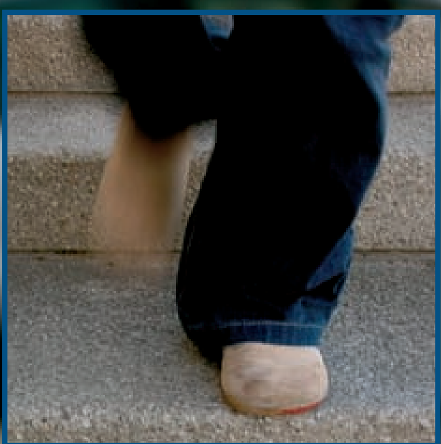
Institute for European Environmental Policy

Unfit for Purpose:
How Car Use Fuels Climate Change and Obesity



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August 2007

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Executive Summary

Before the 20th century, most people in the UK were reliant on their own motive power to travel around – either on foot, or latterly by bicycle. The development of the steam engine and the internal combustion engine in turn brought powered travel to a wider public, though still mainly in the form of public transport, which continued to cater for the larger part of all personal travel until well into the 1950s (Department of Energy, 1987). Only some time after the Second World War did growing affluence and mass production techniques begin to bring the private car within the price range of ordinary working people, thereby setting in train a switch from muscle power to fossil fuel use that has continued virtually uninterrupted ever since.

This study assesses the contribution of this growth in car travel to the decline in human energy expenditure and consequently to the parallel growth in obesity in the UK; and at the same time calculates the contribution to climate change through carbon dioxide emissions as car travel has replaced walking. Through this exploration the study has sought to demonstrate that two of the main challenges facing the UK in health and environment have common origins and some common solutions.

The report first reviews the evidence base on adult obesity. Much of the focus of discussion to date has been centred on food (ie energy intake) as the driving force at the root of this epidemic. Prentice and Jebb (1995) was a key exception, as they concluded that the low levels of physical activity prevalent in Britain were likely to play an important, perhaps dominant, role in the development of obesity, by greatly reducing energy needs from food. This conclusion has found support in a number of other studies since the mid 1990s, and more recent data suggests that average energy intake actually *fell* by approximately 20 per cent between 1974 and 2004. Even allowing for under-reporting, this finding gives further credence to the thesis that the dramatic decline in physical activity post World War II is the dominant factor at work in the obesity epidemic.

Our report records the decline in routine physical activity in the form of active travel with growing car use. Cycling was one of the principal modes of travel in the first half of the 20th century, but declined dramatically from the early 1950s and has remained at a stable but low base since the 1970s. Thus it seems unlikely that this decline is a major determinant of the recent upsurge in obesity, so we have focused largely on walking. Walking is the most widely available form of physical activity, and also a useful means of transport. However, levels of walking have steadily declined in recent decades, and as car ownership increases, many journeys that would once have been made on foot are being replaced by car travel. This has been going on ever since mass motorisation began in the 1960s. Year on year a greater proportion of the time spent travelling is by car and the distance travelled on foot declines. In consequence of this:

- Main car drivers walk only half the distance and for half the time of adults in non-car owning households;
- This equates to a deficit of 56 minutes of walking every week for these drivers relative to adults in non-car households; and
- Over a decade we calculate that this could lead to a weight gain of more than 2 stones.

It is important to understand that for most obese adults their weight gain has accumulated over many years. Small energy imbalances on a daily basis can lead to major weight gain over a decade and more, and our calculations indicate that this decline in walking is in itself enough to account for much if not all of the recently observed upsurge in obesity.

Regarding the contribution of the substitution of walking by car use, carbon dioxide emissions from surface transport have grown more or less in line with road traffic. Emissions from other important sectors have declined over recent decades, but those from transport have grown inexorably to the point where:

- Passenger cars account for over 13 per cent of the UK's total CO_2 emissions, and hence make a major contribution to global warming; and
- On the basis of new main drivers halving their walking distance and travelling instead by car, the cumulative impact on CO_2 emissions over the period 1975-2005 totalled 5.80 Mt CO_2, equal to approximately 22.22 per cent of the overall increase in CO_2 emissions deriving from passenger cars in the last 30 years.

To address the developing epidemic in obesity, we argue that the decline in levels of walking over recent decades could and should be reversed. We estimated the potential of CO_2 reductions achievable by restoring walking where it has been substituted by car in the last 30 years:

- If today we reverted to the walking patterns of 1975, we would save 5.7 per cent of current emissions from passenger cars (4.10 Mt CO_2 out of 72 Mt CO_2); and
- If today *all main drivers* (amounting to more than 26 million people) reverted to the walking patterns they had before owning a car (ie miles walked by people with no car), 11.1 Mt of CO_2 could be saved, amounting to 15.4 per cent of total emissions from passenger cars.

This would require increased attention to changing personal travel behaviour. However the benefits of this are that walking for travel is readily available to most people, and changes could be achieved over a relatively short timescale. This would require:

- provision of tailored support to individuals to help them to initiate and maintain routine walking; and
- significant investment to establish large scale behaviour change programmes across the UK (the cost of such interventions would be dwarfed, however, by the savings in ongoing costs to the NHS and society through ill-health and premature death).

For the longer term, active travel habits should be reinforced by using the continual redesign of the built environment to create environments positively discriminating in favour of walking (and cycling). This means placing walking at the top of a road user hierarchy in order to influence all significant future changes to the built environment.

These relatively straightforward means offer the hope of reversing the rise in obesity, and cutting our contribution to climate change at the same time.

1

Introduction

Summary This chapter reports the background to the rise of mass private car ownership which set in place the means whereby personal energy expenditure for travel could be replaced by burning fossil fuel. It then addresses the scale of the threat both to public health through the consequences of obesity and also the global threat from climate change driven by the release of carbon dioxide into the atmosphere. It further sets out the objectives for the study which is to calculate the contribution of increasing car travel which has replaced walking to the twin crises of obesity and climate change.

1.1 The rise of the private car

In 1950, by far the majority of the power consumed in surface passenger transport went to public transport, reflecting the dominance of public over private motorised transport. Yet by 1980 the pattern had completely reversed, and cars had come to account for the lion's share of transport energy use (Dept. Energy, 1987). Since this activity was powered almost exclusively by fossil fuels (first coal, and then oil) carbon dioxide emissions have followed a similar trajectory to rising car use.

The structural changes to the economy that would bring about the switch to mass car use were established after the Second World War. Mass car production, as first introduced by the car manufacturer Ford in the USA, were established in the UK at sites such as Dagenham, Longbridge and Vauxhall. This domestic manufacturing base enabled cars to be produced in large numbers at prices within the reach of a growing number of wage earners. The declining real cost of cars was assisted by UK government policies which ended petrol rationing in 1950 and the car purchase tax in 1953 (Hamilton and Jenkins, 1989). In addition, the rapid expansion of road capacity from the 1950s enabled more journeys to be made by car. Car ownership was further aided through the burgeoning motor industry's marketing.

With regards to walking, this was a mode of transport very largely ignored in transport planning post World War II until the mid 1990s. Distances between homes and services and facilities became longer as planners focused on accessibility by car, which was to the detriment of walking (and cycling). As Ivan Illich wrote of the USA in 1974:

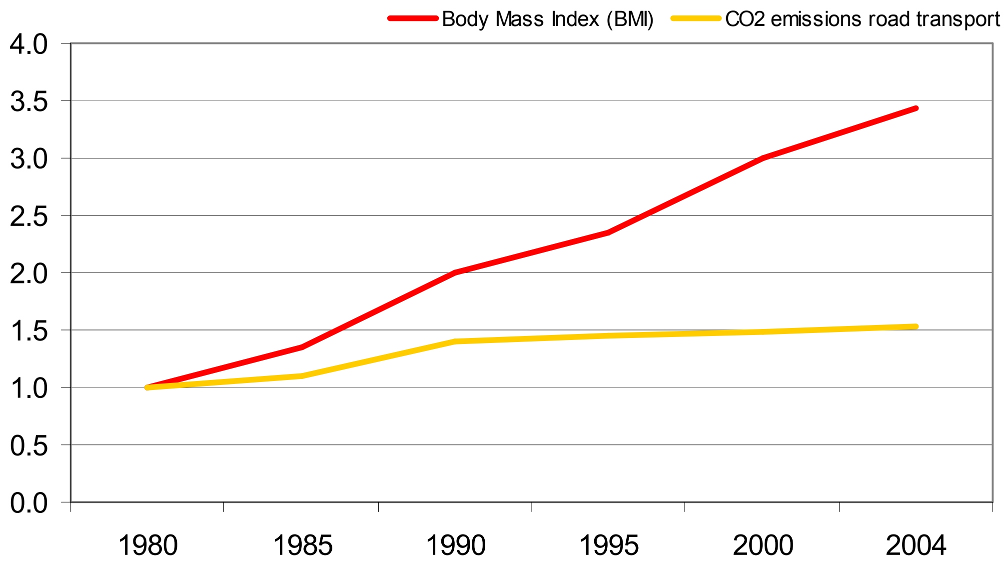
> "motorised vehicles create new distances which they alone can shrink. They create them for all but they can shrink them only for a few" (Illich, 1974).

1.2 The scale of the threats

The following figures highlight these two linked crises:

- Britain has one of the world's fastest growing rates of obesity and England is currently experiencing an epidemic of obesity, with over 23.6 per cent of men and 23.8 per cent of women being classified as obese (DH, 2006); and
- The transport sector is the only sector for which, since 1970, CO_2 emissions have been steadily increasing. In 2005, more than a fifth of all carbon dioxide emitted in the UK came from cars and trucks on our roads. Passenger cars contributed 13 per cent of the UK's total CO_2 emissions in 2003 (National Atmospheric Emissions Inventory, 2005).

Figure 1: CO_2 emissions from passenger cars and Body Mass Index (1980 – 2004)



Source: IEEP elaboration of National Atmospheric Emissions Inventory, 2004; Health Survey for England from 1993 (and predecessors)
Note: emissions from passenger cars are for UK while BMI data are for England. However it is assumed that the prevalence of overweight and obesity in Scotland and Wales are similar.

Obesity[1] is associated with life threatening diseases including coronary heart disease, type 2 diabetes, osteoarthritis, many cancers, and respiratory disease, as well as social stigma and related mental health problems. In England, the prevalence of obesity has trebled since the 1980s, to almost 24 million adults. A further 35 per cent of women and 46 per cent of men are classified as overweight, meaning that well over half of all women and two-thirds of all men in England are currently either overweight or obese. The Government White Paper on public health put the cost of obesity in England at up to £3.7 billion per year, including £49 million for treating obesity, £1.1 billion for treating the consequences of obesity, and indirect costs of £1.1 billion for premature death and £1.45 billion for sickness absence (DH, 2004a). However, it is quite likely that this is an underestimate. In particular, new estimates suggest that employment effects of obesity might be much greater than previously thought. In addition, these estimates are not comprehensive (McCormick and Stone, 2007). The cost of obesity plus overweight is estimated at up to £7.4 billion per year.

