</td>
<td>8.3</td>
</tr>
<tr>
<td>Malaga</td>
<td>12.8</td>
<td>8.3</td>
</tr>
<tr>
<td>Dublin</td>
<td>10.8</td>
<td>8.3</td>
</tr>
<tr>
<td>Stockholm</td>
<td>9.4</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Source: Presentation of Aphekom findings at the Policy Workshop: EU Year of Air – how can we reduce air pollution to improve health? 13 September 2012, Brussels, Belgium, http://www.aphekom.org/c/document_library/get_file?uuid=e5e5777f-968c-484c-8a51-652f132030c7&groupId=10347
AIR POLLUTION IS USUALLY NOT A PROBLEM IN EUROPE

How long could you cycle in your city before the negative impacts of pollution would outweigh the benefits of exercise?

Woodcock, Tainio et al https://ig.ft.com/sites/urban-cycling/
HEAT FOR WALKING & CYCLING: CONCRETE

What?
• Planning of new projects (infrastructure or other)
  • Monetise health benefits of estimated use

• Evaluation of finished projects
  • Monetise health benefits of observed change in use

As part of general economic evaluation of transportation projects
(e.g. relative to cost of investment, ROI, ...)

vito
Example 1:
Cycling bridge over ring road in Antwerp
Connects Bicycle highway F1 (Antwerpen-Mechelen) with Berchem train station and city center.

Expectations:
• New cyclists
• Safer
• Faster (traffic lights)
HEAT FOR WALKING & CYCLING: CASE STUDY

Q1: Your data: amount of cycling from a single point in time, or before and after an intervention
• Single point in time
• Before and after

Q2: Enter your pre-intervention cycling data
• Duration
• Distance
• Trips

Q4: Pre-intervention cycling data
• Average distance cycled/day: 28 km
• Number of days per year: 200

Q7: How many people benefit?
• Number of cyclists: 2365

High level of cycling
5600 km/person/year
Protective benefit: 45%
HEAT FOR WALKING & CYCLING: CASE STUDY

Q2: Enter your post-intervention cycling data
• Duration
• Distance
• Trips

Q4: Post-intervention cycling data
• Average distance cycled/day: 28 km
• Number of days per year: 200
• Q7: How many people benefit
• Number of cyclists: 2601

High level of cycling
5600 km/person/year
Protective benefit: 45%
HEAT FOR WALKING & CYCLING: CASE STUDY

• Q9: How much of the change is attributed to the intervention
  • Proportion: 100%

Q10: Time needed to reach full level of cycling
• Years: 1 year

• Q11: mortality rate
  • Age
  • Average population (20-64 years old)
  • Younger average population (20-44 years old)
  • Older average population (45-64 years old)
• Country mortality data: Belgium (524 deaths/100000 persons/year)
Q9: How much of the change is attributed to the intervention
• Proportion: 100%

Q10: Time needed to reach full level of cycling
• Years: 1 year

Q11: Mortality rate
• Age
  • Average population (20-64 years old)
  • Younger average population (20-44 years old)
  • Older average population (45-64 years old)
• Country mortality data: Belgium (524 deaths/100000 persons/year)
Q12: Value of a statistical life?
• Belgium (4 380 597 Euro)

Q13: Time period over which benefits are calculated?
• Years: 10 years

Q14: Costs to include a benefit-cost ratio in the HEAT calculation?
• Yes
• No

Q15: Cost associated with promoting cycling?
• Total costs: 4 000 000 Euro
• Duration to calculate benefit-cost ratio: 10 years (standard this is equal to Q13)

Q16: Discount rate to apply to future benefits: 5%
HEAT estimate

Reduced mortality as a result of changes in cycling behaviour

The number of individuals cycling has increased between your pre and post data. There are now 236 additional individuals regularly cycling, compared to the baseline.

However, the average amount of cycling per person per year has not changed. The reported level of cycling in both your pre and post data gives a reduced risk of mortality of 45%, compared to individuals who do not regularly cycle.

