ECONOMIC ASSESSMENT OF TRANSPORT INFRASTRUCTURE AND POLICIES

Methodological guidance on the economic appraisal of health effects related to walking and cycling

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ABSTRACT

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SECTION A: METHODOLOGICAL GUIDANCE ON ECONOMIC APPRAISAL OF HEALTH EFFECTS RELATED TO WALKING AND CYCLING

1. Background

1.1. Introduction to this document

The calculation of cost-benefit ratios is an established practice in transport planning. However, the health effects of transport interventions are rarely taken into account in such analyses. This project aimed to review recent approaches to cost-benefit analysis of transport-related physical activity, and to develop guidance for Member States on approaches to the inclusion of health effects through transport-related physical activity in economic analyses of transport infrastructure and policies.

Since the calculation of the costs side of interventions is usually not very complicated, this project focused on approaches to the economic valuation of potential health effects. The result is meant primarily for integration into comprehensive cost-benefit analyses of transport interventions or infrastructure projects, but can also serve for an assessment of the current situation or of investments made in the past.

This document presents the current state of evidence on a number of key methodological issues that have arisen around the economic assessment of transport infrastructure and policies with regard to the inclusion of health effects related to walking and cycling. Based on this discussion options and guidance will then be provided towards a more harmonized methodology for the economic appraisal of health effects related to walking and cycling.

The guidance has been further developed into an illustrative tool which shows how the methodology can be applied to the assessment of health effects related to cycling. This is introduced in section B of this guidance. The illustrative tool is available as an excel spreadsheet (WHO, 2007a) with accompanying user guide (WHO, 2007b).

Section B will explain the assumptions used in the development of the illustrative tool for cycling, and outline the potential limitations of this approach. Finally the possible ways forward for further development of this topic will be discussed.

This guidance document represents a first step towards an agreed harmonized methodology. In forming the recommendations within this guidance, it has been necessary for the advisory group to make a number of judgements, sometimes based on incomplete evidence. Feedback is therefore welcome, so that the guidance and illustrative tool can be further developed in the light of user experience and new evidence.

1.2. Background to the project

This project contributed to the implementation of the Transport, Health and Environment Pan-European Programme (THE PEP) project "Support of safe cycling and walking in urban areas". It followed-up the outcomes of a workshop of the Nordic Council on "Cost-benefit Analysis of cycling" held in February 2005 in Stockholm, which had invited the WHO to support the further development of methods to evaluate the health effects of cycling. It also brought forward discussions that had been held in Switzerland in September 2005 on the occasion of the Walk 21 Satellite Symposium on transport-related physical activity on open questions related to economic valuation of transport-related physical activity and the way forward.

This project aimed at:

- developing a review of approaches to the inclusion of health effects in cost-benefit analyses of interventions related to cycling and walking (e.g. development of infrastructures for cyclists and pedestrians);
- critically discussing the identified indicators, health effects, and relative risks, taking into account scientific accuracy and relevance as well as aspects of feasibility;
- formulating suggestions for options for the further development of a harmonized methodology for the inclusion of health effects into health impact assessments and economic valuations of such interventions, as well as on data sources and methods to be used for these analyses;
- through an international workshop, facilitating the achievement of scientific consensus on these options; and
- publishing a report on the meeting's outcome including operational guidance for practitioners.

The implementation of the project was steered by a core project group of 5 members in close collaboration with an advisory group of international experts (see Annex 1). A preparatory meeting of 5 members of the core group and as well as 4 members of the advisory group and an observer took place on 22 March 2007 in Rome, Italy, as well as a telephone conference with the core group and 8 members of the advisory group. Based on this preparatory work, a consensus workshop was held on 15-16 May 2007 in Graz, Austria.

The project was carried out in close collaboration between THE PEP and HEPA Europe, the European network for the promotion of health-enhancing physical activity.

