Economic Benefits of Accessible Green Spaces for Physical and Mental Health: Scoping study

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Economic Benefits of Accessible Green Spaces for Physical and Mental Health: Scoping Study

CJC Consulting

with

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Contents

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Dr. Liesl Osman wrote the chapter on health benefits and Prof. Ken Willis undertook the economic analysis of health impacts.

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Abbreviations

ADHD	attention-deficit/hyperactivity disorder
ASR	age standardised rate
BMI	body mass index
BTCV	British Trust for Conservation Volunteers
CBA	cost-benefit analysis
CE	choice experiment
CHD	coronary heart disease
CI	confidence interval
COMEAP	Committee of the Medical Effects of Air Pollution
COPD	Chronic Obstructive Pulmonary Disease
CR	crude rate
CUA	cost utility analysis
CV	contingent valuation
CWHP	Chopwell Wood Health Project
EMC	excess morbidity cases
FDA	Food and Drug Administration
GDP	Gross Domestic Product
GHQ	General Health Questionnaire
GOAL	Gateshead Opportunities for Active Lifestyles
GP	General Practitioner
HRQOL	health related quality of life
HSE	Health and Safety Executive
MRS	marginal rate of substitution
NAHDD	number of actual heart disease deaths
NCCDPHP	National Centre for Chronic Disease Prevention and Health Promotion
NHDDIPRA	number of heart disease deaths if all persons were regularly active
NHS	National Health Service
NI	Northern Ireland
NICE	National Institute for Clinical Excellence
NTHSA	National Traffic Highway Safety Administration
PAF	population attributable fraction
PCT	Primary Care Trust
POMS	Profile of Mood States
POS	Public Open Space
POST	Parliamentary Office of Science and Technology
QALYs	quality adjusted life years
QoL	quality of life
RR	relative risk
SF-12	Medical Outcomes Study Health Related Quality of Life Questionnaire – 12 items
SF-36	Medical Outcomes Study Health Related Quality of Life Questionnaire – 36 items
SMR	standardised mortality ratio
SNH	Scottish Natural Heritage
VOSL	value of a statistical life
VPF	value of a preventable life
WHI	Walking the Way to Health Initiative
WTP	willingness-to-pay

Executive Summary

Remit

The overall aim of the study was to investigate the economic benefits, in terms of physical and mental health, of changes in the provision of accessible greenspace[1]. The specific objectives were to:

- Identify the ways in which accessible greenspace may contribute to improvement of physical and mental health.
- Critically review existing relevant research and evidence that is relevant to this area.
- Examine the extent to which associated benefits and costs may be quantified and valued.
- Identify, and provide recommendations on, methodologies for economic valuation of the benefits, in terms of physical and mental health, of accessible greenspace, and the associated costs.
- Identify possible interventions aimed at increasing the economic value of these benefits.
- Set out options for subsequent research.

Context

There is a growing concern in government with the health status of the population and its increasing sedentary lifestyle. 23% of males and 26% of females in the UK are classified as sedentary. The cost of physical inactivity in England is estimated at £8.2bn per year with an additional £2.5bn as the contribution of inactivity to obesity. The Public Health White Paper (Department of Health, 2004a) has, as three of its six overarching priorities, 'reducing obesity', 'increasing exercise' and 'improving mental health'. Greenspace can contribute to the delivery of these objectives.

Health outcomes from access to greenspace

Greenspace is a major resource for physical activity, especially walking, running and cycling. Regular physical activity[2] is highly efficacious as a preventer of illness and as a therapeutic intervention for existing illness. Physical activity is beneficial (*preventative and therapeutic*) for cardiovascular disease, musculo-skeletal diseases, stroke and cancer. Access to and use of greenspace has benefits for *psychological* health but these are more difficult to quantify with the evidence available.

Physical activity and recreation are complementary, in that recreation usually involves some physical activity. It is therefore important that double counting is avoided when appraising the health benefits of greenspace.

Autonomous use of greenspace

People will use greenspace within their own personal strategies for physical activity, and as a psychological resource. The more accessible and attractive the greenspace, the more likely it is to be used by a wide range of people. There is evidence that a greener and tidier environment increases the probability of frequent physical activity and reduces the probability of residents being overweight or obese. Improvement of urban

[1] Greenspace is defined in the study as the non-built environment. It includes both urban and rural contexts.
[2] Physical activity is defined as in Department of Health (2004b).

greenspace has psychological benefit and benefits for social inclusion which are likely to translate into long term psychological benefit.

Generic promotion of autonomous physical activity may be cost-effective because it may stimulate movement along the 'stages of change' in taking up physical activity. However, there is no specific information on this aspect that relates to greenspace.

Health promotion and physical activity programmes

Intervention programmes can improve physical activity levels. Structured health promotion interventions using behavioural intervention techniques geared to individual needs and integrated into regular daily activities are likely to be most effective.

Benefits from the use of greenspace which is not easily accessible, and which is not used on a daily or weekly basis, is more difficult to assess. Medical evidence would suggest that, on its own, this will have a limited effect on physical indicators of fitness, but may have psychological benefits.

Few greenspace-based health programmes have been adequately evaluated and this makes it difficult to use this evidence to draw conclusions on the effectiveness of programmes as health interventions. The change in physical health indicators associated with participation is very small, but psychological benefits appear to be greater. Large-scale surveys are needed which relate greenspace accessibility and use to health outcome measures such as Health Related Quality of Life (HRQOL).

Mortality and morbidity due to lack of physical activity

An alternative approach based on relative risk was used to estimate the excess deaths and morbidity associated with a reduction in the level of sedentary behaviour in the UK population. It was calculated that a 1% unit reduction in the sedentary percentage would save 1,063 lives per year that would otherwise have been lost. If people over 75 are excluded because they are less able or likely to be physically active the figure falls to 343 lives. The same procedure was used to estimate excess morbidity. On this basis a 1% unit reduction in the sedentary population would reduce morbidity cases in the UK by almost 15,000 per year (9,200, if older people are excluded). It was not possible to quantify the benefits from changes in psychological health from greenspace.

Cost-benefit of increased physical activity

Benefits from reduced mortality and morbidity were valued using government estimates of the value of a preventable fatality combined with estimates of medical costs, productivity loss and savings in informal health care costs. The annual value of decreased morbidity and mortality from a 1% unit reduction in the percentage of sedentary people in the UK was estimated at £1.44bn (a mean of £2,423 per additional active person per year). This figure is reduced to £479m if older people are excluded. Seventy percent of the benefit was related to reduced mortality from CHD.

The net benefit from additional greenspace provision or programmes to increase physical activity on existing greenspace depends on provision costs and success in changing sedentary behaviour over the long term.

Economic analysis of greenspace-based physical activity programmes

A number of greenspace-based activity programmes were assessed in order to determine the benefits to participants but a lack of information on additionality, drop out rates and costs limited the conclusions that could be drawn. The potential for significant net benefits from greenspace-related increase in physical activity appears to be substantial if relatively inactive people can be induced to take more exercise over the long term. A physical exercise project using existing greenspace is likely to be cost-effective because it obviates the need for the large capital expenditure associated with gyms. If running costs can be minimised there should be large benefits at relatively little cost.

Gaps in evidence

The main gaps in the evidence on which an economic assessment of health benefits of greenspace can be made are:

1. The value of psychological benefits from greenspace (from physical activity and less active use).
2. Relative risk information for different age groups and the time profile of risks when exercise is continued or discontinued.
3. Information on the benefits from increased physical activity to people who are intermediate in activity between the totally sedentary and those taking frequent physical activity
4. Improved evaluation of activity programmes with measures of health outcomes, drop out rates, additionality and programme costs.

Conclusions

1. A permanent reduction of 1% unit in the UK sedentary population (from 23% to 22%) is estimated to deliver a social benefit of up to £1.44bn per year (£479m if older people are excluded from the calculation). This does not include psychological benefits from greenspace. The evidence on this aspect is limited but benefits may be substantial.
2. Accessible, attractive greenspace is associated with autonomous physical activity. There is evidence that people are more likely to engage in frequent physical activity (with a lower rate of obesity) in locations that have high quality greenspace and a well cared-for environment.
3. Greenspace is most valuable as a physical activity resource where it is used regularly by high volumes of people (mainly in an urban context). It needs to be accessible, attractive, and of sufficient size to facilitate activity (or connect to other areas). Sports fields generally deter undedicated use. Remote greenspace is generally less valuable as a health resource, when assessed in terms of its ability to facilitate high volume and frequent physically active use.
4. Passive use of greenspace (e.g. visual), low-level physical use (e.g. picnicking and social activities) and intermittent or irregular use i.e. not on a weekly or daily basis, is unlikely to give significant physical benefits. However, this use is associated with psychological and quality of life benefits. There is a lack of evidence as to the size of the benefits using validated HRQOL scales such as the gold standard SF-36 or SF-12.
5. There is a general lack of information on the long-term benefits of programmes that encourage greenspace-based physical activity. Data collection in organised programmes is weak and needs to concentrate on additionality, long-term behavioural change (drop out rates) and programme costs including costs to participants. There is a need to incorporate a standardised assessment of physical

activity and brief HRQOL of people entering them. This would provide ongoing baseline data for more extensive follow up studies, and for community studies assessing awareness and willingness to use programmes.

6. The evidence available on activity programmes that use existing greenspace indicates the potential for cost-effective health benefits at low cost if running costs are low. Capital expenditure for woodland or other greenspace--based physical exercise projects is minimal by comparison with gyms and leisure complexes. Much depends on generating additionality by attracting relatively sedentary people into the programmes.
7. The key attribute for classifying greenspace in relation to health is its functionality in relation to physical activity. A dichotomous classification would split greenspace into:
   - That which facilitates physical activity (through scale, attraction and accessibility or through connectedness, including networks of paths); and
   - That which does not.

   With the current evidence base it is not possible to provide a more detailed classification based on the characteristics of greenspace that encourage autonomous use for physical activity. Similarly, it is not possible to classify greenspace according to the psychological benefits it delivers. As the evidence base is extended it should be possible to create a more detailed classification of greenspace in relation to health benefits.

Proposals for further research

Three proposals are made for further research:

1. **Valuing the provision of greenspace facilities for health**. The objective is to assess the factors that would induce sedentary and overweight people to take physical activity in green spaces. A market research type study is proposed using a choice experimental approach.
2. **Estimating the health benefits from the supply of greenspace and its proximity to where people live**. The objective is to assess the feasibility of using National Health Survey data to estimate the contribution of greenspace to mental health, HRQOL and physical activity levels. This is a small scoping study to assess the availability of GIS greenspace information, Health Survey record data and the feasibility of using a logit model to combine these and predict the health benefits of local greenspace provision.
3. **Enhanced monitoring and evaluation of greenspace physical activity programmes**. The objective is to demonstrate improved monitoring and evaluation methods for greenspace-based physical activity programmes by assessing change in physical activity behaviour, health outcomes and economic measures. This is proposed in the context of one or more physical activity programmes and would be collaborative with health professionals.

1 Introduction

1.1 Introduction

There is an increasing recognition of the contribution of greenspace to health in Britain. It is a major resource for physical activity (walking, running, cycling, horse riding etc.). It may also provide a psychological benefit that contributes to mental well-being. Greenspace also contributes to health through improvement of air quality, for example by the filtering by trees of atmospheric pollution. There are thus three potential contexts in which greenspace may benefit health:

- Provision of opportunities for physical activity;
- Provision of a context which has positive benefits for mental health and well-being; and
- Improvement of air quality[3].

1.2 Remit

This is a scoping study which has the overall aim of investigating the economic benefits, in terms of physical and mental health, of changes in the provision of accessible greenspace. The specific objectives are to:

- Identify the ways in which accessible greenspace may contribute to improvement of physical and mental health.
- Critically review existing relevant research and evidence that is relevant to this area.
- Examine the extent to which associated benefits and costs may be quantified and valued.
- Identify, and provide recommendations on, methodologies for economic valuation of the benefits, in terms of physical and mental health, of accessible greenspace, and the associated costs.
- Identify possible interventions aimed at increasing the economic value of these benefits.
- Set out options for subsequent research.

1.3 Health context

There is a growing concern in government with the health status of the population and its increasing sedentary lifestyle. Obesity is a major issue (Department of Health, 2002). The Department of Health (2004b) has reported on the evidence relating to physical activity and its impact on health. It estimates the cost of physical inactivity in England at £8.2bn per year with an additional £2.5bn cost for the inactivity element in obesity. The Public Health White Paper (Department of Health, 2004a) has 'reducing obesity', 'increasing exercise' and 'improving mental health' as three of its six overarching priorities, and an action plan for physical activity (Department of Health, 2005) has been launched. As part of this delivery plan a health concordat has been set up between the Countryside Agency, English Nature, Forestry Commission England, Sport England and the Association of National Park Authorities. This aims to encourage active use of the outdoors to improve people's health and well-being. The network of agencies involved

[3] It was agreed with the steering group that impacts of greenspace on air pollution would only form a small part of the study because the subject had recently been reviewed by Willis *et al*. (2003). Air pollution is considered in Annex I.

will launch a delivery programme in October 2005. There are strategies to increase physical activity to improve health in Scotland (Scottish Executive, 2003a) and Wales (Welsh Assembly Government (2003).

There is no doubt that regular physical activity is highly efficacious as a preventer of illness and as a therapeutic intervention for existing illness. Physical activity is beneficial (*preventative and therapeutic*) for cardiovascular disease, musculo-skeletal diseases, stroke and cancer. Physical activity has not been shown to be *preventive* for all types of mental illness, but there is good evidence that it is *therapeutic* for clinical depression, and for general mental well-being[4]. The Chief Medical Officer's report (Department of Health, 2004b) states that 'mental illness in the form of depression is predicted to become the second most prevalent cause of disability worldwide by 2020'.

The Department of Health (2004b) concentrates on the *preventative effects of physical activity* and concludes that 'for general health, a total of at least 30 minutes a day of at least moderate intensity physical activity on five or more days of the week reduces the risk of premature death from cardiovascular disease and some cancers, significantly reduces the risk of type 2 diabetes and it can also improve psychological well-being'.

Greenspace health benefits may also be derived from improved *psychological* health. Psychological health benefits might include benefits for significant psychological disease such as depression, as well as more subtle benefit in vitality, general mental state, and experience of social inclusion, as found by Kuo *et al.* in their studies of housing projects in America (Kuo & Sullivan, 2001, 2001a). Kaplan & Kaplan (1989) also developed a theory of greenspace having 'restorative' psychological benefit for many people, explaining the preference many people express for access to nature.

1.4 Definition and classification of greenspace

Greenspace is a term normally used in a built or urban context. Kit Campbell Associates (2001) produced a definition and typology of open space (Table 1.1) which subdivides open space into green and civic (non-green) space but places the whole of open space within urban boundaries. Their typology is based on the 'primary purpose' approach, the typology being based on the principal use of the space.

Table 1.1 Typology of open space

<table>
<tr><td colspan="2">OPEN SPACE
Any unbuilt land within the boundary of a village, town or city which provides, or has the potential to provide, environmental, social and/or economic benefits to communities, whether direct or indirect.</td></tr>
<tr><td>GREENSPACE
Any vegetated land or structure, water or geological feature within urban areas.</td><td>CIVIC SPACE
Urban squares, market places and other paved or hard landscaped areas with a civic function.</td></tr>
<tr><td>Parks and gardens
Amenity greenspace
Children's play areas
Sports facilities
Green corridors
Natural/semi natural greenspace
Other functional greenspace</td><td>Civic squares
Market places
Pedestrian streets
Promenades and sea fronts.</td></tr>
</table>

Note: from Kit Campbell Associates (2001)

[4] Extensive reviews of the medical evidence are given in Department of Health (2004b) and Pretty *et al*. (2005). English Nature (2003) has reviewed the positive impacts of nature on psychological well-being.

Planning guidelines in Scotland (PAN 65) now use the Kit Campbell classification of open space (Scottish Executive, 2003). But this definition of greenspace does not account for vegetated land outside a settlement/urban boundary even where it is intimately associated with the urban area (e.g. green wedges and greenbelt).

In planning legislation the concern is more about open space than specifically greenspace since it is open space that provides the contrast with the built environment. Planning Policy Guidance Note 17: Planning for Open Space, Sport and Recreation (PPG17) 2002 states that, 'Open space should be taken to mean all open space of public value, including not just land, but also areas of water such as rivers, canals, lakes and reservoirs which offer important opportunities for sport and recreation and can also act as a visual amenity'.

