Department for Transport

Claiming the Health Dividend:

A summary and discussion of value for money estimates from studies of investment in walking and cycling

Dr Adrian Davis

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Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone 0300 330 3000
Website www.gov.uk/dft
General enquiries https://forms.dft.gov.uk

Foreword

The Department for Transport has supported and sponsored this report to gain an understanding of the research already available outside the Department that helps make the economic case for investing in support for people to take up cycling and walking. We endorse the report and its contents as a good comprehensive overview of the evidence available and the case it makes for health and transport benefits for more people cycling more often.

Pauline Reeves

Deputy Director
Sustainable Accessible Travel

Most transport investment is assessed for its value for money using methods which compare costs against benefits over the lifetime of a project. Traditionally most of the benefits have been associated with reductions in travel time, almost always focused on vehicle occupants.

In recent years the Department for Transport's approach to economic appraisal has been revised. This has established that benefits should be assessed in much wider terms – economic, environmental, social and distributional. The Department's own objectives have been updated to reflect such wider concerns. Its vision is for a transport system which is an engine for economic growth, but one that is also greener and safer and improves quality of life in our communities.[1]

One of the consequences of these changes is that potential health benefits arising from transport investment are now an integral part of the assessment and decision making process. Walking and cycling are the principal means by which we can build physical activity into our lifestyles and so stay healthy, become more healthy and/or reduce our risk of developing 20 conditions and diseases; including coronary heart disease, stroke, type 2 diabetes, cancer, obesity and mental health problems. Theses health impacts are not only a drain on the NHS but on the economy not least through absenteeism. So, a healthier population makes for a more robust and prosperous economy. So, improving health through cycling and walking benefits society at large.

This report compiles the latest available cost benefit evidence from the UK and abroad from studies that have calculated health benefits alongside other benefits such as savings in travel time, congestion and accidents.

The results are compelling. The typical benefit cost ratios are considerably greater than the threshold of 4:1 which is considered by the Department for Transport as 'very high' value for money. This supports the conclusion drawn by Eddington[2] that small-scale transport schemes can really deliver high value for money.

In an era of close scrutiny over public spending there will be added pressure to achieve exceptional value for money. Within transport, investment in walking and cycling are likely to provide low cost, high-value options for many local communities. Moreover, delivery time-spans are far shorter than for most other interventions – which provides another good reason to invest in walking and cycling to help achieve many co-benefits – for business, health, carbon reduction, education, pollution reduction, social cohesion etc.

I am grateful to a number of academic colleagues for comments on earlier drafts of this document. However, responsibility for the views expressed, and for any errors, remain as ever with the author.

Dr Adrian Davis FFPH

Adrian Davis Associates

Visiting Professor,
University of the West of England

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Executive summary

1. The trend across the UK and other developed nations is for physical activity levels to decline. This is associated with obesogenic environments, widespread use of the private car, an increase in sedentary leisure activities and greater mechanisation in the home, workplace and public places. This report focuses largely on the financial benefits accruing as a result of improvements in health when more of the population become physically active through choosing walking and cycling – for part or all of their travel choices. Illness as an outcome of physical inactivity has been conservatively calculated to directly cost the NHS up to £1.0 billion per annum (2006-07 prices). Indirect costs have been estimated as £8.2 billion per annum (2002 prices).

2. Walking and cycling have been identified as a key means by which people can build physical activity into their everyday lives. The volume of literature especially on Cost Benefit Analysis of interventions to promote routine walking and cycling has grown in the past decade or so and reveals that the economic justification for investments to facilitate cycling and walking had previously been under-rated or even ignored. Much of the benefit is derived from reductions in premature deaths with large consequent savings in terms of health and knock–on benefits to the economy.

3. This update of a review published in 2010 assesses the evidence base from both peer reviewed and grey literature both in the UK and beyond. As per the original review it remains the case that almost all of the studies identified report economic benefits of walking and cycling interventions which are highly significant. In terms of value for money, the Department of Transport values 'very highly' any scheme which returns more than £4 for every £1 invested. The mean benefit to cost ratio for all schemes identified in this report is 6.28:1 and for the UK alone the mean figure is 5.62:1.

4. Investment in infrastructure or behaviour change programmes which enable increased activity levels amongst local communities through cycling and walking is likely to provide low cost, high-value options providing benefits for our individual health. This improvement also has major benefits for the NHS in terms of cost savings, for the transport system as a whole, and for the economy through more efficient use of our transport networks.

“Evaluation of the Sustainable Travel Towns project has demonstrated a significant shift from car to more sustainable modes – including walking and cycling – and the potential for active travel policies to deliver significant health benefits and very high value for money.”

Active Travel Strategy, Department of Health/Department for Transport, February 2010

Prologue

In 2010 a desktop review of the literature addressing economic assessments of walking and cycling was published by the South West Regional Office of the Department of Health with an endorsement by the then regional office of the Department for Transport.[3] The report was subsequently cited in reviews within and beyond the UK.

In 2012, DfT commissioned an updated report to re-assess the strength of the economic case for cycling and walking during a time of fiscal austerity and to support investment decision-makers at both national and local levels (particularly given the transfer of public health functions to local authorities). This report compiles the latest available cost benefit evidence from the UK and abroad from studies that have calculated health benefits alongside other benefits such as savings in travel time, congestion and accidents.

As with the original review, while this update does not claim to be comprehensive (eg a systematic review) it does claim to reflect the 'direction of travel' within both peer reviewed and grey literature of the benefit to cost-ratios (BCRs) which accrue from investments in walking and or cycling – through both infrastructure and general promotion work. Studies have been sought both through on-line searches of transport and health databases and some contact with authors.

The financial benefits in terms of health benefits of cycling and walking are often large but have mostly been left out of economic assessments. Moreover, the majority of the recorded benefits accrue from health gains despite the fact that morbidity (illness) costs are mostly excluded from studies so that the economic benefits of cycling and walking attributable to health gains would be even larger than those from reductions in mortality alone. Yet, besides health benefits accruing from physical activity there are also other potential benefits which derive from less congestion, pollution and reductions in road traffic casualties, albeit that the latter is dependent often on the environment, particularly in which those cycling travel e.g. speeds driven and road space allocation.

This review notes that there remain criticisms that even with evaluations which do attempt to capture the benefits of walking and cycling schemes including the Transport Analysis Guidance (TAG) current appraisal frameworks still do not capture costs and benefits sufficiently. This calls into question whether decision makers are being given adequate information to decide between alternative investments.[4] This issue and changes to calculating cost benefit ratios to adjust for such distortions, are discussed.

Some attention has recently been given to the 'cycling economy'. This is welcomed. A study by the London School of Economics shows that the gross cycling contribution to the UK economy in 2010 was £2.9 billion.5 The study took into account factors such as bicycle manufacturing, retail and cycle related employment. This equates to £230 per cyclist, per year. In addition, according to the report, a 20% increase in cycling levels by 2015 could save the UK £207m in reduced congestion and £71m in reduced pollution level each year. While such considerations are not unimportant, they are largely on the hinterland of the scope of this review.

A coda to the prologue is that such a review cannot stand in isolation from the current harsh economic climate. From the lens of current normative behaviour around car use, the economics of habitual use for short journeys such as for the school journey, shopping for a few small items, driving to the gym, are becoming more challenging. In the past decade, the cost of petrol has increased significantly by more than 50%, from 86.9p per litre in January 2007 to 133.3p per litre in January 2012.6 Other motoring costs have risen even more steeply, with the costs of vehicle tax and motor insurance rising by 85% over the same period.7 These might be seen as part of a ‘nudge’ encouraging more people to use the low cost travel options where they can, not least in urban areas where many journeys are short enough to walk or cycle or form part of a longer journey combined with other modes. While many people currently may choose to walk or cycle principally because it is the easiest way for them to meet their access needs and then also to gain health benefits, cost is increasingly supporting a greater move to the cycling and walking modes. The operating and maintenance costs of a bicycle are around 5% of the equivalent cost for a motor vehicle.[8] Walking is, arguably, almost cost neutral.

1. The rationale for investing in cycling and walking

Physical activity

1.1 The trend across the UK and other developed and developing nations is for physical activity levels to decline. This is associated with development of obesogenic environments - widespread use of the private car, an increase in sedentary work and leisure activities and greater mechanisation in the home, workplace and public places. There is also increasing evidence of the link between adult obesity levels and travel behaviour, one indicator of which is that countries with highest levels of cycling and walking generally have the lowest obesity rates.[9] [10] Objective data monitoring through accelerometry reveals that 95% of adults in England are deficient in physical activity and so at elevated risk of disease and ill-health.[11]

1.2 Physical activity is recognised as an important element of a healthy lifestyle, reducing the risks of ill-health and premature death. For this reason physical activity has been identified as a 'best buy' for public health. There is an unequivocal body of evidence which links insufficient physical activity to a range of diseases and other medical problems and premature death (all cause-mortality). The evidence is strongest for chronic diseases, especially:

- cardiovascular disease
- stroke
- obesity
- cancer (colon, and breast)
- type 2 diabetes
- osteoporosis
- depression.[12]

1.3 Among the above, it is only recently that the mental health benefits have been given significant attention. Benefits to mental health like physical benefits appear to be large. For example, increased walking appears to reduce long-term cognitive decline and dementia, a major issue for an ageing population.[13]

1.4 The four Chief Medical Officers of the UK have issued a joint report on physical activity which says that adults (19-64 years) should aim to be active daily.[14] Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week. Walking and cycling as modes of travel can readily contribute in part or whole to reaching these recommendations. Both modes of travel are associated with numerous positive health outcomes in terms of reducing the risk for conditions such as cardiovascular disease, stroke, type 2 diabetes, and a variety of cancers, as well as in terms of mental health, stress, injury risk, health-related quality of life, all-cause mortality and productivity and reduced absenteeism at work.[15] [16] [17] [18] [19] In support of this statement, in the general literature on cycling and walking, studies have reported that residents of more multi-modal communities exercise more and are less likely to be overweight than residents of car-oriented communities.[20] [21] Commuters who walk or cycle tend to be more productive and take fewer sick days.[22] [23]

1.5 Reflecting the strength of the evidence the Chief Medical Officers of the UK have stated that:

"For most people, the easiest and most acceptable forms of physical activity are those that can be incorporated into everyday life. Examples include walking or cycling instead of travelling by car, bus or train.…"[24]

Health care cost savings

1.6 Most studies of physical activity have focused on the economic burden of inactivity in general, often addressing a single disease or a few major diseases. Indeed an early study focused, for example, on the cost-benefit of walking to prevent coronary heart disease.[25] These studies tend to concentrate on direct health care costs - those directly associated with health care by the NHS.[26] [27] Indirect costs include expenditure not directly attributable to the NHS, such as informal care, inferior physical and mental function, deficient physical and mental well-being, and loss of productivity through sick leave, but receive less attention in physical activity studies. Illness as an outcome of physical inactivity has been conservatively calculated to be between £0.9-1 billion per annum in direct costs to the NHS alone (in 2006-07 prices).[28] Indirect costs have been estimated as £8.2 Billion per annum (2002 prices).[29]

1.7 In 2002 the Department for Culture, Media and Sport estimated that a 10% increase in physical activity in adults would benefit England, both directly and indirectly, by at least £500 million per year and would save approximately 6000 lives.[30] Of this £500 million saving, 17% is attributable to direct health costs. Therefore the direct health saving for a 10% increase in physical activity would be £85 million. In 2008, the National Institute for Health and Clinical Evidence (NICE) stated that, based on current research, it can be assumed that the long-term health and economic benefits associated with increases in cycling and walking would 'neutralise any initial costs'.[31] Citing research by the York Health Consortium (2007) they stated that relevant cost–benefit studies actually seem to indicate that the benefits would far outweigh initial costs, possibly by as much as 11 times more benefit.[32] However, NICE noted that more research was required to draw definite conclusions.