1.3. Rationale

In recent years, a few countries (e.g. the Nordic Council) have carried out pioneering work in trying to assess the overall costs and benefits of transport infrastructures taking health effects into account, and guidance for carrying out these assessments has been developed. 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.

1.4. Process

This guidance and the illustrative tool have been developed through a systematic review of the relevant published literature and a comprehensive consensus building process. The project was developed by a core group, with the support of an international advisory group consisting of economists, experts of health and physical activity and experts in transport (see Annex 1). The key steps of development were as follows:

- the group commissioned a systematic review of published economic valuations of transport projects including a physical activity element;
- the results of this review were considered by the expert group, and used to propose options and guidance towards a more harmonized methodology;
- a draft methodological guidance on walking and cycling and an illustrative tool on cycling were developed based on the expert group's recommendations, and was tested and piloted by the members of the group;
- following a consensus workshop of the group, the products of the project, (review; guidance; illustrative tool and user's guide) were approved for publication.

The following sections of this document set out the key steps taken and the considerations of the advisory group, including the assumptions that had to be taken to develop a working illustrative model.

1.5. Systematic review: outline

A systematic review (Cavill & Kahlmeier 2007) was conducted to meet the following objectives:

- to identify relevant publications through expert consultation and tailored searches of the literature;
- to review the approaches taken to the inclusion of health effects in economic analyses of transport interventions and projects; and
- to propose recommendations for the further development of a harmonized methodology, based on the approaches developed to date.

The review built on results of a systematic review which had been carried out by the National Institute for Clinical Excellence (NICE) (Beale et al 2007). To be included in the background review document for this WHO project, studies had to:

- present the findings of an economic valuation of an aspect of transport infrastructure or policy;
- include data on walking and/or cycling in the valuation;
- include health effects related to physical activity in the economic valuation; and

- be in the public domain.

The results from the review were used as the basis for the further development of the project.

1.6. Consensus development

The core project group and 4 members of the advisory group met in Rome in March 2007. The participants welcomed the work done to date and were supportive in principle of the approach being taken. The participants recommended that the systematic review be finalised as a project background document and submitted for academic publication to give the project the greatest possible foundation on which to build. They then discussed a number of core methodological issues that emerged from the review, and discussed how these could be incorporated into guidance.

A consensus workshop was then held on 15-16 May 2007 in Graz Austria[1]. It was attended by 21 international experts from the fields of public health, environment, transport and economics and from science as well as practice. The workshop focused on achieving consensus on the following issues:

- the results and conclusions described in the background paper;
- methodological guidance to be used for the inclusion of health effects related to physical activity into health impact assessments and economic valuations of transport interventions;
- methodological issues that would require further research;
- further developments necessary of the proposed tool for economic valuations; and
- the outline of the final report summarizing the recommendations made by the consensus meeting.

The core issues were discussed in detail at this meeting and during follow-up teleconferences, when the content of the draft guidance and illustrative tool were agreed. The key questions discussed at these meetings will be outlined in detail in section 2.

2. Methodological issues: discussion and guidance

2.1. Introduction

This section sets out the key methodological issues around the economic appraisal of health effects related to walking and cycling.

As an illustration on a possible practical application, these issues were then addressed within the development of the illustrative Health Economic Appraisal Tool (HEAT) for cycling (see section B).

[1] Review of economic analyses of transport infrastructure and policies including health effects related to physical activity. Consensus workshop, 15-16 May 2007, Graz, Austria. Meeting report. WHO Regional Office for Europe, Copenhagen.