Taking this into account, the number of deaths per year that are prevented by this change in cycling is: 0.56
# Financial savings as a result of cycling

*Currency: EUR, rounded to 1000*

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The value of statistical life applied is:</td>
<td>4,381,000</td>
</tr>
<tr>
<td>The annual benefit of this level of cycling, per year, is:</td>
<td>1,815,000</td>
</tr>
<tr>
<td>The total benefits accumulated over 10 years are:</td>
<td>18,146,000</td>
</tr>
<tr>
<td>When future benefits are discounted by 5% per year:</td>
<td></td>
</tr>
<tr>
<td>the current value of the average annual benefit, averaged across 10 years is:</td>
<td>1,321,000</td>
</tr>
<tr>
<td>the current value of the total benefits accumulated over 10 years is:</td>
<td>13,214,000</td>
</tr>
</tbody>
</table>

## Benefit–Cost Ratio

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The total costs of:</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Should produce a total saving over 10 years of:</td>
<td>13,214,000</td>
</tr>
<tr>
<td>assuming 5 year build up of benefits, 1 year build up of uptake, and discounting of 5% per year</td>
<td></td>
</tr>
<tr>
<td>The benefit to cost ratio is therefore:</td>
<td>3.30:1</td>
</tr>
</tbody>
</table>
Please bear in mind that HEAT does not calculate risk reductions for individual persons but an average across the population under study. The results should not be misunderstood to represent individual risk reductions. Also note that the VSL not assign a value to the life of one particular person but refers to an average value of a “statistical life”.

It is important to remember that many of the variables used within this HEAT calculation are estimates and therefore liable to some degree of error.

You are reminded that the HEAT tools provide you with an approximation of the level of health benefits. To get a better sense for the possible range of the results, you are strongly advised to rerun the model, entering slightly different values for variables where you have provided a “best guess”, such as entering high and low estimates for such variables.
Example 2: Estimate the value of the present level of walking on an existing trail in Belgium.

100 elderly people walk 3 km every day

What is the value of that level of physical activity over 10 years?
Scope for the use of HEAT Walking

Please read these explanations carefully to make sure HEAT is applicable to your case.

1) HEAT is to be used for assessments at the population level: for groups of people and not for individuals.

2) This tool is designed for habitual behaviour, such as walking for commuting, or regular leisure time activities. Do not use it for the evaluation of one-day events or competitions (such as walking days.
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q1: Your data: amount of walking from a single point in time, or before and after an intervention

☐ Single point in time

☐ Before and after

Click on "next question" or "back" to move between questions; do not use the back-button of your internet browser. You can also go back to a previous question by clicking on it in the flow chart of questions on the left-hand side of the screen. If you make changes, click on "save changes" before you continue.

Please note that the HEAT tool does not support multiple sessions. Carrying out several calculations in parallel will affect the stability of the HEAT tool. It is recommended to run only one calculation at a time, and to start a new one only once you finished your current assessment.

Hints & Tips

If you select 'Single', you will be asked to enter data on levels of walking only once.

If you select 'Before and after', the tool will prompt you to enter two sets of walking data.

The difference in levels of walking between the pre- and post-measures will be used to calculate the health benefits and associated financial savings.
HEAT for walking

Q2: Enter your walking data

The HEAT model requires an estimate of the average duration spent walking in the study population in order to calculate the corresponding health benefit (based on a relative risk from a review of the epidemiological literature on the health benefits of walking). This duration can be entered directly. If available (and this is the most direct data entry route), or calculated based on the distance, number of steps, or number of trips.

- Duration (average time walked per person)
- Distance (average distance walked per person)
- Steps (average number of steps taken per person)
- Trips (average per person or total observed across a population)
HEAT for walking & cycling: Case study

HEAT for walking

Q4: Average distance walked

Enter the average distance walked per person:

3 km

Is this for an average day, week, month or year?

Day
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q7: How many people benefit?

The tool now requires information on the number of individuals doing the amount of walking you entered in the previous questions.

In most cases, this will also be the number of people who stand to benefit from the reported levels of walking. If the trips data you have entered is based on a representative sample of a larger population, you may need to change this number. In this case, you need to enter the total population number, rather than the number in your sample (e.g., in case of a national travel survey that is representative for the whole population, use the total number of population here, not the sample size of the travel survey). If you use survey data that has already been extrapolated to the whole population, the previously entered value is already the number of the total population and no change is required here.

It is important to ensure the right population figure is entered here, as this can substantially affect the resulting calculations.