Scottish Natural Heritage has extended the PAN 65 classification as a basis for mapping open space in Glasgow (Table 1.2).

Table 1.2 Classification used by SNH for mapping open space (sub classes of PAN 65 open space)

1.1 Public Parks and Gardens	
1.2 Private Gardens or Grounds	1.21 Private gardens
	1.22 Schools
	1.23 Institutions
1.3 Amenity Greenspace	1.31 Housing
	1.32 Business
	1.33 Transport
1.4 Playspace for children and teenagers	
1.5 Sports Areas	1.51 Playing Fields
	1.52 Golf courses
	1.53 Tennis courts
	1.54 Bowling greens
	1.55 Other sports
1.6 Green Corridors	1.61 Green access routes
	1.62 Riparian routes
1.7 Natural/Semi-natural greenspace	1.71 Woodland
	1.72 Open semi-natural
	1.73 Open water
1.8 Other functional green spaces	1.81 Allotments
	1.82 Churchyards
	1.83 Cemeteries
	1.84 Other functional greenspace
1.9 Civic space	

A very similar classification to that of Kit Campbell Associates (2001) is used by DTLR (2002) in its 'Green Spaces, Better Places' publication. This does not define greenspace but merely gives a typology of green and civic spaces. Both are subsets of urban open space. Green spaces consist of parks and gardens, provision for teenagers and children, amenity greenspace, outdoor sports facilities, allotments, cemeteries and churchyards, natural and semi-natural urban greenspace and green corridors.

All the above reports define greenspace as a subset of urban open space. This is too restrictive for the present study where it is important to include rural locations since these may make a contribution to health. Instead we define greenspace as the 'non-built environment'. The key greenspace elements in a health context are those that provide for frequent use in terms of physical activity and/or more passive use (including visual use). This includes woodlands, parks, nature reserves, coastlines, canals, lakes, ponds and rivers, cycleways, footpaths and bridleways, public landscaping, gardens and street trees, play areas, public open spaces and commons, and other countryside that is physically or visually accessible.

At this stage it is not possible to usefully classify these various types of greenspace in terms of their role in health. This aspect is reconsidered in Chapter 5.

1.5 Greenspace-based health initiatives and evaluations

A large number of initiatives have been implemented, that encourage the use of greenspace to provide health benefits. The Sonning Common Health Walks (Ashley *et al*., 1997, 1999) provide an early example of a set of walks designed to encourage the more sedentary public in a medical practice to increase their level of walking. More recently some major initiatives have been the "Walking the Way to Health Initiative", (WHI) administered by the Countryside Agency, the "Green Gym" concept, administered by the British Trust for Conservation Volunteers, and the Forestry Commission's "Health Woodland Improvement Grant". There are numerous others run by local authorities, agencies and health care trusts.

The benefits from such programmes can only be estimated when they have been evaluated. Even then the type and level of evaluations differ substantially and few provide the evidence that is required for an adequate assessment of either the medical or economic benefits (see Section 2.4).

The WHI (2005) was established in 2000 with a budget of around £12m and the aim of supporting 200 'walking for health' schemes across England. 557,170 people took part in organised walks under the WHI in the 2003/2004 year. Although there is information on the type of participants (Countryside Agency, 2001), the initiative has yet to be fully evaluated (Ashcroft, 2005) and no information is as yet available on critical parameters including the number of previously sedentary participants, the duration of their involvement or long-term health outcomes. We understand that evaluations of the Bristol WHI programme and an assessment of a number of other health walks have been commissioned by the Countryside Agency.

Similarly, the Interface NRM (2004) evaluation of a Forestry Commission project in the West Midlands mainly reported on the success of the programme in raising awareness but lacked a formal long-term health monitoring element. The health benefits to participants are therefore unknown.

The Green Gym concept aims to encourage people to take part in conservation activities such as tree planting. It has both preventative and therapeutic aims for both physical and psychological conditions. This is a distinctive programme because it both uses and enhances greenspace with a high emphasis on the psychological benefits from activity in a green outdoor environment. This is reviewed in Chapter 2.

Several other initiatives have been evaluated (e.g. Clark, 2004; Regeneris Consulting, 2005) but these evaluations also suffer from a lack of adequate assessment of long-term changes in activity and related health benefits. This generally reflects the cost of detailed assessment and the careful monitoring required. For example, Clark (2004) evaluated the Groundwork programme 'Walkabout Wrexham'. Interviews with participants showed that around two thirds of participants perceived health benefits from participation in the walks. The main reported benefits were in increased psychological well-being. Social benefits almost certainly contributed here because the programme reduced the social isolation of many participants. However, this type of evaluation has no controls, and uses measures of assessment not normally used in medical studies.

Pretty *et al*. (2005) recently undertook a number of case studies to assess the physical and mental health benefits from green exercise. These covered a range of greenspace activities from walking to fishing and mountain biking. Participants were those normally engaging in these activities and were interviewed before and after taking exercise. This study is reviewed in Chapter 2.

1.6 Economic analysis of investment in greenspace provision

Economic analysis of a health intervention (in this case greenspace provision and use) is usually directed at measuring the value of the health benefits and the costs incurred. However, the types of benefit and cost included can very substantially (see also Section 3.5). The two commonest approaches that might be applied to the economic analysis of greenspace for health are:

1. Cost-benefit analysis. The context is society as a whole (public sector and individuals). Benefits would include the value of reduced risk of mortality and morbidity to individuals involved, the value of their increased output to society due to reduced ill health, and health care costs saved). Costs include intervention costs to society (cost to the individual, and greenspace costs to the public sector).
2. Cost-effectiveness analysis. The context is often restricted to (financial) impacts on the public sector because the interest is in cost-effective intervention by government or a health care agency. In this case the analysis is restricted to an assessment of the change in public sector costs (health care and greenspace costs) in relation to an expected or observed health outcome. The cost per unit outcome is then compared with alternative intervention measures. Changes in output and the value of a reduction in health risk would be excluded because these health outcomes are assumed to be the same for all intervention measures being compared.

It is important to note that (2) gives much lower estimates of benefit because this is restricted to health care costs saved or benefits from alternative intervention measures. In this study we concentrate on (1) because the interest is in the total net benefit to society from additional greenspace provision and use.

1.6.1 Literature on the cost-benefit and cost-effectiveness of physical activity measures

Numerous reports quote the costs of treatment of diseases where lack of physical activity is a risk factor and imply that greenspace provision for activity has some economic justification. More detailed economic analysis is sparse because of limited information on health outcomes in relation to changes in physical activity. Swales (2001, using a Relative Risk[5] (RR) approach to assess the benefits from the Northern Ireland Physical Activity Strategy which aimed to reduce the sedentary proportion of the population from 20% to 15%. He calculated the benefit to society from reduced mortality as 121 lives per year, valued at £131m. However, when physical activity was compared

[5] Relative risk is a measure of how much a particular risk factor (e.g. inactive lifestyle) influences the risk of an outcome (e.g. death by age 70). For example, if RR=0.5 for a factor this means that there is half the risk of the specified outcome for persons exhibiting that factor.

with the cost of other interventions (such as influenza vaccinations) in terms of life years saved, it was estimated to be worth only £2.35m per year to achieve the 5% point increase in activity levels.

A small number of other cost-effectiveness studies on physical activity have been reported although these are mainly in an indoor context. Munro *et al*. (1997) evaluated the health benefits from regular indoor exercise classes for the over-65s. They estimated the annual cost and benefit to public sector funds. Annual costs of hall hire and staff were £85 per person. Annual benefits to the public sector, in terms of reduced in-patient costs, based on RR assumptions, were priced at £60 per head. They estimated that the programme cost £330 per life-year saved, and this was considered to be highly cost-effective as compared with a number of other preventive interventions.

Stevens *et al*. (1998) in a controlled trial using a prescriptive exercise scheme found that recruitment and staff costs were high and only 12% of the participants would have benefited from the programme. The cost analysis demonstrated the high cost of making inactive people active but the relatively low cost of increasing activity levels of individuals already showing intermediate levels of activity.

Wang *et al*. (2004) reported on the cost-effectiveness of developing activity trails in Nebraska and noted that autonomous use of greenspace increased with improved facilities (see also Section 2.5.1).

1.6.2 Quality adjusted life years

Quality adjusted life years (QALYs)[6] have been proposed as a comprehensive measure of health outcomes or health related well-being (Garber, 2003). QALYs are analogous to life expectancy but also take into account effects on psychological health and quality of life. But there are problems with defining the preference weights and the probabilities of alternative states of health from which the QALYs are calculated. QALYs have been widely used in assessing the cost-effectiveness of interventions and the National Institute for Clinical Excellence (NICE) is reported to use an upper limit on intervention costs of £30,000 per QALY (Gillespie and Melly, 2003) although this is not being universally applied[7]. Further discussion of QALYs is given in Section 3.5.2 and Annex 1.

In this study we concentrate on identifying the benefits of greenspace for health in an essentially cost-benefit framework, with a change in health state as the single outcome. We have not explored the cost effectiveness of greenspace as compared with other health interventions. Not only would this require cost and outcome data on alternative measures but there are no straightforward substitutes which could act as comparators for greenspace.

1.7 Structure of the report

Chapter 2 reviews measure of health and the evidence for benefits to health from autonomous use and promoted programmes. Benefits of greenspace for health are analysed in economic terms in Chapter 3, and Chapter 4 describes a number of case studies that illustrate the potential health benefits from use of greenspace for physical activity. The final chapter draws conclusions and lists options for further research.

[6] See also Annex II
[7] see Financial Times October 11th 2005 p20.

A number of individuals were consulted during the study (see Annex III) and this widened our knowledge of the evidence available and the provided information on a number of practical health programmes that used greenspace.

2 Greenspace and its benefits for health

2.1 Measurement of health benefits

Health benefits for greenspace users are most reliably measured in terms of the direct effect on health outcomes. The principal outcome measures of health interventions are:

- **Reduced mortality**. Reduced death rates for illnesses such as cardiovascular disease.
- **Reduced physical and psychological morbidity**. This includes reduced diagnosed disease (physical and psychological), reduced contact with health services for treatment of symptoms and disease (hospital admissions, GP contact).
- **Improved Health Related Quality of Life (HRQOL).**
- **Gain in Health Utility and Quality Adjusted Life Years (QALYs).**

Health benefits can also be measured indirectly (and more pragmatically) through health indicators. These are quasi health outcomes. They can only be validly used when change in the health indicator has been found to be associated with health benefit. Some main groups of health indicators are:

- **Change in physical health measures** e.g. blood pressure, Body Mass Index (obesity score), VO_2Max (lung efficiency).
- **Change in mental health measures** e.g. General Health Questionnaire scores, Beck Depression Inventory, hospital anxiety and depression questionnaire scores.
- **Change in health behaviours** e.g. level of physical activity.

Table 2.1 summaries the main health outcomes and a number of indicators that may be used to infer change in outcomes.

Table 2.1 Measuring health

Health outcomes	
Survival (Mortality)	
Morbidity (physical and psychological disease and health service use)	
HRQOL (Health related quality of life)	
QALY (Quality adjusted life years)	
Some health indicators (Quasi health outcomes)	**Type of indicator**
Blood pressure	Physical/physiological
Cholesterol levels	Physical/physiological
Respiratory capacity (VO_2Max)	Physical/physiological
Obesity (Body Mass Index)	Physical/physiological
Beck Depression scale	Psychological
Hospital Anxiety and Depression scale	Psychological
Physical activity	Health behaviour

2.2 Key questions relating to greenspace and health

There are two fundamental questions that need to be answered in the assessment of health benefits from greenspace. These are:

- "Do health promotion programmes which encourage use of greenspace for physical activity show positive effects on health indicators, and/or health outcomes?"
- "Does provision of greenspace lead to improvement in health indicators, and/or health outcomes, even without dedicated health promotion programmes?"

If these can be answered positively then a further step in the analysis is to assess the cost-benefit of intervention to promote existing greenspace or increased greenspace provision.

2.3 Health promotion of physical activity

Physical activity reduces the risk of physical illness including heart disease and stroke, and is therapeutic for depression, the most prevalent mental illness in the UK. The Chief Medical Officer's report (Department of Health, 2004b) produced guidelines for the minimum amount of physical activity needed to obtain physical and psychological benefits. Recommended minimum levels are 30 minutes of at least moderate intensity physical activity a day on 5 or more days of the week. The majority of adult men and women in the UK do not reach these levels of activity.

The report concluded that health promotion interventions can be effective in producing changes in physical activity, from which long term physical and psychological health benefits were likely. Interventions that promoted moderate intensity physical activity, particularly walking, and were not dependent on dedicated exercise facilities such as gymnasiums, were most likely to be associated with long-term changes in exercise behaviour. Interventions were also most likely to be successful if they were individualised (designed to suit the regular activities of a particular person) and based on behaviour change principles. One American study of 7,500 men (Lee *et al*., 2003) found that regular physical activity had coronary heart disease health benefits over a seven year follow up even when it did not reach the ideal minimum level recommended. Physical activity can give health benefits even when it is not begun until middle age or later (Parsons, 2001; Lacroix *et al*.,1996).

The most direct method of health promotion for physical activity is 'physical activity prescribing' where individuals are recommended (by a GP or other health professional) to take part in physical activity programmes. Evidence-based reviews of controlled trials have found evidence for positive but moderate, effects of "physical activity prescribing" on increasing physical activity behaviour over follow-up times of at least 6 months. In one review (Hillsdon *et al*., 2005) of 11 studies (3,409 participants), comparing intervention and control groups, there was a pooled standardised mean difference of 0.31 (95% CI 0.12 to 0.50) on standardised scales of physical activity.

However, although pooled effects for increase in physical activity were significant, they were not high and not all interventions were successful. Furthermore, although physical activity increased, it did not generally reach the levels which were aimed for by the programmes. Seven studies (1,406 participants) found benefit in cardiovascular fitness (pooled standardised mean difference of 0.4 (95% CI 0.09 to 0.70)) but this may not have reached levels which were associated with significant change in long-term health outcomes.

The potential HRQOL benefits of health promotion of physical activity are illustrated by the Glasgow “Walk In to Work Out” study. This was a controlled trial of ‘prescribed walking’ as a replacement for driving to work. At six months the intervention group, who received encouragement and support, was almost twice as likely to have increased walking to work as the control group (odds ratio of 1.93, 95% CI 1.06 to 3.52). Scores for health related quality of life (SF-36) increased significantly in the intervention group (by about 7% on average across subscales). Twenty-five per cent of the intervention group continued active walking commuting at the 12-month follow up. But the study did not examine whether perceived environmental characteristics influenced the likelihood that a participant would take up walking as commuting behaviour. The author of the study comments that the main barrier to walking reported by participants was weather conditions and that there was little mention of physical environment characteristics. (Personal communication. N Mutrie, May 13 2005).

A random telephone survey of 1,400 American adults found that SF-36 scores (HRQOL) were positively related to level of exercise behaviour reported by respondents (Laforge *et al.*, 1999) Several evidence-based reviews have shown that exercise/physical activity is beneficial for clinically diagnosed depression. In December 2004, the National Institute for Clinical Excellence (NICE) recommended in its guidelines for treating depression in primary and secondary care that: ‘Patients of all ages with mild depression should be advised of the benefits of following a structured and supervised exercise programme of typically up to three sessions per week of moderate duration (45 minutes to one hour) for between 10 and 12 weeks.’(National Institute For Clinical Excellence, 2004).

A recent report commissioned by the Mental Health Foundation (Halliwell, 2005) found that GPs wished for alternatives to drug therapy for treatment of depression in primary care, but believed that non-pharmacological treatment options were difficult to access. Forty-two percent of GPs surveyed agreed that some kind of exercise referral was available to them; 15% of these had used exercise as a therapeutic option.

However, exercise referral/physical activity prescribing does not necessarily mean that a programme uses greenspace facilities. Many physical activity programmes use indoor community exercise facilities and are gym based, or use behavioural approaches to build exercise within routine activities, such as in the Glasgow Walk In to Work Out programme.

2.3.1 Health promotion of physical activity: summary of the evidence

- Physical activity is important for health, and intervention programmes can improve physical activity levels.
- Benefit from physical activity is most likely if the programme is integrated into regular daily activities, and does not require use of a special exercise facility.
- Physical health benefit is gained even when the physical activity does not reach the levels recommended by the Chief Medical officer’s report.
- Structured health promotion interventions, using behavioural intervention techniques, and geared to individual needs are likely to be most effective.
- Greenspace provides a possible resource for exercise referral, but exercise referral is not necessarily linked to greenspace facilities. This makes it difficult to draw conclusions about just how important greenspace attributes are for successful prescribing of physical activity.
- It seems likely that people would be more willing to persist in programmes which were based in attractive settings, but there is little direct evidence that this is the

case.