1.8 In 2012 researchers modelled the impact of increasing levels of cycling and walking on direct NHS costs for seven diseases – namely type 2 diabetes, dementia, cerebrovascular disease, breast cancer, colorectal cancer, depression and ischaemic heart disease – associated with physical activity deficits.[33] The calculations were limited to settlements of 20,000 residents or more, representing roughly 82% of the population of England and Wales. The researchers calculated increases in cycling and walking with changes in other mode use via km travelled. This was modelled for a doubling of average distances walked per day and an eight fold increase in the amount of cycling[34], as per Table 1.1.

Table 1.1: Modelled changes in average daily distances travelled per head for various modes of transport

	Walking(km)	Bicycling (km)	Motorbike (km)	Car (km)	Bus (km)	Rail (km)
2010 data	0.6	0.4	0.2	13.8	2.9	7.2
Increased cycling and walking	1.6	3.4	0.1	10.1	2.9	7.6
Cycling and walking shortest distances	1.1	1.9	0.1	10.1	2.9	7.6

Source: Jarrett, J. et al 2012 Effects of increasing active travel in urban England and Wales on costs to the National Health Service. The Lancet, 379: 2198-2205.

1.9 The health benefits of increased active transport were modelled for the period 2012-31 taking into account modelling of road traffic injuries. The largest cost savings came through reductions in the expected number of cases of type 2 diabetes, which alone dwarfs costs due to injuries, leading to savings of roughly £9 bn over 20 years. Overall, the researchers calculated that roughly £17B could be saved by an increase in cycling and walking over the 20 year period. They predicted that the cost-savings to the NHS would rise sharply towards the end of the period because of the long lag period between reductions in prevalence of some cancers and dementia.

1.10 Data from the study, in Table 1.2, shows the potential yearly spending averted at 2 year time points because of increased walking and cycling in relation to NHS expenditure for 2010-11. The researchers assumed that the NHS budget would increase by 3% each year and calculated as a percentage the in-year expenditure averted. After 20 years, spending averted by increased walking and cycling represents roughly 0.8% of estimated yearly NHS expenditure.

Table 1.2: Projected National Health Service expenditure and potential expenditure averted from walking and cycling*		
	Yearly National Health Service programme budget expenditure	Expenditure averted by active travel (%)
2012	£ 107,000,000,000	£ 15,073,571 (0.01)
2014	£ 113,516,300,000	£ 213,350,782 (0.19)
2016	£ 120,429,442,670	£ 397,426,586 (0.33)
2018	£ 127,763,595,729	£ 531,146,644 (0.42)
2020	£ 135,544,398,708	£ 655,907,606 (0.48)
2022	£ 143,799,052,590	£ 774,012,597 (0.54)
2024	£ 152,556,414,893	£ 870,250,405 (0.57)
2026	£ 161,847,100,559	£ 976,967,538 (0.60)
2028	£ 171,703,588,984	£ 1,142,576,091 (0.67)
2030	£ 182,160,337,553	£ 1,360,441,001 (0.75)

* Model assumes a 3% yearly increase in expenditure

1.11 Research in England by Rutter reported cost-benefits in relation to cycling.[35] For 100,000 people, evenly spread between the ages of 20 and 60, taking up regular cycle commuting, would result in 50 fewer deaths per year as an aggregate of health benefits and reduced road traffic casualties among those cyclists. This is equivalent to around 1660 life years. Assuming a value of around £30,000 per life year, this resulted in a net benefit of just over £50 million from those 100,000 cyclists. Using the DfT's own valuation of a statistical life (as applied in TAG) this figure would be higher at £82.7m.

1.12 In the US it has been calculated that if 10% of adults began a regular walking programme, the savings in costs associated with heart disease would total $5.6 billion.[36] And if an extra ten per cent of the Western Australian population became active there would be productivity gains of $60 million. In Australia an estimate based on national figures demonstrates that potential savings of 44 million (Aus) dollars per year would be achieved by a five per cent increase in physical activity levels in Western Australia. In addition, studies have shown that for every one per cent increase in the proportion of Australians who are sufficiently active, the national cost of three diseases – heart disease, diabetes and colon cancer – could be reduced by about $3.6 million per year.[37]

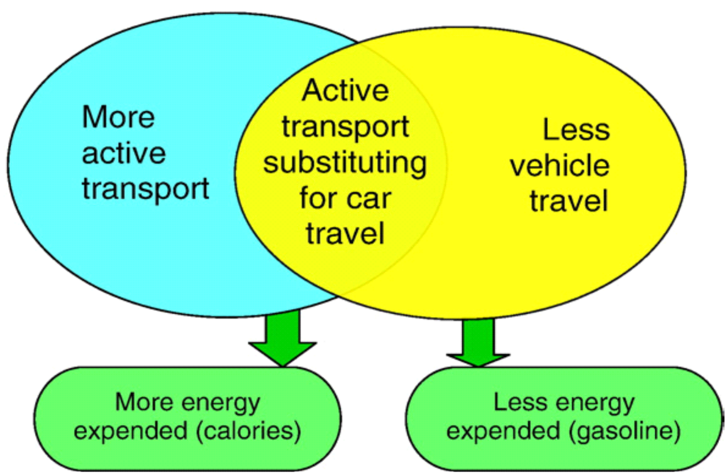
Co-benefits - beyond health

1.13 Next to providing considerable health benefits, walking and cycling also play an important part as 'co-benefits' in reducing carbon dioxide emissions, conservation of land, air pollution, noise as well as traffic congestion – which contributes to economic prosperity.[38] Co-benefits have been identified as an important area for collaboration, not least concerning climate change and carbon reduction. [39] [40]

1.14 "The strengthened role of local authorities improving health, through public health and commissioning, is a real opportunity for clinicians to work with councillors and officers to realise the co-benefits for health and the environment of action on climate change." [41]

1.15 What has also become increasingly cited in the literature is a need for a substitution of carbon energy by calorific energy, leading to many co-benefits beyond direct improvements in human health. This is represented in the Figure 1.1 below.[42]

Figure 1.2: Two major co-benefits of cycling and walking when substitutions are made from sedentary modes



1.16 Co-benefits reach wider than merely the carbon agenda and air quality. Recently, for example, the evidence around physical activity and academic performance has confirmed what researchers have been suggesting for well over two decades. This is that physical training by way of active lifestyles and through exercise can contribute to improved cognition. In 2010 the Centre for Disease Control and Prevention in the US concluded that there was substantial evidence that physical activity helps improve academic achievement.[43] Moreover, their review suggested that physical activity can have an impact on cognitive skills and attitudes and academic behaviour, all of which are important components of improved academic performance. In 2012 a systematic review reported that although there were few high quality studies the researchers found evidence that participation in physical activity is positively related to academic performance in young people.[44]

1.17 The above evidence is supported by recent research findings in neurological studies investigating the links between physical activity and cognitive performance. In 2010, in a randomised trial, researchers concluded that there is

> "Compelling evidence that physical activity between lessons is a valuable component of the school curriculum, for academic as well as physical development." [45]

1.18 This finding has been supported by subsequent studies. As a coda, many of the studies conclude that opportunities for physical activity should be made available to students and these should emphasise cardiovascular fitness over body composition. Separately, studies on cycling and walking have demonstrated that children who travel activity have better cardiovascular profiles than those who do not.[46] Consequently, if habitualised into the routines of daily living, cycling and walking among school children will help them to perform better at school academically (a key Education objective), and take less time off school through sickness. Following from this there is a good case that there will be a more educated workforce and being fitter will also take less sickness leave so contributing more to economic prosperity (see below for discussion on absenteeism).

1.19 Below, Table 1.3 illustrates the potential co-benefits of cycling and walking and how they might impact across a range of central government departments. Similar tables could be developed for each local highways authority.

Table 1.3: An illustration of a Co-benefits framework across a range of Government departments

Department	Main benefits	Other benefits
Education	Strong evidence that in young people as physical activity increases academic performance improves*	Impact on cognitive skills and attitudes and academic behaviour
Work and Pensions	Helping people get back to work*	Reducing absenteeism and cost to economy
Energy and Climate Change	Reduction in transport-related greenhouse-gas emissions through less motor vehicle use and increases in distances walked and cycled*	Increased energy security

Environment, Food, and Rural Affairs	Reduced carbon emissions from less motor vehicle use - improves air quality, reduced noise*	Supporting rural economic agenda - tourism enabling better access to nature
Communities and Local Gov	Support for high street vitality and social cohesion*	Low carbon approach to access for growth areas*
Business, Innovation and Skills	Physical activity, wellbeing and performance at work *	Happiness advantage of positive psychology
Culture, Media and Sport	Leaving a tangible Olympic legacy in terms of population health*	Once in a generation opportunity
Treasury	'Very High' Benefit to Costs*	Speed of implementation (eg with 24 months)*

* Benefits also for DfT and DH

2. Common metrics and considerations for robust appraisal

2.1 There exists a broad range of different metrics used in various studies, and among different academic disciplines, which seek to assess value for money. This often makes comparisons difficult. Two of the main approaches in the literature, which are similar, are:

- Cost Benefit Analysis (CBA) – Provides a direct comparison of the costs and benefits, both of which are expressed in monetary terms. A higher Cost-Benefit Ratio (CBR) indicates larger returns on investment.
- Cost Effectiveness Analysis (CEA) – CEA takes a funder perspective (i.e.: the public sector) on costs and benefits. It estimates the monetary resources needed to achieve a unit improvement in health. This may be compared with other interventions to compare their relative cost effectiveness in achieving a pre-set objective. The QALY is a common metric that allows a range of different programmes and interventions to be valued in like terms and compared. CEA uses Quality-Adjusted Life Years (QALY) in the monetisation process. For example, the cost-effectiveness ratios of community based physical activity interventions in a US study were reported to range between \$14,000 and \$69,000 per QALY gained, relative to no intervention.[47] The researchers concluded that even the low end of the range was considered reasonable in terms of cost per QALY.

