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Health Economic Assessment Tool for Cycling (HEAT for cycling)

User guide

Version 2

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Contents

1. Introduction to the Health Economic Assessment Tool for cycling

This guide is an introduction to the World Health Organization Health Economic Assessment Tool for Cycling (HEAT for cycling). It is intended to be read alongside the tool, which is available to download as an Excel spreadsheet (Rutter et al, 2007).[1]

The tool has been produced to illustrate the principles outlined in the WHO document *Methodological guidance on the economic appraisal of health effects related to walking and cycling* (Cavill et al, 2007) and to assist anyone who wishes to conduct an economic appraisal of the health effects related to increased cycling. It is designed to complement existing tools for economic appraisals of transport interventions which have traditionally tended to focus on other issues such as emissions or congestion.

The tool will produce an estimate of the mean annual benefit (per cyclist; per trip; and total annual benefit) due to reduced mortality as a result of cycling.

It can be applied in a number of situations:

- when planning a piece of new cycle infrastructure. It will allow the user to model the impact of different levels of cycling and attach a value to the health benefit resulting from an estimated level of cycling when the new infrastructure is in place. This can be compared to the costs to produce a benefit:cost ratio (and help make the case for investment), or as an input into a more comprehensive economic appraisal;
- to value the mortality benefits from current levels of cycling, such as to a specific workplace, across a city or in a country;
- to provide input into more comprehensive economic appraisals, or prospective health impact assessments. For example to estimate the mortality benefits from achieving national targets to increase cycling or to illustrate potential cost consequences to be expected in case of a decline of the current levels of cycling.

It will help to answer the following question:

> If x people cycle y distance on most days, what is the value of the health benefits that occur as a result of the reduction in mortality due to their increased physical activity?

The tool has been developed through an expert consensus process and building on a systematic review of the literature. However, there are many ways that it could be developed, and feedback on the first illustrative version of this tool and accompanying documentation is welcome.

[1] See http://www.euro.who.int/transport/policy/20070503_1

2. Brief introduction to the project

This project aimed to assist practitioners who are engaged in conducting economic appraisals of transport projects.

In recent years, a few countries have pioneered approaches to the assessment of the overall costs and benefits of transport infrastructures taking health effects into account. However, important questions remain to be addressed regarding the type and extent of health benefits which can be attained through investments in policies and initiatives which promote more cycling and walking. Addressing these questions is important to: a) support Member States in their assessments of the health and environmental impacts of alternative transport policy options; b) promote the use of scientifically robust methodologies to carry out these assessments, and c) provide a sound basis for advocating investments in sustainable transport options.

This project therefore aimed to facilitate the harmonization of methodological approaches by providing guidance for practitioners based on a review of existing approaches to the economic valuation of health effects of transport-related physical activity.

More detail of the background to the project is given in the document Methodological guidance on the economic appraisal of health effects related to walking and cycling (Cavill et al, 2007).