- Because physical activity programmes are organised around daily/weekly activities it is difficult to estimate whether there are benefits from use of greenspace which is not easily accessible, and which is not used on a daily or weekly basis, such as holiday programmes. Medical evidence would suggest that this kind of programme will not have an effect on physical indicators of fitness, but may have psychological benefits.

2.4 Health promotion linked to greenspace

The sizeable body of evidence that health promotion programmes can increase physical activity, which is likely to lead to physical and psychological benefit, does not in itself help in estimating the significance of greenspace for health benefits.

Estimation of health benefits from a medical evidence perspective needs evaluation of programmes specifically linked to greenspace. In the UK, walking and activity programmes of this kind are being carried out under the WHI (Paths to Health in Scotland) sponsored by the British Heart Foundation and Countryside Agency. These initiatives are examples of organised greenspace physical activity.

A medical, evidence based, perspective seeks large scale evaluations using validated health indicators as outcome measures. Ideally these should be randomised controlled trials, but large cohort studies are recognised as giving acceptable evidence. It is not possible to be confident about conclusions drawn from non-randomised trials with small numbers, which use measures which are not well validated. In the UK to date there are only three evaluations of greenspace programmes that have attempted to evaluate health benefits in a controlled way, acceptable as objective evidence of benefit. None really reaches the level of strong evaluation, by medical evidence based criteria. Nonetheless, all of these trials are important as starting points for understanding greenspace benefits. They are the best evidence available to date.

The studies are:

- The Sonning Common health walks initiative (Lamb *et al*. 2002).
- Two evaluations of Green Gym programmes (Reynolds, 1999; 2002).
- Selected case studies of Green Exercise (Pretty *et al*. 2003).

2.4.1 The Sonning Common health walks initiative.

The Sonning Common health walks programme(Lamb *et al*., 2002) has been highly successful as a community initiative and has been evaluated in a randomised controlled trial. The evaluation measured change in health behaviour (activity levels) and change in cardiovascular risk factors but did not measure HRQOL.

Of 260 participants randomised between the health walks group or an ‘advice only’ group 73% completed the trial. Of these, the proportion increasing their activity above 120 minutes of moderate intensity activity per week was 22.6% in the advice only and 35.7% in the health walks group at 12 months (between group difference =13% (95% CI 0.003% to 25.9%, p=0.05), giving an increase of 15% among those who continued to take part in the study. Cardiovascular risk factors remained unchanged.

When those who dropped out were included, using their last known recorded data, the between group difference was only 6% in favour of health walks, which was not statistically significant. The study also shows the problems of enlisting sufficient participants in evaluations of programmes to have statistical power to show that the changes in behaviour were not random fluctuations. The 6% difference found for the

Sonning Common walks would have needed group sizes of more than 800 in each of the activity and the control groups to have been statistically significant.

It can be seen that the control group, who were not offered the opportunity to take part in the programme, sought out other ways of increasing physical activity behaviour, leading to the 'natural ' increase in physical activity among 22.6% of the control group who were not offered participation in the Sonning walks programme.

This illustrates the problem of evaluating benefits of a programme when individuals in a control group are free to seek out alternatives to the programme being studied, leading to an increase in health behaviour in the control group without taking part in the programme. A rigorous critique would argue that the programme has added little to the likelihood of individuals increasing physical activity, (only 6% by comparison with the intervention group) and that the 'advice only' arm is a cheaper way of achieving behavioural change. However, if all active interventions were removed this would then presumably limit the resources available to individuals who are independently developing strategies and seeking resources to increase their physical activities.

2.4.2 Green exercise: The Green Gym programme

The Green Gym programme is a progression from the Sonning Common walks programme. It was developed as a way to encourage sedentary people to become active by taking part in conservation activities, sponsored by the British Trust for Conservation Volunteers (BTCV). The Department of Health supports Green Gym projects. There is also local government funding for Green Gyms. There are more than 60 Green gym projects running in the UK. Green Gyms are free, and open to people of any age, fitness level or ability. BTCV is keen to promote the schemes to people who experience mental health problems, as well as other socially excluded groups.

Green Gym projects can involve improving footpaths, creating community gardens managing local woodlands, or enhancing school grounds. Groups meet regularly at least once a week. Each session is led by a BTCV member of staff who is trained in basic exercise physiology, who supervises participants in safe exercise techniques. Sessions usually last for half a day, but participants can attend for a shorter period if they prefer, and are encouraged to work at their own pace.

As for the Sonning Common walks, Green Gym has been highly successful as a community activity. There are many qualitative reports of benefit, but only two formal evaluations. Oxford Brookes University carried out an evaluation of Sonning Common (Oxford) Green Gym activity (Reynolds,1999) and then of the Portslade (Sussex) Green Gym (Reynolds, 2002). The evaluations assessed physical indicator change, impact on psychological health (using the Hospital Anxiety and Depression scale) and impact on HRQOL using the SF-12, a short form of the SF-36 HRQOL measure. Twenty-three participants entered the Sonning Common evaluation, of whom 15 were available for follow up at six months. Thirty-seven entered the Portslade evaluation of whom 17 were followed up at three months and 13 at six months. In both studies a high proportion of participants were not currently in paid employment (70% for the Sonning Common evaluation and 50% in the Portslade evaluation).

In the Sonning Common evaluation numbers were small. There was a small but statistically significant improvement in HRQOL scores among those who were available for follow up, but the data should be treated with caution given the large drop out from the baseline group The Portslade evaluation also has the handicap of drop out for follow up. It found a marked trend among those who persisted in the Green gym activities for improvement in moderate or severe impairments in anxiety and depression at the three month follow up, measured by the Hospital Anxiety and Depression scale, and mental health scores of participants as measured by the SF-12 scale, but this improvement diminished in the following three months. This rebound effect is not uncommon in mental health interventions. Slight improvements were also found in physical indicators in both studies.

Qualitative interviews with the participants who persisted in the activities found that they valued the activities and considered that they had had a variety of social and psychological benefits from the activities.

Again, the message from the green gym programmes appears to be that they act as a resource which many people find valuable, but that there will be a self selection process resulting in a high drop out rate.

2.4.3 Pretty: Selected case studies of Green Exercise

Mood state can improve among people whose physical fitness improves (measured by aerobic fitness such as heart rate and Max oxygen uptake). DiLorenzo *et al*. (1999) found that psychological state as measured by POMS improved among people taking part in a twelve week programme of physical exercise, compared to a matched control group, and that at one year follow up this psychological befit remained significant..

Pretty *et al*. (2003) carried out a major review of the physical and mental health benefits of green exercise, and reported on 10 case studies. These case studies show that participants were more likely to have a degree than the general population (39% vs. 16%), less likely to smoke (12% vs. 27%), and likely to be at least as physically active as the UK general population. Pretty *et al.* used the EQ5-D to measure Health Status before beginning the programme activity, and found that EQ5-D scores were also close to population average. They also used the GHQ to assess mental health before the activity day and again found scores of participants (median 6) indicated good mental health but there was no longer term follow up to assess extent of change in EQ5-D, GHQ, or change in usual physical activity.

Before and after the day's activities Pretty measured mood through the POS scale and self esteem by the Rosenberg scale. Self esteem was higher among those taking part in most (though not all) of the case study activities at immediate completion of the activity.

However, it is not known if this increase in self-esteem persisted beyond the point of measurement on the day of the activity. If self esteem changes persisted they might be associated with mental health benefits but self esteem was not found to be related to physical health benefit in a large Finnish epidemiological study (Stamatakis *et al*., 2004).

2.4.4 Health promotion linked to greenspace: conclusions

Organised greenspace health promotion of physical activity has the drawbacks of:

- Requirement for trained supervisors to run programmes.
- High drop out rates for participants.
- Less likely to be used by people who are in full time employment.
- Accessibility of greenspace (compared to activities built into the usual activity of participants).

However, all physical activity programmes have the first three limitations, and there is no evidence that greenspace is a worse setting for active programmes than a dedicated sports or exercise facility.

From the qualitative data collected in all these studies it strongly appears that greenspace activities suit some people, and that there are physical and psychological benefits for these people. The change in physical health indicators associated with participation is very small, but psychological benefits appear to be additional to the physical health benefits. However, we do not have data on whether benefits persist when individuals leave the programmes. This leaves unresolved the question of whether health promotion through organised activity in greenspace is cost-effective.

2.5 Benefits from autonomous use of greenspace

2.5.1 Physical activity benefits

Certain types of greenspace are associated with increased likelihood of positive health behaviour even without active health promotion. Large scale studies in Australia (Giles-Corti *et al.,* 2005; Giles-Corti and Donovan, 2002) have found that the likelihood of using Public Open Space (POS) for physical activity increases with increasing ease of access (short distance and lack of barriers such as major highways) but this effect is significantly moderated by attractiveness and size. Thus, POS is most likely to be used for physical activity if it is large (average size of POSs 6 hectares) and physically attractive. 'People with very good access to attractive and large POS were 50% more likely to have high levels of walking, defined as at least six walking sessions per week, totalling 180 minutes'.

Observational study of the POSs referred to in the postal surveys showed that of 772 people observed using the POS 64% were walking or jogging, 12% were cycling and 5% were engaged in organised sport. Interestingly, provision of organised sport areas (e.g. cricket pitches) was negatively associated with rated attractiveness of a POS; all those carrying out organised sport were in low scoring POSs. Giles-Corti concludes that POSs without dedicated sports space are more successful in attracting walkers, joggers and people seeking space for passive pursuits such as picnicking. Attractiveness features which influenced use for walking were trees, water features, birdlife and size. Giles-Corti comments that size appeared to reflect the attractiveness of being able to "lose oneself" in a POS.

In a recent European cross sectional study Ellaway *et al*. (2005) found that higher levels of greenery and lower levels of graffiti and litter in residential environments are associated with being physically active and not overweight and obese. Residents in high 'greenery' environments were 3.3 times as likely to take frequent physical exercise as those in the lowest greenery category. They conclude that efforts to promote activity should take into account these environmental facilitators and barriers. Whilst cross-sectional analysis has limitations, the results support the view of Cabe Space (2004) that 'access to good-quality, well-maintained public spaces can help to improve physical health'.

Wang *et al*. (2004) evaluated the cost effectiveness of developing four walking trails in Nebraska. They found that physical activity increased with the development of the trails. They calculated that the average annual cost per person becoming more physically active as a result of the development of the trails was US$98 (range US$65-253). The cost per user of trails was higher when the target group was persons who are active for general health or for weight loss, because these groups were smaller than the overall user group.

Wang's results and those of Ellaway and Giles-Corti strongly suggest that attractive, accessible greenspace will be used to increase physical activity, and is thus likely to provide health benefits to the users.

On a population basis, mortality and morbidity benefits can be expected from this increased physical activity. There is a lack of evidence which would allow estimation of the likely size of quality of life effect associated with increase in physical activity. Including health status measures in studies similar to those of Giles-Corti and Wang would allow a clearer picture of the cost of quality of life benefit derived from the increased physical activity in greenspace.

2.5.2 Well-being: psychological and quality of life benefits

There are several ways in which experience of nature as more enjoyable than urban environments might have an effect on quality of life. Enjoyment of greenspace might encourage people to carry out more physical activity than they would otherwise do (e.g. a regular walk in a park). Physical activity in itself then leads to improved quality of life, independent of long term benefits in morbidity and mortality. There is also a potential 'restorative' effect of the natural environment which might translate into improvement in quality of life even when the natural environment was only being used passively. As noted above, some people appear to naturally seek to incorporate physical activity into their lives as a self developed therapeutic activity, and greenspace could play an important role as part of the natural strategies developed for physical and mental health.

Studies suggest that people use environmental resources for physical activity as part of their own individual strategies for improving mental health. The Mental Health Foundation (1997; 2000) has found that physical activity is seen by many people as an important strategy for managing mental distress. A study by the National Schizophrenia Fellowship reported that 85% of those surveyed who had used exercise as a treatment found it helpful to them (MIND, 2000). In another study of people who had experienced mental health difficulties 50% felt exercise had helped them to recover (Baker & Strong, 2001).

There is a consensus that exposure to nature can be 'restorative', that is, this exposure provides a satisfying use, and has mental health benefits even when the experience is passive. The classic study quoted for this is Ulrich's 1982 study of faster recovery time for patients whose hospital rooms had 'natural' views, rather than limited views of other parts of the hospital building (Ulrich, 1984). Bodin reported in a small study of runners, that those who ran through urban parks reported more feelings of happiness than those running through streets (Bodin and Hartig, 2003). Heerwagen *et al*. (1995) alternated a clinic waiting room between a large mural depicting a view of distant mountains, clustered trees, and open grassy areas, and a blank wall. He found that patients felt calmer or less stressed on the mural days.

Kuo *et al.* carried out a series of studies on the restorative effects of the natural environment within housing projects in America (Kuo and Sullivan, 2001; Kuo and Taylor et al., 2004; Sullivan *et al.*, 2004). They found that when urban public housing residents were randomly assigned to buildings with varying levels of nearby nature (trees and grass) residents in the less green environments reported more aggression and violence, and had higher levels of mental fatigue. An important aspect of Kuo's study was that the project buildings were uniform; all had originally been provided with green surrounds but over time much of this greenspace had been paved in order to keep maintenance costs down, leaving a range of degrees of greenery around individual blocks. Residents were randomly assigned to blocks and were homogenous in income education and life circumstances. Results indicate that the presence of trees and grass was related to the use of outdoor spaces, in particular the amount of social activity that took place, and the proportion of social to non-social activities.

Thus, greenspace had restorative benefits and benefits for 'social capital' in Kuo's studies. Extent of social participation has also been shown to be significantly positively related to quality of life as assessed by the short form of the SF-36 scale (Savage *et al*., 2003).

Finally, Kuo's group examined the impact of relatively "green" or natural settings on attention-deficit/hyperactivity disorder (ADHD) symptoms across diverse subpopulations of children (Kuo & Taylor, 2004). Parents nationwide rated the after-effects of 49 common after-school and weekend activities on children's symptoms. After-effects were compared for activities conducted in green outdoor settings versus those conducted in both built outdoor and indoor settings. Green outdoor activities reduced symptoms significantly more than activities conducted in other settings did, even when activities were matched across settings. Findings were consistent across age, gender, and income groups; community types; geographic regions; and diagnoses.

In a Swedish study Grahn and Stiggsdotter (2003) surveyed 953 randomly selected individuals in nine Swedish cities on their health and their use of neighbourhood green spaces. Statistically significant relationships were found between access to small scale greenspace (private gardens, allotments or a summer cottage) and self-reported experiences of stress – independent of the informant's age, sex and socio-economic status. The more often a person spent time in an urban open greenspace, the less often he or she reported stress-related illnesses. Time spent in urban parks and public open space was also significantly related to stress, independent of time in one's own garden, although the relative impact of this time on well-being appeared to be weaker than time spent in 'owned' space.

Grahn also examined the effect of a view of greenspace, or access to greenspace at participants' workplace. She found a significant linear relationship between reported well-being and level of greenspace access. Her analysis suggested that having a greenspace view was as significant as having access in reported well-being.

2.5.3 Problems in measuring well-being

Although studies suggest that well-being is increased by greenspace contact, either through its use for physical activity or through its general restorative effect, it is difficult to quantify this benefit because objective measures of Health Related Quality of Life (HRQOL) have not been measured in most greenspace studies carried out so far. This could be done, on a national basis. The 1996 National Statistics Health survey (Department of Health, 1998) gives UK population data on HRQOL (measured by the SF-36) and Health Utilities (measured by the Euroqol EQ5-D). If this National Statistics data could be associated with use of greenspace resources, and levels of physical activity, this would provide useful baseline data.

However, what is more limiting is that there are very few data on change in HRQOL associated with change in contact with greenspace, or increase in physical activity. If HRQOL measures were used in studies such as the Kuo studies, following up individuals in areas which have had greenspace improvement, this would provide important data allowing quantification of HRQOL benefit associated with greenspace improvement.

Thus, before conclusions about health status benefits of greenspace can be made, evaluations that follow change over time are needed.