Some studies have attempted to assess data on the health and climate impacts of transport (eg McCarthy and Ferguson, 2005). In particular, they draw attention to the difficulty of collecting together information across many fields. Some studies have tried to give an economic evaluation of the impacts of transport on health. The costs and benefits are considerable. However, it is the burden of disease arising from issues such as physical inactivity which often dwarf the costs of intervention which can help facilitate routine physical activity, as indicated in Table 1.

[1] See Annex 2 for the definition of obesity

Table 1: Some economic costs of the impact of transport on health

Area	Economic evaluation	Source
Hospital and ambulance costs of injury accidents	Cost £560 million (GB)	DfT (2002b)
Physical inactivity	Cost £8.2 billion (England)	DH (2004a)
Reductions in PM_{10}, sulphur dioxide and ozone	Net benefit £1.69-£1,295 million (GB)	DH (1999a)
Implementation of 110 '20 mph zones' in Kingston upon Hull	Cost £4 million Benefit £40 million	IPPR (2002)

Source: Health Development Agency (2005)

In considering **carbon dioxide (CO_2) emissions**, the UK is not on track to meet its own commitment to reduce emissions of carbon dioxide by 20 per cent below 1990 levels by 2010 and to put itself on the path to reduce carbon dioxide emissions by 60 per cent by 2050. One of the main reasons for this failure has been the growing emissions from the road transport sector.

The latest report on the science of climate change of the UN's Intergovernmental Panel on Climate Change, published in February 2007 (IPCC, 2007), established that warming of the climate system is now 'unequivocal' and there is now 90 per cent probability that human action has contributed to recent climate change, primarily through fossil fuel burning and land-use change.

Indeed climate change is already happening. The IPCC (2007) affirms with greater certainty that the global average surface temperature has increased by around 0.74 degrees Celsius over the past hundred years. In the UK, during the 20th century, the annual mean central England temperature warmed by about 1°C. This led to observed changes in the UK's climate: the growing season for plants in central England has lengthened by about one month since 1900; heat waves have become more frequent in summer, while there are now fewer frosts and winter cold spells; winters over the last 200 years have become much wetter relative to summers throughout the UK; a larger proportion of winter precipitation (rain and snow) now falls on heavy rainfall days than was the case 50 years ago; after adjusting for natural land movements, the average sea level around the UK is now about 10cm higher than it was in 1900 (UKCIP, 2007).

The recent assessment from the IPPC (2007) found that 'there is more than a 90 percent probability that hot extreme temperatures, heat waves and heavy precipitation events will continue to become more frequent'.

1.3 Aims and Objectives

On the basis of an analysis of the literature and new calculations about the decline of personal energy expenditure and associated carbon dioxide emission increases, this report aims to assess and explain the contribution of increased car travel to UK obesity and climate change. It is the impact of increased motor vehicle ownership and use which is central to this assessment. The report sets out impacts of the contributions of increased car use in terms of its substitution for walking over a period of 30 years as:

- A dangerous reduction in physical activity levels which have made a major contribution the growth of obesity; and
- A source of increasing CO_2 emissions from the transport sector.

This study thus seeks to assess the contribution of this growth in car travel to the decline in human energy expenditure and consequently to the parallel growth in obesity in the UK; and also to assess the contribution to climate change through carbon dioxide emissions as the growth in car travel has replaced active travel modes (principally walking) since 1975/76. Through this exploration the study has sought to demonstrate that two of the main challenges facing the UK in health and environment have common origins and some common solutions.

Principally, it will be argued, energy substitution has occurred so that walking has been replaced increasingly by private motorised travel, partly as a function of wealth and partly too as rising car ownership has led to changes in landuse, enabling longer journeys to undertake the same or similar tasks which could previously have been undertaken using human energy. This has both contributed substantially in a sharp decline in personal energy expenditure because walking is the most important way by which (at a population level) physical activity is undertaken, and also contributed to increasing carbon dioxide emissions, the main contributor to climate change.

This is not an entirely new thesis. Hillman and Whalley drew attention to the increase in personal fossil energy expenditure through increased car use as early as 1983 (Hillman and Whalley, 1983). Little, however, has been written about the links and possible common origins of the twin crises of obesity and climate change, despite the fact that the trajectory of steeply increasing car ownership and use has occurred over a time period which covers the parallel sharp rise in obesity levels (Higgins and Higgins, 2005). Research exploring links between car use and obesity is now being published, particularly as part of US and Australian academic research programmes.

It is important to state that we have attempted to cover the period 1975 to 2005. This is because for travel data the National Travel Survey data is largely drawn from 1975/76 to 2005. Year 1975/76 is used as baseline except in cases where it is not available or not fully applicable; otherwise we use 1980 as the baseline. Some sources currently provide data as far as 2004 (ie

National Atmospheric Emissions Inventory and obesity data, see also Annexes). With regards to obesity, data is available from 1980 (see Annex 1 and 3) and this provides trend data against which the 'intervention' of growing car ownership and use growth is set.

1.4 Structure of the Report

The report is structured as follows:

- Chapter 2 discusses the aetiology of obesity, concluding with a review of recent studies on the contribution of motorised transport to the decline of energy expenditure;
- Chapter 3 illustrates the 'road to obesity', namely the role of car ownership in the shift in travel patterns and decrease of energy expenditure, in particular related to the decrease in walking;
- Chapter 4 makes the links between obesity and carbon emissions, offering a quantification of the impacts of road transport on obesity levels and CO_2 emissions;
- Chapter 5 explores the potential for change and assesses policy options to reverse these trends; and
- Chapter 6 draws together conclusions.

1.5 Summary

This chapter has provided some brief historical background to the spread of private motor cars after World War II. With widening car ownership has come greater use, exacerbated by changes in land use to accommodate this change away from public transport and human powered transport. The aims and objectives of the report have set out a hypothesis that it is this substitution of car use in place of walking which has contributed both to the rise of obesity and to increases in carbon dioxide emissions.

2

The causes of obesity and the contribution of private motorised transport

Summary This chapter provides evidence as to the sharp decline in human energy expenditure with industrialisation and the growth of motorised personal transport post World War II. It sets out a debate as to the causes of obesity in terms of personal energy intake and energy expenditure before reporting on recent studies which have identified the role of car use in contributing to the decline in energy expenditure and to the continuing rise of obesity.

2.1 Historical perspective

No change in human life since the invention of agriculture, metallurgy and towns in the New Stone Age has been so profound as the coming of industrialisation (Hobsbawm, 1980). The industrial revolution marked a major transformation, not least in the expansion of towns and cities. This was to lead to major changes in travel behaviour and personal energy expenditure so that human energy would, in time, be substituted by the use of machinery which in most cases involved the burning of fossil fuels. The invention of steam train, followed by the bicycle and the car at the turn of the twentieth century started a revolution in travel behaviour. Long distance travel opportunities were largely confined to the burgeoning middle classes and tradesmen in the nineteenth century, with the working classes confined to the distance they could walk or ride, aside from perhaps an annual train ride to the seaside. But from the mid twentieth century onwards widening car ownership enabled many families to travel further afield than ever before, especially for holidays and day trips.

A historical perspective is also important in the understanding of the relatively recent and dramatic rise in obesity in many western nations including across Great Britain. For nearly all human evolutionary experience, energy acquisition and expenditure (as physical activity) have been inextricably linked, but economic growth accompanying the Industrial Revolution disrupted this ancient relationship. During the past two centuries, adjusted per capita income, one measure of subsistence efficiency, has increased 12-fold in Western nations.

The best current estimates are that the physical activity of pre-industrial humans averaged about 1000 kcal a day and that their caloric intake was typically about 3000 kcal a day. Their subsistence efficiency was thus about 3 : 1.In contrast, sedentary humans in contemporary affluent societies commonly consume 2100 kcal a day with expenditure, as physical activity, of perhaps 300 kcal a day, a subsistence efficiency of 7 : 1. A person consuming 2100 kcal a day would need an expenditure of 700 kcal a day as physical activity to re-establish the estimated Palaeolithic relationship. If current activity is about 300 kcal a day , then an additional 400 kcal a day, an hour's aerobic activity or the equivalent, would be required (Saris *et al*, 2003).

Considering a more limited time-span but arguably one in which many labour-saving devices have been developed and within reach of much of the adult population, in the 50 years between 1945 and 1995 it has been calculated that average energy expenditure reduced by around 800 kcals per day – equivalent to walking about 16 km or 10 miles less per day.

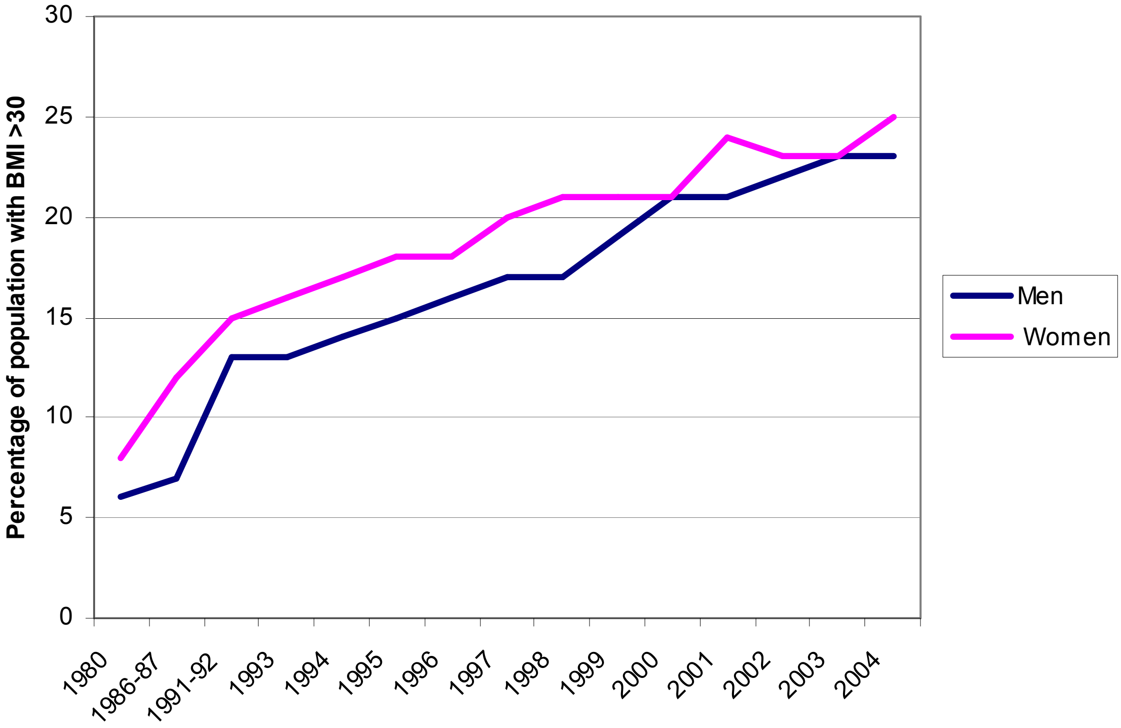
The growth of time and labour saving technologies means that activity levels of around the mid-1940s are unlikely ever to be reached again without conscious effort. Now, most people recognise that their parents and grandparents were much more physically active in their everyday lives than younger generations. Moreover, some researchers argue that in the presence of an abundant (and energy-dense) food supply, obesity, at least at the population level, is almost an inevitable consequence of modernisation (Prentice, 1997; Eggar *et al*, 2001).