3. The Health Economic Assessment Tool (HEAT for cycling): an overview

3.1. Basic workings of the tool

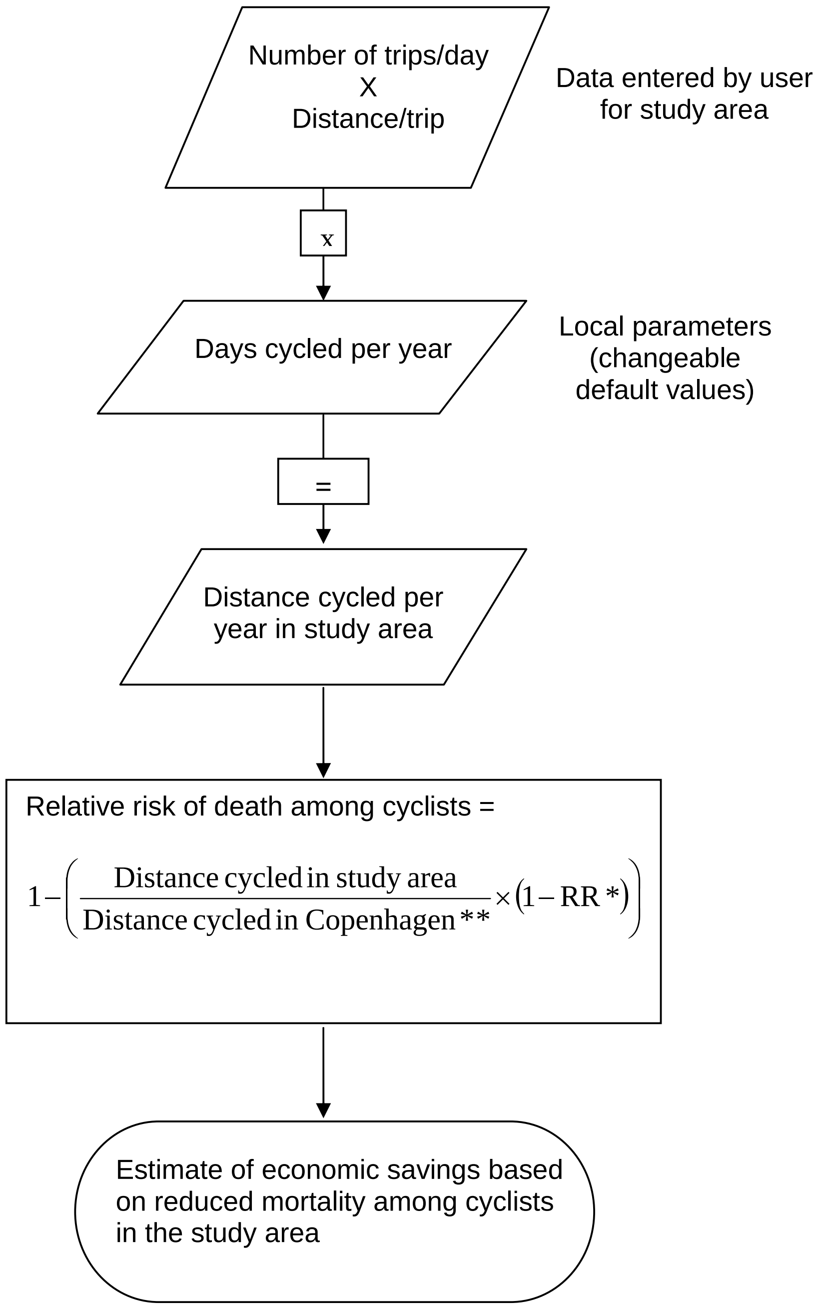
The tool is based on the relative risk data from the Copenhagen Center for Prospective Population studies (Andersen et al., 2000) which found a relative risk of all-cause mortality of 0.72 among regular commuter cyclists aged 20-60 years relative to the general population. The study controlled for the usual socioeconomic variables (age, sex, smoking etc.) as well as for leisure time physical activity. As recommended (Cavill et al, 2007), it therefore also took account of a possible activity substitution: i.e. whether an observed increase in rates of commuter cycling could be compensated by a reduction of leisure time physical activity.

The tool then applies the data entered by the user to calculate the total value of the economic savings due to reductions in all-cause mortality among these cyclists.

Assuming a linear dose-response relationship, the risk reduction for the actual days spent cycling is calculated based on estimates of total number of days cycled, distance cycled, and average speed. The tool produces a global estimate of economic savings from reduced all-cause mortality as well as savings per kilometer cycled or per trip.

The basic workings of the tool are shown in Fig 1 below.

Figure 1. Basic workings of the HEAT for cycling



*RR = relative risk of death in underlying study (0.72) (Andersen et al., 2000)

**Distance cycled in Copenhagen calculated based on 3 hours per week for estimated 36 weeks/year at estimated 14km/h

3.2. Who is this tool for?

The tool is based on the best available evidence and transparent assumptions. It is intended to be simple to use by professionals from a wide variety of groups operating both at the national and local level. These include:

- transport planners
- traffic engineers
- health economists
- special interest groups working on transport, public health, physical activity, cycling, the environment etc.

3.3. What can the tool be used for?

The main use of the tool is as an input to comprehensive cost-benefit analyses of new transport infrastructure, or as a tool for assessment of existing infrastructure.

The tool provides an estimate of the economic benefit due to reduced mortality as a result of cycling. Ideally it would be supplemented with additional data on other potential health outcomes form cycling (morbidity) and combined with other transport-related outcomes such as improvements to congestion or reduced journey times for a comprehensive assessment. These and other enhancements will be considered for inclusion in future versions of the tool.

The tool could also be used to illustrate potential cost consequences from a potential future decline in the current levels of cycling.