2.5.4 Benefits from autonomous use of greenspace: conclusions

- People will use greenspace within their own personal strategies for physical activity, and as a psychological resource. The more accessible and attractive the greenspace, the more likely it is to be used by a wide range of people and deliver health benefits.
- Studies are needed which show how greenspace use is incorporated within the variety of strategies people use to maintain physical and psychological health.
- Improvement of urban greenspace has psychological benefit and benefits for social inclusion which are likely to translate into long term psychological benefit.
- More remote greenspace, which is accessed only intermittently, may have psychological benefit through perception of availability as a restorative resource.
- Large scale surveys of HRQOL are needed which relate GIS data and greenspace accessibility to HRQOL.

2.6 Health behaviour change

The implicit framework of the evaluations of greenspace so far discussed has been that benefit of greenspace is assessed through change in health outcomes, associated with change in health behaviour.

However, health behaviour theory postulates that individuals move through a series of psychological changes before fully adopting improved health behaviour. The "Transtheoretical Model", developed by Prochaska and Velicer (1997) identify stages that individuals cycle through as they change health behaviours. These are:

- **Precontemplation**: Precontemplators are not seriously considering changing their behaviour in the next 6 months. They are very resistant to change and deny any need for change.
- **Contemplation/ Preparation**: Contemplators/preparers are considering a health behaviour change. In the preparation stage, some behavioural change has begun.
- **Action**: the individual is carrying out the health behaviour, but it has not yet fully stabilised as a permanent health habit.
- **Maintenance**: In the maintenance stage, people have sustained the behaviour for at least 6 months.
- **Relapse**: People who have been successful in achieving the health behaviour in the past, but are not carrying it out at present.

These stages are cyclic because it is common for people to relapse from a health behaviour, that is, to fail to maintain it in the long-term, and then to re-enter the cycle. This attempt-relapse-attempt cycle is not necessarily a bad sign for ultimately gaining the health behaviour goals. In smoking cessation, for instance, having tried to stop smoking is a positive indicator for success in a new attempt to stop (Lennox *et al*., 2001).

A Canadian government study of physical activity among 2,500 people assessed population distribution through stages of change for physical activity. When level of activity over the past year was assessed for each stage of change, the importance of the cycle of change can be seen (Figure 2.1). Even when the desired level of active physical change had not been achieved, and when people rated themselves as just ‘thinking about’ changing activity levels (the contemplation group) there was a significantly greater likelihood that individuals had achieved minimum guideline levels of physical activity in the past 12 months. The survey found almost no people who were in the 'precontemplation' stage in relation to physical activity. It appears that the overwhelming majority of people perceive physical activity as something which in principle they would like to do.

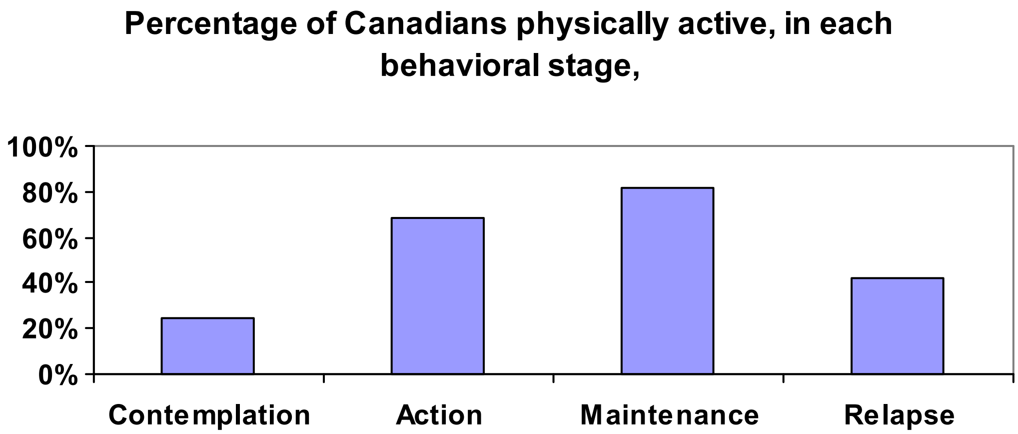

Figure 2.1: Physical activity and stage of behavioural change. (Canadian Fitness and Lifestyle Research Institute, 1995)

2.6.1 Conclusions on health behaviour change

Stage of change theory is important in evaluating use of greenspace. It shows that knowledge of greenspace and intention to use greenspace for activities, may be associated with positive changes in health behaviour and quality of life even before individuals reach their desired level of greenspace use. That benefit may persist although a long period of time has passed since they have used greenspace. This may be particularly important for assessing benefits of intermittent use of remote greenspace and greenspace which is only used at certain times of the year.

2.7 Overall conclusions

- If greenspace activity programmes are to generate evidence on their effectiveness they need to incorporate a standardised assessment of physical activity and brief HRQOL of people entering them.
- Collection of these data would also allow evaluation of the extent to which greenspace is a useful resource for organised physical activity programmes compared to other types of exercise interventions. Some greenspace programmes have high drop out rates. It is not yet known if these rates are less than in non-greenspace exercise interventions.
- Accessible, attractive greenspace is associated with unprogrammed physical activity behaviour by its users. The level of physical activity of many users is likely to be associated with quality of life and psychological benefits, but there is a lack of evidence of the size of these effects, using validated scales such as the gold standard SF-36.
- The Giles-Corti studies show that dedicated sports space in greenspace areas is a discouragement to use of greenspace for individual physical activity.
- Passive use of greenspace (e.g. visually), low level physical use (e.g. picnicking and

social activities) and intermittent or irregular use i.e. not on a weekly or daily basis, is unlikely to give physical benefits. However, this use is associated with psychological and quality of life benefits. Again there is a lack of evidence as to the size of the benefits using validated HRQOL scales such as the gold standard SF-36 or SF-12.

- Greenspace use is likely to be part of a variety of strategies which people use to maintain physical and mental health, and may be an important element in individual strategies even when used intermittently. There is evidence that greener and tidier environments are associated with higher levels of physical activity and reduced obesity.
- Stages of change theory could provide an important framework for evaluating benefit of greenspace. Benefit may be present for people who are in preparation or relapse stages of greenspace use. This is particularly important in relation to people who have entered activity programmes and then dropped out.

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3 Measuring health impacts in economic terms

3.1 Introduction

In this chapter we assess the way in which greenspace-related intervention in health may be measured in economic terms. The emphasis is on benefits from physical activity in preventing illness. As Department of Health (2004b) and the review in Chapter 2 have made clear, quantitative information on psychological benefits is more limited and further research is required before they can be included in an economic assessment.

A number of factors need to be assessed in order to quantify the economic value of greenspace provision for physical exercise, and its use in terms of delivering health benefits:

- The probability of additional exercise with greenspace.
- The health impact of this additional exercise.
- The value of the health benefits of the exercise.
- The costs of greenspace provision.

The proportion of day visits to greenspace is dominated by outdoor sport and leisure (20% of day visits); and by hiking, walking, and rambling (19% of day visits) (Pretty *et al*, 2005). Walking is seen as one of the most beneficial and preferred ways of enhancing physical health and psychological well-being; and walking is seen as an inexpensive policy goal by agencies across the UK: it requires no equipment or expense by the individual apart from transport and is an ideal way for most people to become more active (Pretty *et al*, 2005). It also has a high adherence rate, it is an everyday activity, and it is available to most people.

The impact and value of greenspace for health depends upon the reference point against which the quantity of greenspace is measured. This could be additional green with reference to the current amount of greenspace; or any quantity of greenspace between two points along a continuum from zero to the current amount. In theory the value of greenspace for health should increase at a decreasing rate as more greenspace is provided.

3.2 Probability of additional exercise with greenspace

There is considerable evidence to indicate a correlation between physical activity and the physical environment: the physical design of neighbourhood influences behaviour. For example, Craig *et al.* (2002) investigated the relationship between 27 neighbourhood and environmental characteristics (e.g. variety of destinations, visual aesthetics, traffic, etc.) and data on walking to work, from the 1996 Canadian census. A positive relationship was observed between an environmental score and walking to work, controlling for income, university education, poverty, and degree of urbanization. Similar results were obtained by Frank *et al.* (2005) using a different methodology: a study based on actual observed behaviour of 357 adults, relating physical activity with objectively measured aspects of the physical environment around the participant's home whilst controlling for socio-demographic covariates. Measures of the physical environment, including land-use mix, residential density, and street connectivity, were positively related to the number of minutes of moderate physical activity (mostly walking) per day. 37% of individuals in the highest walkability quartile engaged in ≥30 minutes of physical activity, compared to only 18% of individuals in the lowest walkability quartile.

Individuals in the highest walkability quartile were also 2.4 times more likely than individuals in the lowest walkability quartile of walking ≥30 minutes per day.

Whilst evidence lends itself to the argument that a combination of urban design, land-use patterns and transport systems that promote walking and cycling will help create more active and healthier individuals, more conclusive evidence requires refined measures of the environment and of walking and cycling trips (Handy *et al*., 2002) as well as the health characteristics of individuals induced to participate in walking and other activities as a consequence of the provision of better environmental features. Bedimo-Rung *et al.* (2005) outlined a conceptual model to guide thinking on what park environmental and policy characteristics might enhance physical activity levels. They pointed out that visitation rates to parks to engage in physical activity is related to park features, condition, access, aesthetics, and safety; whilst park activity participation rates also depend upon demographic, socio-economics, and regional characteristics. Inner city and poor residents have lower participation in running and jogging compared to middle income residents.

Parks *et al.* (2003), in a cross sectional study of 1,818 US adults, found that lower income residents were less likely than higher income residents to meet physical activity recommendations. Rural residents were least likely and suburban residents most likely to meet recommended exercise levels. Suburban high-income residents were more than twice as likely to meet recommendations compared to rural, lower income residents. Significant differences in physical activity occurred depending upon neighbourhood streets, parks, and malls as places to exercise, and from those reporting social encouragement to exercise; whilst fear of injury, being in poor health, and dislike of exercise were barriers to exercise. However, evidence of a positive dose-response emerged between the number of places to exercise and the probability of attaining recommended levels of physical activity.

The effect of attractiveness and accessibility of public open space on use for physical activity has also been investigated by Giles-Corti *et al.* (2005) in two studies within the 408 km^2 of metropolitan Perth, Western Australia. Interviews were conducted with 1,803 adults, aged 18 to 59, on access to public open space and physical activity, specifically investigating the effect of distance, attractiveness, and size of public open space. 28.2% of respondents reported using public open space for physical activity. The likelihood of using the open space increased with increasing levels of access. Those with good access to large, attractive open spaces, were 50% more likely to achieve high levels of walking.

The Mayor of London (2004) argued that the provision of bicycle lanes can increase the use of cycles for travel to work and other trips. For example, movement of cycles across the Thames has, since monitoring began in 1996 with the introduction of cycling lanes, risen by 43% to just under 30,000. However, most of the increase appeared to be attributable not to the introduction of a cycling policy and cycling lanes *per se*, but as a response to the introduction of the Congestion Charge in 2003. The number of cycles entering the congestion charging zone increased by 30% within 6 months of the charge being introduced (Mayor of London, 2004). In this case the pricing 'stick' proved much more effective than the provision of cycling lane 'carrots'.

The health outcome of greenspace provision, such as parks or urban woodland, depends upon the extent to which this greenspace results in individuals who previously did not undertake exercise (or undertook an insufficient amount of exercise) now participate in exercise. This cannot be assessed by simply observing how many people use the new greenspace, since some of users may not be in need of additional exercise or they may have substituted exercise in the new greenspace for exercise elsewhere.

Many people undertake recreation both for enjoyment and physical exercise. The value of recreation is therefore likely to encapsulate both a WTP for recreation *per se* and also some WTP for physical exercise. Studies of recreational value do not attempt to disaggregate total recreational value into the utility of its different psychological components (e.g. friendship, exercise, achievement, etc.) Thus the physical exercise or health value *per se* of different forms of recreation is unknown. But there is clearly complementarity between recreation and physical exercise: physical exercise that is recreationally enjoyable is more likely to be undertaken than physical exercise that has no recreational benefits. Designing green space that enhances recreational enjoyment as well as providing physical exercise opportunities is likely to be used by a greater number of people. Because recreation and physical exercise can and often are complementary, it is important to avoid double counting in any appraisal of the benefits of green space.

3.3 Net additional effects of greenspace provision

Isolating the net effect of greenspace requires the identification of:

- Autonomous exercise: that which would have been induced anyway without the additional greenspace: e.g. walking along existing rights-of-way, or due to other effects e.g. government advertising campaigns, etc. (see Section 2.5);
- Created exercise: directly attributable to the greenspace, i.e. that which would not have occurred otherwise (see Section 2.4); and
- Diverted exercise: that which is diverted to the new greenspace but which would have occurred in any case at another location.

It is important to measure the *net additional effect* of greenspace provision by correctly identifying exercise *created* as a result of the greenspace, and eliminating exercise in greenspace that is autonomous (since it would have taken place anyway) or diverted (e.g. from other venues such as streets, existing parks, etc). In the latter case the provision of new greenspace simply results in a displacement effect. It is also important to assess the extent to which ‘created exercise’ participants in the new greenspace are in need of exercise. This may vary by the type of greenspace. Local green spaces may encourage new participants; more distant trails that are classified as ‘moderate’ or ‘hard’ rather than ‘easy’ in walking terms may mainly attract people who are already physically active. This is exemplified in a study by Doust (2003), commissioned by Forest Enterprise. It presented data on calories burned for different body weights for different walking and cycling routes at six sites in Wales, to encourage the use of the forests for exercise. An evaluation of visitors to these sites using the calorie information, revealed that 75% of forests visitors were already habitually active, although 20% were not habitually active but intended to become more active.

3.3.1 Measuring created exercise

Exercise which is ‘created’ (either people who previously did not exercise; or people who now exercise up to some approved prescribed level) can be assessed either through revealed or stated preference methods.

There is a substantial revealed preference literature investigating people’s choice of destination on the basis of recreational attributes at different sites and cost (in time and money) of access; and how the probability of participation and site choice will vary as attributes (e.g. greenspace provision) change. Such studies have investigated recreational day trip destinations of anglers, hunters, swimmers (at beaches), mountain climbers, trail walkers, etc. But they could equally well be applied to more local destination choices to participate in short period walks.

Alternatively stated preference models can be used to investigate the extent to which the provision of a new good (i.e. greenspace) will increase participation in exercise (i.e. the amount of exercise amongst those who already take some exercise; and the extent to which it induces people who previously did not exercise to now participate in some form of exercise). Such stated preference methods could vary the attributes of the greenspace [location, distance from the participant's house, different amenities in the greenspace, and other concerns (e.g. safety)] to determine whether this would induce the participant to participate in a certain level of physical activity.

3.4 Health impact of additional exercise

Current advice from the Department of Health is that people should have at least 30 minutes of moderately intensive activity (e.g. brisk walking) on at least 5 days in a week (POST, 2001). It is estimated that only around 37% of men and 25% of women currently achieve this level of activity (Joint Health Survey Unit, 1999); and that 23% of men and 26% of women were sedentary (took less than one 30 minute period of moderate activity per week) (POST, 2001).

Research (POST, 2001) suggests that for:

- Coronary heart disease (CHD) approximately 40% of deaths are associated with inadequate physical activity; inactive people have nearly twice the risk of developing CHD than active people; and that persuading sedentary people to take regular light exercise (e.g. walking) could reduce deaths from CHD by 14%;
- Stroke: increasing physical activity could reduce the number of strokes by around 25%, although existing data are not conclusive regarding a relationship between physical activity and stroke (NCCDPHP, 1999);
- Cancer: physical exercise is associated with decreased risk of certain types of cancer. The risk of colon cancer is three times higher for sedentary people than it amongst the most active members of the population.

3.4.1 Methods of measuring health impacts

There is imprecision in measurement and considerable variation in the design of studies to measure the health benefits of physical activity; some of which standardise for some confounding effects (e.g. smoking, weight reduction, etc.) whilst others do not. Hence different studies tend to produce differing results. Mean effects are hence often subject to fairly wide confidence limits with respect to the relative risk reduction of death from engaging in regular physical activity (see NCCDPHP, 1999).