2.2 The Road to Obesity

Physical activity is one of the most basic human functions. The human body has evolved over millions of years. As hunter-gatherers, people needed to walk great distances to find food, and to run fast and to escape attack. Food was scarce and difficult to obtain, causing the human body to adapt by conserving energy to use during times of famine. As civilisation developed, human strength and movement continued to be used for farming, building and transport (WHO, 2006a). During the twentieth century and notably from post World War II, however, physical activity levels started to decline significantly in industrialised societies through mechanisation in the home, at work, at leisure and in transport. The necessity for physical activity has thus been removed from much of life so that people may ignore or be unaware of how essential it is for health and wellbeing. Combining this change with a food transition, that food has become plentiful and easily available to most people in western countries, the result is that these countries are experiencing an alarming increase in the prevalence of obesity.

Britain has one of the world's fastest growing rates of obesity. England and Wales is currently experiencing an epidemic of obesity, with over 23.6 per cent of men and 23.8 per cent of women being classified as obese (DH, 2006). Levels of obesity in women are higher in Scotland at 26 per cent than in women in England, (Scottish Executive, 2005a) while obesity levels are lower in Wales at 18 per cent for both men and women (although the latter are self-report data) (National Assembly for Wales/ONS, 2006). Figure 2 provides data on the growth of obesity among adults in England and Wales over the past two decades. Other data for the UK suggests that the trends in Scotland, Wales, and Northern Ireland follow a similar trajectory.(Davey, 2004) Other countries, such as the Netherlands, have experienced much smaller increases from a low baseline of about 5 per cent in the 1980s to about 8 per cent in 1997 (Seidell, 1999). However, there is a worldwide pandemic of obesity and overweight (the precursor to obesity) and these body sizes have or are likely to become the norm in many societies world wide (Pescatello, VanHeest, 2000).

Figure 2: Obesity rates in England (1980; 1986; 1992-2004)

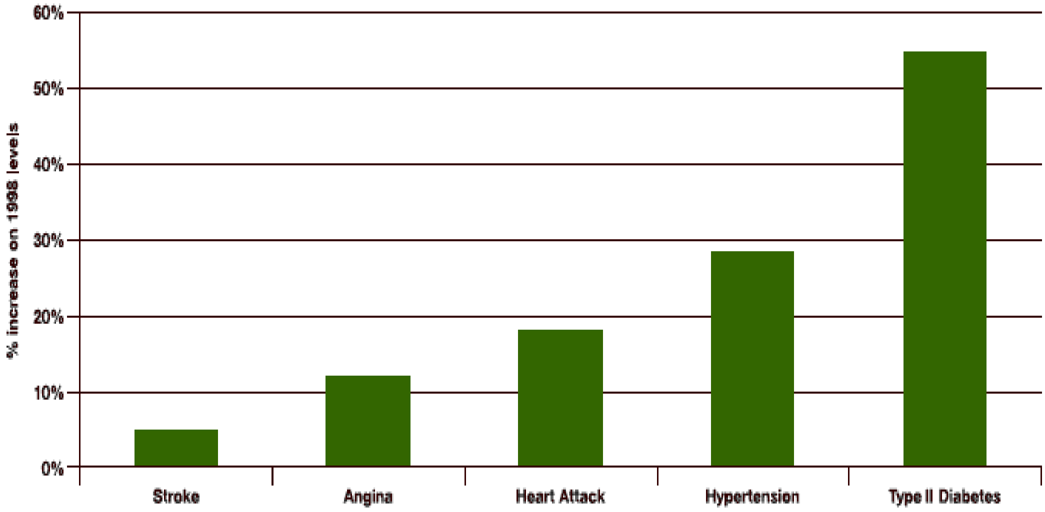


Sources: Health Survey for England from 1993 (and predecessors)

Obesity is associated with life-threatening diseases including coronary heart disease, type 2 diabetes, osteoarthritis, many cancers, and respiratory disease, as well as social stigma and related mental health problems. As a direct consequence of the increasing weight of the population, the prevalence of type 2 diabetes mellitus, with all its health consequences, is rising at an alarming rate. By 2023, if current increases in obesity prevalence continue, then the rises expected in obesity-related disease will be dramatic and are illustrated in Figure 3. Anything that lowers activity levels is a concern in light of the WHO's assessment that physical inactivity is a risk factor for obesity, and that inactivity is ranked as the eighth leading contributor to global mortality and the 14th most significant risk factor in terms of the global burden of disease (Ezzati *et al*, 2002).

The incremental but significant increase in the proportion of the population which is overweight or obese since 1980 is not related to genes or changes in medical practices. Although there are powerful genetic factors affecting individual families who have genetic susceptibility, the overwhelming influence for 99 per cent of the population is environmental (IOTF, 2002). While genes are important in determining a person's susceptibility to weight gain, energy balance is determined by calorie intake and physical activity. Thus societal changes and a worldwide nutrition transition are driving the obesity epidemic (WHO, 2003).

Figure 3: A dramatic rise in diseases linked to obesity is expected by 2023



Source: taken from Department of Health, 2004a

While many researchers have placed the global food production, marketing, and distribution sector (including sugar-rich drinks, fast food and other multinational food companies) at the centre of blame for these changes (Popkin, 2006), there are other profound, and equally responsible factors that must be understood to enact effective public policy to address them (Brownell and Horgan, 2004). These other factors include the worldwide shifts in trade of technology innovations that affect energy expenditures during leisure, transportation, and work.

2.3 The scientific debate on obesity: energy intake versus energy expenditure

In the scientific literature it appears that, where views are given as to the relative roles of energy intake and expenditure in obesity, the verdict tends to be divided largely along professional lines. Many of those concerned with food policy, nutrition and diet claim the dominant role of energy intake. Likewise, many concerned with physical activity claim the dominant role of energy expenditure in obesity. Below are some of the key papers reflecting this debate but we have not attempted a comprehensive literature review.

Perspectives on the role of personal energy intake

The main candidates for food as a dominant contributor to obesity are the widespread availability of energy-dense foods (usually high in fat and low in water and fibre) including sweetened cereals, confectionery, snacks, fast-food from restaurants, sugar-rich drinks, all exacerbated by larger portion sizes. Moreover, an important example of the changes in the global food system are found in the rapid increase in consumption of low-cost edible vegetable oils. This situation is aggravated by widespread advertising (particularly on television) (British Heart Foundation, 2004; Popkin, 2006) which are dominated by foods high in fat, sugar and salt (Jebb, 2007).

According to the International Obesity Task Force and the International Association for the Study of Obesity, obesity is primarily diet-induced, the result of a sustained excess of energy-dense foods with high fat and refined carbohydrate, e.g. sugar content as well as an insufficient consumption of fruits and vegetables. This is compounded by increasingly sedentary lifestyles and changing environments which curtail opportunities for physical activity. Physical inactivity alone, they state, does not explain the obesity epidemic. Such a view is similarly taken by others, for example, a Harvard University study likewise concluded that energy intake is the dominant factor at work in the rise of obesity (Harvard University, 2003).

Lindström *et al* focus on diet in their analysis of diabetes (Lindström *et al*, 2005). They state that obesity is the outcome of a positive energy balance over time and that obese individuals are, or have been at some stage, eating more calories than they need, and the excess energy has been stored as fat. While acknowledging the role of physical activity they note that the current environment offers constant availability of affordable palatable energy-rich foods, with no need to consume the energy through physical activity.

Lean *et al* suggest that, through economic analysis of recent trends and differences within and between countries, increases in energy intake may be the predominant cause of increasing obesity, with physical activity playing an early facilitating but now compounding role (Lean *et al*, 2006). In support of this view they cite that in the United States, dependence on motorized transport, automated appliances in the home and workplace, and television viewing was established by 1970 whereas obesity rates only began to accelerate by the 1980s and 1990s.

In the 'middle ground' there is, perhaps, the largest group that does not identify which, if any, determinants of obesity are dominant. They tend to focus on environment in the sense of easy access to food and little need for exercise (Jain, 2004; Crawford, 2002). Hill and Peters describe the need to 'cure the environment' through: consumer education effort to reduce portion sizes, including responsible actions by restaurants in this regard; to foster a preference for less energy-dense foods in young children; and make the environment more conducive to physical activity (Hills and Peters. 1998). Swinburn *et al* highlight that physical activity is at least as important as energy intake in the genesis of weight gain and obesity and that there are likely to be many interactions between the two sides of the equation (energy intake and expenditure) in terms of aetiology and prevention (Swinburn *et al*, 2004). This has been termed obesogenic environment where the 'twin tracks' of energy in and energy out are on a downhill slope of the obesogenic environments (Swinburn and Egger, 2004).

In 2006 the National Institute for Health and Clinical Excellence (NICE) issued the first national guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children in England and Wales (NICE, 2006). It stated that multicomponent interventions are the treatment of choice. Weight management programmes should include behaviour change strategies to increase people's physical activity levels or decrease inactivity, improve eating behaviour and the quality of the person's diet and reduce energy intake. To prevent obesity, most people should be advised they may need to do 45–60 minutes of moderate-intensity activity a day, particularly if they do not reduce their energy intake. Recommended types of physical activity include:

- activities that can be incorporated into everyday life, such as brisk walking, gardening or cycling;
- supervised exercise programmes; and
- other activities, such as swimming, aiming to walk a certain number of steps each day, or stair climbing.

NICE stated that dietary changes should be individualised, tailored to food preferences and allow for flexible approaches to reducing calorie intake. In addition, NICE advises that even if they do not lose weight people should be encouraged to improve their diet, because there can be other health benefits.

Blundell and King state that low levels of physical activity have played a major role in the increasing prevalence of obesity since the early 1980s (Blundell and King 1998). They caution that reasons why increased physical activity often produces disappointing effects, arise from inappropriate food choices, a desire for self-reward after exercise and misjudgements about the relative rates at which energy can be expended or taken in. Moreover, Blundell and Cooling note that such an approach gives an equal weighting to food choice and appetite control, physical activity (deliberate and incidental), and physiological factors, in the maintenance of energy balance and in departures from balance (Blundell and Cooling, 2001). They conclude that there is a combination of different routes to obesity and this puts the emphasis on individual patterns (of physiology and behaviour) and which seems more realistic than the idea of a single or dominant regulator of body weight. It is also of note that the on-going government Foresight Project is called 'Tackling Obesities' in recognition of this multiplicity of causes and resulting heterogeneity (Jebb, 2007).