2.2 Of these CBA appears to have greater currency in the transport literature and transport economic appraisals. It is, therefore, the most common means of assessing the health economic benefits of interventions designed to increase active transport. The BCR is given by the ratio:

$$\frac{Present\ Value\ of\ Benefits\ (PVB)}{Present\ Value\ of\ Costs\ (PVC)}$$

2.3 The BCR is, therefore, a value for money measure (or return on investment), which indicate how much net benefit would be obtained in return for each unit of cost to public accounts. This is clearly relevant in the real world situation of limited funding available from public accounts.[48]

2.4 Although all schemes with a benefit-cost ratio greater than 1 might be worth pursuing, financial constraints, not least during periods of public finance contraction, mean that it is necessary to prioritise some schemes above others, at least in terms of value for money. The Department for Transport's WebTAG Guidance categories value for money (VfM) as per Table 2.1 below so that schemes scoring over 4 are those most worth pursuing i.e. for every £1 invested the return is over £4.

Table 2.1: Value for money	
BCR	**VfM**
Less than 1	Poor
Between 1 and 1.5	Low
Between 1.5 and 2	Medium
Over 2 and up to 4	High
Over 4	Very High

Source: Dept. Transport Value for Money Assessments Guidance[49]

Caveats to the use of existing appraisal methods

2.5 There are a great variety of costs, benefits and assumptions which can undermine confidence in results. This may be due to uncertainty of what costs / benefits to include, where these may be accrued and the inherent difficulties of measuring the health benefits of active transport. Often there is little evidence to be able to assess a range of key assumptions. Physical activity researchers have highlighted such shortcoming.[50] Assumptions include:

- current levels and intensity of physical activity and this in actual studies as well as in modelling
- whether the user has simply changed route (and so is now being counted) or has transferred from another mode and whether that mode was a sedentary mode
- risk of assigning a reduction to air pollution or casualties such as with trails where a significant proportion of users may arrive at the trail by car
- not addressing either pollution changes nor casualties as a result of reported or estimated changes in walking and/or cycling

2.6 Moreover, it has been noted that a criticism of the World Health Organisation (WHO) Health Economic Assessment Tool (HEAT)[51] is that the relative risk estimate derived in Copenhagen from Andersen et al's study[52] might not translate to other locations (eg with different traffic risk or air pollution levels). However, Matthews et al report risk reductions for cycling among women in Shanghai of very similar magnitudes, providing assurance that this effect may be fairly location independent.[53]

2.7 Nonetheless, current economic evidence synthesis asserts that the greatest economic benefit of cycling and walking using new infrastructure built for that purpose is the additional health benefit accruing from new cyclists and walkers but studies are largely not designed to provide evidence to test this assertion. Others note the seduction of the 'elegant simplicity of benefit cost ratios' but argue that it is crucial to move away from monetised benefit and towards a multi-criteria analysis[54] or macroeconomic modelling.[55]

2.8 In addition, a difficulty with the transport approach to economic appraisal and evaluation is that the health-related benefits may comprise a large portion of the total benefits effect yet are subordinate to and obscured by the valuation of transport modal shift, costs of construction and maintenance, depreciation of infrastructure costs and external costs. Physical activity and wider benefits cannot be realised through new infrastructure for walking and cycling without transport modal shifts first taking place.[56] Consequently this encourages estimates of benefits to be prospectively calculated. The use of the WHO HEAT is designed to provide such calculations and so a short note about HEAT is provided in this document.

2.9 The DfT's Transport Analysis Guidance (TAG) has been revised a number of times over the past decade, most recently in 2009. In part the changes were responses to criticisms including that reductions in motorised transport through promotion of cycling and walking modes and public transport would reduce revenue to the Exchequer from fuel duty. In 2009 this approach was abandoned so that from 2010 new schemes were assessed using a different approach, in which tax effects are not confused with the ratio of benefits to costs of the scheme itself.[57] Moreover, there have been changes to the Green Book in 2003 which will alter the BCR value for a particular project:

- The standard project appraisal period was increased to 60 years, which would increase the stream of benefits for longer-lived projects and hence increase their BCR;
- The standard discount rate was reduced to 3.5 per cent, which would reduce the extent to which future benefits were discounted, and hence increase the BCR[58]; and
- Standard allowances were to be added to capital costs to allow for optimism bias, which would increase total costs and hence reduce the BCR.[59]

2.10 Another UK paper has assessed the Department for Transport's evaluation practice.[60] Taking three case examples the authors examine how costs are assigned using TAG in order to assess if it is sufficiently capable of determining the likely value of investments in cycling and walking. Their analysis is, for the purpose of this review, largely out of scope since it is focusing on TAG as a tool itself but a BCR is cited below for a scheme in Oxford to enhance the built environment and be of benefit to pedestrians and those using bicycles.

2.11 It is also worth a short note highlighting the value of time. It has been suggested that the time savings of cycling, in particular, are very large to users and that this alone should result in a change of view so that cycling is seen as a competitive model of travel in the urban context and not primarily to achieve improved health or reduce car use.[61] But perhaps more substantively that TAG as it currently operates cannot effectively deal with the assigned values of different mode users when they switch mode. It has been argued cogently that using particular salary costs is problematic and distort the outcome if a significant modal shift is achieved. There is no reason to assume that a driver who shifts to cycling will suddenly have a different value of time, which is based on the value of lost work time.[62] One clear example of this is that when, as Leader of the Opposition, the Prime Minister cycled to work. For TAG the chauffeurs' time, (who drove with Mr Cameron's work boxes) was valued more highly than the time of Mr Cameron.

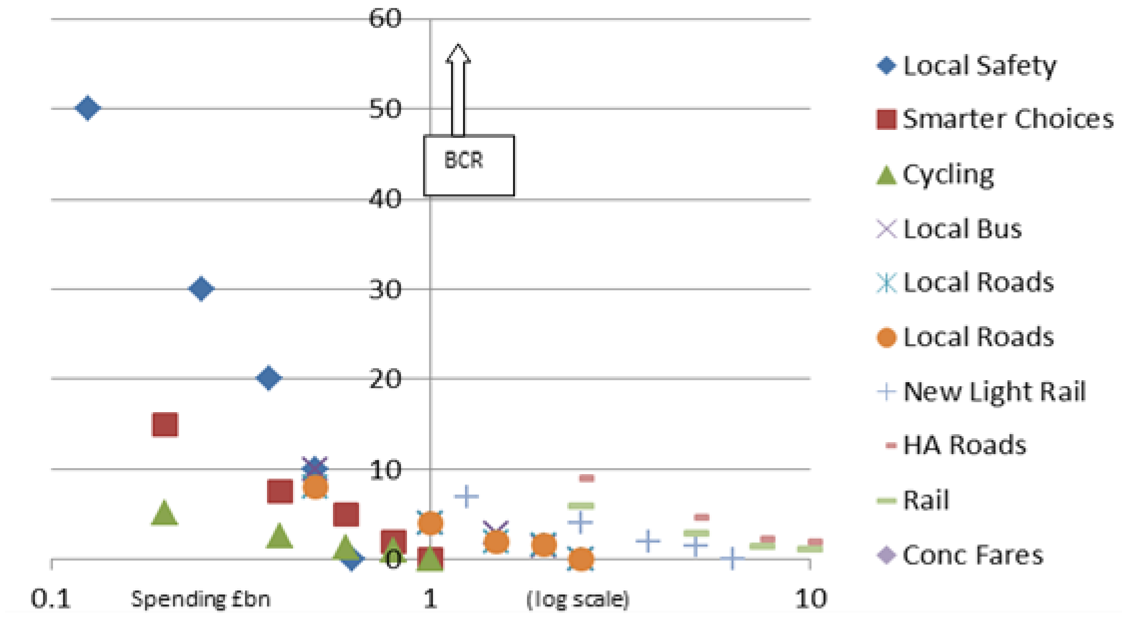
2.12 It should also be noted that the size of the health benefit as a proportion of total benefits, often being reported to be between 50-60%, may by extremely conservative. As the TAG notes:

"it is worth bearing in mind that the potential morbidity benefits are likely to be relatively significant as well and may even compare at approximately the same level against the reduced mortality benefits."[63]

2.13 Reviewing the impacts of the changes on BCRs of various transport schemes Goodwin has noted that a strong pattern has emerged of which types of transport expenditure have the greatest value for money in terms of speed of implementation, travel times, safety, and other economic costs such as health (Figure 2.1).