Studies investigating the impact of increased physical activity invariably use a population attributable fraction (PAF) to estimate the proportion of deaths, or other measure of disease burden, caused by a particular risk factor. PAF represents the proportion of a disease in the population that could be eliminated if the exposure were removed from the population. Thus, say, for heart disease:

$$PAF = (NAHDD - NHDDIPRA) / NAHDD$$

where NAHDD = number of actual heart disease deaths; NHDDIPRA = number of heart disease deaths if all persons were regularly active. Since NHDDIPRA cannot be directly measured, PAF is calculated by another formula incorporating the prevalence of the risk (*p*), and the relative risk (RR) of those at risk compared to those without the risk.

$$PAF = p(RR - 1) / [1 + p(RR - 1)]$$

where PAF = population attributable risk; RR = relative risk; and p = proportion of the population exhibiting the risk.

The impact of physical activity on deaths, and averted hospital admissions, depends upon the proportion of sedentary people in the population. Swales' (2001) Northern Ireland (NI) study was based upon an estimated 20% of the population being sedentary, and hence at greater risk of premature death or illness from three principal diseases: CHD, stroke and colon cancer. On assumptions about the relative risk from lack of physical activity of CHD, stroke, and colon cancer, he estimated excess deaths due to physical inactivity to be 1,271 due to CHD, 709 due to stroke; and 82 due to colon cancer; or 2062 in total. With a sedentary rate of 15% the respective excess deaths would have been 1031, 600, and 65; or 1696 in total. Since this proportion benefiting from the physical activity policy in NI (as elsewhere in the UK) is unknown, Swales assumed that the physical activity strategy in NI would reduce the sedentary population by 5% units from 20% to 15% of the population: a reduction in 366 deaths (=2,062–1,696).

Tables 3.1 to 3.3 document deaths from CHD, stroke and colon cancer for males and females in the UK in relation to population by age groups.

Table 3.1 UK deaths by coronary heart disease: males and females

	All ages	<35	35-44	45-54	55-64	65-74	75+
Males							
Population	28,581,233	13,420,047	4,334,429	3,854,688	3,061,093	2,300,533	1,610,443
Deaths	64,473	131	950	3,376	8,035	16,426	35,555
Excess deaths	12,055	24	178	631	1502	3,072	6,648
Females							
Population	30,207,961	13,255,941	4,442,961	3,921,713	3,157,716	2,635,541	2,794,089
Deaths	53,003	45	191	735	2,406	8,035	41,591
Excess deaths	10,937	9	39	152	496	1,658	8,582

Source: National Statistics (2002) Census 2001: First results on population for England and Wales. The Stationery Office, London (for population). British Heart Foundation (2004) *Statistics* Database. www.heartstats.org (for deaths by cause, age, and sex) [reports data from the Office for National Statistics (2003). *Deaths Registered by Cause and Area of Residence* (personal communication); Scotland General Register Office (2003), Northern Ireland General Register Office (2003)].

Table 3.2 UK deaths by stroke: males and females

	All ages	<35	35-44	45-54	55-64	65-74	75+
Males							
Population	28,581,233	13,420,047	4,334,429	3,854,688	3,061,093	2,300,533	1,610,443
Deaths	25,538	106	256	685	1,582	4,689	18,220
Excess deaths	2151	9	22	57	133	395	1,535
Females							
Population	30,207,961	13,255,941	4,442,961	3,921,713	3,157,716	2,635,541	2,794,089
Deaths	41,847	89	246	609	1,178	3,854	35,871
Excess deaths	3942	8	23	57	111	363	3379

Table 3.3 UK deaths by colon cancer: males and females

	All ages	<35	35-44	45-54	55-64	65-74	75+
Males							
Population	28,581,233	13,420,047	4,334,429	3,854,688	3,061,093	2,300,533	1,610,443
Deaths	8,588	28	119	474	1,404	2,534	4,029
Excess deaths	1,041	3	14	57	170	307	489
Females							
Population	30,207,961	13,255,941	4,442,961	3,921,713	3,157,716	2,635,541	2,794,089
Deaths	7,619	23	92	320	779	1,664	4,741
Excess deaths	1,028	3	12	43	105	225	640

3.4.2 Relative risk and population attributable risk

The calculation of excess deaths requires an estimate of PAF, which itself requires the RR for each disease. RR is subject to uncertainty: different studies have estimated different RRs for a specific disease. Moreover, the RR depends upon the ‘with-without’ perspective: how much physical exercise takes place to that which would occur in its absence, and without greenspace. For example, for colon cancer, US Department of Health and Human Services (1996) found different RRs depending upon the comparators: RR = 3.6 (95% CI: 1.3-9.8) for least active relative to most active at work and leisure; 1.8 (95% CI, 1.0-3.4) low activity relative to high (work and leisure); and for sedentary relative to active: 1.6 for men (95% CI, 1.1-2.4) and 2.00 for women (95% CI, 1.2-3.3). Some studies adjusted for one of more confounding factors such as age, sex, BMI (body mass index), smoking, diet (e.g. various factors such as energy intake, fibre, protein, fat, etc.) in the calculation of RR; other studies do not. Results also have wide statistical confidence intervals (CI). Thus, some uncertainty surrounds the RR rate to be adopted for CHD, stroke, and colon cancer.

In this study we assume the population benefiting is sedentary; and that the colon cancer RR, for sedentary relative to active, is 1.6 (to account for the probability the population benefiting may not actually become fully ‘active’, but only become irregularly active). The RR of 1.6 is slightly lower than that used by Swales (2001) which was 1.8 for colon cancer; but higher than that employed in some American studies. A RR of 1.4 was used by Walker and Colman (2004) for colon cancer in a study of the cost of physical inactivity in Halifax, Nova Scotia. Swales (2001) used a RR of 2.0 for CHD and 3.0 for stroke. We also adopt a RR of 2.0 for CHD; but for stroke an RR of 1.4. The NCCDPHP (1999) concluded that because of different pathophysiologies, physical activity may not affect ischemic and hemorrhagic stroke in the same way. Thus the NCCDPHP report concluded that existing data do not unequivocally support an association between physical activity and the risk of stroke. Nevertheless some studies have revealed an inverse association between physical activity and stroke. A RR of 1.4 for stroke was also used by Walker and Colman (2004); whilst a stroke RR of 1.6 was used by Bricker *et al.* (2001) for physically and irregularly inactive population. There are no data on RR by age groups, so, following Swales (2001) the same RR from physical inactivity is applied for each age group respectively, for each disease.

PAF was calculated on the above RR for CHD, stroke, and colon cancer, with a sedentary rate of 23% for men and 26% for women. The number of avoidable deaths attributable to physical inactivity is estimated by multiplying the deaths attributable to each inactivity related disease by the PAF for that disease.

The results show that there are 22,992 excess deaths from CHD due to inadequate physical activity; 6,093 for stroke; and 2,069 for colon cancer. How many of these deaths could be averted from increased physical activity from the provision of green spaces depends upon the extent to which green spaces induce physical activity amongst the 23% of men and 26% of women who are currently sedentary. Unfortunately the research on the probability of exercising as a result of the provision of greenspace (e.g. Ellaway et al., 2005) needs to be extended before the effect on reducing the proportion of sedentary population can be reliably estimated.

In itself the provision of more greenspace, or increased access to greenspace, may only induce a small proportion of the sedentary population to engage in physical activity. Moreover, some of those in the sedentary population who actually engage in physical activity due to greenspace may still have a higher RR if the physical activity does not lower their risk to that of the active non-obese population (e.g. because although they undertake some exercise it is insufficient and/or they continue to have poor diets).

If we assume that greenspace provision reduces the sedentary proportion of the population from 23% to 22% for men, and from 26% to 25% for women, then the number of deaths averted are as reported in Table 3.4. Thus, if greenspace only resulted in the proportion of the sedentary males and females in the population falling by 1%, it would have the effect of saving 1,063 lives in the UK that would otherwise have been lost as a result of CHD, stroke, and colon cancer.

Table 3.4 UK deaths averted by greenspace provision reducing sedentary population from 23% to 22% for males, and from 26% to 25% for females.

	All ages	<35	35-44	45-54	55-64	65-74	75+
CHD							
Male lives saved	429	1	6	22	54	109	237
Female lives saved	336	0	1	5	15	51	264
Stroke							
Male lives saved	85	0	1	2	5	16	61
Female lives saved	138	0	1	2	4	13	118
Colon							
Male lives saved	41	0	1	2	7	12	19
Female lives saved	34	0	0	1	4	8	21
Total	1,063	1	10	34	89	209	720

However, it is unlikely that the same proportion of people aged 75+ would either be capable of taking, or could be induced to undertake, the recommended amount of moderate physical exercise five times per week. Hence, following Swales (2001), we might arbitrarily exclude potential physical exercise benefits to these very elderly people. Since the simple PAF or RR calculation suggests most benefits accrue in the oldest age group, excluding deaths averted in this age group has the effect of substantially reducing estimated UK deaths averted due to physical exercise. Excluding deaths averted in the 75+ age group reduces the effect of a 1% unit decrease in the proportion of sedentary population attributable to greenspace, so that greenspace would have the effect of saving only 343 lives from CHD, stroke and colon cancer.

But it is questionable, once people 75+ are induced to exercise, whether health benefits to this age group should be excluded. A study by Brown *et al.* (2000) of different female age groups and activity levels, suggested that low-to-moderate levels of exercise are associated with a range of health benefits for women of all ages. Taylor *et al.* (2004) explore the causal relationships between sedentary behaviour and physical activity programmes and cardiovascular, musculoskeletal, and psycho-social health, independent living and health related quality of life into old age. They conclude that there is growing evidence to support the antidepressant effect of exercise and its role in improving emotional, cognitive, social, and perceived physical function of older adults and alleviating physical symptoms. Munro *et al.* (1997) suggest from available evidence that physical activity for the over-65s is cost effective for the NHS.

3.5 Value of health benefits

The economic benefits from the provision of green spaces can be valued in financial terms to the individual; public exchequer terms with respect to government; and in cost-benefit terms with respect to society as a whole.

The financial benefits to the individual from improved exercise may be quite small relative to the costs to the public exchequer. For morbidity, loss of earnings is reimbursed through social security sickness benefits or company social insurance schemes, and the costs of medical treatment are largely incurred by the National Health Service (NHS) and not the individual. For those retiring early, company pension schemes often offer favourable treatment for early retirement on ill-health grounds. Thus, improved exercise is not fully incentive compliant to the individual financially.

More significant benefits from improved health through greater exercise accrue to the public exchequer. These include public exchequer saving through:

- Lower medical costs (e.g. in the long run fewer GP consultations, hospital outpatient consultations, in-patient days, drugs, medical aids, etc., and other health care cost savings such as ambulance trips, etc.).
- Lower social security costs (e.g. reduced sickness payments, incapacity payments, etc.).
- Increased tax (income, VAT, etc.) and National Insurance revenues (e.g. through people being able to work longer or undertake more physically active jobs).

The benefits and costs to society from avoidable illness and deaths include lost output (present value of lost earning plus any non-wage payments made by the employer, i.e. a human capital appraisal), plus medical costs avoided, plus non-pecuniary benefits and costs to family members and friends through avoided pain and suffering.

3.5.1 Value of a preventable fatality

The human capital approach to the value of avoidable illness and death is based on the notion that morbidity and premature death results in lost output to the economy from that individual. This opportunity cost approach can readily value lost output from the ill health and premature death of economically active people; but clearly under this approach there is no lost output from improved health of the economically inactive (e.g. those retired), since by definition no output is lost by their death.

Nevertheless, the economically inactive still value avoiding the risk of death and illness. Hence the human capital methodology has been replaced by an approach based upon the individual's willingness-to-pay (WTP) to avoid the risk of death or injury. This study employs WTP methodology to avoid the risk of death or harm. It uses estimates of the value of a statistical life (VOSL) saved or the value of a preventable fatality (VPF), and estimates for the value of reduced incidence of illness, as appropriate, that have been established during recent years in the UK.

The VPF was originally established in the mid 1980's when the human capital approach was replaced by a WTP approach to avoid the risk of death. The research by Jones-Lee *et al.* (1985) employed a contingent valuation method to assess the population's WTP for a small reduction in the (already small) probability of a traffic accident and the risk of death in such an accident. The study employed what is now a rather antiquated methodology, even by the Government's own criteria (Pearce and Özdemiroglu *et al.*, 2002), whilst for a significant number of respondents WTP was inconsistent or invariant to the size of the risk change. The standard deviation of the mean WTP value was extremely large. Nevertheless the average WTP value to avoid the risk of death was accepted by the government and has been used ever since (with updating to reflect increases in gross domestic product (GDP)) to value preventable fatalities not only in transport but also, with suitable adjustment, in other sectors of the economy (H. M. Treasury, 2003).

The current VPF for road deaths used by Government is £1.312m (3rd quarter 2003 prices). This includes human cost, lost output, and medical costs (Table 3.5).

Table 3.5: Value of preventable fatality, accidents, and illness

	Description	Values (2003 Q3 prices)
Fatality		£1,312,260
Injury: permanent incapacitating	Moderate severe pain for 1-4 weeks. Thereafter some pain, gradually reducing, but may reoccur when taking part in some activities. Some permanent restrictions to leisure and possibly some work activities.	£207,200
Serious	Slight to moderate pain for 2-7 days. Thereafter some pain/discomfort for several weeks. Some restrictions to work and/or leisure activities for several weeks/months. After 3-4 months, return to normal health with no permanent disability.	£20,500
Slight	Injury involving minor cuts and bruises with a quick and complete recovery.	£300
Illness: permanently incapacitating illness	Same as for injury.	£193,100
Other causes of illness	Over one week absence. No permanent health consequences.	£2,300 + £180 per day of absence
Minor	Up to one week absence. No permanent health consequences.	£530

Source: Department of Transport (2004); Health and Safety Executive (2004). All values are average figures and include human cost, lost output, and medical costs. The difference between the values for a permanent incapacitating injury and a permanently incapacitating illness accounts for the large human cost attributed to injuries due to their short-term effect. The "human cost" (i.e. WTP) element for a fatality is £860,380. There may be some variation in these costs depending on the type of morbidity.

These values were derived in the road accident context. The VPF amount is applied to value avoided deaths in other contexts e.g. by the Health and Safety Executive (HSE) for work related deaths. The VPF figure is weighted to reflect cognitive psychological aversion to different types of death associated with voluntariness of risk, immediacy, knowledge, control over risk, newness of risk, chronic-catastrophic, common-dread, severity of consequences. Thus, for estimates of the benefits from reducing exposure to asbestos risks the HSE currently doubles the VPF figure to allow individual aversion to dying from cancer and the additional personal and medical costs (H. M. Treasury, 2003: Annex 2, para. 33).

However, there is no agreement on how the basic VPF ought to be adjusted to reflect cognitive psychological aversions to different types of death. The HSE, Department of the Environment, Transport and the Regions, Home Office and HM Treasury jointly commissioned research to assess whether the VPF estimate was affected by differing dimensions of risk in different circumstances (e.g. rail accidents, domestic fires and fires in public places relative to road accidents). The dimensions were scale (number likely to be killed in a single event); personal control (how much personal control people have over risks); voluntariness (how much choice people have in being exposed to the risks); media-attention (how much media attention the risks receive); expert-knowledge (how much experts know about the risks); uneasiness (how uneasy people feel about the risks); number-per-year (the number of deaths per year resulting from each of the risks); age-groups-affected (the ages of people affected); and household benefit (the benefits of the safety programmes to respondents and their households). Research by Chilton *et al*. (2002) on this issue revealed that trade-offs between preventing deaths in different hazard contexts were much less pronounced than had been thought (the VFP varied by less than 20% between the different contexts).

3.5.2 Value of health benefits due to physical activity

What needs to be determined is whether the values in Table 3.5 can be used to value excess deaths and reduced illness by engaging in more physical activity. Values are likely to vary according to factors such as dread (of particular risk or type of death), voluntariness, and other factors listed above. Dread effects vary substantially by cause of death. For expected utility maximizers Chilton *et al.* (2005) list these as pedestrian accident 1.0; accident in the home 1.28; automobile driver/passenger accident 1.19; train accident 1.59; fire in public place 0.95; hazardous production plant 1.32; drowning 2.19; and domestic fire 2.03. However, the disutility of these dread effects can be offset by a lower baseline risk, eliminating the case for adding a premium to WTP for the standard VPF.

Two contingent valuation (CV) surveys (in Hamilton, Ontario; and in a national sample of US residents) provide recent evidence on the effect of age and baseline health on WTP for mortality risks. Respondents in both surveys were ≥40 years of age. The study by Alberini *et al.* (2004) found weak support for the notion that WTP declines with age, and then only for the very oldest residents (aged 70 or above). They found no support for the idea that people with chronic heart or lung conditions or cancer are willing-to-pay less to reduce the risk of dying than people without these illnesses. If anything, people with these illnesses were willing-to-pay more.