This centre ground is also reflected in the European Charter on Counteracting Obesity, signed in 2006, which states that:

> 'An energy imbalance in the population has been triggered by a dramatic reduction of physical activity and changing dietary patterns, including increased consumption of energy-dense nutrient-poor food and beverages (containing high proportions of saturated as well as total fat, salt, and sugars) in combination with insufficient

consumption of fruit and vegetables. According to available data two thirds of the adult population in most countries in the WHO European Region are not physically active enough to secure and maintain health gains, and only in a few countries does the consumption of fruit and vegetables achieve the recommended levels. Genetic predisposition alone can not explain the epidemic of obesity without such changes in the social, economic, cultural and physical environment.' (WHO, 2006b).

Perspectives on the role of personal energy expenditure in obesity

An early case for the dominant role of physical inactivity was made in 1995, in an influential paper by Prentice and Jebb. They posed the question of whether obesity was as a result of gluttony or sloth? (Prentice and Jebb, 1995). They concluded that it was likely that low levels of physical activity prevalent in Britain must play an important, perhaps dominant, role in the development of obesity by greatly reducing energy needs from food. The mismatch between energy intake and energy expenditure was the central message of their analysis (Prentice and Jebb, 2004). Their claim is supported by recent data for the UK which reports that total energy intake actually fell by approximately 20 per cent between 1974 and 2004 (Information Centre, 2006). Even allowing for the fact that there is some under-reporting of food consumption in all dietary surveys, such a large decline, indicates that there has indeed been a significant decline in energy intake, yet the prevalence of obesity continues to increase.

It is a repeated claim that the majority of studies examining obesity and health have not adequately accounted for physical activity. As Blair and Church note, when physical activity has been considered, investigators have often relied on simple self-report questionnaires in which inaccuracy can increase proportionally with the respondent's weight. They argue that physical activity and diet are closely linked and each must be measured accurately and considered carefully when examining the other (Blair and Church, 2004).

Biddle and Fox draw on Prentice and Jebb in seeking the root cause of the increase in obesity in the UK (Biddle and Fox, 1998). They focus on the greater reliance on motorised transport and other labour-saving devices, and the availability and attractiveness of home entertainment provided by television, videos and computers which have substantially increased. They note that this has led to a tendency to move less, perform less physical work and to sit down more during leisure time. Over extended periods, this can make a substantial difference to energy balance.

A report on obesity in Scotland notes that progressive physical inactivity occurs with age and this inactivity is the principal explanation for age-related weight gain in Britain given current dietary patterns (Scottish Intercollegiate Guidance Network, 2006). The age-related prevalence of overweight and obesity implies that excess weight gain in adults usually starts in the 20-40 year old period with maximum body weight usually being reached in middle age. The report also refers to evidence that there is an almost uniform decline in energy intake with age related to a fall in spontaneous physical activity which may amount to 700 kcal/day for the sports-fit young man or woman compared with an inactive retired person of 65 years (James et al, 1989).

Astrup stresses that a high dietary fat content is unlikely to be the only environmental factor responsible for obesity (Astrup, 2005). A sedentary lifestyle with a low level of energy expended on physical activities is another causative factor, which interacts with dietary fat content. He cites studies reporting weight loss being achieved by low fat diet alone of 2.8 kg, with diet and exercise combined achieving a 5.7 kg weight loss. These studies were in non-obese individuals. On a population basis the change of a mean body weight of 5 kg may produce quite a dramatic change in the prevalence of obesity. Astrup concludes that the decrease in physical activity observed in population studies may, therefore, be responsible for the continuing increase in the prevalence of obesity and the very modest, if any, decrease in dietary fat intake is not sufficient to retard this development.

Pescatello and Van Heest note that while it is acknowledged that an obesity-conducive environment is the culprit, particularly physical inactivity and over-nutrition, of these two offenders, it is apparent that declines in physical lifestyle activity have made the major contribution to the worldwide obesity epidemic (Pescatello and Van Heest, 2000). Others have noted a related association that physical activity appears to be a critical element of long-term weight loss (Jakicic *et al*, 1999). Moreover, physical activity is important for achieving proper energy balance, which is needed to prevent or reverse obesity. Not only is energy expended during physical activity, physical activity also has a positive effect on resting metabolic rate (Rippe and Hess, 1998).

A more remarkable conclusion has been drawn by the House of Commons Health Committee. In 2004 it reported on obesity and made a powerful statement about the specific contribution of physical activity through cycling (House of Commons Health Committee, 2004). This was that achieving the Government target on cycling (trebling by 2010 to 6 per cent) might be more significant than any of the myriad other individual measures considered in their report. This report drew on extensive evidence provided about energy intake as well as energy expenditure.

> 'If the Government were to achieve its target of trebling cycling in the period 2000–2010 (and there are very few signs that it will) that might achieve more in the fight against obesity than any individual measure we recommend within this report.' (p.116)

However, unlike walking, cycling is a minority activity, and would remain so even with a trebling of cycling trips between 2000 and 2010.

2.4 Studies of the contribution of motorized road transport to decline in energy expenditure

As noted in the Introduction, until the twenty first century, little exploration of changes in travel behaviour as a major factor in the long-term decline in personal energy expenditure had been undertaken despite the fact that the trajectory of steeply increasing car ownership and use has occurred over a time period which covers the parallel sharp rise in obesity levels. This is beginning to be redressed, particularly through US and Australian academic research programmes although the evidence base is currently limited to a small number of studies.

Frank *et al* (2004), have reported that rising car ownership has been accompanied by changing land-use patterns to accommodate increased car use. They note that within the built environment, the land development patterns (i.e. public transport and pedestrian-friendly vs. car-orientated) and the mode of transport investment (i.e. in public transport, walking and cycling paths vs. highways) are closely inter-related and between them they have a profound effect on physical activity levels. This evidence suggests that the design of the physical environment in which we live, work, and play results in a choice set where active forms of transportation and healthy food options are relatively inconvenient, and are more costly in terms of time and money, than less healthy alternatives – which may or may not even be available (Frank and Niece, 2005). Mason has highlighted that since the 1980s the proportion of overweight, obese and inactive Australians has increased in parallel with greater car reliance (Mason, 2000). Car reliance not only impacts on energy expenditure, but research points to the possibility that car reliance may also have an impact on energy intake via changing dietary practices and the provisioning of food ingredients (Norberg-Hodge et al, 2002; Rychetnik et al, 2002).

The obesity epidemic is paralleled across much of the developed world, a world in which the built environment has increasingly been designed to accommodate travel by car at the expense of walking and cycling. Since 2000 an association between the built environment and obesity has been reported through a number of studies in both the US and Australia (Lopez-Zetina *et al*, 2006; Hinde and Dixon, 2005). The amount of time spent in cars appears to be a key factor and has been reported in a number of studies, eg Wen *et al* (2006) and by Frank *et al* (2004). Wen et al's findings were for a significant association between commuting to work by car and overweight or obesity compared with active travel modes and use of public transport. They also found a significant association between car use and physical inactivity, which they report, may contribute to the understanding of the relationship between car use and overweight and obesity. Their research findings are consistent with Frank et al's US research which found that each additional kilometre walked per day is associated with a 4.8 per cent reduction in the likelihood of obesity, whereas each additional hour spent in a car per day was associated with a 6 per cent increase in the likelihood of obesity. This research underpinned the importance of land-use densities in enabling access to be achieved through short walk or cycling trips (Frank et al, 2004).

Similar relationships have been observed in China: adults who purchased motor scooters/motorcycles or cars to travel to work doubled their likelihood of becoming overweight, in comparison to those that made no change in their mode of transportation. The study looked into vehicle ownership and obesity levels among 4741 Chinese adults aged 20 to 55 years. They found that the odds of being obese were 80 per cent higher for men and women in households who owned a motorized vehicle compared with those who did not own a vehicle. Men who acquired a vehicle experienced a 1.8-kg greater weight gain and had 2 to 1 odds of becoming obese compared to those who continued to rely on more active modes of transportation (Bell *et al*, 2002).

2.5 Summary

This Chapter has reported on the major changes that have occurred with industrialisation. This has included changes to diet as well as to physical activity levels. With a significant decline in energy intake reported in a recent national survey, together with other evidence as to the sharp decline in energy expenditure, those that have made the case for a dominant role in obesity for the sharp decline in energy expenditure have the stronger case. The Chapter has concluded by highlighting recent research which has specifically identified the role of car use, and associated land use structured around car use, in reducing the need for physical activity and contributing to weight gain.

3

The shift in travel patterns in the UK: Contributing to the climate and obesity crises

Summary This Chapter charts the rise in the dominance of the car with rising number of licence holders. Year on year car use has steadily replaced other forms of transport for all journeys including local journeys which in terms of distance could be most easily walked.

3.1 The rise and rise of car dominance

Reflecting the post-war era of steep growth in car travel, the Buchanan Report of 1963, *Traffic in Towns* (Ministry of Transport, 1963), which had a major influence on transport planning in the UK in the following decades, noted how highly prized the importance of car ownership was at that time:

> "Television-sets and washing machines may for the time being take precedence in the hierarchy of domestic needs, but as a longer term objective it is questionable whether anything is so much desired as a family car."

As Banister has noted (Banister, 1995), once attained the car became the normal way of travel for those with access to one:

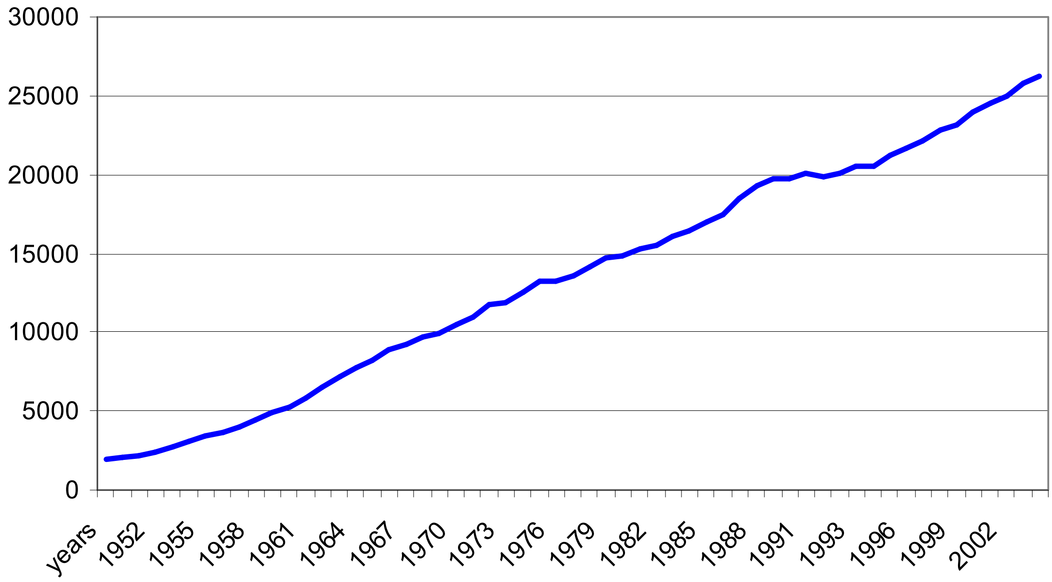
> "It is generally believed to be the most desirable form of transport and will normally be used as the preferred form of transport, no matter how attractive the alternatives might be."