Important note: Please bear in mind that HEAT works for averages across the population under study and not individual persons. The larger the study population is the more accurate the results will be.

Number of walkers:

* Please enter full number without delimiters such as commas or full stops
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Summary of walking data

Review your entered data

Average distance walked per person per day in km: 3
This level of walking is likely to lead to a reduction in the risk of mortality of: 17%
Total number of individuals regularly doing this amount of walking: 100

Please bear in mind that HEAT is to be applied for assessments on a population level, i.e. in groups of people, not in individuals. HEAT does not calculate risk reductions for individual persons but an average across the population under study. The results should not be misunderstood to represent individual risk reductions.
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q8: Choose: evaluate the benefits of all current walking or assess the impact of an intervention?

- All current walking
- Impact of an intervention

Hints & Tips

If you select 'All current levels of walking', the tool will provide an estimate of the value of all the walking data you entered.

If you select 'Impact of an intervention', the tool will ask you for an estimate of the proportion of your walking data that can be attributed to the intervention.
HEAT FOR WALKING & CYCLING: CASE STUDY

More than for cyclist example → because 74y is upper limit
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q12: Value of life

What is the value of a statistical life?

The value of a statistical life is derived with a methodology called “willingness to pay” to avoid death in relation to the years this person can expect to live according to the statistical life expectancy. Please bear in mind that such assessments do not assign a value to the life of one particular person but refer to an average value of a “statistical life.” This will form the basis of the financial savings shown in the model.

Wherever possible, enter a country-specific value or use a country value from the dropdown menu (not available for Andorra, Monaco and San Marino). If not known, use the European default value of €2,487 million (WHO European Region), €3,387 million (EU-27 countries) or €3,771 million (EU-27 countries plus Croatia), respectively.

First, select the country for which you want to carry out your assessment, and choose the currency (local currency, EUR or USD).

Please enter the local value of statistical life:

Country: Belgium
Currency: European euro (EUR)
Value of statistical life: 4,380,597 EUR

Hints & Tips

According to economic theory, the willingness to pay comprises lost consumption, intangible costs (e.g., suffering) and the share of health costs paid directly by the victims.
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q13: Time period over which benefits are calculated

Please select the time period over which you wish average benefits to be calculated

10 years

The time period should not be longer than you believe the entered amount of walking is being sustained.

Hints & Tips

This tool shows both total and average benefits over a time period selected by the user.

The time period over which savings should be examined is often standardized within a country, and where possible you should select the time period used locally; the default value has been set at 10 years.
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT for walking

Q14: Costs to include a benefit-cost ratio in the HEAT calculation

If you know how much it costs to promote walking in your case (e.g. in case of a specific promotion project or new infrastructure), and would like the tool to calculate a benefit-cost ratio for your local data, please select "Yes".

☐ Yes

Otherwise please select "No" and continue.

☐ No

Cancel  Back  Next
HEAT for walking

Q16: Discount rate to apply to future benefits

In most cases, the economic appraisal of health effects related to walking will be included as one component into a more comprehensive cost-benefit analysis of transport interventions or infrastructure projects. The final result of the comprehensive assessment would then be discounted to allow the calculation of the present value. In this case, enter “0” here. If the health effects are to be considered alone, however, it is important that the methodology allows for discounting to be applied to this result as well. As default value, a rate of 5% has been set.

Please enter the rate by which you wish to discount future financial savings:

5.0 percent

Back  View HEAT calculation
HEAT FOR WALKING & CYCLING: CASE STUDY

HEAT estimate

Reduced mortality as a result of changes in walking behaviour

The walking data you have entered corresponds to an average of 3 km per person per day.
This level of walking provides an estimated protective benefit of 17% (compared to persons not walking regularly).
From the data you have entered, the number of individuals who benefit from this level of walking is: 100
Out of this many individuals, the number who would be expected to die if they were not walking regularly would be: 0.81
The number of deaths per year that are prevented by this level of walking is: less than 1

Financial savings as a result of walking

Currency: EUR, rounded to 1000

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The value of statistical life in your population is:</td>
<td>4,381,000</td>
</tr>
<tr>
<td>The annual benefit of this level of walking, per year, is:</td>
<td>612,000</td>
</tr>
<tr>
<td>The total benefits accumulated over 10 years are:</td>
<td>6,119,000</td>
</tr>
</tbody>
</table>