2.14 In summary, by far the best returns come from smarter choices, local safety schemes, cycling schemes, and the best of local bus and some rail quality and reliability enhancements, together with new light rail systems in some places. Traditional road capacity schemes are now giving much lower estimated value for money than cited in Eddington, due (a) to a change (for the better) in the way that taxation is accounted for in the studies, and (b) the effects of lower motorised traffic growth, whether due to road pricing, other policies, or to changing trends.[64]

Figure 2.1: Value for money related to expenditure



Source: Goodwin, 2011

3. Cost Benefit Analysis (CBA) of cycling and walking interventions

3.1 CBA of cycling and walking projects was not commonly undertaken prior to the twenty-first century and even now the volume of studies is relatively limited although growing in number to the point where there is enough data of sufficient quality to be confident as to the significance of the benefits consistently presented.[65] [66] A caveat remains, however, in that each study will have made assumptions in order to undertake analysis and/or modelling estimation. We also have little knowledge of how data has been generated for analysis in each of these studies. With such caveats, even by 2000 Elvik was able to report that the findings indicated that including health impacts arising from existing and new users could make a major difference to CBA results.[67] Moreover, by 2007 the WHO was able to report that:

"A consensus exists among experts in many OECD countries that significant public health benefits can be realised through greater use of active transport modes."[68]

3.2 A signal as to the growing importance of CBA is that the Cabinet Office has considered physical inactivity costs (among others) and the need to reflect these by steering transport policy in urban areas to promote cost effective interventions including cycling promotion.[69]

"These results suggest that transport policy has the opportunity to contribute to a wider range of objectives. This is supported by emerging evidence on specific schemes e.g. high benefit cost ratios for cycling interventions." p. 3

3.3 Most of the studies are focused on infrastructure intervention (modeled or actual). Most include calculations for reductions in ill-health and premature death, but not all studies do. Studies of single cycle/pedestrian routes comprise a large proportion of the academic literature to date. Thus, in 2013 there is a seam of data on the CBA/BCRs of environmental facilities on promoting physical activity in the general population through walking and cycling that can be assessed in order to make conclusions about the likely cost-effectiveness of changes in levels of cycling and walking use.

3.4 As a coda to this section, issues such as sickness and absenteeism reduction are included within TAG but CBA and BCRs are, of course, only part of the decision-making process for scheme approvals. In this regard reductions in absenteeism can play an important part in economic growth terms through a reduction in costs incurred by businesses as a result of healthier staff taking less sickness leave. An example is provided by a Dutch study of regular cycle commuters. They missed significantly fewer days a year than non-cyclists: on average 7.4 days a year (cyclists) compared to 8.7 days a year (non-cyclists). There was also a relationship between distance, commute frequency and degree of absenteeism: the more often and the greater the distance, the lower the absenteeism.[70] In 2007 an Evidence Review was conducted for Transport for London to assess the peer-reviewed evidence.[71] The most significant finding was that an increase in physical activity of more than one hour per week, easily achieved by walking or cycling to work, would be expected to lead to a measurable reduction in levels of absenteeism.

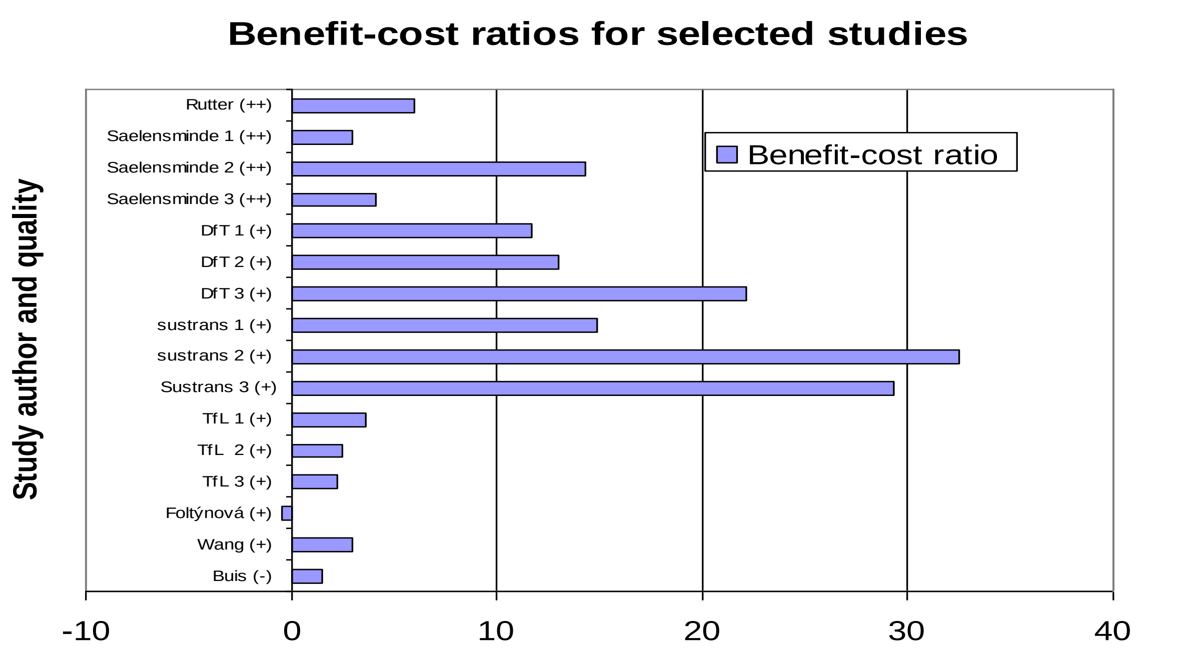
3.5 The authors concluded that this was of clear commercial benefit to employers and supported the business case for investing in workplace travel plans. No studies were found directly reporting on cycling and walking and absenteeism and productivity.

Reviews

3.6 The seam of data includes a systematic review (16 studies) of economic analyses of transport infrastructure and policies including health effects related to cycling and walking.[72] Looking at this systematic review it shows that cost-benefit analyses of cycling and walking infrastructure generally produce positive BCRs – with the assumption that people cycling would continue cycling at the present rate for at least 10 years (although several of the Sustrans studies were conducted with a 30 year time span). Although the researchers noted that these should be treated with caution due to the diverse methods used, nonetheless, it could be concluded that of sixteen BCRs for various cycling/walking projects, only one was negative, and the size of the BCRs were high (Figure 3.1). Study quality was assessed against the National Institute for Health and Clinical Excellence (NICE) checklist for quantitative intervention studies. Quality ranged from 2++ (high quality external and internal validity) to – (few quality criteria fulfilled).

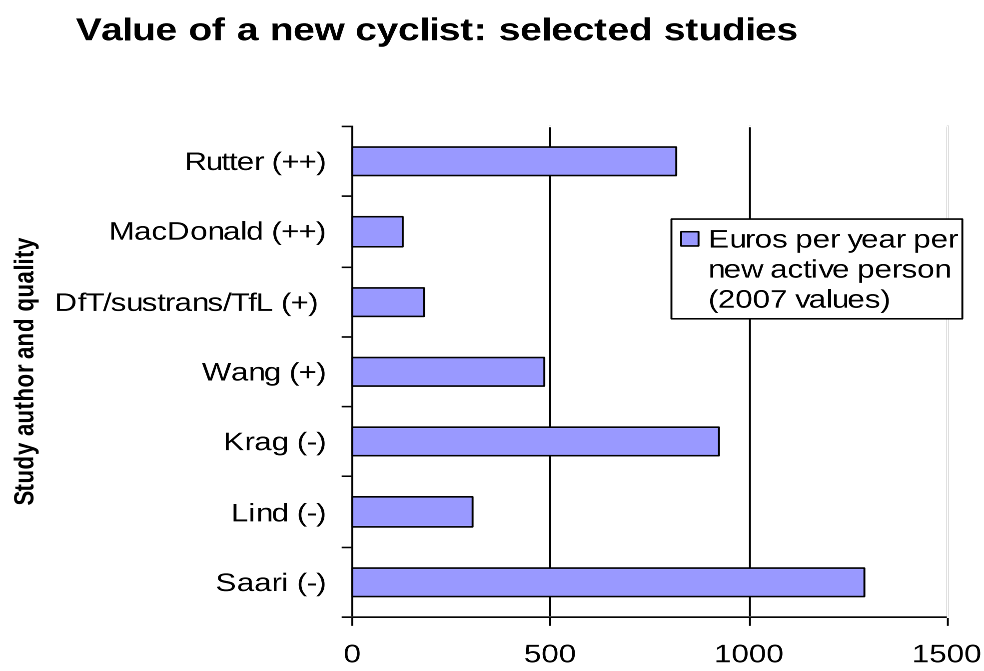
The authors also noted that: “The BCRs were also of an impressive magnitude: the median BCR was 5:1, which is far higher than BCRs that are routinely used in transport infrastructure planning.”

Figure 3.1: Benefit cost ratios for selected studies



3.7 Figure 3.2 (below) shows the variation in values attributed to one new walker/cyclist. These ranged from €127 to €1290. Much of this variation is accounted for by different assumptions – for example Lind and Saari based their valuations on the same overall estimates but use different assumptions when reporting the data. Importantly, it was also noted that neither the size of the BCR (Figure 3.1) nor the average value per cyclist (Figure 3.2) seemed to be systematically related to the quality of the study, i.e. it was not the case that lower quality studies produced higher values or vice versa. This last point is important and encouraging in that it supports the view of the 2010 edition of this review that BCRs are consistently high – and so high value for money.

Figure 3.2 - Value of a new cyclist from selected studies



3.8 A recent paper added to the UK literature since the original review has assessed the state of the economic evaluation evidence concerning infrastructural environmental interventions for walking and cycling and their health benefits.[73] The authors identify a critical issue in that the transport approach to economic appraisal and evaluation subordinates the health benefits that may comprise a large proportion of the total benefit effect. Health benefits become subordinated to and obscured by other items in the wider evaluation process. Items in the wider evaluation process include the valuation of transport modal shift, costs of construction and maintenance, depreciation of infrastructure costs and external costs and benefits (p 529). The authors were not explicit in how they graded studies but there was agreement that the four common studies were of 'fair quality' e.g. 2+ according to NICE criteria.

3.9 Lastly, a review of the current state of economic evaluation evidence concerning infrastructural environmental interventions for walking and cycling and their health benefits make a number of important findings.[74] Most pertinently, the authors report that while studies often adopt similar approaches in the generation of economic effectiveness evidence for walking and cycling infrastructure, the methods used to measure and value health benefits and the range of benefit-cost ratios estimated are diverse.

4. The UK evidence for BCRs

4.1 BCRs only include the monetised impacts of projects, whereas projects will have other, non-monetised, impacts that may be identified. Clearly walking and cycling, where they replace car trips, can contribute to reductions in carbon emissions which also positively impact on air quality, and congestion. Most, but not all UK examples, are calculated over a 10 year appraisal period.

4.2 It terms of identification of sources of information included, schemes have been identified through on-line searches through a range of search engines in seeking peer reviewed evidence and through contacts and a snowballing technique to identify both peer reviewed and grey literature. As noted in the Prologue, this report does not claim to be comprehensive but rather to reflect the direction of travel within both peer reviewed and grey literature. One of the interesting findings is the relatively limited number of economic evaluations of walking and cycling interventions in both the UK and beyond.