2.2. Principles

A number of principles were agreed as the background to the development of the guidance:

- Any proposed method must be based on the best available evidence, with clear sources and explanation and justification for all assumptions and limitations. The systematic review found the quality of the evidence used in economic valuations to be highly variable, and studies often failed to cite their sources and to explain all calculations with sufficient transparency.
- While being evidence-based, the method for economic appraisal should be as easy to use as possible. This is particularly important for the transport sector: economic valuations of transport interventions are complicated and contain many components, and if the health component is too complicated, and requires specific health knowledge, it is likely to be done incorrectly, or even left out altogether. At the other end of the scale, some studies have used a simple metric of an agreed figure for cost per km cycled/walked or cost per trip, but this has the disadvantage of being insufficiently transparent and lacking in flexibility. The guidance attempts to take a middle ground between these two approaches by providing guidance that is comprehensive and evidence-based yet still easy to use.
- The format of any practical tool supporting the application of the options for a harmonized methodology should be as user-friendly as possible, ideally in the form of a spreadsheet. One example is the ICLEI spreadsheet (ICLEI, 2003) which provides a good example of a usable tool that can enable a wide range of professionals to conduct a simplified, yet evidence-based, economic valuation of the health effects of walking to school.

2.3. Health effects of walking and cycling

Walking and cycling as one form of physical activity have positive impacts on a number of aspects of health. One of the critical first aspects of an economic appraisal of the health effects related to walking and cycling is to consider which aspects of health should be included in the appraisal.

The relationships between cycling and walking and health have recently been reviewed by WHO (van Kempen et al, in press), drawing on evidence as reviewed by WHO (Bull et al., 2004) and summaries such as the US United States Institute of Medicine’s (IOM, 2007) as well as other major studies and consensus statements, which were also discussed with a group of leading international experts. This section will summarise key aspects of this review, and draw out findings with relevance to the inclusion of health effects within any economic appraisal.

2.3.1. All-cause mortality

The strongest and clearest evidence exists for the association between physical inactivity and an increased risk of death, which has been shown in numerous studies (USDHHS 1996, Kesaniemi et al., 2001; Department of Health, 2004). Of particular relevance here are the findings of the Copenhagen Center for Prospective Population studies[2] which found a substantial decrease in the risk of death among those who spent 3 hours per week commuting to work by bicycle compared to those who did not commute by bicycle (Andersen et al., 2000). This finding is supported by a recent Chinese study reporting similar results in women (Matthews et al., 2007). Evidence suggests a linear or curvilinear dose-response relationship and there is no evidence of a threshold. For walking, Hakim et al. (1999) showed a clear decrease in all-cause mortality for men who walked more than 1 mile per day. Also for walking, this study suggests a linear or dose-response relationship without a threshold.

2.3.2. Cardiovascular disease

Strong evidence exists for the relationship between physical activity and a reduction of risk of mortality and morbidity from cardiovascular disease, particularly acute myocardial infarction and other forms of ischemic heart disease (Bull et al. 2004; Kesaniemi et al., 2001; IOM, 2007). There is an inverse relation between physical activity and cardiovascular disease incidence and mortality. While the exact shape of the dose-response curve is still a matter of discussion, assuming a linear shape could be seen as a conservative approach. Manson et al. (2002) demonstrated that walking was associated with a similar risk reduction for cardiovascular events (including both mortality and morbidity) as vigorous exercise.

2.3.3. Stroke

The evidence for an association between physical activity and ischemic stroke is still equivocal (Kohl HW, 2001). The unclear picture might be partly due to the fact that many studies did not differentiate between ischemic and haemorrhagic strokes (Bull et al., 2004) and studies that have looked at these outcomes separately suffered from the decrease in the number of events which impedes definite conclusions. The biological mechanisms are thought to be related to decreased atherosclerosis and hypertensive disease.

Fewer data are available for stroke than for coronary heart disease, but evidence from case-control and prospective studies suggest that physical activity can reduce the incidence of stroke. Lee et al. (2003) demonstrated that people who were highly active had a 27% lower risk of stroke incidence or mortality than less active people. Similar results were seen in moderately active people compared with inactive people (Department of Health, 2004).

2.3.4. Cancer

Physical activity is associated with a reduction in the overall risk of cancer (Bull et al. 2004). Based on a review of 41 studies Thune & Furberg (2001) observed a crude graded inverse dose-response association between physical activity and colon cancer.