When future benefits are discounted by 5% per year:

the current value of the average annual benefit, averaged across 10 years is: 472,000

the current value of the total benefits accumulated over 10 years is: 4,725,000
SUMMARY & CONCLUSION
HEAT FOR WALKING & CYCLING: CONCLUSION

Input
• How many people walk/cycle?
• Time, distance or #trips
• Cost of Intervention infrastructure or promotion campaign

Defaults
• mortality rate
• VSL
• Time frame
• Discount rate
Output

- ‘Protective benefit’
- Average benefit per year (key output)
- Over longer period (default = 10 years)
- Discounted benefit per year
- (Cost-Benefit ratio)

Tool designed for transport planners
Evidence-based
Transparent
Simple to use

Order of magnitude only
Health economic assessment tools (HEAT) for walking and for cycling

More information

What data do I need?
To produce an assessment, you need to provide data on the number of people walking or cycling, and the amount of walking they are doing (or are projected to do).

ECONOMIC ASSESSMENT OF TRANSPORT INFRASTRUCTURE AND POLICIES
CWICALC: A DEDICATED MODEL FOR FLANDERS

Accidents & health

Air pollution & health

Physical activity & health

Investment
Investment & Pollution & Physical activity & health

MODEL

Bicycle/Walk data

Indicator = €
HEAT compared to CWICalc

- Estimate benefits of regular cycling/walking
- Estimate external benefits
- Compare with investment (e.g. building bicycle highway)
- *New update*: including air pollution, accidents, climate *(but not morbidity)*
- Order of magnitude
- VSL (country specific)

http://old.heatwalkingcycling.org

- Estimate benefits of regular cycling/walking
- DALY’s & external benefits/costs
- Impact of increase in cycling accidents
- Impacts of air pollution: PM2.5
- Compare with investment (e.g. bicycle highway)
- YOLL & Cost of Illness & WTP (Willingness To Pay)
- VOLY (Flanders)
- Order of magnitude
+ Mortality & Morbidity:
  - ischaemic HD, cancer (bowel, breast)
  - diabetes type II, depression,
  - dementia (>70j)
+ Option: congestion, CO₂, noise

https://sites.google.com/site/cwicalc/input
Model specifics

- Adults
- Shift car => cycling / walking
- Establishing health benefits takes years
- Health benefit is capped
- VOLY: 40000 euro (some use up to 180000 euro; 40000 euro = conservative).

=> CWICalc is very conservative!

- Specifieke values for Flandes (Belgium). Treatment costs depend on national organisation of health care system
- Air pollution : PM2.5 only (WHO preferred indicator)
Counting cyclists on Bicycle highways

Jij telt mee!
Vandaag: 3870 fietser
Deze maand: 54828 fietser
Je fietst veilig? Doe het zelf met een FIETSLABEL-Via antwerpen.be
19:02
Why Flanders?

- lots of data on cycling (counts)
- high air pollution
- data on accidents

- Scenario 1:
  - F1 Mechelen-Antwerpen
  - 600 cyclists
  - 27 km/day
  - 4 days per week
  - 20 year evaluation period
  - Building Cost: $6 \times 10^6$ Euro
Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways

Jurgen Buekers a,⁎, Evi Dons a,b, Bart Elen a, Luc Int Panis a,c

a Flemish Institute for Technological Research (VITO), Boeretang 200, 2400 Mol, Belgium
b Centre for environmental studies, Hasselt University, Agoralaan Building D, 3590 Diepenbeek, Belgium
c School for Mobility, Hasselt University, Wetenschapspark 5 Bus 6, 3590 Diepenbeek, Belgium