Table 4.1: Links to School/Tackling the School Run: Sustrans
All Sustrans scheme BCRs included here are calculated over a ten year appraisal period

Project/Intervention	Description	BCR
Yeadon to Guisely Links to Schools scheme*	Involved the construction of a new traffic free path. The total cost of the scheme was £133,028. The pre route user survey was performed in 2007 and the post intervention survey in 2008. Information on route users collected through these surveys was used to inform the economic evaluation.	To calculate the benefit cost ratio, the total benefit over the ten year appraisal period (£413,186) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £136,877. The resulting benefit cost ratio (BCR) is 3:1.

	It was estimated that 37 more individuals were cycling and 327 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 127 cycle and 1,345 pedestrian trips. In the post survey the annual usage estimate for children's trips was 3,128 as cyclists and 13,015 as pedestrians. The benefits to children cannot be monetised within the existing framework.	
South Shields Links to Schools scheme	The Links to Schools scheme implemented at South Shields was an urban road adjacent route. The total cost of the scheme was £189,956. The pre route user survey was performed in June 2005 and the first post intervention survey immediately after the intervention in November 2005. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 6,231 adult cycle trips and 97,157 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 20,345 adult cycle trips and 206,784 adult pedestrian trips. It was estimated that 101 more individuals were cycling and 892 more individuals were walking between the pre and post surveys. In the pre-survey, the annual usage estimate for children was 4,312 cycle trips and 119,624 pedestrian trips. In the post survey the annual usage estimate for children was 14,598 cycle trips and 217,246 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	To calculate the BCR, the total benefit over the ten year appraisal period (£1,159,383) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £195,452. The resulting BCR is therefore 5.9:1.

Marske Links to Schools scheme	The Links to Schools scheme at Marske included the construction of a short section of segregated traffic free path and a new toucan crossing. The total cost of the scheme was £27,398. The pre route user survey was performed in 2006 and the post intervention survey in 2007. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 3,450 adult cycle trips and 62,063 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 13,171 adult cycle trips and 81,828 adult pedestrian trips. It was estimated that 70 more individuals were cycling and 161 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 3,873 cycle trips and 372,926 pedestrian trips. In the post survey, the annual usage estimate for children was 14,930 cycle trips and 301,883 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	To calculate the BCR, the total benefit over the ten year appraisal period (£358,780) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £28,191. The resulting BCR is therefore 12.7:1.
Brent Links to Schools scheme	The total cost of the Links to Schools scheme delivered in Brent was £248,164. The pre route user survey was performed in 2007 and the post intervention survey in 2009. Information on route users collected through these surveys was used to inform the economic evaluation.	To calculate the BCR, the total benefit over the ten year appraisal period (£637,605) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £255,345. The resulting BCR is therefore 2.5:1.

	A total annual usage estimate of 30,296 adult cycle trips and 430,816 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 35,633 adult cycle trips and 458,963 adult pedestrian trips. It was estimated that 38 more individuals were cycling and 229 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 1,594 cycle trips and 111,962 pedestrian trips. In the post survey the annual usage estimate for children was 1,263 cycle trips and 71,473 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	
Kings Lynn Links to Schools scheme	The total cost of the Links to Schools scheme delivered in Kings Lynn was £150,000. The pre route user survey was performed in 2009 and the post intervention survey in 2010. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 42,790 adult cyclists and 59,455 adult pedestrians was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 58,343 adult cycle trips and 62,026 adult pedestrian trips. It was estimated that 111 more individuals were cycling and 21 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 49,929 cycle trips and 84,893 pedestrian trips. In the post survey the annual usage estimate for children was 33,227 cycle trips and 91,091 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	To calculate the BCR, the total benefit over the ten year appraisal period (£477,743) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £154,340. The resulting BCR is therefore 3.1:1

Dingwall Tackling the School Run scheme	The total cost of the Tackling the School Run scheme delivered in Dingwall was £190,000. The pre route user survey was performed in 2007 and the post intervention survey in 2009. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 2,270 adult cycle trips was estimated on the basis of count data collected during the pre-survey. No pedestrians were counted during the pre-survey at this site. From data collected in the post survey, the annual usage estimate was 15,974 adult cycle trips and 3,111 adult pedestrian trips. It was estimated that 98 more individuals were cycling and 25 more individuals were walking between the pre and post surveys.	To calculate the BCR, the total benefit over the ten year appraisal period (£257,541) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £195,498. The resulting BCR is therefore 1.3:1
East Linton Tackling the School Run scheme	The total cost of the Tackling the School Run scheme delivered in East Linton was £72,000. The pre route user survey was performed in 2007 and the post intervention survey in 2009. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 201 adult cycle trips and 32,292 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 343 adult cycle trips and 127,004 adult pedestrian trips. It was estimated that 1 more individual was cycling and 771 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 12,883 cycle trips and 97,781 pedestrian trips. In the post survey, the annual usage estimate for children was 18,225 cycle trips and 99,704 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	To calculate the BCR, the total benefit over the ten year appraisal period (£754,223) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £74,083. The resulting BCR is therefore 10.2:1.

Thame Links to Schools scheme	The total cost of the Links to Schools scheme delivered in Thame was £121,556. The pre route user survey was performed in 2004 and the post intervention survey in 2005. Information on route users collected through these surveys was used to inform the economic evaluation. A total annual usage estimate of 10,870 adult cycle trips and 23,084 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 19,507 adult cycle trips and 55,984 adult pedestrian trips. It was estimated that 62 more individuals were cycling and 268 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 3,600 cycle trips and 11,449 pedestrian trips. In the post survey, the annual usage estimate for children was 9,202 cycle trips and 14,805 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	To calculate the BCR, the total benefit over the ten year appraisal period (£479,009) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £125,073. The resulting BCR is therefore 3.8:1.
Cheltenham Links to Schools scheme	The total cost of the Links to Schools scheme delivered in Cheltenham was £180,000. The pre route user survey was performed in 2004 and the post intervention survey in 2005. Information on route users collected through these surveys was used to inform the economic evaluation.	To calculate the BCR, the total benefit over the ten year appraisal period (£725,532) is divided by the total cost of the scheme. The cost must first be adjusted to market price cost by removing VAT then uplifting by a factor for average indirect tax. The cost of the scheme adjusted in this way is £185,209. The resulting BCR is therefore 3.9:1

	A total annual usage estimate of 14,128 adult cycle trips and 23,090 adult pedestrian trips was estimated on the basis of count data collected during the pre-survey. From data collected in the post survey, the annual usage estimate was 26,661 adult cycle trips and 76,159 adult pedestrian trips. It was estimated that 90 more individuals were cycling and 432 more individuals were walking between the pre and post surveys. In the pre survey, the annual usage estimate for children was 20,672 cycle trips and 38,614 pedestrian trips. In the post survey, the annual usage estimate for children was 17,149 cycle trips and 16,194 pedestrian trips. The benefits to children cannot be monetised within the existing framework.	

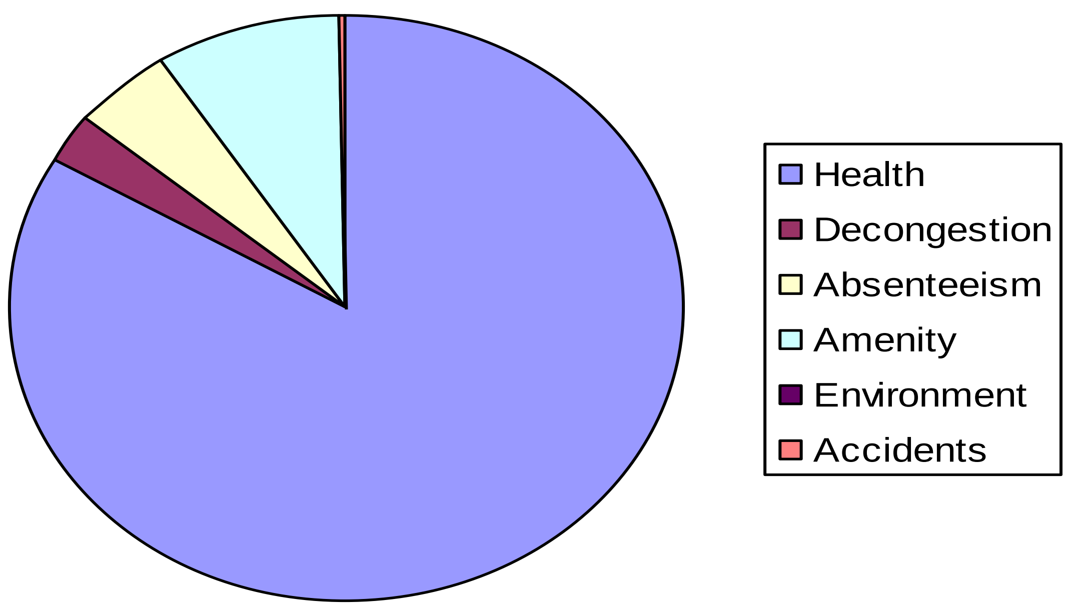
4.3 An example of the distribution of user benefits by WebTAG parameters is given below for the Yeadon to Guisely Links to Schools scheme. Here the health parameter value is 83% of the total of the six parameters. Averaging the health parameter as a percentage value across all the above nine Sustrans schemes gives a value of 74% of the total i.e. the health benefits are attributable to 74% of the monetised benefits.