A study published by the DfT on transport and social inclusion (DfT, 2003b) describes the causes and consequences of car dominance as follows:

- rising prosperity led to rising car ownership;
- car ownership led to a huge rise in mobility;
- policies exacerbated the trend towards a car-centred society (e.g. planning policies enabled out-of-town shopping and housing developments which were less suited to public transport; policies allowed bus fares to rise faster than motoring costs; the reduction in the costs of owning, insuring and maintaining cars);
- walking became a less suitable mode as a consequence of increasing distances and crime and as fear of crime increased;
- walking and cycling options did not keep pace as they have always been marginalised in transport planning;
- public transport costs continue to rise; and
- for those with a car, the car became their favoured means of transport, and for those without this potentially leads to social exclusion.

With the rise of car ownership which grew strongly from the early 1960s there was a parallel decline in walking and cycling, whereas the number of registered cars increased constantly, from 1950 to 2005 (see Figure 4 below).

Figure 4: Private cars registered (thousands, 1950 – 2005)

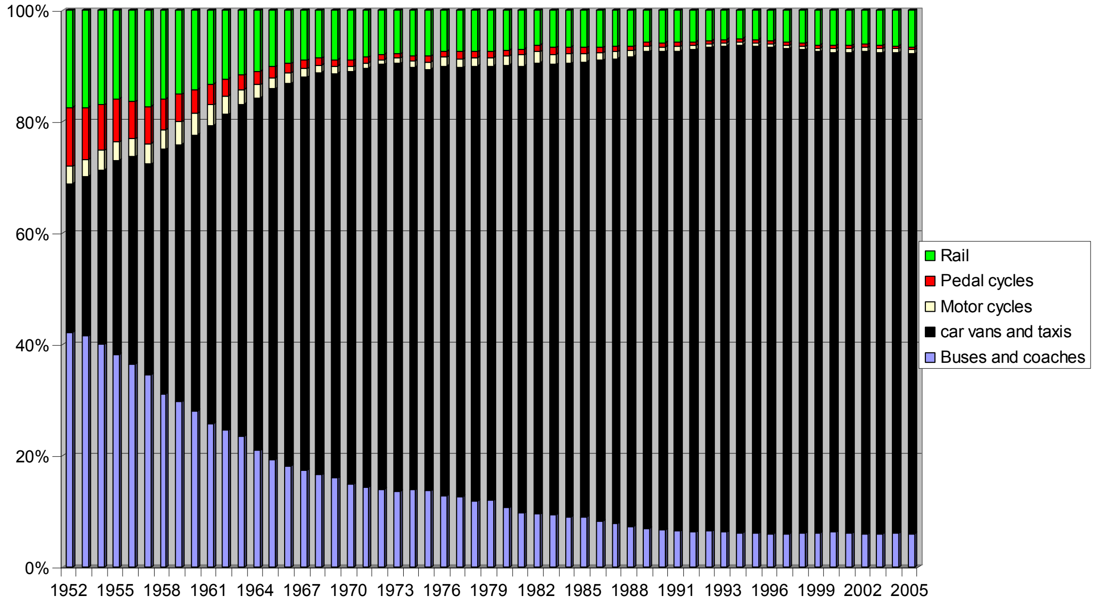


Source: DfT, Transport Statistics GB 2006

The growth in full car licences saw full licence holders increase from 49 per cent in 1975/76 to 72 per cent of the whole adult population by 2005 (an increase of 49%). There was a particularly large increase among women, from 29 to 63 per cent (an increase of 121%), compared with men who registered an increase an increase of 16% (from 69 to 81 per cent over this period) (DfT/ONS, 2005). This reflects a significant degree of 'catch-up' in licence holding amongst women, who in the early days of mass car ownership had been much less likely to drive than men.

As we can see from the table below representing the modal shift in the last 53 years (from 1952 to 2005) passenger transport by car has been constantly eroding the transport share of every other mode.

Figure 5: Passenger transport by mode (bpkm/percentage, 1952 – 2005)



Source: DTI, 2006 Note that pedestrian journeys are not recorded on this graph

Distance Travelled

Over the last 50 years, the need to travel has become greater and more complex as society became increasingly organised around the car: average distances to work, education, hospitals and shops have increased sharply. The increase in car ownership also enabled an expansion in travel distances. In 1960, each person typically travelled some 5,600 km; by 2005, that figure had increased to over 11,597 km (NTS). This represents a 53 per cent increase in distance and is mostly a reflection of increased car use.
The proportion of trip stages by car has also continually increased: in the last ten years (1995 – 2005) it increased from 55 per cent to 60 per cent; while the proportion of stages made on foot decreased from 33 per cent to 27 per cent over the same period (NTS).

Travel Time and Travel Speed

In Great Britain, aside from the oil crisis in the mid-1970s, the amount of time people spend travelling has remained fairly constant at about an hour per day. Over the decades, however, more of our travelling time is being consumed through car use as we travel more often and longer distances (Table 2).

Table 2: Distance, trips and hours travelled per person per year - 1975/1976 to 2005

	Distance travelled (miles)	All trips	Trips of 1 mile or more	Time taken (hours)	Average trip length (miles)	Average trip time (minutes)
1975/1976	4,740	935	659	330	5.1	21.2
1985/1986	5,317	1,024	689	337	5.2	19.8
1989/1991	6,475	1,091	771	370	5.9	20.4
1995/1997[1]	6,981	1,086	794	369	6.4	20.4
1998/2000	7,164	1,071	810	376	6.7	21.1
2005	7,208	1,044	818	385	6.9	22.1

Source: NTS, 2006

In 2005, 38.6 minutes of the average of 62 minutes used travelling per day was spent travelling by car and 11.8 minutes walking or cycling. In contrast, in 1972/73 25.4 minutes per day were spent travelling by car and 16.8 minutes walking or cycling.[2]

Thus, during the course of a week, 35 minutes of active travel has been 'lost', a decline of approximately 30 per cent, while time spent travelling by car increased by just over 50 per cent between 1972/73 and 2005. Importantly, it appears that time spent in cars as a proportion of daily travel has increased at the expense of physically active modes, and this appears to be an important determinant of the rise in adult obesity, as the studies of US and Chinese citizens above have reported.

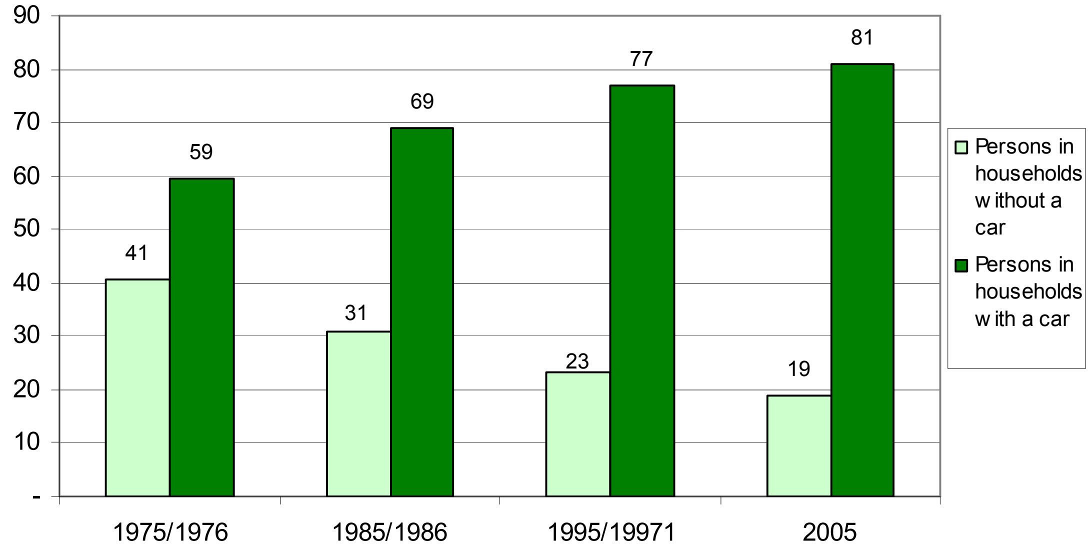
Another crucial change, which brought about complexity in our ways of travelling, is the change in the allocation of travel time for different purposes. Time budgets have changed: early morning, evening and weekend journeys are more important than ever before, as work and shopping are now less focused around a nine-to-five schedule. Also, the increased female participation in the workforce has created more complex journeys which now involve, for example, childcare, school, work and shopping.

[2] Data supplied by the National Travel Survey team, DfT, 30th March 2007.

Car access and walking

In the post World War II period there has been a large change in household car ownership. From 1975 to 2005 the proportion of those living in households without a car fell from 41 to 19 per cent.

Figure 6: Adult personal car availability (%)



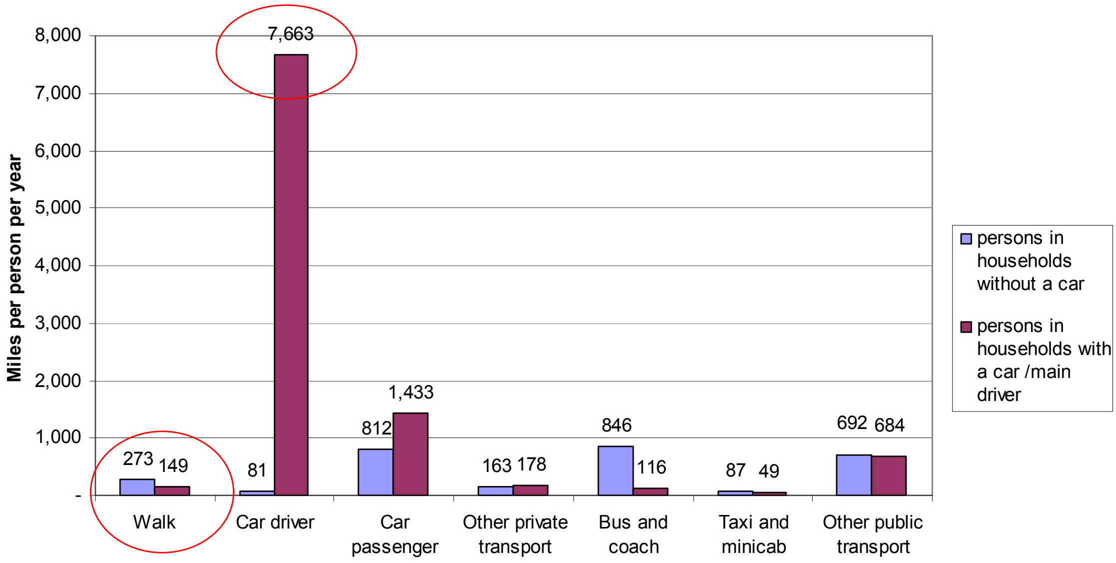
Source: NTS, 2006

As we will demonstrate in the following paragraph, car ownership brought a significant change in travel behaviour, determining that people walk less than they used to, in particular for short distances (ie under 1 mile) and on journeys to and from work, both representing important activities that used to ensure regular and significant levels of energy expenditure.