3.4. What should the tool not be used for?

The current tool can not be directly applied to walking, as it is based on a study which compared the relative risk of all-cause mortality between regular cyclists and non-cyclists (Andersen et al., 2000). The tool is only to be applied to adult populations, not to children. The underlying study (Andersen et al., 2000) included subjects up to 60 years of age, so applying the tool to considerably older populations is not recommended.

As mentioned above the tool does not produce comprehensive assessments of all benefits of cycling, so it should not be used in place of a full economic analysis. For methodological reasons it only considers the impact on mortality and not morbidity. A number of other limitations to the tool are described in more detail in the accompanying *Methodological guidance on the economic appraisal of health effects related to walking and cycling* (Cavill et al, 2007).

3.5. What input data are needed?

The user only has to enter data on two basic elements of the observed or modelled cycling patterns:

- number of cycle trips per day
- mean trip length

The tool then calculates the overall value of this level of cycling, based on a number of default values. These have been derived from the literature and agreed as part of the expert consensus process, and should be used unless more relevant or accurate data are available.

In addition, users can enter data on the following aspects which will help to make the estimates more appropriate for the respective local situation:

- the proportion of these trips that are one part of a return journey (or 'round trip'). This proportion will be high if the route in question is regularly used as a commuter route (or route for regular transport-related cycling). This is likely to be the case in most situations;
- the value of a statistical life (in economic terms). A default value commonly used across Europe is provided in the model, but users may adapt this value, for example by adopting agreed values for their country

Other measures – such as years of life, or quality-adjusted life years (QALYs) could also be included by users, to provide a more sophisticated analysis. However, for pragmatic reasons at this stage the basic functions of the tool are based on the "value of statistical life" approach, as it is more easily available, easier to understand by non-specialists, and results in more conservative estimates.

3.6. Data sources

Input data for the model might come from a number of sources including:

- cycle route user surveys or monitoring
- population-level travel surveys
- traffic counts
- informed estimates

In all cases it is important to use the most reliable data possible, and to validate these with secondary sources where available. Default values are provided for the main parameters of the model, based on best evidence and expert opinion.

3.7. What data will the tool produce?

The tool will produce an estimate of the following outputs:

- maximum annual benefit.
- savings per km cycled per individual cyclist per year.
- savings per individual cyclist per year.
- savings per trip.
- mean annual benefit
- present value of mean annual benefit

The **maximum annual benefit** is the total value of reduced mortality due to the level of cycling entered by the user. This is a maximum value, as it assumes that the maximum possible benefits to health will have occurred as a result of the entered level of cycling. In reality, the health benefits are likely to accrue over time, and this build-up period can be adjusted.

The **mean annual benefit** is the key output of the model. It adjusts the maximum annual benefit *(total value of lives saved due to the level of cycling entered by the user)* by three main factors:

- an estimate of the timeframe over which benefits occur. There is evidence to suggest that mortality reductions are likely within five years of a change in level of cycling (Cavill et al, 2007; Andersen, 2000; Matthews, 2007) so this is the default value.
- a build-up period for uptake in cycling, which allows the user to vary the projections in uptake (such as for a new cycle path which may see increasing use over time) and varies for full usage occurring between 1 and 25 years; and
- Total time period. This allows the user to look at discounted benefits averaged over a period of between 1-25 years.

The **present value of mean annual benefit** adjusts the above outputs to take the diminishing value of costs and outcomes over time into account. The model suggests a discount rate of 5% but this can be varied by users.

4. The HEAT for cycling: Instructions for users

4.1. How to access the tool

The tool is available to download as an MS Excel spreadsheet (Rutter et al, 2007[2]).

When first opening the spreadsheet you may find a warning about macro security. The user needs to allow the spreadsheet to use macros, to enable the spreadsheet to work correctly. Macros are simple instructions that are contained within the spreadsheet that allow it to conduct basic calculations. To enable macros, click *Enable Macros* when you see a security warning.

You may need to change the security setting on your computer to allow macros. To do this:

- close the spreadsheet, but keep Excel open (by clicking the black X at the top right of the spreadsheet);
- go to Tools, then Options;
- within Options click the tab *security;*
- select the button *Medium*. This allows you to choose whether or not to run potentially unsafe macros;
- re-open the WHO spreadsheet. You should now see a security warning. Click *Enable Macros*;
- the spreadsheet should now open correctly.
- If you encounter problems with macros, you can download the alternative version which has auto screen formatting macros removed.