Table 4.2: Breakdown of user benefits arising from the Yeadon to Guisely Links to Schools scheme			
Value (£, total over ten year appraisal period)			
Parameter	**Cyclists**	**Parameter**	**Cyclists**
Health	£195,192.94	Health	£195,192.94
Decongestion	£13,227.52	Decongestion	£13,227.52
Absenteeism	£8,436.14	Absenteeism	£8,436.14

Amenity	£48,550.64	Amenity	£48,550.64
Environment	£619.70	Environment	£619.70
Accidents	£1,216.75	Accidents	£1,216.75
Total	£267,243.69	Total	£267,243.69

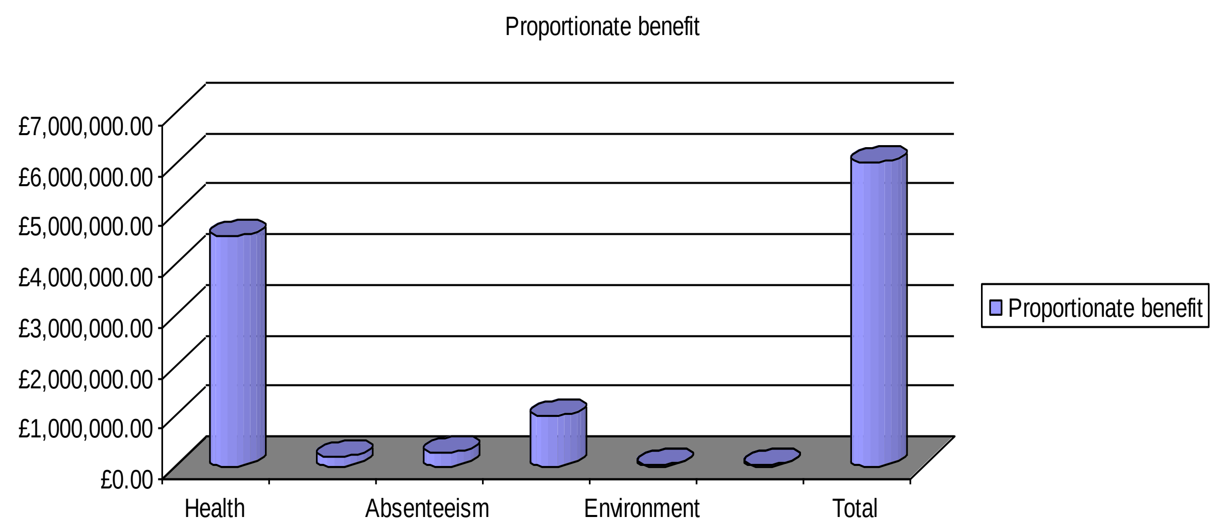
4.4 Viewed as a pie chart the dominance of health benefits is very clear for the Yeadon to Guisely Links to Schools scheme.

Figure 4.1: Pie chart of user benefits arising from the Yeadon to Guisely Links to Schools scheme



4.5 Viewing all 9 schemes for the proportionate share of benefits again shows how dominant the health benefits are.

Figure 4.2: Proportionate share of benefits



Travel Actively funded Sustrans projects 2008-2011

4.6 From 2008 to 2011 Sustrans has delivered 10 Cycling and walking projects across England, engaging with communities, universities and workplaces to give people opportunities to walk and cycle more often.[75] The projects are part of the Travel Actively portfolio, funded by the Big Lottery. The Cycling and walking projects have given 80,561 people opportunities to become more active through a range of activities. Evaluation carried out by Sustrans' Research and Monitoring Unit (RMU) on data provided by participants during the project showed that the Cycling and walking projects had been successful in increasing levels of walking and cycling for leisure and for cycling and walking among participants.

4.7 Sustrans' Cycling and walking projects increased physical activity. There was a 9% increase in survey respondents doing at least 30 minutes of physical activity on five or more days per week, from 32% to 35% (based on data from 906 respondents). Given that the total cost of the project, including match funding, was £4,055,000, then this gives a BCR of 7.6:1.

Sustainable Travel Towns

4.8 Research published by the Department for Transport in 2004 reported on the effectiveness of smarter choices or 'soft measures' ie behaviour change interventions. This research concluded that with cautious assumptions, about where best to invest in smarter choice measures (eg in urban areas rather than rural) such interventions “offer very acceptable value for money. Using current DfT practice estimating the value of the effects on travel time in the number of vehicles,

4.9 “Each £1 spent on soft measures could produce benefits of about £10 on average, and considerably more in congested conditions. Inclusion of values for potentially positive effects on safety, health or the environment would further increase the value for money. This gives a good margin of robustness to changes in assumptions or methods or calculations.”[76]

4.10 The conclusions to the economic value of the Sustainable Travel Towns was that the congestion BCR was also 4.5:1 and the authors likewise concluded that the programme offered a very high value for money.[77]

Research for Cycling England

4.11 Research by SQW Consulting for Cycling for England sets out a summary of the monetary values that have been estimated for one new cyclist, cycling regularly for a year.[78] A model was developed with four different scenarios: urban on-road, urban off-road, rural on-road and rural off-road. The values for these scenarios are shown in Table 1. The scenarios suggest that the annual economic benefits range from around £540 to £640 with the greatest economic benefits for cycling generated by urban off-road projects and the least by rural on-road ones. The average benefit per additional cyclist is £590 per year.

4.12 While the differences between the scenarios are reasonably significant, it is important to note that the greatest impact that cycling has is on the health benefits of additional cyclists. These health benefits are universal. If people can be convinced to cycle, around two-thirds of the economic benefit generated does not depend on the location or type of facility.

4.13 The figures in Table 4.3 provide a simple and straightforward way to assess whether a cycling project is likely to generate a positive return on investment. As a rule of thumb, every £10,000 invested would need to generate at least one extra cyclist, each year, over a 30 year period in order to break even. Where the effect of the intervention is likely to be shorter, the number of extra cyclists will need to be higher.

Table 4.3: Annual values attributed to each additional cyclist, cycling regularly for one year - the figures assume that 50% of cycle trips replace a car trip

Benefits (annual for each additional cyclist)	Urban	Rural

Health Benefits	On Road	Off Road	On Road	Off Road
Value of loss of life	£408.67	£408.67	£408.67	£408.67
NHS Savings	£28.30	£28.30	£28.30	£28.30
Productivity gains	£47.69	£47.69	£47.69	£47.69
Pollution	£34.57	£34.57	£6.49	£6.49
Congestion	£68.64	£68.64	£34.32	£34.32
Ambience	£13.20	£53.60	£13.20	£53.69
Total Benefits	£601.06	£641.46	£538.66	£479.06

Source: SQW

4.14 Using the WHO's HEAT tool, Cycling England researchers estimated the value of the reduction in adult mortality.[79] The HEAT analysis found a maximum annual benefit (once the maximum health benefit had been reached after an estimated five years) of £8.9 million per annum. Taking into account the build-up of health benefits in the HEAT tool, the present value of the mean annual benefit of this additional level of cycling is in the region of £4.5 million per year. Over ten years, assuming the new cyclists remained cycling at the current level, this would result in a saving of £45 million.

4.15 The SQW report included a number of case studies of the economic impact. The value of the benefits for every one pound invested varies considerably, ranging from 34 pence to over £40. However, this range is understandable given that some of the projects have only very recently been completed. This is particularly true of Priory Vale, Queen Elizabeth Park and Surrey University's Manor Park campus. The average benefit to cost ratio of the five case studies is just under 2:1 excluding the Hull case study which is much higher than the other results. Including this outlier, the average benefit to cost ratio is almost 10:1. It is also worth stressing that these cases were identified independently by the consultants as typical examples.

4.16 The Cycle Demonstration Towns programme cost £2.8 million per year of direct Cycling England/Department for Transport grant, matched by funding from the local authorities which averaged £3.4 million per year, for three years. This is a total of £18.7 million, which equates to a net present value of £17.45 million at the start of the project. Thus, for each £1 invested, the value of decreased mortality is £2.59. This figure is for decreased mortality only.

4.17 A benefit cost ratio using DfT approved Transport Appraisal Guidance[80] built on this analysis found a benefit of between 2.6 and 3.5. Mortality benefits were appraised using an adapted version of the WHO HEAT tool for cycling which contains a range of assumptions. The additional benefits included amenity, reduced congestion and reduced absenteeism. The range resulted from the uncertainty over accident dis-benefits (ranging from zero to £15 million). It was found there were significant gaps in the evidence to support the analysis. The analysis was conservative in that it assumed that the benefits would only last 10 years. It also did not include any benefits from reduced morbidity (ill health) and was calculated only for adults and included no benefits from additional children cycling. The BCR range increases to 4.7-6.1 if the benefits could be sustained for 30 years assuming some on-going investment in behaviour change programmes and training.[81] The reduced mortality rates alone accounted for £2.50 of benefit for every £1 spent on the scheme.

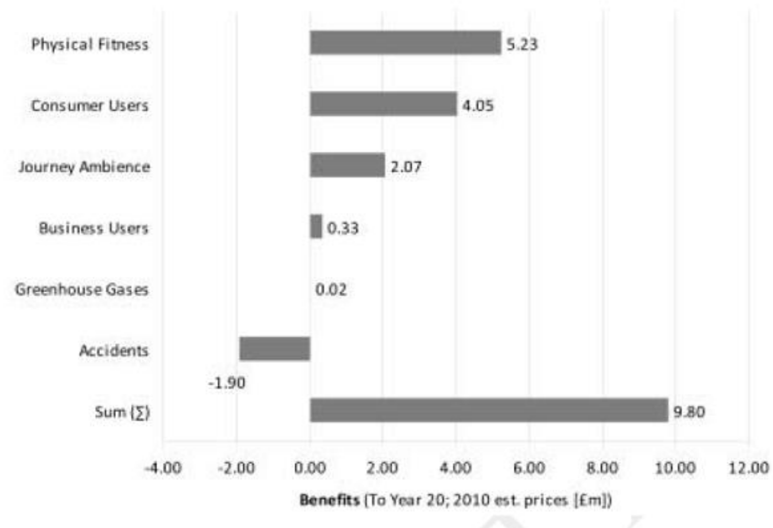
Local Authorities

4.18 The retrofitting of seven streets in Hull has proved to be extremely successful, combining low costs with a high number of additional cyclists. The implementation of a 20mph speed limit and other measures also contributed to the growth in cycling.

4.19 York City Council assessed the value of one of its cycle route scheme using the above data. The Malton Road cycle route scheme cost £600K for infrastructure works and would achieve a benefit to cost ratio of 1:1 if the scheme created an additional 60 cyclists (approximately) for this urban, off-road route. By 2007 there was an average of 439 cyclists, an increase of 178 cyclists, constituting a true increase over 10 years.[82]

4.20 Broad Street, Oxford:
A proposal to improve Broad Street, in central Oxford, for pedestrians and cyclists was evaluated for its economic costs and benefits using the Department for Transport TAG.[83] As with many appraisals of walking and cycling (above) the physical fitness element accounted for the largest portion of estimated benefits (45% - see Figure 4.3 below). This approach uses the value of a statistical life (£1.654M in 2012) and an average distance of a cycle commute of 4km as well as a calculation for relative risk of death from all causes corresponding to distance travelled. Thus, it includes any projected increases in injuries as a result of increased exposure among cyclists and pedestrians. The BCR for the scheme was calculated as 6.5:1.