The majority of studies investigating the benefits of physical activity and breast cancer reported a risk reduction among physically active women. Thune & Furberg (2001) concluded that an inverse association with a dose-response relationship between physical activity and breast cancer exists.

[2] The Center pooled data from three cohort studies: 1) the Copenhagen City Heart Study, 2) Copenhagen Male Study and 3) Center for Preventive Medicine (former Glostrup) Studies.

Evidence for other types of cancer such as colorectal or prostate cancer is less conclusive.

2.3.5. Type II diabetes

There is strong evidence for the role of physical activity in the prevention of type II diabetes (Bull et al. 2004; Kesaniemi et al., 2001; IOM, 2007). Regular physical activity is also an important component for the treatment of type II diabetes.

2.3.6. Other health outcomes

Although there is recognition of the detrimental effects of lack on physical activity for mental health, bone health, muscular health and quality of life (see section 2.4) there is insufficient evidence to compute the magnitude of risk reduction and the attributable burden associated with physical inactivity.

2.4. Mortality or morbidity?

As summarized above, physical activity has positive impacts on many aspects of morbidity related to conditions including coronary heart disease, stroke, diabetes, some cancers, musculoskeletal health and aspects of mental health including anxiety and depression, reduction of falls in elderly people and improvements in overall quality of life. From a population health point of view, these benefits materialise quicker than reductions in mortality (see section 2.12). They can also be important individual motivators for walking and cycling, as people may be more likely to increase physical activity to improve their immediate health and wellbeing, rather than to prolong their life. However, as of now, evidence on morbidity is still less strong than that of mortality. Therefore, including the impact of morbidity in an economic appraisal would lead to a larger extent of uncertainty. One pragmatic option might be to include the notion that morbidity benefits represent an agreed proportion of the calculated mortality benefits, and to attach an appropriate monetary value. However, the consensus meeting (see section 1.6) recommended taking a more conservative approach with a focus only on all-cause mortality for the time being.

2.5. Conclusions and options for a harmonized approach

For a number of reasons, all-cause mortality is the most suitable health-outcome to be included into economic assessments for the time being:

- death from any cause is a stronger measure, as it takes account of all deaths, and does not restrict the study to a specific pre-determined subset of diseases;
- data on total mortality are expected to be relatively readily available in most countries, including at the local level, and to be less influenced by possible misclassifications of the underlying cause of death;
- in consideration of the possible use of the tool by professionals that do not have specific health knowledge, the use of one simple parameter reduces the possibility of mistakes in the application of the tool.

If a study nevertheless prefers to use disease specific mortality, for the following causes the strength of evidence can be considered as being sufficient:

- cardiovascular disease
- stroke
- colon cancer
- breast cancer
- type II diabetes

It should be noted that this method would be likely to produce very conservative estimates of the mortality benefits.

Relative risks for all-cause mortality are given in Annex 2. For relative risks for specific health conditions, refer to Bull et al. (2004).

2.6. The nature of the physical activity-health relationship: dose-response or thresholds?

A common aspect of epidemiological studies is that they report relationships between health outcomes and different categories or levels of exposure. For example sedentary people may be compared with people active over a specific threshold, such as 150 minutes activity per week. However, there is a strong consensus that physical activity has a dose-response relationship with most health outcomes, with greater levels of physical activity associated with greater health benefits. It is therefore recommended that a dose-response relationship is incorporated into any economic appraisal of walking and cycling. This means that all increases in walking or cycling would be associated with a reduction in risk, irrespective of whether the individual reached some pre-determined threshold.

2.7. Activity substitution

This guidance is concerned with the health impact of transport infrastructure and other types of transport interventions that are expected to result in increasing rates of walking or cycling. However, most of the literature on disease risk relates to total physical activity – usually a composite index expressing overall energy expenditure (often measured as kcal per week) or time spent active – including a wide range of non-transport activity, such as leisure time and occupational activity. This therefore raises the issue of *activity substitution: i.e.* if we observe an increase in rates of walking and cycling, does it necessarily mean there has been an increase in total physical activity? For example people may have stopped jogging when they started cycling; or a new cycle path may have meant their new journey was actually shorter. In both examples, total physical activity would have actually declined.