As Figure 7 illustrates, ownership of a car is associated with substantially higher mileage by car, though less mileage by foot, bus, rail and other modes.

In particular, for the purposes of this report, it is interesting to see how car ownership influences walking patterns. Indeed, the average person who lives in a household without a car makes *twice as many trips* on foot than the main driver of a car (359 compared to 174) (DfT/ONS, 2006). Also, the distance travelled on foot by a person without a car is almost twice the distance of a main driver on average. Instead, main drivers use the car to travel almost 100 times the distance a person without a car makes as car driver. In contrast, a person with no car typically uses the bus to travel 7 times the distance travelled by bus by a main driver (NTS, 2006).

Figure 7: Travel distance by mode by personal car access in 2005 (miles)



Source: NTS, 2006

Another cause of car dominance has been the rising costs of alternatives such as public transport. This change too is important as public transport trips are often accompanied by stages of walking or cycling. Indeed, while the cost of motoring has remained relatively steady in real terms over the last 15–20 years, the cost of bus fares has risen by over 30 per cent since 1985 (DfT, 2003b).

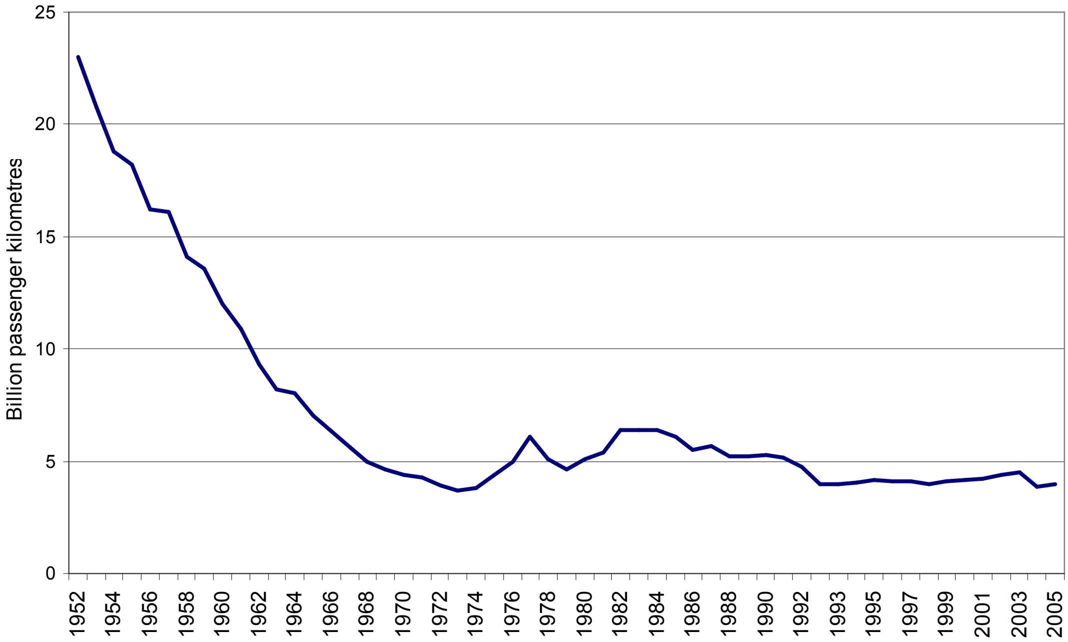
3.2 Patterns of walking and cycling

The average decline in walking and cycling, as reported by the NTS, masks potentially large variations between individuals and hence even more serious declines in active travel amongst many adults.

Cycling

While data capture for both walking and cycling have been relatively poor in comparison to that of motorised travel, it is possible to see for cycling, according to Department of Transport data, a steep decline especially during the fifties, passing from 11 per cent of all passenger travel in 1952 to 4 per cent in 1960, and then down to 1 per cent in 1970 and then a levelling out by the mid 1990s at around 0.5 per cent.

Figure 8: Bicycle use 1952 – 2005 (bpk)



Source: TSGB 2006

These data suggest that cycling had been through a major decline prior to the rise of obesity from around 1980. Details on average cycle mileage per person (available from 1975/76) record a steady decline from 1975/76 of 79 miles per person per year to 35 by 2005 (in total a decline of 55%). In the last ten years (between 1995 and 2005), distance travelled by bicycle fell by 16%.[3]

However the picture is different when we consider distance cycled per rider instead of using population averages. This clearly shows that the decline is almost entirely accounted for by a declining number of people cycling regularly, while those who still do have maintained a more or less constant average level of use, by both distance and time. Data per rider per week appear to be constant (13 miles per week per rider) since 1985 and the time spent per week per rider also remained constant.

Also, particularly with cycling, averages of time or distance travelled can amply chart the general decline over the past decades, but do little to illustrate the prevalence of cycling or its importance amongst those who do still do so. That is, cycling activity is very unevenly dispersed amongst the population, with some people cycling significant distances, while most cycle little or not at all. Indeed, the official figures may understate the distance cycled by regular cyclists, as the NTS data available only cover cycling on highways, and arguably do not reflect the fact that cycling on off-road cycleways is increasing (Sustrans, 2006).

[3] Methodological note: NTS data on cycling does not consider cycling outside highway which is considered to have increased in cycle pathways by 10%.

The proportions cycling to work fell form 4.4 per cent in 1971 to 3.7 per cent in 1981, 3.2 per cent in 1991 and 2.7 per cent in 2001. Here again the proportion of those living in a household with no car cycle to work more, 6 per cent , compared to those with one and two cars, 3 and 1 per cent respectively (Census 2001).

Given that regular cycling is now confined to a small proportion of the population and that its major decline predated the period of this study, cycling is not considered separately beyond this point in relation to obesity. However, given that obesity is a cumulative process, it is quite possible that there are many people who have experienced weight problems in later life having given up regular cycling some decades ago. Encouraging cycling could well be part of the solution to our weight and climate change problems, but probably by no means the whole of it.

Walking

Walking is the most environmentally friendly and healthy form of transport. It is healthy as it can provide the regular exercise needed to prevent obesity and related illnesses. Also, it is equitable as it can be performed by virtually everybody at no cost. As Morris and Hardman (1997) summarised:

> "Walking is the most natural activity and the only sustained dynamic aerobic exercise that is common to everyone except for the seriously disabled or very frail. ...Unlike so much physical activity, there is little, if any, decline in middle age. It is a year-round, readily repeatable self-reinforcing habit-forming activity and the main option for increasing physical activity in sedentary populations."

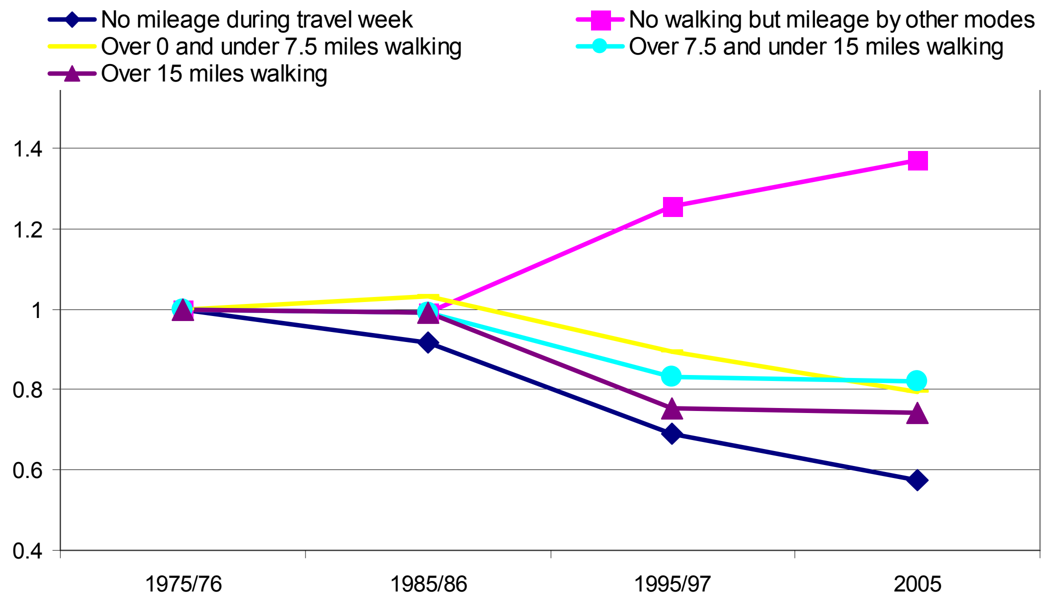
Walking is an important travel mode with 23 per cent of all journeys in Great Britain being made mainly by foot, (NTS, 2005). However, as with cycling, the data for walking (which is available from 1975/76) record a steady decline. In particular the National Travel Survey shows that the average distance walked per person per year has been steadily dropping from 248 miles in 1975/76 to 169 miles in 2005 (DoT, 1993: DfT/ONS, 2005). The major difference, in comparison to cycling, is likely to be that walking has declined much less dramatically than has cycling. However, because walking is an everyday activity which everybody can do at no expense, a sign of its decline is a significant indicator of decline in overall human energy expenditure.

Firstly, we are interested in assessing how trends in walking have changed. One fifth of all journeys (22 per cent) are under one mile, a distance that can be easily carried out by foot. However in 1975/76 the proportion of journeys under one mile made by foot was 86 per cent, in 1985/86 and

1994/95 it was 81 per cent, and in 2005 it fell to 76 per cent. The majority of the remainder of trips under one mile (21 per cent) were by car. Much of the decline in the total number of walk trips can be associated with the strong trend in trip lengthening and with the increased use of the car also for short distances.

As illustrated in the previous section, in the last 30 years there was a strong increase in trip length from 4.7 miles in 1975/76, to 5.2 mile in 1985/86, to 6.2 miles in 1994/96 and finally to 7.2 in 2005. Figure 10 below shows how distances carried out by foot in the travel week have been constantly declining, shifting substantially to other modes of transport.

Figure 9: Distance walked during the travel week by people aged 17 and over 1975/76-2005 (1975/76 = 1.0)



Source: NTS, 2007

From the perspective of health and obesity threats, frequency (i.e. regularity) and distance of journeys by foot are the most important factors. The journey purpose affects the frequency of journeys. There will therefore be quite a different impact on energy expenditure if someone walks for non-frequent leisure purposes or if he or she walks to work on a regular basis. Therefore, walking to work or for part of the journey (such as walking to and from a railway station) 'matters more', because it is an activity occurring on a daily basis and performed by a relatively large proportion of the adult UK population. Over 20 per cent of all journeys made by adults are journeys to and from work.

However, as car ownership has increased and as jobs have dispersed, fewer people walk to work (NTS, 1998). Between 1971 and 2001 proportions of the working population walking to work have more than halved, from 22 per cent in 1971 to 10 per cent in 2001 (Census, 2001). Different factors that influence whether a person chooses to walk include the geographical distance, the topography of the area, accessibility of public transport and the availability of cars.