Figure 4.3: Costs and benefits assigned to changes in Broad Street, Oxford



4.21 Below is a compendium of the BCRs from the above studies. For these UK projects the average BCR is 5.62:1.

Table 4.4: Compendium of BCRs for UK walking and cycling infrastructure projects

Study	**Study focus/location**	**Benefit to cost ratio**	**Comment**
Macmillen et al 2010	Oxford	6.5:1	Walking and cycling enhancements
SQW Consulting, 2008	UK	10:1.	Estimated impacts of five cycling infrastructure projects
Cycling England	England	2.59:1	Increases in cycling associated with Cycling Demonstration Towns - mortality benefits only.
Sustrans	Yeadon to Guisely Links to Schools scheme	3:1	The Yeadon Links to Schools scheme involved the construction of a new traffic free path.
Sustrans	South Shields Links to Schools scheme	5.9:1	The Links to Schools scheme implemented at South Shields was an urban road adjacent route.

Sustrans	Marske Links to Schools scheme	12.7:1	The Links to Schools scheme at Marske included the construction of a short section of segregated traffic free path and a new toucan crossing.
Sustrans	Brent Links to Schools scheme	2.5:1	The total cost of the Links to Schools scheme delivered in Brent was £248,164.
Sustrans	Kings Lynn Links to Schools scheme	3.1:1	The total cost of the Links to Schools scheme delivered in Kings Lynn was £150,000.
Sustrans	Dingwall Tackling the School Run scheme	1.3:1	The total cost of the Tackling the School Run scheme delivered in Dingwall was £190,000.
Sustrans	East Linton Tackling the School Run scheme	10.2:1	The total cost of the Tackling the School Run scheme delivered in East Linton was £72,000.
Sustrans	Thame Links to Schools scheme	3.8:1	The total cost of the Links to Schools scheme delivered in Thame was £121,556.
Sustrans	Cheltenham Links to Schools scheme	3.9:1	The total cost of the Links to Schools scheme delivered in Cheltenham was £180,000.
Sustrans	England-wide	7.6:1.	Travel Actively funded Sustrans projects 2008-2011
	Average	**5.62**	Simple, non-weighted average

5. Conclusions

5.1 Health benefits are a fully recognised component within CBA calculations within transport planning in England through TAG. As with other areas of public policy decision making about interventions to increase physical activity, decisions are likely to be swayed by the economic case as much as by the general congestion reduction, health or environmental benefits. This is particularly accentuated in times of fiscal restraint. Consequently, an evidenced based approach to decision making, as required by Government, is especially important in informing the economic case.

5.2 The volume of literature on CBA/BCR of interventions to promote routine walking and cycling has grown in recent years and reveals that the economic justification for investments to facilitate cycling and walking has been undervalued or not even considered in public policy decision-making. Yet, almost all of the studies reported within this review cite economic benefits which are highly significant, with BCRs averaging 5.95 (UK and non-UK).

5.3 Consequently, environmental and other interventions to facilitate increased population physical activity through cycling and walking are likely to be amongst the ‘best buys’ across many areas of public policy i.e. public health benefits, cost savings for health services and for transport planning. The significant BCR values reported here should have a substantial influence in informing national transport ambitions. Additionally, a more mature transport policy enables recognition and adjustment in the light of the multiple inter-connections between transport and other areas of public policy – not least to claim the cost savings which accrue when fossil fuel is replaced by human energy – the co-benefits.

5.4 As a coda, evidence of the high value of BCRs for cycling and walking should also be considered alongside the speed of delivery of walking and cycling interventions which for infrastructure projects are usually within 2 years compared to 8-12 years for major schemes, adding to the activeness of cycling and walking interventions. Implementation can clearly be quicker for behaviour change schemes. Added to this, small scale schemes often get contracted to local-based companies rather than major schemes (with shareholders with no requirement for interest in supporting local economies).

6. Appendix A: Non-UK BCR evidence Cost Benefit Analysis (CBA) of cycling and walking interventions

CBA (and BCR) calculations of traffic safety measures: EU PROMISING Project

A.1 CBA calculations of various traffic safety measures using European data show that measures for cyclists and pedestrians result in a more positive ratio than other travel modes.[84]

- Measures to restrict speed such as those now in use in increasingly more urban areas reduce the average risk of accidents by more than 50%. The ratio between benefits and costs is 9:1
- Separate cycle paths have a positive effect on safety for both motorised vehicles and cyclists and also benefit traffic flow. The ratio is 9:1
- A measure that gives cyclists right of way at traffic junctions by means of an advanced stopping line over the full width of the road also improves safety for cyclists and other traffic and has an even more positive ratio of 12:1.[85]

BCRs for three Norwegian cities

A.2 A CBA of walking and cycling tracks in three Norwegian cities reported a series of benefits.[86] These benefits included improved fitness, reductions in health costs, decreased air and noise pollution and reduced parking costs. A range of other factors were included in the calculations including traffic accidents, travel time, insecurity, school bus transport, and medical and welfare costs (the latter being 60% of the total cost). The CBA/BCR included conservative estimates of some benefit components:

- Traffic accidents - assumed that the number of traffic accidents resulting in injury would remain unchanged because of the new walking and cycling tracks.
- Travel time – assumed that travel times for pedestrians and cyclists remain unchanged.

- Insecurity - felt by pedestrians and cyclists moving along a road was included at a cost of 2 Norwegian Kroner (NOK) per kilometre. Assuming an average speed of 10–20 km/h the cost of insecurity was about NOK 20–40 per hour for cyclists.
- School bus transport - assumed that 50% of children previously using a bus would not need this if walking and cycle track networks were constructed.
- Less severe diseases and ailments and less short-term absence – assumed that short-term absence from work would be reduced by 1 percentage point (from 5% to 4%) and that 50% of new pedestrians and cyclists would see improvements in their health.
- Severe diseases and ailments and long-term absence/disability - moderate amounts of daily physical activity reduce risk of premature mortality in general.

A.3 Risk reductions were related to just four types of severe diseases or ailments - cancer, high blood pressure, type-2 diabetes and musculoskeletal ailments. Estimated costs due to welfare loss for people suffering from these diseases or ailments were included. The welfare loss is estimated to be 60% of the total costs - the same magnitude as for welfare loss for people injured in traffic accidents used in Norwegian CBAs of other road investments.

A.4 External costs of road transport included were:

- CO2-emissions, local emissions to air,
- Noise
- Congestion
- Infrastructure costs
- Parking costs – commute trips by car replaced by walking or cycling were assumed to reduce parking costs for businesses in Trondheim, Hamar and Hokksund by NOK 1165, NOK 560 and NOK 3254 per month, respectively.

A.5 A summary of the CBA results are presented in Table 7, demonstrating that investment in walking and cycle networks in the three Norwegian cities (best estimates of future pedestrian and bicycle traffic) appear to be highly cost effective.

Table A.1: BCR of investments in walking and cycling track networks in Hokksund, Hamar and Trondheim				
	Hokksund	**Hamer**	**Trondheim**	**TOTAL**
TOTAL BENEFIT	153.7m NOK (£14.5m)	309.1m NOK (£29.2m)	3023.3m NOK (£285.3m)	3486.1m NOK (£329m)
TOTAL COSTS	30.2m NOK (£2.85m)	20.1m NOK (£1.9m)	767.4m NOK (£72.4m)	817.7m NOK (£77.15m)
Net benefit/cost ratio	4.09	14.34	2.94	

Unit: Norwegian Kroner (NOK 1 = GB £0.094)

Sydney cycling network

A.6 The objective of a study, undertaken for the City of Sydney, was to assess the economic desirability of investing in the development of the Inner Sydney Regional Bicycle Network.[87] For Australia, this study is the first known attempt to estimate the impact of improvements to cycling infrastructure on cycling demand at a (Sydney) network level. The key feature of our demand modelling approach is its ability to model the effects of different types of cycle infrastructure and variations in separation offered by different cycling treatments.

A.7 The economic appraisal indicates that the full development of the Inner Sydney Regional Bicycle Network is economically desirable. The net economic benefits accruing from the development of the Inner Sydney Regional Bicycle Network, over a 30 year evaluation period and discounted at a real rate of 7%, is over half a billion, returning a BCR of around 4:1. The breakdown of the benefits demonstrates the importance of recognising cycling specific benefits. Collectively, health benefits and journey ambiance provide a significant uplift in overall benefits, accounting for 41% of total benefits under the Do-Something Scenario. However, the Inner Sydney Regional Bicycle Network is still estimated to produce a net benefit even when removing journey ambiance and health benefits.

Table A.2: Top ten BCRs under the Do-Something Scenario				
BCR Ranking	**Origin LGA**	**Destination LGA**	**BCR**	**Cumulative Cost**
1	Randwick	Sydney	54.14	2,242,000
2	Marrickville	Sydney	21.29	3,581,000
3	Botany	Randwick	13.99	4,477,000
4	Leichhardt	Sydney	13.24	5,601,000
5	Waverley	Sydney	11.92	8,015,000
6	Rockdale	Sydney	9.20	10,187,000
7	Canterbury	Sydney	5.23	12,410,000
8	Woollahra	Sydney	5.18	13,700,000
9	Botany	Rockdale	5.14	14,501,000
10	Botany	Sydney	5.01	16,365,000

A.8 A mean BCR is 18:1 from these top 10 but 4:1 overall for schemes in Sydney.

Walking and cycling trails in Nebraska, USA

A.9 A US study team analysed walking and cycling trails in Nebraska and reported societal benefits.[88] CBA data were

- The per capita annual cost of using the trails was US$209.28 (£120) (including construction, maintenance, equipment and travel).
- Per capita direct medical benefit of using the trails was $564.41 (£320).
- The cost-benefit ratio was 2.94, meaning that every $1 invested in trails for physical activity led to $2.94 in direct medical benefit (£1.67 for every £1 invested).
- As a result, an active person is calculated to have spent $564 (in 1998 dollars) less on medical care than an inactive person.

A.10 The results indicate that building walking and cycling trails is cost beneficial from a public health perspective, assuming the trail can be used for 10 years or more and that the resource cost of such trails may be outweighed by the direct health benefits alone.[89] Equipment and travelling to and from the trails formed the major part of the cost demonstrating the importance of increasing awareness of the health benefits of physical activity.

Danish bicycle promotion

A.11 A study of a Danish bicycle promotion scheme, using conservative estimates of health benefits, calculated net benefits of 3.1 billion Euros (£2.108 billion).[90] It was assumed that improving infrastructure and continued marketing activities would bring a 50% increase in cycling, associated with a 30% increase in walking across Denmark over 12 years.