4.2. How to use the tool: 3 simple steps

Step one: enter your data

All assessments require the two fields in step 1 to be completed:

- number of trips per day: enter the number of cycle trips observed (or estimated) per day. This might be on a specific cycle route; across a city; or on a cycle network, in any direction. Examples of data sources are given in section 3.5. If the specific data are not available, or the tool is being used to assess projected increases (or decreases) in cycling this figure should be estimated as accurately as possible.
- mean trip length: this is the average length of each cycle trip (in km). This will usually come from surveys of cyclists, either on the route or from a random sample across the population. There are three main ways of estimating distance (Schantz and Stigell, 2006):
  1. The most reliable is to ask cyclists to draw their route on a map, so that it can then be measured with a digital curvimetric device.
  2. The second best method is to ask cyclists their origin and destination points, and multiply the straight-line distance between the two points by 1.25.

[2] See http://www.euro.who.int/transport/policy/20070503_1,

3. Another method is based on subjective estimations of distance travelled from cyclists. However, there is evidence that this approach leads to overestimating the distances by about 8 % and is not always reliable. Thus, if subjective measures are used, it is suggested to correct for overestimation by multiplying with the factor 0.92.

Step two: check the parameters

Most users will not need to change any of the parameters in step two. These have been set based on the best information currently available, and agreed by the expert group during a consensus workshop. They represent the most likely appropriate default values in real life situations. They should only be changed if reliable local data are available, as changes to these parameters can have a significant impact on the final values. They should be checked to ensure that they are applicable to the local situation but changed only if necessary. To change any of these parameters, click on the button *click here to change local parameters.*

- **Mean number of days cycled per year.** This is the estimated number of days cycled per year. This figure has a default value of 124 days per year, which was the reported level of cycling in a study carried out in Stockholm, Sweden (Schantz and Stigell, in press).
- **Proportion of these trips that are one part of a return journey (or 'round trip')**. This allows the user to adjust the assessment to take account of cyclists who are observed on a route at one specific time point, and who then return on the same route later in the day. This is particularly important for assessments done on routes used for commuting. This adjustment enables the assessment to take account of the number of unique cyclists on each route. The default value is set at 0.9, as it is assumed that 90% of cyclists observed cycling in one direction will be making a return trip later in the same day. Setting this figure at 1 assumes that all cyclists will be making return journeys. Only change this figure if reliable local data are available.

Note: if conducting an audit of existing levels of cycling (for example assessing the value of all cycling across a city), it is important to set this value at zero. This means that all trips entered in step one will be assumed to be undertaken by individual cyclists and not as part of a return journey on a specific cycling path.

- **Proportion undertaken by people who would not otherwise cycle.** This is a key variable that makes a significant difference to the calculation. It allows the model to take account of the proportion of cyclists that are new users directly as a result of the infrastructure or policy being assessed. This allows for the notion that a certain proportion of cyclists observed on any route will have cycled anyway – irrespective of any change to provision of cycling facilities or policy – so their health is unlikely to have benefited directly. It enables the model to calculate the net increase in physical activity as a result of the increased cycling

Note: For evaluations of existing levels of cycling, this can be changed to 1.0, so that the model assumes all cyclists to be benefiting their health through their cycling. The default value is set at 0.5, meaning that 50% of observed cyclists will be assumed to be benefiting their health through their cycling, which is a conservative estimate.

- **Mean proportion of working age population who die each year.** This can be derived from published mortality data for people of working age for the study country. Enter the number of deaths of people aged 25-64 per year divided by the number of people aged 25-64. This allows the tool to focus on the ages that are most likely to cycle, and reflects the relative risk of all-cause mortality in this age group. The default value is set at 0.005847 which is the WHO European Region average from the European Mortality Database (WHO, 2007c).
- **Value of statistical life (in local currency).** Enter here the standard value of a statistical life used in the country of study in Euros. This will form the basis of the cost savings in the model. If not known, use the default value of €1,500,000 which is the standard value used across Europe (University of Leeds, 2007).
- **Discount rate.** Enter here the discount rate to be used for calculating the value of future benefits. Savings which occur in future years will be discounted by this percentage per year, and will be shown in the 'present value' section of step 3. As default value, a rate of 5% has been set.

The results of the assessment depend on a number of assumptions:

- **Build up of benefits**

This is the estimated time it will take for cyclists in the model to realise the mortality benefits of the cycling entered at step one. The default value is set at 5 years, based on the results of the systematic review and expert consensus (Cavill et al, 2007). This should only be changed if a solid data foundation is available.