High car ownership is associated with a reduction in the number of people walking to work. For people living in a household with a car the proportion walking to work is less than half that in households without a car: 25 per cent of people living in a household without a car walk to work, compared to 9 per cent of those living in households with one car, and 7 per cent of those with two cars. Conversely, 50 per cent of those living in a household with one car and 69 per cent for those with two cars, use the car to get to work.

3.3 Summary

This chapter has set out to demonstrate that car use has eroded the role of walking (and cycling) and that car ownership itself is a valid proxy for reduced likelihood of walking, such that people in households without cars walk twice as much as main drivers in households with access to cars. This evidence serves to 'dovetail' with that of Chapter 2 in order to show that time spent in cars is time that may previously have been spent walking and that this change is a significant contributor to the obesity crisis.

4

Making the links: Modal shift, obesity and climate change

Summary This chapter assesses the impact that the substitution of walking by car use has had on CO_2 emissions and provides calculations as to the additional CO_2 emitted per individual driver at an aggregate level for drivers in Great Britain and cumulatively over 30 years. Calculations are also provided for likely weight gain derived from a weekly loss of 56 minutes of walking during the period 1975 – 2005.

4.1 Changes in travel patterns and their impacts on CO_2 emissions

The introduction of the car and the increase in distances travelled (see previous chapters) brought about two main changes in individual travel patterns, which in turn had an impact on CO_2 emissions in the UK:

- *Increase in distances travelled:* the car substituted rail and bus for long journeys and affected travel behaviour: for the same purpose an average individual travels longer distances by car than previously travelled by other modes. The constant increase in distance travelled by car caused an increase in CO_2 emissions.
- *Giving up walking short distances*: car ownership is associated with a substantial decrease in walking. Main drivers in households with car access walk half the distance per year compared with an adult with no car. The average driver gave up half of their walking to work or to local shops or for escorting to education. This shift contributed to additional

CO_2 emissions, which, we argue, could be easily saved through behavioural change (see chapter 5).

However, as these are part of complex and interlocking set of changes in travel patterns, there is no obvious method for calculating what share of CO_2 emissions is directly attributable to the decline in walking. In the following paragraphs we will present the impacts on CO_2 emissions related to the increasing reliance on cars and, in particular, we will estimate the impact on CO_2 derived from the shift from walking to car driving. In order to do this we have used the following datasets and methodology (we present the two methodologies in detail in Annexes 3 and 4):

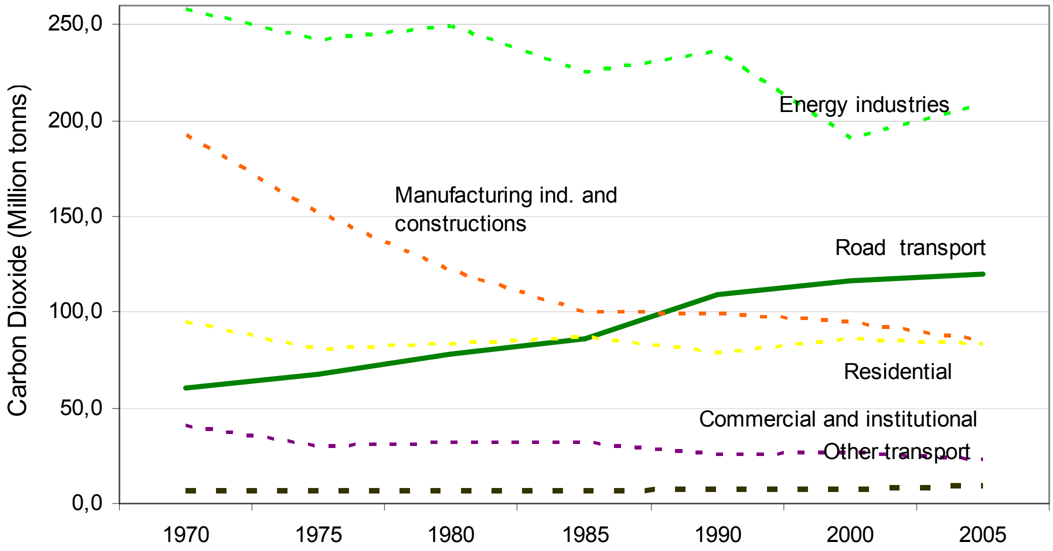
- *National CO_2 emissions from passenger cars:* the increase in car use and increase in distance travelled is well reflected in the national emissions inventory (National Atmospheric Emissions Inventory, 2004).
- *Impact on CO_2 of the shift from walking to driving:* in order to estimate the shift we have analysed an historical series of time budgets and main mode of travel for the UK adult population (NTS data 1975 – 2005).
- Further narrowing the scope, we have analysed the impact of car ownership on travel behaviour, in particular on walking, focusing our analysis on main drivers in households with car access (NTS, 2006). If compared with people with no car, an individual who becomes a main driver gives up half of their annual walking activity and emits additional CO_2 as a result.

For the CO_2 emissions derived from the shift from walking to car driving on local distances, we have developed two estimations: one based on the evidence that time budgets has not changed over the last 30 years and that walking reductions have shifted to car or local bus. The other is based on the assumption that, because main drivers walk half the distance of adults in households with no car, the shift has been produced by car ownership and the substitution must have gone all to car.

4.2 Carbon emissions from road transport and passenger cars in the UK

Since 1970, all sectors in the UK have more or less steadily reduced their CO_2 emissions, with the exception of the road transport sector. This been the only sector for which emissions have been steadily increasing. In 2005, road transport was the second major source of CO_2 accounting for 21 per cent of the UK’s total. Today, more than a fifth all carbon dioxide emitted in the UK comes from cars and trucks on our roads.

Figure 10: Estimated emissions of carbon dioxide 1970 – 2005 (Mt CO_2)



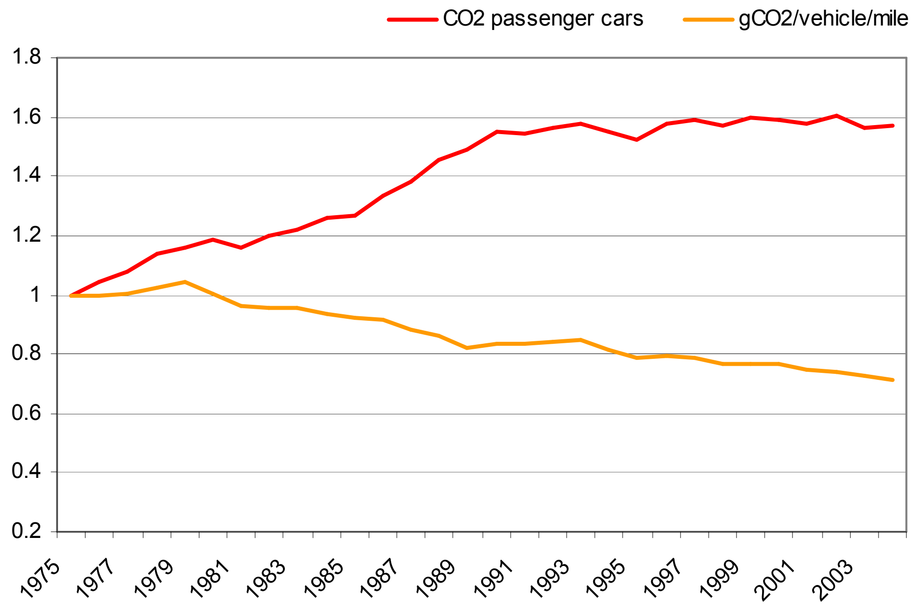
Source: Defra, 2007

In 2005, CO_2 emissions in the UK totalled 554 Mt (Defra, 2007) and road transport was the second major source of CO_2, accounting for more than a fifth of all carbon dioxide emitted in the UK (21 per cent of UK's total CO_2 emissions). It is mainly because of the increase in road transport emissions, that the UK will not be able to meet its own commitment to reduce emissions of carbon dioxide by 20 per cent below 1990 levels by 2010, which would contribute towards the longer term goal of achieving a 60 per cent reduction by 2050. Instead, CO_2 emissions fell by just 6.4 per cent between 1990 and 2005.

Passenger cars contributed 13 per cent of the UK's total CO_2 emissions in 2004 (National Atmospheric Emissions Inventory, 2004). As for the road transport sector in general, compared to other sectors' decline, passenger cars' emissions continue to increase: emissions from passenger cars increased by 57 per cent in the last 30 years, from nearly 46 Mt CO_2 in 1975 to 72 Mt CO_2 in 2004.[4] Moreover, passenger cars' emissions, since 1990, they have instead increased by 1.3 per cent, and by 0.9 per cent as a percentage of total road emissions.

[4] Data of the National Atmospheric Emissions Inventory on carbon emissions from passenger cars are only available up to 2004 (accessed May 2007).

Figure 11: CO_2 emissions from passenger cars from 1975 to 2004 ('000 tonnes)



Source: IEEP elaboration of National Atmospheric Emissions Inventory, 2004

While the improvements in new passenger car CO_2 emissions since the 1980s have approximately kept pace with the growth in traffic, this is unlikely to be enough to off-set growing demand and the consequences of people buying bigger cars and more powerful engines (Fergusson, 2005). Given these premises, without a change in travelling behaviour, it is more than likely that UK emissions from passenger cars will begin to rise once more.

As already anticipated, in the following paragraphs we will estimate the impacts on CO_2 brought by car ownership and the relative changes in individual travel behaviour, focusing in particular on the increase in CO_2 emissions resulting from individuals switching from walking to driving.

4.3 Calculating the CO_2 emissions from shifting travel hours from walking to driving

It can be seen from the previous paragraph that car use is responsible for a significant share of national CO_2 emissions. The purpose of this paragraph is to show what proportion of this is directly attributable to the associated decline in distance walked – and hence how much CO_2 might be avoided if walking activity were restored to its 1975 level.

Method 1

The first methodology used to calculate additional CO_2 emissions is based on NTS data on time budgets and modal shares from 1975/76 to 2005 of the adult population in the UK (*average adult*).

It is recognised in transport research that the time spent travelling per person over the last 30 years has not changed significantly. Therefore, it is likely that the hours lost from walking (i.e. counting for short distance journeys and journeys for local purposes), have been gained by other transport modes, namely car and local buses, and that the same time has therefore been used to travel longer distances – achieved by burning fossil fuel.

As we can see from the table below, the time spent walking per person per year decreased by 23 per cent from 1975/76, from 87 to 67 hours per year by 2005. Of this decrease (i.e. 20 hours per year less spent walking by the typical adult), 16.46 hours went to car driving (for more details see Annex 4).

Table 3: Total time spent travelling by main mode (hours/year/adult)

	1975/ 1976	1985/ 1986	1990/ 1992	1995/ 1997	1998/ 2000	2005
Walk	87	84	80	73	70	67
Car/van driver	91	101	127	141	146	151
Bus in London	8	7	7	7	8	10
Other local bus	42	33	28	26	25	24

Source: IEEP elaboration of NTS 2007

As a result, a typical adult emits 0.07 tonnes CO_2 if compared with 1975, deriving from giving up walking and using the car instead. In total, at least an additional 4.10 Mt CO_2 were emitted in 2005 by individuals as a result of walking less than in 1975 (see Annex 4 for details of the method used). This is almost 15.7 per cent of the total CO_2 emissions' increase from passenger cars over the last 30 years; the greatest part is accounted for by the greater distance driven.