Copenhagen, aiming to be World No. 1 Cycling City

A.12 Copenhagen has publicly set out to become the top cycling city in the world. The Danish Ministry of Transport's manual for calculating cost-benefit did not include a method for assessing cycle projects. The City of Copenhagen therefore devised a cycling assessment procedure based on the principles set forth in the manual. From a cost-benefit point of view the investments were particularly sound, giving an equivalent or better rate of return than road construction projects such as the widening of the motorway around Roskilde or a new motorway near Silkeborg.[91]

World Health Organisation - Health Economic Assessment Tool

Cycling figures in hard cash - Denmark

- When a person chooses to cycle this is a clear gain for society of 1.22 Danish Kroner per kilometre cycled.
- Conversely, society suffers a net loss of 0.69 Danish Kroner per kilometre driven by car.
- In cost-benefit terms the health and life expectancy benefits of cycling are seven times greater than the accident costs.
- The cost of a bicycle is 33 øre (0.33 of a Danish Kroner) per cycled kilometre covering purchase price and maintenance. The equivalent cost for a car is 2.20 Danish Kroner per driven kilometre.[92]

Unit: Danish Kroner (DK 1 = GB £0.11 as of November 2012)

A.13 In 2007 the World Health Organisation published guidance on the economic appraisal of health effects related to walking and cycling and a tool to calculate the costs and benefits resulting from cycling interventions – Health Economic Assessment Tool.[93] This was premised on the fact that in recent years, a few countries 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 remained 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.

A.14 Addressing these questions was stated as important in order 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.

Research for New Zealand Government research

A.15 More recently the New Zealand Land Authority commissioned a study to value economically the health benefits of cycling and walking modes.[94] A starting point for the study was the WHO HEAT tool. Elements of several methodologies were integrated and applied by the New Zealand researchers to estimate a value per km that could be easily incorporated into the existing economic evaluation methods. Mortality, morbidity and health-sector costs were all included in the total annual benefits that could be realized by an inactive person becoming physically active. These benefits were weighted and distributed across the average physical activity profile of the population to produce scenarios of an annual benefit per person.

A.16 For cycling this meant a per kilometre benefit of between $(NZ) 1.77 (£0.80) and $(NZ) 2.51 (£1.10). This is comparable to other calculations of benefit, including that generated using the HEAT tool.

A.17 http://www.vtpi.org/documents/walking.php

Barcelona: Bicing - Bicycle sharing scheme

A.18 Rojas-Rueda, et al.[95] quantified the overall health impacts to users from shifting urban driving to cycling, including increases in accident risk, air pollution exposure and improved public fitness. In this case study, the 181,982 Barcelona Bicing public bike rental system users are estimated to experience 0.03 additional annual traffic accident deaths, 0.13 additional air pollution deaths, and 12.46 fewer deaths from improved fitness, resulting in 12.28 deaths avoided and a 77 benefit: risk ratio. This does not account for the additional health benefits from reduced accident risk to other road users or reduced air pollution emissions to other residents. The authors conclude that public bicycle sharing schemes can help improve public health and provide other benefits.

Grabow, et al. (2011)

A.19 Grabow, et al. (2011)[96] estimated annual changes in health outcomes and monetary costs expected from reduced local air pollution emissions and improved public fitness if 50% of short trips were made by bicycle during summer months in typical Midwestern U.S. communities. Across the study region of approximately 31.3 million people, mortality is projected to decline by approximately 1,100 annual deaths. The combined benefits of improved air quality and physical fitness are estimated to exceed $7 billion/year. These findings suggest that significant health and economic benefits are possible if bicycling replaces short car trips. Less car dependence in urban areas would also improve health in downwind rural settings. No CBA/BCR is provided.

Rabl and de Nazelle

A.20 Rabl and de Nazelle[97] estimated the health gain for an individual in switching from car to walking or cycling for a 5 km (one-way) journey 5 days / week, 46 weeks / year (2.5 km for walking). They estimated the health impacts caused by shifts from car to bicycling or walking, considering four effects: changes in physical fitness and ambient air pollution exposure to users, reduced pollution to other road users, and changes in accident risk. Switching from driving to bicycling for a 5 km one way commute 230 annual days provides physical activity health benefits worth 1,300 € annually and air emission reduction worth 30 €/yr. overall. The commuter that switches mode bears additional air pollution costs averaging 20 €/yr, but this cost depends on cycling conditions and can often have the opposite sign if cyclists are separated from major roadways. Calculations include gains to the individual from physical activity and to the general public from reduced air pollution but losses to the individual from increased risk of accidents / injury and greater exposure to air pollution. The public health gain of decreased air pollution was estimated to be €33 / year but individual losses through increased exposure €19 year. Loss due to fatal injury to the individual was costed at €53 / year. Importantly, their data for Paris and Amsterdam imply that any increase in accident risk is at least an order of magnitude smaller than physical activity health benefit. No CBA/BCR provided.

Dane Country, Wisconsin: Building pavements

A.21 In a UK context nearly all urban roads have pavements. In the US as well as in many developing countries this is often not so. Guo and Gandavarapu[98] investigated the benefits of pavements and concluded that the incremental costs of residential sidewalk construction is usually repaid by the health benefits of increased physical fitness and reduced vehicle air pollution. They estimated that building sidewalks on all city streets would increase average daily non-motorized travel 0.097 miles and reduce automobile travel 1.142 vehicle-miles per capita. The increased walking and cycling provided 15 kcal/day per capita in average additional physical activity, predicted to offset weight gain in about 37% of residents, providing substantial healthcare cost savings. The estimated health benefit of $90.93 million and air pollution benefit of $8.23 million yielded a combined benefit value of $99.16 million for year 2002 alone. Based on a conservative service life estimate of 10 years and an annual discount rate of 3%, the total benefit of the county-wide sidewalk construction across the 10-year life cycle was $845.85 million in 2002 dollars. Dividing the total benefits by the total construction cost of $450.8 million gave a benefit to-cost ratio of 1.87, indicating a positive return on investment.

Portland (USA): Bicycle network

A.22 In 2008, the City of Portland estimated the hypothetical cost of rebuilding the entire 274 mile bikeway network at $75. In 2003, the city also initiated the Smart Trips programme which encourages bicycling, walking, and public transport, at an estimated cumulative cost to 2012 of $7.2M. Gotschi [99] estimated that Portland, Oregon's 40-year $138-605 million bicycle facility investments would provide $388-594 million healthcare savings, $143-218 million fuel savings, and $7-12 billion in longevity value, resulting in positive net benefits. Gotschi concluded that the benefit-cost ratios for health care and fuel savings were between 3.8.1 and 1.2:1 (average of 2.5:1) and an order of magnitude larger when value of statistical lives is used. He stated that the CBA of investment in bicycling in a US city showed that such investments were cost effective, even when only a limited selection of benefits were considered.

Table A.3: Compendium of BCRs for Non-UK walking and cycling infrastructure projects

Study	Study focus/location	Benefit to cost	Comment
Gotschi, 2011	Infrastructure in Portland	2.5:1	Hypothetical cost of rebuilding bikeway network
Guo and Gandavarapu, 2010	Benefits of building pavements	1.87:1	US specific focus on benefits of pavement building – possible application in UK to rural roads without pavements
PROMISING, 2000 EU Project	Restrict speed in urban areas.	9:1	Reduce the average risk of accidents by more than 50%.
PROMISING, 2000 EU Project	Separate cycle paths	9:1	Positive effect on safety for both motorized vehicles and cyclists and also benefit traffic flow
PROMISING, 2000 EU Project	Advanced stop lines for cyclists	12:1	Advanced stopping line over the full width of the road also improves safety for cyclists and other traffic

Norwegian cities 2004	Hokksund	4.09:1	Cycle network infrastructure
Norwegian cities 2004	Hamer	14.34:1	Cycle network infrastructure
Norwegian cities 2004	Trondheim	2.94:1	Cycle network infrastructure
Rojas-Rueda, et al. 2011	Barcelona : Bicing – Bicycle sharing scheme	77.1:1*	Major bicycle-sharing scheme and costs inc. from casualties against health benefits
Walking and cycling trails, 2005	Nebraska walking and cycling trails	2.94:1	Off-highway cycle pedestrian routes in Nebraska
Yi, M., Adams, D., Garcia, C., Chandra, P. 2011	City of Sydney	4.1:1	Demand modelling approach to investing in the development of the Inner Sydney Regional Bicycle Network
	Mean	6.28*:1	Simple non-weighted average

* Excludes Bicing study which, with a very high BCR, would provide a substantively different mean figure of 12.72:1

7. Appendix B: Using the World Health Organization's Health Economics Assessment Tool (HEAT) for Walking and Cycling

A.23 HEAT is incorporated within the DfT’s Transport Analysis Guidance (TAG Unit 3.14.1)[100] and its application by local authorities to cycling and walking interventions is now recognized as increasingly valuable in capturing the quantifiable benefits of walking and cycling. The tool is designed to help conduct an economic assessment of the health benefits of walking and cycling by estimating the value of reduced premature mortality that results from specified amounts of walking and cycling as exercise. As a consequence of only including premature mortality and not also illness (morbidity) the tool is conservative in the estimates that it makes. While TAG does take some account of reduced absenteeism due to increased exercise through walking and cycling, WHO have suggested that the benefit may be double if reductions in illness were included.

A.24 The tool can be used for a number of different situations, for example:

- When planning a new piece of cycling or walking infrastructure to help to test the case for investment.
- to value the reduced mortality from past and/or current levels of cycling or walking, such as a single route, as well as across an authority.
- to provide input into more comprehensive economic appraisal exercises (such as large schemes which may impact on walking and cycling levels), or prospective health impact assessments.

A.25 Local Highway authorities may wish to revisit TAG to ensure that they have fully taken account of Unit 3.14.1 (or ask any external consultant teams they use), not least because the evidence of the overall benefits consistently shows that many cycling interventions score very highly in terms of Benefit to Cost Ratios and that as much as 70% of the overall benefit is derived from the health gains. For example, in the DfT assessment of the first six Cycle Demonstration Towns the ‘physical fitness’ benefit was 70.7%.[101] For walking the ‘physical fitness’ benefit also tends to reach similar levels.[102] England and Sweden are examples where the tool has been incorporated into departments for transport recommended methodological approach for estimating the health impact of walking and cycling.[103]

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