There is evidence to suggest that the health benefits from the use of greenspace by children could be more valuable than that from adults. Dickie and Messman (2004) estimated that the marginal rate of substitution (MRS) between child and parent illness is about 2, indication that parents value children's illness attributes twice as highly as their own. The MRS was larger for younger children and fell towards unity as the child approached adulthood. This large MRS appeared to reflect parental altruism rather than parent child differences in initial health or illness costs. Parents WTP to avoid their own or child illness increased with income, declined with fertility, and increased at a decreasing rate with duration and number of symptoms, and depended upon perceived discomfort and activity restrictions.

3.5.3 Quality Adjusted Life Years

The Department of Health (2004b) rightly argue that in addition to measuring lives, or year of life, saved, it is important to measure the quality of life. The Quality Adjusted Life Year (QALY) allows the health impact of both life years and quality of life to be expressed in a single measure. QALYs weight life years by the quality of life experienced in those years. QALYs were originally designed to avoid difficulties associated with putting a money value directly on health. Instead a QALY is used to undertake a cost-utility analysis (CUA) as a way of efficiently allocating resources in health care. Thus QALYs can be used to put monetary values on different health states. In the USA $50,000 per QALY is used assess the effectiveness of health care intervention (Hay and Sterling, 2005); whilst in the UK £30,000 per QALY has been adopted as a criterion by the National Institute for Clinical Excellence. The FDA (Food and Drugs Administration) in the USA adds the medical costs of illness to the value of quality of life impacts to determine a total dollar value of the benefits of each health outcome assessed. In the UK, Gillespie and Melly (2003) use a QALY value of £30,000 to estimate the economic value of increased physical activity associated with a 5% increase in physical activity in Scotland. However, the £30,000 value appears to be a cost rather than a benefit estimate of a QALY.

Deriving an economic benefit value of a QALY either involves using a contingent valuation method (CVM) to estimate a specified QALY increase; or converting the VOSL or VPF by annuitizing the VPF over the remaining expected life years. However, the latter procedure appears to contradict the findings of studies such as those by Alberini *et al.* (2004). Moreover, there is no information on whether morbidity values derived from the VPF conform to actual WTP values to avoid these morbidity effects.

Poor health may not only be pain and disability, but also stress and ability to carry out usual activities. WTP values in Table 3.5 take this into account. However, for some cases of CHD and colon cancer, and particularly stroke, the quality of life may be profoundly affected, suggesting the morbidity values for incapacity effects in Table 3.5 should be much higher. In other words Table 3.5 should have a scale of more than three broad categories. Thus the NTHSA (National Traffic Highway Safety Administration) in the USA has a six category scale for injuries and fatalities, which for each category sums injury related costs, non-injury related costs, and quality of life impacts (values), to derive a total cost value for each category. On a relative scale to the VFP, this varies from 0.45% for minor injury (whiplash, bruise, broken tooth), 4.69% for moderate injury (closed leg fracture, finger crush), 9.33% for a serious injury (open leg fracture, amputated arm, etc.), 21.73% for severe injury (partial spinal cord severance, concussion with neurological signs: unconscious for <24 hours), 71.38% for critical injury (complete spinal cord severance, extensive neurological damage), to fatal 100%. If a similar detailed scale in relation to degrees of severity of CHD and stroke in the UK were compiled it would permit a more accurate assessment of the value or cost of different health states associated with physical exercise.

An alternative approach would be to use a QALY value to estimate health benefits of physical exercise attributable to greenspace. A QALY approach would be more relevant if a green-space physical exercise programme only induced the recommended level of physical of physical exercise over a short period (e.g. 6 month or one year), after which the individual returned to his or her sedentary level of activity.

A VPF approach is relevant where the intervention results in a permanent reduction in the risk of death. However, physical activity to the recommended level will reduce the level of risk of CHD and other diseases for sedentary people over the period in which the exercise takes place. After this period the physical risk of CHD, stroke, and colon cancer reverts to the relatively higher risk for the sedentary population.

The value of a QALY needs to be related to benefits people derived from improved health, and not a cost that NICE will not exceed. QALYs would measure the physical exercise benefits of green-space as one full QALY for each death averted, plus a part QALY for improved health of those moving from a sedentary state to a physically active state.

Unfortunately there is no significant consensus on how to calculate the value of a QALY; hence there are significant variations in the value of a QALY. Hirth *et al* (2000) has revealed how, for the USA, from a meta analysis of 42 studies on the value life, the median value of a QALY varies from US$24,777 (human capital), $93,402 (revealed preference: non-occupational safety), $161,305 (CV estimates), and $428,286 (revealed preference: job risk) depending on the approach adopted.

Deriving the value of a QALY from the VPF in the UK, assuming a life expectancy of 32 years, provides a QALY value of £40,445 (in 2004 prices) (Mason *et al.*, 2005), although higher values can be derived using this approach depending upon the assumptions made. Such a value is much higher than the £30,000 value used by NICE.

3.6 Effect of exercise on morbidity rates

Morbidity statistics are more difficult to collect than mortality statistics. There are more stages of morbidity than mortality: GP consultations, GP referrals, hospital diagnosis, outpatient treatment, and in-patient treatment. GP diagnoses or referrals may be false positives or false negatives, as may the results of hospital tests and consultations, and therefore may not end up as treatment cases.

3.6.1 Incidence of morbidity

The incidence of CHD and stroke by age and sex are reported by the Office for National Statistics (2000) from a sample survey of 211 GP practices, with 1.4 million patients (2.6% of the population), in England and Wales (Table 3.6). Cases of CHD and stroke were defined by diagnostic criteria, treatment criteria, or both. The CHD case criterion was patients who had a diagnosis of CHD ever-recorded i.e. were diagnosed in any year up to 1998 and who were receiving treatment with aspirin, or drugs, during 1998. Stroke cases were patients who were recorded as having a stroke during 1998. The rates of CHD and stroke by age groups were applied to the UK population age distribution to derive estimates for the UK as a whole. These are presented in Table 3.6.

The same procedure was used to estimate excess morbidity, as that used to calculate excess mortality. It was assumed the same RR, prevalence or risk, and proportion of sedentary population moving from inactive to active would pertain for morbidity as for mortality. On this basis the excess morbidity cases (EMC) are those documented in Table 3.6 If greenspace results in the proportion of the sedentary males and females in the population falling by 1% unit (from% to 22% for males; and from 26% to 25% for females) then this would have the effect of reducing morbidity cases in the UK by 14,414 for CHD and by 445 for stroke. Again, excluding those aged 75+ from the analysis reduces these estimates to 8,910 for CHD and 224 for stroke.

Table 3.6: Prevalence of coronary heart disease and stroke by age and sex (UK)

Age	0-34	35-44	45-54	55-64	65-74	75-84	85+	CR	ASR
CHD males									
rate/1000	0.1	4.9	30.2	94.5	184.0	230.5	233.8	42.0	37.2
No. cases	1,342	21239	116,412	289,273	423,298	299,744	72,486		1223,794
EMC	9	142	776	1,928	2,821	1,997	483		8,155
CHD females									
rate/1000	0.1	1.7	13.0	49.3	111.5	166.6	180.0	32.4	21.9
No. cases	1,325	7,553	50,982	155,675	293,863	329,879	146,524		985,802
EMC	8	48	324	988	1,,866	2094	930		6,259
Stroke males									
rate/1000	0.2	0.5	1.2	3.5	8.1	16.3	20.5	2.3	2.0
No. cases	2,684	2,167	4,626	10,714	18,634	21,197	6,356		66,377
EMC	9	7	16	36	63	71	21		223
Stroke females									
rate/1000	0.2	0.4	0.9	2.0	5.4	11.3	20.4	2.2	1.4
No. cases	2,651	1,777	3,530	6,315	14,232	22,375	16,606		67,486
EMC	9	6	12	21	47	74	55		222

Source: Office for National Statistics (2000) for rates; 2001 Population Census for age distribution. CR = crude rate (all ages); ASR = age standardised rate (all ages) EMC = excess morbidity cases. Number of cases and EMC are estimates.

Table 3.7 presents the 1-year survival numbers for people diagnosed with colon cancer, by age and sex, for England. Again the same procedure as for CHD and stroke, and assumption on the proportion of the sedentary population impacted by greenspace, was used to estimate excess morbidity for colon cancer. Extrapolating these excess morbidity cases (EMC) to the UK as a whole suggests that, on the basis of the assumptions adopted, physical exercise attributable to greenspace would result in 68 fewer male cases of colon cancer and 69 fewer cases of female colon cancer, or 137 fewer cases in total. Excluding those aged 70+ from the analysis reduces this estimate to 35 for males and 31 for females, or 66 in total.

Table 3.7 Colon cancer morbidity by age and sex, 1992-94 England

Age	15-39	40-49	50-59	60-69	70-79	80-99	Total
Males	213	630	1,798	4,085	4,357	1,858	12,941
EMC	1	3	8	19	20	9	60
Female	194	635	1,605	3,472	4,476	3,026	13,408
EMC	1	3	7	16	20	14	61

Source: Office for National Statistics (2003).

3.7 Value of decreased morbidity

The economic costs of CHD are high. Lui *et al.* (2002) and the British Heart Foundation (2005) have estimated the cost of CHD at £7,055 million per year in 1999 prices. This comprises £1,730 million in terms of health care costs, and £5,325 million in terms of production and/or informal health care costs. However, £701.2 million of this was attributable to production loss due to mortality, and some of the health care costs will also be incurred on patients who subsequently do not survive. Inpatient care at £917.2

million, and medication at £582.4 million, comprise the two largest items of health care costs. Total medical costs (£1,730 million) divided by the number of CHD occurrences (2,209,596) is £783 per CHD patient. So, if greenspace induced physical exercise such that the proportion of sedentary males and females in the population fell by 1% unit (from 23% to 22% for males; and from 26% to 25% for females) then this would save £11.286 million in medical costs per year associated with CHD; or £6.977 million (=8,910*£783) if people aged 75+ are excluded.

Increased physical activity will also induce reductions in productivity loss due to morbidity (estimated to be £2,207 million per year in 1999 prices) plus savings in informal care costs (estimated to be £2,416 million in 1999 prices). This amounts to (a mean of) some £2,903 per CHD incident. If it is assumed that greenspace results in 14,414 less CHD incidents, then the reduction in productivity and informal health care costs amounts to some £41.845 million per year; or £25.866 million (=8910*£2903) if the population aged 75+ is excluded.

The welfare value from improvements to health due to physical exercise is likely to be larger than the above estimates. The above estimates are based on costs incurred as a result of CHD, not people's WTP to avoid CHD. A more accurate estimate of the benefit of reduced morbidity from CHD would be obtained by mapping the value of people's WTP to avoid different degrees of severity of CHD. This could be approximated by using the values in Table 3.4 for example. This would require statistics on the proportion of CHD incidents with varying severity, medical, and disability conditions. Unfortunately such statistics are not available.

The direct health care cost of stroke to the UK has been estimated to be £1,655 million (British Heart Foundation, 2005). Dividing these medical costs by the number of stroke occurrences (133,863) gives a cost of £12,363 per stroke patient. This presumably reflects the longer care treatment time for stroke patients. There are no estimates for productivity costs and informal care costs for stroke, but these are also likely to be very substantial per patient compared to CHD costs. So, again, if greenspace induced physical exercise such that proportion of the sedentary males and females in the population fell by 1% unit, this would save £5.5 million (=£12,363 * 445) in medical costs per year associated with stroke; or £2.769 million (=224*£12,363) if the population aged 75+ is excluded.

It has been estimated that the hospitalisation costs of each colon cancer patient are £3,000 (Health First Europe, 2005). There would be additional medical costs to the health service in terms of General Practitioner time and costs that might add say another £650 per patient. If so, this would suggest savings in medical costs of around £0.5 million for reduction in the prevalence of colon cancer. The new drug 'Avastin' might prove an alternative to surgery for colon cancer treatment, but this would initially be likely to increase medical costs (treatment is estimated to cost £2,400 per month with treatment over 10 months).

3.8 Summary of mortality and morbidity benefits of physical activity

The benefits of increased physical activity due to greenspace for CHD, stroke, and colon cancer, increase the probability of immediate survival. Unlike reductions in air pollution due to greenspace (see Annex I) the effect of physical exercise on CHD, stroke, and colon cancer, is not to simply add one, two, or three months on to a person's life at the end of his/her life. It affects the probability of survival now. Hence the appropriate valuation approach is similar to the case for valuing mortality and morbidity as a result of road accidents.

Table 3.8 presents a summary of possible benefits of greenspace provision with respect to reductions in mortality and morbidity, assuming greenspace induced physical exercise such that proportion of the sedentary males and females in the population fell by 1% (from 23% to 22% for males; and from 26% to 25% for females).

Table 3.8 Annual value of health benefits from a 1% unit change in the sedentary population (£m) (UK)

	Mortality		Morbidity		Total	Total**
	Cases (no)	Cost (£m)	Cases (no)	Cost (£m)	Cost (£m)	Cost (£m)
CHD	766	1005.19	14414	41.85	1047.04	372.31
Stroke	223	292.63	445	*5.50	298.13	60.51
Colon cancer	74	97.12	137	*0.50	97.62	46.18
Total	1,063		14,996		1442.79	479.00

* indicates that costs are initial medical costs only and do not include long term treatment costs and more importantly lost output (wages) as a consequence of being partially or wholly incapacitated.
** total excluding those aged 75+ for CHD and stroke and 70+ for colon cancer.

The value ranges from £479 million to £1,442 million per year depending on whether older people (75+) are excluded or included in the analysis. This range can be regarded as a minimum set of values for two reasons. First, for stroke and colon cancer morbidity the health value is for savings in medical costs only, and does not include other benefits such as reductions in lost working time (e.g. wages). Second, the morbidity benefits should be based upon people's WTP to avoid contracting these diseases. Typically such an approach to valuation produces higher estimates of benefits than simply counting medical costs saved and lost wages. Unfortunately due to a lack of information both on the severity distribution of the incidence of CHD, stroke, and colon cancer across the population, and information of people's WTP to avoid these different degrees of severity, it is not possible to operationalize this approach at the current time.

These benefits of increased physical activity are larger than those estimated by the Government Strategy Unit (2002). The 'Game Plan' estimated the total cost of physical inactivity in England to be £1.89 billion per year. This was based upon direct health care costs of physical inactivity, loss of earnings due to sickness absence, and earnings lost due to premature mortality. Set against these benefits were sports injury[8] costs of £996 million per year, giving a net benefit of around £500 million per year from eliminating physical inactivity in England. The difference between the 'Game Plan' estimates and those in this report can be partly explained by the methodology adopted (estimates in this report are based on WTP to avoid the risk of death and illness, and these will be significantly greater than lost earnings), and geographical coverage (UK in this report compared with England in the 'Game Plan').

3.9 Cost of provision of greenspace

The economic cost of provision of greenspace schemes to improve health through increased physical activity will vary enormously in different schemes.

[8] We have not adjusted our benefit estimates for the costs of injury associated with the use of greenspace. Since the predominant activity is walking these costs are expected to be relatively minor.

Many schemes use existing greenspace. The economic cost for this type of scheme can be quite small. The greenspace is regarded as a ‘public good’ with zero opportunity cost of consumption. Hence there is no capital cost, only a small variable cost to implement the scheme. Such a scheme may simply consist of the provision of information in printed or web site form documenting walking routes through green spaces.

Where greenspace is created for physical activity costs will be much greater. Such greenspace provision will incur a direct cost: both capital cost, and variable costs for maintenance. Alternatively the greenspace could be evaluated in terms of an opportunity cost: the opportunity foregone of using the land for greenspace rather than some alternative urban use. These costs are likely to vary significantly depending upon location (region of country and location within urban areas). Of course such greenspace is likely to provide additional benefits other than health: e.g. amenity and landscape benefits, which will be reflected in higher house prices and rental for houses and properties in proximity to green spaces. These benefits should be included in any CBA of the policy or individual greenspace project.