The systematic review showed that this issue was frequently not accounted for in economic analyses. It was often assumed that any observed increase in cycling or walking automatically leads to an increase in total physical activity. This leads to an over-estimation of benefit.

It is recommended that activity substitution is accounted for in economic analyses as far as possible. This means not making an assumption that any increase in cycling or walking automatically leads to an increase in total physical activity (as people may cycle more and do less of another activity as a result). Again, taking activity substitution into account results in more conservative estimates.

There are two specific approaches that can be adopted to allow for activity substitution:

- using a relative risk (RR) that controls for other types of physical activity. For example the Copenhagen Center for Prospective Population studies (Andersen et al 2000) reported a RR for regular cyclists compared to non-cyclists, controlling for a number of factors including other types of physical activity. This means that it can be assumed that it is the level of cycling alone that is responsible for the decrease in risk of all-cause mortality. The finding of a strong difference in mortality between cyclists and non-cyclists also implies that cyclists do have a greater level of total physical activity, so activity substitution is unlikely to have taken place to any degree;
- incorporating a factor into the calculations to allow for the possibility that the level of cycling or walking being assessed will not have increased total physical activity among some of the observed participants.

2.8. Walking and cycling

Ideally, a methodology for economic appraisal would allow an assessment of the health effects related to both walking and cycling. However, the currently included evidence suggested addressing cycling in the first instance, for a number of reasons:

- the systematic review found that economic appraisals of cycling were more common than those of walking;
- data are readily available on the reductions in all-cause mortality among cyclists, controlling for other physical activity. While good quality studies exist for walking (Hakim et al 1999, Manson et al 2002) they do not readily lend themselves to development of an illustrative tool;
- cycling is likely to be a more memorable behaviour than walking, and therefore to be subject to less measurement error.

It is intended that this approach to economic appraisal of cycling could be used as the basis for development of the illustrative tool, with a similar tool could then be developed for walking accordingly in a subsequent phase.

2.9. Age groups

An ideal tool would be able to take account of the differential effects of physical activity on children and adults, and on adults of different ages. A recent summary of the evidence of health benefits of physical activity for children indicated a strong and consistent effect on skeletal health fitness, blood pressure in hypertensive children and weight loss (IOM, 2007). Despite a recent study showing that physical activity is related to cardiovascular disease risk factors in children (Andersen et al 2006), the evidence base for the health effects of physical activity on children is not yet as large as that for adults (IOM, 2007; Cavill et al 2001). The majority of epidemiological studies have been conducted on adults, mainly because the disease endpoints (such as coronary heart disease) are relatively rare in children. In addition, little is currently known about whether physical activity in children influences later patterns of physical activity in adults. Any model that relates childhood activity to changes in adult mortality or morbidity will therefore be based on too many assumptions.

Even models developed specifically for data on adults should be specific about the age groups to which they apply. A recent summary of the evidence of health benefits of physical activity in the elderly indicated a strong and consistent effect on CHD, Type II diabetes, osteoporosis, fitness, activity of daily living, cognitive functions, fall prevention, quality of sleep, sarcopoenia, but no relative risks are available (IOM, 2007).

For these reasons, the expert group concluded that economic appraisals should focus on adults only in the first instance based on the present state of knowledge. The age groups to which the results may be applied should be made explicit. If any model is subsequently applied to children, or older adults, any assumptions should be made explicit.

2.10. Interactions between transport-related physical activity, air pollution and road traffic injuries

With the introduction of transport-related physical (in-)activity as a relatively new topic into the discussion of transport-related health effects, the question arises on possible interactions between exercise through cycling and walking, and exposure to ambient air pollution as well as road traffic injuries.

Unfortunately, no review is available on active transport and physical activity which takes the possible negative effects through ambient air pollution into account.