ABSTRACT

In Flanders, a European hot spot for air pollution, alternatives to car transport are put in place to increase the daily level of physical activity (PA) among the population and reduce air pollution and global warming. To evaluate the economic impact of increased PA (cycling and walking), a health impact model was developed for a given volume of PA, relative to car use, within a defined population in Flanders. Flanders is an interesting region because of the combination of high air pollution, high cycling volumes and good data availability e.g on crashes and PA. The model uses two health indicators: external costs and DALYs. Considered impacts in the model are: mortality and morbidity related to increased PA, air pollution exposure for society and active individuals and crash risks. In addition to health, external costs for CO₂ emission, congestion and noise exposure can be considered. The model was applied to the new bicycle highways Antwerp–Mechelen and Leuven–Brussels, which were built near important traffic axes to provide the densely populated region with an alternative to car use. Different sensitivity analyses with a variable number of cyclists and travelled distances were elaborated to check the robustness of the results. Overall, the conclusion was that increased PA outweighed other impacts. The benefit:cost ratio

https://www.researchgate.net/publication/281612872_Health_impact_model_for_modal_shift_from_car_use_to_cycling_or_walking_in_Flanders_Application_to_two_bicycle_highways
Crash risk over estimated or under estimated?
# Results (costs in €)

Table 2
Direct and indirect (productivity loss) costs in Flanders (Belgium) for selected diseases. Cost are valid for the total period of illness and are expressed in euro 2010, if enough information was available for correction based on HICP*.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Direct costs(^b) in model</th>
<th>Indirect costs(^b) (productivity loss) in model if selected age for physical activity is &lt; 65 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast cancer</td>
<td>23,156</td>
<td>23,309</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>33,930</td>
<td>116,022</td>
</tr>
<tr>
<td>Diabetes Type II</td>
<td>85,000</td>
<td>85,000</td>
</tr>
<tr>
<td>Depression</td>
<td>1984</td>
<td>5,175</td>
</tr>
<tr>
<td>Dementia</td>
<td>183,000</td>
<td>-</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>12,722</td>
<td>22,032</td>
</tr>
</tbody>
</table>

\(^a\) Harmonised Indices for Consumer Prices; see: \url{http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=prc_hicp_aind&lang=en}  
\(^b\) Costs related to premature death are not considered here as they are already accounted for in the physical activity — premature mortality dose-response relationship.
## Costs of cycling accidents

<table>
<thead>
<tr>
<th></th>
<th>weight</th>
<th>Avg. cost (€)</th>
<th>CI_low (€)</th>
<th>CI_high (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO_I</td>
<td>22.4%</td>
<td>295</td>
<td>157</td>
<td>476</td>
</tr>
<tr>
<td>LIGHT_I</td>
<td>47.5%</td>
<td>322</td>
<td>244</td>
<td>411</td>
</tr>
<tr>
<td>ABI_ST</td>
<td>25.7%</td>
<td>820</td>
<td>588</td>
<td>1089</td>
</tr>
<tr>
<td>ABI_LT</td>
<td>4.4%</td>
<td>9348</td>
<td>3764</td>
<td>17425</td>
</tr>
<tr>
<td>minor accident</td>
<td>100%</td>
<td>841</td>
<td>579</td>
<td>1205</td>
</tr>
</tbody>
</table>

- Risk of minor accident is 155 per million kilometers cycled ([link](#))
  (one accident every 6500 km)

- Risk of injury is 121 per million kilometers cycled
  (one injury each 8300 km)

- Average cost of minor accident is 841 euro ([vs €60.776 for major non-fatal accident](#))
  (0.125 euro/ km)

- Total cost of minor accidents in Belgium is 57 - 183 million €/year

Cycling highways expected to lower both the risk and the cost
Results (costs/benefits)
**Results:** (costs/benefits)

Most scenarios positive.

<table>
<thead>
<tr>
<th>Impact factor</th>
<th>euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity (reduced mortality)</td>
<td>$1.2 \times 10^7$</td>
</tr>
<tr>
<td>Physical activity (reduced morbidity)</td>
<td>$2.3 \times 10^6$</td>
</tr>
<tr>
<td>Reduced air pollution society (mortality)</td>
<td>$7.4 \times 10^4$</td>
</tr>
<tr>
<td>Air pollution active mobility</td>
<td>$-8.9 \times 10^5$</td>
</tr>
<tr>
<td>Crash risk</td>
<td>$-1.4 \times 10^8$</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$+1.2 \times 10^7$</td>
</tr>
<tr>
<td>Infrastructure construction costs</td>
<td>$-6.0 \times 10^6$</td>
</tr>
</tbody>
</table>