3.10 Conclusions

- A relative risk approach to assessing the benefits from physical activity indicates that a 1% reduction in the UK sedentary population would reduce mortality by 1,063 cases per year and morbidity by almost 15,000 cases.
- Conventional methods of benefit valuation imply a total social benefit of at least £479 million and possibly £1.44bn per year from a permanent reduction of 1% unit in the sedentary population. This value range may be underestimated but depends highly on the value ascribed to a preventable fatality.
- The net value of additional greenspace or programmes to increase physical activity on existing greenspace depends on provision costs and success in changing sedentary behaviour over the long term.
- The evidence suggests that there are positive mental health outcomes from access to greenspace. This element is not included in the assessments made here.
- Further research is needed to determine whether the psychological benefits from greenspace (from physical activity and visual use) can be quantified in economic terms using a relative risk approach.

4 Case studies in greenspace use

4.1 Introduction

The previous chapters go some way towards providing a basis for assessing policies and programmes associated with greenspace use and provision to improve health. The focus has been mainly on enhanced physical activity as a preventative measure in reducing the risk of certain diseases. It was beyond the scope of this study to determine whether the psychological benefits from greenspace use (physical or visual) or the therapeutic value of greenspace for a variety of conditions including mental illness can be evaluated in economic terms. This would probably require the use of health outcome measures such as HRQOL or QALYs since the risk data on mortality and morbidity relating to mental health conditions are limited.

The relative risk approach coupled with valuation estimates for mortality and morbidity appears to be the only feasible approach for analysing the cost and health benefits of greenspace provision and use at present. QALYs and HRQOL measures need further investigation and may have potential for future use in cost effectiveness analysis.

4.2 Appraisal of net benefits from policy intervention

The UK population of 59.6m consist of 29.2m males and 30.4m females. A 1% unit decrease in the sedentary population means that 596,000 individuals become active. The benefit from shifting these to the active state was estimated conservatively (excluding the over-75s) to be to be £479m per year in Table 3.8. The social value per person moved to an active state is thus around £800 per person per year[9]. This is the benefit to society from reduced risk of mortality and morbidity. This is also the break-even programme cost to society, including costs to participants and organisational costs, if the programme is assessed solely in terms of health benefits.

In the following sections we analyse the health benefits, as far as possible in economic terms, from a number of actual greenspace-related programmes. The key intermediate outcome in a walking programme is the number of people involved who change from a sedentary to a long-term active state. The value of the health benefit can then be compared with the programme costs. Most existing greenspace is a public good for which the costs associated with increased use are minimal or zero.

4.2.1 New activity provision on greenspace (trails in Glen Tress Forest Park, Peebles)

The previous reviews have shown that activity levels on new greenspace will be greatest where it is accessible to population centres, attractive and where it offers scale through size or connectedness. Displacement effects will be least where the existing greenspace stock is limiting activity. Since purchase of urban land for greenspace creation is costly, the most cost-effective approach is likely to be through connecting existing areas to create cycle ways and walking routes.

We take an extreme example based on a study of trail making for walking and mountain biking in Glen Tress (CJC Consulting, 2004). In this case the annual use visits numbered 250,000 walkers and 70,000 bikers. To assess the health benefit using the

[9] This is a mean across the population. The value may be higher for the higher age groups that are most likely to take part in walking programmes. However, relative risk data are not available for different age groups. Without these a detailed age-based analysis cannot be undertaken.

method of Chapter 3 requires knowledge of the numbers of additional regular users following trail making whose behaviour has been changed to active from sedentary. This is unknown so no concrete cost-benefit can be undertaken. However, let us assume that a modest 1% of the walkers and bikers have become 'active' as a result of the trail making. At a conservative £800 benefit per year (see above and the caveat of Footnote 9) the total health-related benefit is around £2.56m per year for these 3,200 users. Many users will also derive recreational and social benefits from their visits for which separate benefit estimates are not available. However, personal travel costs to users should be deducted and these would not be insignificant for remote sites like Glen Tress. Even so, with annual costs to the Forestry Commission, including annualised investment costs, of £234,000 it is clear that the investment does not have to achieve a high level of behavioural change to be cost-effective.

4.2.2 Walking programmes

In this section we attempt to assess three examples of actual walking programmes in north-east England. They all use existing greenspace and encourage people to walk more than they would otherwise do.

The Radio Ramblers

This group comprises 92 members, 2 of whom are junior members. Approximately 50 to 55 members participate in each walk. A walk is organised once per fortnight. Walks occur in rural areas, and a private hire bus is used to transport members to and from the walk. All rambles involve countryside walks typically over a distance of 7 to 10 miles, occasionally including woodland walks. Walks take place at varying country locations in the Lake District, Northumberland, Durham and Yorkshire. Urban green spaces do not feature in the walks of the group, since urban green spaces are regarded as being too limited in size for longer distance walks; whilst walks along urban street and roads are considered unattractive and lacking challenge and interest.

The bulk of the membership (60) is aged between 55 and 65. No one in the group could be described as 'over-weight'; and all are physically active in some way.

The health benefits of the fortnightly walk are probably marginal; the group members are not sedentary nor over-weight and the 'additionality effect' of the group is small, in the sense that if the group did not exist its members would join other similar groups and walks. However, the countryside and existing rights of way in the countryside play an important role in the walks of the group. The opportunity cost (of consumption of these rights of way) is zero. If these rights of way were not available members of the group would stop walking.

Age Concern (Gateshead) (The Rainbow Ramblers)

This group of approximately 90 walkers is organised through 'Age Concern'. They meet every other Tuesday for a 2 to 4 hour walk at different locations within Tyneside. All walks have to be accessible by public transport, and many commence and finish at a Metro station.

About 3 in 5 walks involve walking through some form of greenspace. The greenspace walks tend to be through more attractive green spaces e.g. Jesmond Dene (with its stream, trees, and attractive winding path) rather than across Newcastle Town Moor which is just open grassland.

Approximately half of the group attend each walk. About 20% of members are aged 55 to 65; with the remainder being 65+. A few members of the group have part time jobs; but the majority are retired. None of the group could be classified as 'over-weight'. Most engage in additional walks of up to 2 hours duration at least once per week; and a few are also members of other rambling groups, and participate in longer walks (4 hours to 6 hours) one day per week. All tend to be people with interests who could not be described as 'sedentary' or 'couch potatoes'.

The health benefits of the fortnightly walk are therefore probably marginal, since group members are not sedentary nor over-weight, participate in other walks, and would probably substitute another walk if the group did not meet. However, greenspace plays a role in the walks of the group. Existing green spaces are used, so the opportunity cost (of and production and consumption of the greenspace) is zero. The only cost (apart from the monetary and time cost of participants attending the walk, which must be less than the benefit they derive from it, otherwise they would not participate) is a group leader reconnoitring the walk beforehand.

Chopwell Wood Community Health Project

The Chopwell Wood project aims to improve health, by providing a range of physical, and stress relieving, activities within a woodland setting. Participants are recruited:

- By referral through local health care professionals and GPs.
- From five Derwentside primary schools.

Clients attending local GP surgeries with health problems (over-weight, obesity, and other conditions; all of which would benefit from physical exercise) can be referred to the Chopwell Wood Health Project (CWHP) following the GP medical consultation. The referral period lasts for 13 weeks, within which the client can attend prescribed activities at a reduced price (£1.35 per visit), after which the client pays the full public fee of £3.25 per visit (Powell, 2005a). The CWHP also accepts "self-referrals" by members of the public, who also pay the reduced price of £1.35, after a medical consultation. Activities include walks, cycling, Tai Chi, and conservation activities.

Stage 3 and 4 pupils from 5 primary schools are offered 4 visits per year, as multi-curricular visits, with physical activity being combined with history, geography and science lessons.

The CWHP attracted around 170 referrals (to 1st June 2005), of which 30 were referrals by 4 local GPs. The remainder were mainly attracted through the Gateshead Opportunities for Active Lifestyles (GOAL) programme, a joint initiative between Gateshead Primary (Health) Care Trust and Gateshead Council; with some self-referrals. The age of the clients is predominantly late 40s, with the youngest being 22 and the oldest being 68 years of age. Referrals are mainly to address problems of obesity, high blood pressure, and diabetes.

Out of the 30 GP referrals, 12 completed the full 13-week course, with the remainder dropping out at some point during the course (Powell, 2005b). A monitoring and evaluation report on the CWHP is due to be completed in August 2005. Evaluation will be undertaken for four mutually exclusive categories of client:

1. Those participating but deemed by a GP not to be in need of exercise.
2. Those referred and deemed to be in need of exercise by a GP, but who do not engage in the programme.

3. Those referred and deemed to be in need of exercise by a GP, and who engage in the programme but do not complete it.
4. Those referred and deemed to be in need of exercise by a GP, and who engage in and complete the programme.

The greatest impact of the CWHP has centred around cycling and Tai Chi. Bikes and cycling equipment are provided, and rides are along traffic free roads, engendering confidence compared to cycling along roads with significant amounts of traffic. As a result of their experience in the CWHP cycling programme, 6 people purchased cycles, which clearly indicates a life-style change; and more have purchased cycling equipment, suggesting that they may also purchase cycles in the future and engage in a more significant life-style change. Tai Chi takes place in a community centre, but many enquiries have been made about when, weather permitting, it will transfer outside to the woodland. People participating in this activity clearly see amenity benefits of performing the activity outdoors. On the other hand, many Tai Chi group members are already members of Tai Chi groups, so the additional benefit of the CWHP may be more marginal with respect to this activity.

Activities are run by volunteers, and meetings for each activity are typically held once every two weeks. The CWHP is more concerned with infusing enthusiasm for physical activity, which the client continues either in Chopwell Wood or at some other venue after the completion of the course, rather than the 13 week course itself solving a particular health problem at that point in time. An evaluation of this type of greenspace project clearly needs to monitor over a subsequent period of 1 or 2 years whether the client is still continuing with some form of physical activity.

The size of the benefits attributable to the CWHP are critically dependent upon the assumptions about the *ex ante* and *ex post* health of those completing the CWHP. Those referred to the CWHP by GPs are mainly obese and in need of physical exercise; but without detailed patient records their degree of obesity could not be established, nor whether and how many suffered from high blood pressure, diabetes, etc., and hence the impact that physical exercise would have on their future well-being. We assume that the 12 who completed the CHWP continue with exercise as a result of the programme; and postulate that the effect of the CWHP is to return participants from having an above average Standardized Mortality Ratio (SMR) to the average SMR of people in that age group (50 to 70 years old).

The impact of obesity on SMRs for different age groups has been documented by Bender *et al.* (1999) in a study of age and obesity in Dũsseldorf. No excess mortality was associated with a body mass index (BMI) of at least 25 but less than 32 kg/m^2, for the 50-74 age group. But SMRs did increase significantly in higher BMI categories for those aged 50-74. So health benefits in terms of reduced mortality would really flow to CWHP participants who are moderately or severely obese, and who lost weight in addition to taking physical exercise.

Population death rates are about 10 per 1000 for the 50-70 age group. Epidemiological data suggests that the effect of physical activity is to reduce CHD risk by up to 60%. On the other hand a review of physical activity programmes by Hillsdon *et al.* (2005) concluded that although these programmes were likely to improve physical activity levels, they usually failed to achieve the levels of improvement specified by health recommendations. Hence the death rate may not decline by as much as 60% for CHD. On the other hand CWHP type programmes will also lower the probability of death from stroke and colon cancer. So, overall, a CWHP type programme might save between 2 and 6 lives per 1000 from the programme.

Thus, assuming physical activity saves between 2 and 6 lives per 1000, the expected preventable fatalities from the first cohort of 12 participants who completed the CWHP will be between 0.024 and 0.072 lives saved. At £1.3 million per life saved the expected (capitalized) health value of the CWHP will be between £31,200 and £93,600 for mortality reductions. In addition there will be some expected savings in medical costs from morbidity and avoided production losses due to reduced absence from work from the other participants on the programme.

The initial 13 week cohort really represents only one-quarter of a year's output. So in appraising the CWHP it is important to make some projection of benefits in the future (i.e. the health benefits of a continuing flow of participants). The costs of the CWHP will include some capital costs in addition to continuing variable costs directly related to the number of participants. The size of any benefit/cost ratio for the CWHP will depend on the size of future benefits in relation to initial capital costs and continuing running costs.

Of course, considerable uncertainties exist with respect to estimates of health benefits. It was not possible for this study to ascertain the obesity and BMI of those referred; nor whether participants continued exercising to levels specified in health recommendations, after completing the scheme. There might also have been an autonomous increase in physical activity: individuals may have joined another exercise scheme not associated with woodland. A more accurate evaluation of the CWHP clearly requires information from the medical records of individual referrals on the illness for which they were referred, and the seriousness of the illness (i.e. the probability of the individual's death without the exercise). It also requires some monitoring of participants over time after they have completed the CWHP course. This presumably will be documented in the report by the Gateshead PCT on the CWHP. However, there is evidence to suggest that participants in an intervention group were almost twice as likely to increase physical activity as a control group (without physical exercise encouragement) six months later, and 25% of the intervention group who received an information pack were regularly active 12 months later (Mutrie, *et al.*, 2002).

But if physical exercise based on forest and woodland attracts greater participation, appeals to a certain type of sedentary and overweight person who would not otherwise exercise, and generates greater exercise and weight loss amongst participants, then the health benefits, across the country, of woodland could be significant in terms of reduced mortality and morbidity.

A woodland-based physical exercise project using existing greenspace is cost effective because it obviates the need for large capital expenditure to build gyms and running costs that gym and leisure complexes incur. Capital expenditure for the woodland-based physical exercise projects is minimal by comparison with gyms and leisure complexes, and running costs are low when activities are led by volunteers. Thus schemes such as the CWHP may deliver large benefits at relatively little cost. Moreover, the wood has the capacity to cater for a larger number of clients in need of physical exercise with only minimal increases in running costs.

4.3 Conclusions

- There is a general lack of information on the long-term additionality of exercise programmes and greenspace provision for physical activity.
- Data on the costs of promotion and provision of physical activity programmes, and

personal costs to participants are also not generally available.

- There is a need to measure health (including psychological), social and recreational benefits in programmes and to better understand the processes of behavioural change relating to physical activity change.
- The above indicate that better monitoring and evaluation procedures are needed for exercise programmes if the outcomes are to be useful for the assessment of health outcomes, and costs and benefits in economic terms.
- There appears to be the potential for significant net benefits from greenspace-related increase in physical activity but success depends critically on context, additionality and the persistence of behavioural change.
- There is little information on how programmes should best be targeted to make them most cost-effective. Targeting of sedentary individuals already taking limited exercise and referrals from surgeries are probably most cost effective.
- Generic promotion of autonomous physical activity may also be very cost-effective because it may stimulate movement along the ‘stages of change’ as has occurred with smoking cessation (see Section 2.6). However, there is no information relating to greenspace.

5 Conclusions and proposals for future research

5.1 Conclusions

1. A permanent reduction of 1% unit in the UK sedentary population (from 23% to 22%) is estimated to deliver a social benefit of up to £1.44bn per year (£479m if older people are excluded from the calculation). This does not include psychological benefits from greenspace. The evidence on this aspect is limited but benefits may be substantial.
2. Accessible, attractive greenspace is associated with autonomous physical activity. There is evidence that people are more likely to engage in frequent physical activity (with a lower rate of obesity) in locations that have high quality greenspace and a well cared-for environment.
3. Greenspace is most valuable as a physical activity resource where is used regularly by high volumes of people (mainly in an urban context). It needs to be accessible, attractive, and of sufficient size to facilitate activity (or connect to other areas). Sports fields generally deter undedicated use. Remote greenspace is generally less valuable as a health resource, when assessed in terms of its ability to facilitate high volume and frequent physically active use.
4. Passive use of greenspace (e.g. visual), low-level physical use (e.g. picnicking and social activities) and intermittent or irregular use i.e. not on a weekly or daily basis, is unlikely to give significant physical benefits. However, this use is associated with psychological and quality of life benefits. There is a lack of evidence as to the size of the benefits using validated HRQOL scales such as the gold standard SF-36 or SF-12.
5. There is a general lack of information on the long-term benefits of programmes that encourage greenspace-based physical activity. Data collection in organised programmes is weak and needs to concentrate on additionality, long-term behavioural change (drop out rates) and programme costs including costs to participants. There is a need to incorporate a standardised assessment of physical activity and brief HRQOL of people entering them. This would provide ongoing baseline data for more extensive follow up studies, and for community studies assessing awareness and willingness to use programmes.
6. The evidence available on activity programmes that use existing greenspace indicates the potential for cost-effective health benefits at low cost if running costs are low. Capital expenditure for woodland or other greenspace--based physical exercise projects is minimal by comparison with gyms and leisure complexes. Much depends on generating additionality by attracting relatively sedentary people into the programmes.
7. The key attribute for classifying greenspace in relation to health is its functionality in relation to physical activity. A dichotomous classification would split greenspace into:
    - That which facilitates physical activity (through scale, attraction and accessibility or through connectedness including networks of paths); and
    - That which does not.