Available evidence from individual air pollution studies does not allow a clear conclusion to be drawn on the extent to which the significant positive effects of commuter cycling (Andersen et al., 2000; Mathews et al., 2007) are influenced by a negative effect of air pollution (O’Donoghue et al. 2007; Rank et al., 2001; Chertok et al., 2004, van Wijnen et al., 1995; Kingham et al., 1998; Adams et al., 2001; Kingham et al., 1998).

There were differences in results depending on the type of air pollutant studied. It seems, however, that only for NO_2 clearly higher uptakes were found for commuter cyclists on general roads after including ventilation of cycling study subjects (e.g. van Wijnen et al., 1995) which was about 2 times that of car drivers. For the other pollutants, uptake seemed to be lower or only sometimes approached that of car drivers. Since the air pollution studies were not longitudinal in design and did not look at health outcomes, it also remains open to which extent short episodes of increased exposure influence long-term health outcomes in comparison to long-term background exposures. Some studies applied a more clinical approach such as the one by Mills et al. (2007), a chamber study in 20 men with a history of myocardial infarction exposed to either dilute diesel exhaust or filtered air which found elevated risks. While these studies often have limited potential for generalization and this particular one did not report fitness or levels of physical activity of the subjects, they are relevant with regard to biologic pathways. The two longitudinal studies on commuter cycling and mortality (Andersen et al., 2000; Mathews et al., 2007) did not assess individual exposure of their subjects. However, it is likely that participants in the Chinese study were exposed to significantly higher levels of air pollution than those in Copenhagen (World Bank, 2007). These studies indicate that benefits from exercise are probably more important for health than possible negative effects of air pollution.

Another possible detrimental effect on benefits from commuter cycling and walking could come from a higher risk of accidents. First of all, the number of deaths associated with physical inactivity in the European Region is estimated to be about five times as high as those caused by road traffic crashes (WHO, 2000). Nevertheless, accident risks for cyclists and pedestrians per distance travelled are on average considerably higher than those for vehicle occupants (WHO, 2004). However, the suggestion that more cycling and walking could increase the number of road traffic accidents is not supported by comparisons between countries in Europe (Jacobsen, 2003). Increased active transport appears to be linked to reduced road crash deaths, implying that increasing presence of walkers and cyclists improves the awareness of motor vehicle drivers and/or that policies to separate motorized from non-motorized transport are effective. An analysis in the Australian context confirmed these findings (Robinson, 2005) and this conclusion is also supported by the comparison of fatality and injury rates in Germany and the Netherlands with relatively high levels of cycling and walking to those of the United States (Pucher and Dijkstra, 2003). Additional evidence comes from the Odense Cycling City project (Troelsen et al, 2004) and the London Congestion Charge project (Mayor of London - Transport for London, 2007) where despite large increases in cycling over time, the number of cycling accidents decreased.

Overall, evidence suggests that if promotion of active commuting is accompanied by suitable transport planning and safety measures (which could at the same time lead to decreased air pollution exposure if more cycling occurs away from main roads), active commuters are likely to benefit from the “safety-in-numbers” effect. In a conservative model, an assumption could be made that the risk for traffic injuries remains unchanged, as done e.g. by Rutter (2006) in his economic calculation of benefits from commuter cycling through reduced mortality.

2.11. Costs applied

In order to conduct an economic appraisal of walking and cycling it is necessary to agree a method to valuing health, or life. There are a number of ways that this can be done:

- agreeing a standard ‘value of a statistical life’. This is often used in transport appraisals and reflects the willingness to pay of a middle-aged person to avoid a sudden death. A common example is the value agreed by the UNITE study (University of Leeds, 2007);
- a cost of illness approach. This applies costs (for example costs to the National Health Service or loss of earnings) to each specific disease;
- a years of life lost (YLLs) approach, which allows a more comprehensive assessment of health effects.
-

As this project was aimed primarily at transport appraisals, it was thought more helpful to use the ‘value of a statistical life’ approach, as this is more common in transport appraisals such as in the United Kingdom’s New Approach to Transport Appraisal (Department for Transport, 2007). Other methods could be adopted if data are available to allow a more comprehensive assessment.