Benefit:cost ratio: 2.0

---

*a Scenario 1 with building costs for the bicycle highway set to $3 \times 10^5 \text{ €/km}$ (see Table 3)
Fietsosstrades betalen zichzelf tot 14 keer terug

16/03/2016 om 05:00 door svw
### OTHER SCENARIOS

<table>
<thead>
<tr>
<th>Scenario</th>
<th># cyclists (per day)</th>
<th>Travelled distance (km/day)</th>
<th>Benefit:cost ratio model for different building costs</th>
<th>Scenario remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antwerp-Mechelen</td>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Scenario1</td>
<td>600</td>
<td>27</td>
<td>2.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Scenario2</td>
<td>2600</td>
<td>12</td>
<td>4.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Scenario3</td>
<td>4400</td>
<td>16</td>
<td>10.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Scenario4</td>
<td>4400</td>
<td>27</td>
<td>14.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Leuven-Brussels</td>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Scenario1</td>
<td>500</td>
<td>37</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Scenario2</td>
<td>1100</td>
<td>37</td>
<td>3.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Scenario3</td>
<td>1624</td>
<td>32</td>
<td>5.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Hypothetical</td>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Scenario1</td>
<td>650</td>
<td>10</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Scenario2</td>
<td>1700</td>
<td>10</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Scenario3</td>
<td>350</td>
<td>20</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Scenario4</td>
<td>950</td>
<td>20</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* A: building costs of highway equals $3 \times 10^5$ €/km; B: building costs of highway equals $8 \times 10^5$ €/km. For the calculation of building costs of the bicycle highways a discount model were: 50% of cyclists are males, distance is travelled 4 times/week, evaluation period is 20 years, mean age of the cyclists is 45 years. The impact of noise, congestion, CO2 ratios which is a conservative approach.

* Scenario data extracted from reports with statistical data on highway usage. All scenarios assume that if the trips were not made by bicycle, they would have been made by car.
CONCLUSION

Research shows that cycling is healthier than not cycling
(If it increases the physical activity of sedentary people)

Air pollution
• Exposure peaks can be very high
• Physiological changes are evident
  • Scientifically challenging
  • May lead to clinical effects in the long term

⇒ Policy should reduce exposure (e.g. bicycle highways)

Accidents
• Risk of minor accident in general traffic is much higher than expected
  (even among experienced cyclists)
• Costs are high

⇒ Policy should eliminate conflicts, risks, consequences (e.g. bicycle highway design)

⇒ Cost efficient policies/infrastructure is possible
⇒ Benefits almost always (much) higher than cost
Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways

Jürgen Buekers, Evi Dons, Bart Elen, Luc Int Panis

In Flanders, a European hot spot for air pollution, alternatives to car transport are put in place to increase the daily level of physical activity (PA) among the population and reduce air pollution and global warming. To evaluate the economic impact of increased PA (cycling and walking), a health impact model was developed for a given volume of PA, relative to car use, within a defined population in Flanders. Flanders is an interesting region because of the combination of high air pollution, high cycling volumes and good data availability e.g. on crashes and PA. The model uses two health indicators: external costs and DALYs. Considered impacts in the model are: mortality and morbidity related to increased PA, air pollution exposure for society and active individuals and crash risks. In addition to health, external costs for CO2 emission, congestion and noise exposure can be considered. The model was applied to the new bicycle highways Antwerp-Mechelen and Leuven-Brussels, which were built near important traffic axes to provide the densely populated region with an alternative to car use. Different sensitivities analyses with a variable number of cyclists and travelled distances were elaborated to check the robustness of the results. Overall, the conclusion was that increased PA outweighed other impacts. The benefit-cost ratio

Buekers J, Dons E, Elen E, Int Panis L. Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways. Journal of Transport and Health, 2,549-569,2015.

https://www.researchgate.net/publication/281612872_Health_impact_model_for_modal_shift_from_car_use_to_cycling_or_walking_in_Flanders_Application_to_two_bicycle_highways

Aertsens J et al. 2010. Commuting by bike in Belgium, the costs of minor accidents. Accident; analysis and prevention 42(6):2149-57

https://www.researchgate.net/publication/45799144_Commuting_by_bike_in_Belgium_the_costs_of_minor_accidents