    With the current evidence base it is not possible to provide a more detailed classification based on the characteristics of greenspace that encourage autonomous use for physical activity. Similarly, it is not possible to classify greenspace according to the psychological benefits it delivers. As the evidence base is extended it should be possible to create a more detailed classification of greenspace in relation to health benefits.

5.2 Gaps in evidence

Gaps in the evidence base on which an economic assessment of health benefits of greenspace can be made are listed below:

1. Quantitative information on the relative risk impacts of greenspace on mental health and well-being such that the value of psychological benefits from greenspace (from physical activity and visual use) could be derived.
2. Relative risk information for greenspace/physical activity impacts relating to different age groups in the population and the time profile of risks when exercise is continued or discontinued. This is needed to identify the cost-effectiveness of physical activity introduced at different stages in the life cycle.
3. Information on the benefits from increased physical activity to people who are intermediate in activity between the totally sedentary and those that satisfy the Chief Medical Officer's 30 minutes a day, 5 times a week standard (Department of Health, 2004b).
4. Direct evaluation information with appropriate measures of health outcomes, drop out rates, additionality and programme costs, from greenspace-based activity programmes on a scale sufficient to give statistically valid results.
5. The allocation of personal welfare benefits from the use of greenspace as between health, recreational and other social benefits.
6. Evidence on how the quality and quality of greenspace affects autonomous use, and how people incorporate greenspace within the variety of strategies they use to maintain physical and psychological health.
7. Alternative or supplementary bases for economic analysis such as QALYs and HRQOL measures.

5.3 Options for future research

We propose three different types of research each of which would contribute to the evidence base on the health impacts of greenspace. We have concentrated on research that falls within our area of profession competence. We have accordingly not made proposals for research on the measurement of psychological health benefits from physical activity and greenspace, despite the fact that such research is clearly required.

1. Valuing the provision of greenspace facilities for health.

Context: Physical activity programmes need to change sedentary behaviour yet the best routes for achieving this are little understood.

Objective: To assess the factors that would induce sedentary and overweight people to take physical activity in green spaces.

Method: This might best be undertaken through a market research type study. This could be in the form of a choice experiment (CE):

- Administered through a Community Health Project such as the Chopwell Wood

Health Project, to people deemed by GPs and other experts to be in need of physical exercise.

- Population generally in an area to capture the increased probability of different categories of obese and also of non-obese people to take additional exercise (i.e. those not referred through GP programmes).

The factors for both samples might include distance to greenspace, type of green space, attributes of the green space, whether there was an organised programme of exercise, types of physical exercise offered, equipment provided, discussion or information of diet and exercise, cost to participant, etc. Often statistically significant results can be obtained in CEs with quite small samples of respondents e.g. 50. Three or four such small samples could be administered around the country to account for different locational contexts (e.g. inner urban, suburbs, rural areas, etc.). The preferences of different groups in society could be also be analysed in the CE if a stratified random sample were adopted so that a sufficient number of observations were represented in each of the sub-groups of interest.

The data from the three of four case studies could also be pooled for the analysis. Such a study would not only estimate the number of participants engaging in physical exercise for health reasons to existing green spaces, and also how this number would increase as different facilities were provided in the greenspace. It would also permit an estimate of the value of each facility so that a financial cost revenue analysis could be undertaken to set along side a CBA using government VPF estimates and estimates of the value of avoided morbidity to the health service, the economy, and the individual.

This study could be extended to obtain a greater understanding of personal physical activity strategies among different types of people who use different types of greenspace. The Giles-Corti framework of classifying greenspace characteristics and relating to physical activity could be used but we propose the incorporation of SF-36 or SF-12 measures. Such a study would provide detailed information on the attributes on green space that induce physical activity. In addition to this stated preference study, there would also be considerable merit in undertaking an observed behaviour study of the impact of green space on health, outlined in Project 2 below. This would be better able to investigate the impact of green space on psychological well-being.

2. Estimating the health benefits from the supply of greenspace and its proximity to users

Context: There is a lack of evidence relating data on psychological well-being, and access to greenspace. However, the General Health Surveys of the Department of Health which have been carried out annually since 1991 are based on post code sampling. In 1994 the health survey assessed physical activity and mental health (using the GHQ and self reported psychiatric self) and in 1996 the health survey used the SF-36 and Euroquol questionnaires. The full (anonymised) datasets for the Health Survey are available through the Data Archive at Essex University.

Objective: To assess the feasibility of using National Health Survey data for estimating the relative contribution of greenspace to variation in mental health, HRQOL and physical activity levels.

Method: It is possible these data could be used to estimate the contribution of proximity to greenspace (and to different types of greenspace) to mental health and quality of life, and the contribution of greenspace proximity to likelihood of achieving the nationally recommended physical activity levels. Case study areas could be selected with different types of greenspace (using simplified Giles–Corti criteria such as size, structure etc). If a proximity variable based on post codes was developed it could be linked in the health survey data to individual data using logistic regression techniques to assess the relative contribution of proximity and type of greenspace to spatial variation in GHQ scores, SF-36 and Euroqol scores, and reported physical activity levels. The data sets provide socio-demographic information which could be used to adjust for variation among respondents.

The same approach could be used to assess the ability of greenspace to account for variation in physical activity since this is also recorded in the Health Survey dataset. Taken together the models should allow the impact of greenspace supply and proximity to place of residence on both psychological physical health to be determined. The suggested proposal depends on the availability of a number of datasets.

We therefore propose an initial limited feasibility study to assess:

- The supply of GIS mapped greenspace information;
- Suitable measures of greenspace supply and proximity;
- The availability of Health Survey data in the Data Archive; and
- The performance of the logit model linking greenspace to health outcomes.

3. Enhanced monitoring and evaluation of greenspace physical activity programmes

Context: The lack of satisfactory monitoring of most physical activity programmes on greenspace. The outcome is that it is difficult to evaluate programmes in terms of their costs and benefits (health outcomes in physical and economic terms). Given the importance of the health agenda and the current investment in activity programmes there is a strong case for much larger studies that would give greater statistical power and precision in analysing the results.

Objective: To demonstrate improved monitoring and evaluation methods for physical activity programmes by assessing change in physical activity behaviour, health outcomes and economic measures.

Method: This is proposed in the context of one or more greenspace-based physical activity programmes proposed by partners in the health concordat. It would be collaborative with health professionals.

A minimum requirement would be at least 300 participants in green exercise programmes with a six month monitoring of their activity. On entry participants would complete a validated physical activity questionnaire, such as the International Physical Activity Questionnaire (IPAQ), the SF-36 HRQOL questionnaire, and the Physical Activity Stages of Change questionnaire. These measures would be repeated at six months for all those who began the programme, including drop outs.

In this way the study would measure the additionality of the programme and provide valid measures of the health outcome. Monitoring of costs to participants and programme organisation would be required to complete the cost-benefit assessment.

The inclusion of the stage of change questionnaire would allow assessment of (i) how far the programme increases physical activity (rather than merely transfers patterns of activity) and (ii) effects of the programme on physical activity intention of participants who had dropped out. Stage of change research suggests that even brief apparently 'unsuccessful' participation may increase positive health behaviour.

A study of this kind would address the problems identified in the review of previous UK evaluations. i.e. small numbers leading to lack of statistical power to show that behavioural and quality of life changes are significant (Reynolds, 2002) and lack of follow up to show that psychological benefits persist beyond the day of carrying out the activity (Pretty, 2003).

6 References

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7 Annex I: Air Pollution

The provision of greenspace provides additional benefits to those of opportunities for physical exercise. Plants absorb and capture pollutants through the stomata (pores on the surface of the leaf), and on leaf/needle and bark surfaces. The effect of greenspace on pollution absorption depends on the urban pollutant activity foregone (i.e. the land-use that would otherwise have occupied the land), and the type of plant cover embraced by the greenspace: trees, and shrubs to a lesser extent, absorb more pollution than grass. The layered canopy structure of trees, which has evolved to maximise photosynthesis and the uptake of carbon dioxide, provides a surface area of between 2 and 12 times greater than the land areas they cover.

The Committee of the Medical Effects of Air Pollution (COMEAP), set up by the UK government found the strongest link between health and pollution was associated with particulates (PM_{10}), sulphur dioxide (SO_2) and ozone (O_3) (Department of Health, 1998). A study by Powe and Willis (2004) assessed the benefits of SO_2 and PM_{10} absorption by trees in terms of extending life expectancy of the population and reducing hospital admissions. Working at a resolution of 1km^2 with woodland over 2 hectares, and using an epidemiological model, it was estimated that, for Britain as a whole, pollution absorption by woodland of SO_2 and PM_{10} saves between 5 and 7 deaths, that would otherwise have been brought forward, and between 4 and 6 hospital admissions each year.

The health impact of air pollution absorption is to change an individual's length of life, typically increasing it by a few months (it is usually estimated to be 1 to 3 months). A recent longitudinal study by Rabl (2003) estimated that the mortality of adults > 30 years old was 330 per million persons for a 1 μg/m^3 increase in PM_{10} per annum over expected lifetime. Thus Rabl (2003) estimated that a permanent reduction in PM_{10} by 15 μg/m^3, would increase life expectancy by about 4.5 months. To put this in perspective, typical concentrations of PM_{10} in urban areas in England are around 20 to 30 μg/m^3, and the average reduction in PM_{10} attributable to trees in 1 km grid squares with trees in England is 0.049 μg/m^3. Hence the effect of woodland on air quality is quite small.

WTP for health improvements from reductions in air pollution are evaluated differently from WTP to reduce the probability of being killed in a road accident or the probability of avoiding CHD, stroke, and colon cancer. It is argued that people would not be willing-to-pay the conventional VPF amount for extending their life, which may already be in a pretty poor health state, by one to three months. Moreover, since this health benefit occurs many years in the future, it has been argued that this benefit should be discounted back to the present. Cropper and Sussman (1990) estimated the value of changes in the conditional probability of dying in the context of a life-cycle consumption-savings model. They show that an individual's WTP at age 40 for a change in his conditional probability of dying at age 60 is what the individual would pay at age 60 for a change in his probability of dying over the next year, discounted back to age 40. This suggests that reducing exposures to carcinogens with latency periods or pollutants whose main effects are not likely to be felt until later in life will yield substantially smaller benefits than reducing exposure to substances with immediate effects. This effectively reduces the benefit substantially. Thus the Department of Health (1999) raised VPF for air pollution to £2 million, because it was an involuntary risk which people would pay more to avoid, but then reduced the value to account for values such as age, impaired health status, etc. (see Table 8.1).

Table 8.1 Adjustment of air pollution VPF by supplementary factors (£ millions, 1996 prices)

Factor	Calculation	VPF	Justification
Age	£2 * 0.7	£1.400	WTP >65 years 0.7 mean value of population
Reduced life expectancy	£1.4 * 1/12	£0.120	Reduction of 1 year of average life expectancy beyond retirement age
Reduced life expectancy	£1.4 * 1/12 * 1/12	£0.010	Reduction of 1 month of average life expectancy beyond retirement age
Impaired health status	£0.120 * 0.7/0.76	£0.110	Lower quality of life (QoL) than average elderly population (0.76) and with COPD with rated QoL 0.4 (std. 0.2-0.7)
Impaired health status	£0.120 * 0.2/0.76	£0.032	Lower quality of life (QoL) than average elderly population (0.76) and with COPD with rated QoL 0.4 (std. 0.2-0.7)
Risk, wealth, income, socio-economic status			No adjustment advocated
Futurity	5yrs : 95% 10 yrs : 90% 15 yrs : 86% 20 yrs : 82% 25 yrs : 78%		Mortality occurs at some time in future after first exposure to air pollution. Thus, future risk reductions benefits are valued at current rates discounted by pure time preference rate (1%)

Source: Department of Health (1999).

A similar conclusion was reached in a study by Chilton *et al.* (2004) for Defra to ascertain how much people were willing-to-pay for reductions in health risks associated with pollution. Using A CV format, different sets of respondents were asked their household's WTP, on an annual basis for the rest of their lives, for (i) gaining *X* months of life expectancy in normal health; (ii) gaining *X* months of life expectancy when elderly and in poor health; (iii) avoiding hospital admission with breathing difficulties; and (iv) avoiding 2 or 3 days of breathing discomfort every year. Combined (trimmed mean) values to avoid all four effects were £153, £146, and £167 for an extra month, three months, and six months, respectively. *X* was randomly varied at 1, 3, and 6 months across respondents. Trimmed mean annual household WTP to extend life expectancy by 1 month was £60, and for 6 months £81, for normal health; whilst it varied from £16 to £17 respectively for additional time in poor health. The report strongly recommended that the value should be based on the one month sub-sample response, giving a capitalised value for one month in normal health of £27,630 per case per household; and £1,310 to avoid hospital admission and £1,280 to avoid 2 or 3 days of breathing discomfort.

Using the values from the Department of Health (1999) Powe and Willis (2004) estimated economic value of the health effect of pollution absorption of woodland to be less than £900,000 per year. However, this was only for woodland over 2 hectares. Smaller areas of woodland, located closer to population and pollution sources, will generate additional air pollution absorption benefits to those estimated by Powe and Willis (2004). And grassland will absorb some pollution relative to built forms that might otherwise occupy the greenspace. Nevertheless, the health benefits of pollution absorption by green spaces is likely to remain relatively small in comparison to potential improvements in health due to the use of such green spaces for physical activities.

8 Annex II: HRQOL and QALYs as measures of health benefit.

HRQOL (Health related quality of life) and **QALYs (Quality Adjusted Life Years)** measures were originally constructed for use in clinical trials to answer the question of whether a change in a physical indicator such as improved blood pressure levels was perceived by patients as translating into an experienced benefit in their every day health experience.

HRQOL measures are sets of questions which ask respondents to agree or disagree with statements about their health state over the last month or longer. Responses are added to provide a score for health dimensions. The gold standard HRQOL is the SF-36. Its sub dimensions are Physical Functioning, Physical role performance, Social Functioning, Social Role Performance, Mental health, Pain, Energy and vitality and Overall assessment of health).

QALYs are derived from utility scores for specific health state on a continuum between, for example, 0 (= death/total disability) and 1 (= perfect health). Thus, a health state of limited physical ability but no mental health disability might have a utility index of 0.8. If accompanied by mental health disability its utility score might be 0.5.

The utility scores for each health state are arrived at through large scale population surveys asking people to locate a described health state on the continuum from death/total disability to perfect health. The basic idea of a QALY is that one year of perfect health-life experience is worth 1, and one year of less than perfect health is adjusted by the utility score for the health state of that year. Thus if an intervention moves a patient's usual health state from 0.6 to 0.8 in health utility score that patient gains 0.2 Quality Adjusted Life Years for each year they spend in the new health state. The gold standard QALY measure is the EQ5D questionnaire which uses five questions to categorise health states: Level of Mobility, Level of Self care, usual activity level, Pain, Anxiety/Depression.

QALY measures are appropriate when measuring change in physical health from an intervention, particularly when this is reduction of physical disability, and when comparing relative costs of interventions to give health gain.

QALY disadvantages are

- They cannot be used to compare populations.
- They are not sensitive to small changes in fairly healthy populations.

HRQOL measures are more sensitive to overall health change than QALY measures and more sensitive to psychological improvement, and can be used to compare populations.

HRQOL disadvantages are

- HRQOL scores do not have 'worst state' 'best state' anchor points: the meaning of an HRQOL is seen by comparing it to scores of the general population.
- HRQOL scores have not been suitable to quantify 'life year quality' gain in the way that QALYs can. However, recent research has developed algorithms for making translation from change in SF-36 scores to QALY gains.

9 Annex III: Consultees

Hugo Crombie	Health Development Agency
Dr.Jenny Bywaters	National Institute for Mental Health in England (NIMHE)
Linda Seymour	Mentality
Leonard Almond	BHF National Centre for Physical Activity and Health, Loughborough University
Peter Ashcroft	Countryside Agency
Lesley Burns	Research & Evaluation Division, NHS Scotland
Veronica Reynolds	Countryside Agency
Vanessa Ashby	Sport England
Dr Charlie Foster	British Heart Foundation Research Group, Division of Public Health & Primary Health Care, University of Oxford
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