- **Build up for uptake**

This figure allows adjustment for the estimated time it will take for the level of cycling entered at step one to be achieved. This can be particularly useful for assessments of new cycle interventions. For example if a new cycle path is built and it is estimated it will take 5 years for usage to reach its steady state, this figure should be changed to 5. The default value has been set at 1 year.

- **Timeframe for calculation of mean annual benefit**

This is the time over which the discounted mean annual benefit will be calculated. This is usually standardized within each country; the default value has been set at 10 years.

All of these default values can be changed by clicking on the button *Click here to change the timeframe used in calculation*, if reliable local data are available.

4.3. Interpreting results

Results are presented in six different ways, depending on the assumptions above:

- **Maximum annual benefit**

This is the total value per year of lives saved (mortality only) assuming a 'steady state' of health benefits has been achieved. This builds on the value achieved at the end of the 'build up of benefits' time period, and therefore assumes that all cyclists will have realised the benefits of reduced mortality due to their cycling. This should always be quoted as a maximum rather than an average value.

- **Savings per kilometer cycled per individual cyclist per year**

This is a simple average value for every kilometer that each cyclist rides per year. This figure is €0.81 as long as the default values are used.

- **Savings per individual cyclist per year**

This value is most sensitive to the distance that cyclists travel on average (with longer average trip length leading to greater benefits).

- **Savings per trip**

This value is also most sensitive to the distance that cyclists travel on average (with longer average trip length leading to greater benefits).

- **Mean annual benefit**

This is the main output of the model. This takes the period set for the build-up of benefit into account (see previous section) and averages the benefit over the timeframe for calculation of mean annual benefit. This output is highly dependent on the number of years entered.

- **Present value of mean annual benefit**

This is the second main output of the model, using the discount rate from section two to calculate the present value, taking the diminishing value of costs and outcomes over time into account.

4.4. Assumptions

The model uses a number of assumptions, which were agreed at the expert consensus meeting:

- the relative risk data from the Copenhagen Center for Prospective Population studies (Andersen et al, 2000) can be applied to cyclists in other settings (as suggested by Matthews et al, 2007);
- there is a linear dose-response relationship between risk of death and distance cycled (assuming a constant average speed)
- no thresholds have to be reached to achieve health benefits
- men and women have the same level of relative risk

4.5. Advanced data entry

There are a number of features of the tool that can be used to fine-tune the assessment. In general these should only be amended by users with a good understanding of economic assessment methods. If in any doubt please direct enquiries about the working of the tool to (hepa@ecr.euro.who.int).

- **Underlying study parameters.** The parameters used in this tool come from the Copenhagen Center for Prospective Population studies, a prospective study on different types of physical activity, including cycling to work and for leisure time, on mortality risk. The study included about 30,000 men and women who were followed up for an average of 14.5 years. These are critical to the functioning of the tool and should not be changed unless the assessment is to be based on a similarly robust study.
- The parameters **average speed and mean number of days cycled per year** are assumptions based on best available evidence, but could be varied by the user if better data from the local context were available. The speed value is based on hours of commuting per week from the Copenhagen study (Andersen et al. 2000) combined with data from the Stockholm commuting studies on frequency of tours per week over the year, distance and duration (Schantz and Stigell, 2006 and in press). Based on an estimated distance of 4 km per trip, the observed distance-speed relationship produces an estimated average speed of 14 km/h (Schantz and Stigell, 2008).

- The main elements of the **timeframe used in calculations and the nature of relationship between benefit and time** were described above. However, as well as varying the basic elements (time build up for benefits; time build up for uptake; time for mean annual benefit calculation) you can also determine whether the relationship between benefit and time is linear, exponential or logarithmic in shape, and the strength of the exponential/logarithmic factor, respectively.
- **Graphs and error adjustment.** The final button *Click here to view full calculation, graphs and adjust error* shows the full calculations behind the spreadsheet as well as all the main outputs in graphical form. The bottom half of the spreadsheet contains a number of slider controls for error adjustment. These can be used to include error margins (or confidence intervals) around any of the entered data. Move the slider until the values correspond with the wished error values. The upper and lower limits will then be shown in the graphs. Note that some confidence intervals are already entered, including those around the relative risk estimates from the underlying Copenhagen study, and the mean proportion of population who die each year.

The button *reset all default values* restores all the values to their defaults, including values for mean number of days cycled per year, proportion of trips as part of a return journey and all other key parameters.

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