2.12. Time period for build up of benefits

It is recognised that many economic appraisals are conducted without taking account of the dynamic nature of transport and physical activity patterns and the time needed for them to have an impact on mortality levels. For example it is common to compare the level of cycling before a bike path was built with the level after it was built, and apply a value to the change in cycling (as a result of decreased risk of death). But this does not take account of the likely time-lag between increasing cycling and observing benefits.

It is therefore important to recognise that there will be a time delay between increases in physical activity and measurable benefits. This needs to be related to the time period in the study on which any assessment is based. For example the Copenhagen Center for Prospective Population studies (Andersen et al., 2000) measured decreases in mortality over an average follow-up period of 14.5 years. Matthews et al. (2007) found similar findings in an even shorter follow up period of 5.7 years. Therefore, it was concluded that be seen that for a "build up" period to reach full effects of five years is a reasonable assumption to use, that will result in conservative estimates.

In addition, there should be flexibility for different assumptions about the speed of level of uptake of cycling or walking. For example one new cycle path may stimulate immediate uptake, while another might take a year or more to see levels increase. This component should be built into appraisals, to allow for varying levels of uptake.

2.13. Discounting

In most cases, the economic appraisal of health effects related to walking and cycling 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 take account of inflation, and allow a calculation of the net present value.

If the health effects are to be considered alone however, it is important that the methodology allows for discounting to be applied to the result.

SECTION B: APPLYING THE APPROACH TO CYCLING

3. Health Economic Assessment Tool for Cycling

3.1. Introduction to an illustrative approach

The principles and guidance from section A (chapters 1 and 2) have been developed into an illustrative tool, the Health Economic Assessment Tool for Cycling (HEAT for cycling).

The HEAT for cycling is:

- based on the above principles and guidance and best available evidence;
- developed from the literature review and expert consensus;
- a simplified model which allows applications by non-experts, reducing complexity and the need for extensive input data;
- applicable to cycling only (it is foreseen that a HEAT for walking-tool will be developed at a later stage);
- applicable to adults; and
- open for debate, further developments and improvement,

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 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 cost-benefit analysis;
- 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 cost benefit analyses, 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 improvements in their overall mortality rate?

The tool uses 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 cyclists aged 20-60 years. The illustrative model has incorporated both elements suggested regarding activity substitution: the relative risk used has been adjusted for leisure time cycling in the study and the tool incorporates a factor into the calculations to allow for the possibility that the level of cycling being assessed will not have increased total physical activity among some of the observed cyclists.

The tool applies the data entered by the user to calculate the total value of the savings due to reductions in all-cause mortality among these cyclists. The risk reduction associated with the actual days spent cycling is calculated (assuming a linear dose-response relationship with no threshold) based on estimates of total number of days cycled and average speed. The tool produces a global estimate of savings which can then be used to calculate savings per km or trip cycled.

The illustrative tool works as a static model, producing cost savings through a reduction in mortality:

- representing maximum annual health benefit once in a ‘steady state’ (in other words, after a user-defined period of time when maximum health benefits have been achieved);
- assuming a build-up of the full effect, which is spread over a user-defined time period; representing the discounted Net Present Value. The illustrative model also allows the build-up period to be varied to demonstrate differences by assuming different durations.

The use of a linear dose-response curve is conservative as Andersen et al. (2000) have found evidence for a curvilinear association. This means that the model may underestimate the benefits to health especially at the low end of the curve, i.e. among people with initially low levels of physical activity through cycling.

3.2. Strengths of the illustrative model

- requires simple user inputs;
- uses published data on risk of mortality from all causes (not only from a subset of specified diseases);
- uses a relative risk figure that controlled for leisure-time physical activity (addressing concerns about activity substitution);
- takes account of length of trip/distance travelled;
- adjusts for time spent cycling and assumes a linear dose-response relationship between distance cycled and reduction in risk of death;
- does not assume that cyclists achieve a specified threshold of total physical activity;
- takes account of how many trips are being taken by the same people (i.e. the proportion of cyclists that are “unique”);
- uses a published value of statistical life;
- provides default values for the underlying parameters, based on best available evidence;
- enables users to vary these underlying parameters e.g. to attribute benefits to only a proportion of users and to adapt the number of hours or distance cycled and other parameters if local data is available;
- allows the advanced user to incorporate confidence intervals around any of the entered data;

- enables the benefit to be discounted.

3.3. Limitations of this approach

- Currently only applies to cycling but walking will be added later by introducing the relative risk data;
- assumes direct linear relationship between cycling and risk of all-cause mortality (but a more complex non-linear relationship can be applied);
- does not take account of men and women separately (but it could if different relative risks were introduced);
- does not take account of the different relative risks for different age groups (but uses a relative risk which is adjusted for age);
- does not take account of morbidity, and as such is more conservative in the estimates produced;
- assumes a standard cycling speed (but can be adjusted to allow for different speeds);
- assumes that the relative risks found in one study population can be applied to different populations and settings.

3.4. Potential improvements to the illustrative model

There are a number of issues that could be addressed in the future, to develop the model further:

- identification of a suitable relative risk and appropriate dose-response relationship for walking;
- use of Value of life years lost (i.e. the willingness to pay of a person to avoid a sudden death in relation to the years this person can expect to live according to the statistical life expectation) or Quality-Adjusted Life Year (QALY) based approach rather than total value of a statistical life - this would require some measure of mean life years lost for deaths from all causes in this age group or valuation of quality of life;
- use an estimate of cyclists' "power output" (speed multiplied by distance) to take account of potential additional health benefits of faster cycling due to higher energy expenditure;
- base the calculations on more precise estimates of days cycled per year than in the Copenhagen study;
- use a more sophisticated relationship for the variable (curvilinear) slope of the relative risk curve.

3.5. Transferability and applicability to different settings

This guidance is intended for as broad an audience as possible within WHO Member States. It is therefore important that it provides data that are transferable to a variety of situations, and in different geographical contexts, especially in countries in Eastern Europe, Central Asia and the Caucasus (EECCA countries).

There are a number of reasons to support the transferability of this approach:

- the relative risk of cycling vs non-cycling is likely to be consistent across different settings and between countries;
- similar relative risks were found in settings as diverse as Copenhagen and China;
- the minimum data needed to use the approach are likely to be available in most contexts;
- there are a number of parameters built into the model that can be varied according to local conditions.

There may be potential limitations to transferability of the approach to countries with very low levels of cycling, with very poor air quality or with very insecure traffic situations, as these may influence the relative risks of cycling vs. non cycling. It is hoped that the approach (and the illustrative tool) will be piloted in a variety of contexts and settings, to allow it to be further refined in the future.

3.6. Next steps

The proposed model offers a strong option for the way forward, as it combines scientific credibility and transparency in a user-friendly format, based on a small number of reasonable assumptions. More refinements are possible, but it is recommended that this tool is thoroughly pilot-tested and reviewed at this stage before it is further developed.

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Annex 1

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Annex 2

Relative risks considered by this project

Table 1: Relative risks for all-cause mortality

Study population	Level of activity of most active group	Relative risk of all-cause mortality	Source
Regular cyclists aged 20-60 years	3 hours per week commuting by bicycle	0.72*	Andersen et al., 2000
Women aged 40-70	>3.5 met-hours/day cycling to/from work but not for exercise	0.66+	Matthews et al., 2007

* adjusted for leisure time physical activity; body mass index, blood lipid levels, smoking and blood pressure

+ adjusted for age; marital status; education; household income; smoking; alcohol drinking; number of pregnancies; oral contraceptive use; menopausal status; other types of physical activity; and several chronic medical conditions

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