Therefore, if today we reverted to the walking patterns of 1975, we would save 5.7 per cent of current emissions from passenger cars (at least 4.10 Mt CO_2 would be saved out of the 72 Mt CO_2 coming from passenger cars in 2005).

Method 2

Further narrowing the focus, the behaviour of *main drivers* in comparison to persons with no car reveal that car ownership is associated with substantially higher mileage by car and a substantial decrease in mileage on foot, this too has an impact on CO_2 emissions.

Here we compare data on car use and walking which refer to persons in households with car access and persons in households without car access. In particular, within the former, we focus on the main driver, which shows striking differences in travel patters, compared with people with no car (but also within households with cars, where main drivers show a tendency to use the car more often, for longer distances and to walk less, than the 'other drivers' and the 'non drivers' in the same household).[5]

The main differences in travel habits brought by car ownership are both unhealthy and environmentally damaging:

- Main drivers drive almost 10 times the distance of people in households with no car, travelling therefore an additional 7,581 miles per year in 2005;
- Main drivers walk half the distance compared with people in households with no car, totalling 124 miles by foot less per year; and
- Main drivers tend to travel much longer distances for the same purpose as people with no car at the local level. For example, they travel approximately 11 times the distance for shopping and escorting children to education.

In 2005, a main driver typically drove 7,663 miles per year by car, driving 7,581 miles more than a person with no car. As a result of driving, the average main driver in the UK emits 2.23 tonnes of CO_2 per year. This represents approximately 20.3 per cent of an average individual's annual carbon footprint in the UK.[6] In contrast, a person living in a household with no car emits 0.023 tonnes CO_2 from car driving in a year.

Moreover, a main driver *walks* half the distance of a person living in a household without a car (149 miles per year against 273 miles respectively – data are for 2005). Also within households with car access, main drivers walk much less than the 'other drivers' and the 'non drivers', who walk respectively 213 and 218 miles in a year on average.

As a result of giving up walking, a main driver, in 2005, contributed typically 0.42 additional tonnes of CO_2, in comparison to a person in a household with no car access (this amount takes into account the increase in distances travelled by a car driver for the same purpose, e.g. shopping and escorting to education; see Annex 4 for methodology).

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[5] Data used for this section was provided by NTS. NTS 'Travel by main mode and personal car access', available for the following years: 1975/76, 1985/86, 1989/91, 1992/94, 1995/97, 1998/00, 2002, 2003, 2004 and 2005.

[6] The average individual's yearly carbon footprint (UK Carbon Footprint Calculator, http://www.carbonfootprint.com/results.php) in the UK is 10.96 tonnes CO_2. It includes also the following direct emissions: gas, coal and oil for heating (1.6 tonnes CO_2), electricity consumption (1.3 tonnes CO_2), public transport (0.36 tonnes CO_2) and holiday flights (0.651 tonnes CO_2). The average carbon footprint which takes into account secondary emissions doubles the emissions of an average person to 10.9 tonnes CO_2, it includes secondary emissions deriving from Food and Drink, Clothes and Shoes, Car Manufacture, Buildings, Furniture and Appliances, Recreation and Services, Finance and other services, Share of Public Services.

Therefore, if today *all main drivers* (amounting to more than 26 million people) reverted to the walking patterns they had before owning a car (ie miles walked by people with no car), at least 11.1 Mt CO_2 could be saved, amounting to 15.4 per cent of total emissions from passenger cars.

Since 1975, the cumulative impact on CO_2 emissions of *new main drivers* halving their walking reached 5.80 Mt CO_2 in 2005, equal to approximately 22.2 per cent of the overall increase in CO_2 emissions deriving from passenger cars in the last 30 years.

In summary, the two methods of CO_2 estimation exercise, produced two results:

- A *'top down'* estimation (as it distributes the shift to all adult population, i.e. average adult population), achieved using shifts in time budgets for the average adult population, which represents the *'lower bound'* of our estimations (i.e 4.10 Mt CO_2 over 30 years and 0.07 tonnes CO_2 per person in 2005); and
- A *'bottom up'* analysis, which focuses on *main drivers* giving up walking, resulting in higher emissions and representing the *'upper bound'* (i.e 5.80 Mt CO_2 over 30 years and 0.42 tonnes CO_2 per main driver per year).

Each case it should be stressed that these are quite conservative estimates; the real figure could be rather higher.

4.4 Personal energy balance

Considering the issue of obesity, Swinburn and Eggar (2004) note that the chronic positive energy balance that leads to obesity is apparently relatively small. It is therefore paradoxical that obesity is so persistent and difficult to treat, because, in Western countries at least, the basic causes of obesity are readily apparent to everyone (eating too much and exercising too little). That is, calories (kcal) in and kcal out. Jebb (2002) notes another material consideration which is that major weight gain rarely occurs over short periods of time, but rather over many years, usually reflecting an average energy imbalance of only 1 or 2 per cent per day.

The average weight gain in Britain is less than 0.5 kg a year. A modest but persistent accumulation of only 50-200 kcal daily leads, over a 4-10 year period, to a slow but progressive weight increase of 2-20 kg before the metabolic and physical cost of maintaining this additional weight balances the additional intake. Body weight then stabilizes at this higher level (Scottish Intercollegiate Guidelines Network, 2006). Hence reversing this trend to maintain a stable weight requires only a minor increase in physical activity, or a small cut in the energy we consume (Jebb, 2002). It has been estimated that weight gain and obesity in the majority of the population could be addressed if people ate a few less bites at each meal or took approximately 2000 extra steps each day (Hill and Wyatt, 2003).

Arithmetically, people get heavier if they consume more calories or expend fewer calories. On average, about 3,500 kcals is one pound. Any increase in calorie consumption or reduction in caloric expenditure of that amount increases weight by one pound for a typical person.[7] Typically weight gain is about 75 per cent fat and 25 per cent lean tissue. Achieving at least 30 minutes of at least moderate intensity physical activity on 5 or more days a week (150 minutes per week) will represent a significant increase in energy expenditure for most people, and will make a substantial contribution to their ongoing weight management. However, in today's sedentary society, and in the absence of a reduction in energy intake, 30 minutes' activity a day on five or more days a week, the advice from Chief Medical Officers on reducing risks to health, may not be enough to prevent the development of obesity for many people, and 45-60 minutes of moderate intensity activity per day may be needed. There is increasing acceptance of the need for an hour a day on at least five days a week for some people in order to control or reduce body weight. This is double the minimum recommendation in order to achieve health-related benefits from physical activity (DH, 2004b).

Obesity calculations relating to replacement of walking trips by car: 1980-2005 and background information

Adult obesity has increased between 17-18 per cent since 1980 in Great Britain (then at 7%) which equates to approximately 4 million additional obese adults by 2004. (calculated on basis of 38 millions adults in England, Scotland and Wales in 1981 and 40.7 million, derived from ONS (ONS, 2005).

In order to assess how much walking is undertaken transport researchers tend to rely on the National Travel Survey (NTS).[8] Between 1975/76 and 2004 12.9 million adults have gained a full car driving licence (19.4 m to 32.3 m) (Dept, Transport, 2006). NTS data suggests that main drivers walk approximately half the distance per year of adults in non-car households (Dept. Transport 1995). Thus, gaining a full licence to drive a car and the likelihood of subsequent main access to a car results in a substitution of walking for car use. For example, in 1992/94 a main car driver walked on

[7] There are differences in metabolisms across human beings, and it is also possible that different caloric expenditures may have different impacts on the amount of weight gained or lost. But, these statements are true on average.

[8] NTS does not include walk trips away from the public highway. For example, in NTS 2005 respondents were asked how often they took walks of 20 minutes or more without stopping, for any reason. Unlike trips recorded in the travel diary, this included walks which were not on the public highway or in parks. Thus, these trips are additional to those otherwise stated in the NTS.

average 141 miles per year, while an adult in a car-free household typically walked 272 miles per year. This equates to 0.38 and 0.75 miles per day respectively (ie 7 and 15 minutes respectively at 3 mph walking speed). Thus, an 8 minute daily difference is 56 minutes less walking by main drivers per week.

The following calculations draw on the average reduction of 8 minutes of walking among main car driver compared to non-car household adults per day. An 8 minutes walk based on a walking pace of 3 mph for a 200 lb adult (ie 300 kcals per hour[9]) would equate to 40 kcals. However, this needs to be contrasted against the amount of calories used while driving. Car driving cannot be taken as using just 90 kcals per hour, as per sitting quietly. Thus driving has been estimated to expend 105 kcals per hour and so 14 kcals for 8 minutes.[10] Thus the difference between walking and driving would be 195 kcals per hour and 26 kcals for 8 minutes.

In calculating the consequent weight gain over time it is of note that 3,500 kcals is equivalent to 1lb in weight. Thus a reduction of 26 kcals per day equals 9,490 kcals per year, equivalent to a 2 lb 11 ounces weight gain per year arising from an 8 minutes per day reduction in walking.

Over a period of ten years this could increase body weight by 1 stone 13 lbs arising from an 8 minutes per day reduction in walking. This is a sufficient increase in its own right to move a 5 ft 9 in (1.75m) adult from a BMI of 24 (healthy) to 28.5 and significantly overweight.

Over a period of thirty years this could increase body weight by 5 stone 11 lbs arising from an 8 minutes per day reduction in walking. This is a sufficient increase in its own right to move an adult from a BMI of 24 (healthy) to significantly obese with a BMI over 35.[11]

NTS data shows that the percentage of adults aged 17 and over in GB who report that they do not walk during the travel week but accumulate mileage

[9] Derived from Ainsworth in The Compendium of Physical Activities Tracking Guide http://prevention.sph.sc.edu/tools/docs/documents_compendium.pdf accessed 9th March 2007.

[10] No validated information source has been located on calorie expenditure for driving a car.

[11] These calculations assume that there are no compensating changes in diet. It also acknowledges that increases in weight gain in itself increases resting metabolic rate and thus energy expenditure and that it has been estimated that weight gain may therefore be attenuated by approximately 25 per cent. (Swinburn *et al.*, 2006). Even allowing for changes in metabolic rate the impact of the decline in walking identified still leads to substantial weight gain over the time period considered in our calculations sufficient to make a major contribution such as from a healthy body weight to that of obese.

using other modes grew by 14 per cent between 1975/76 and 2005, equivalent to approximately 5.5 million adults.

If 5.5 million adults who become full car licence holders between 1975/76 and who consequently reduced their walking by 8 minutes on average a day, at a conservative estimate, then the calculations above suggests that this could increase their body weight significantly. This could 'tip' a person into a positive energy balance, and over a period of years lead to obesity. At a population level this could account for the sharp rise recorded in obesity since 1980.

Also, it is important to note that the replacement of walking by car trips in reducing human energy expenditure may be augmented by increases in other sedentary behaviours such as increased TV viewing, use of computers and less physical activity in the workplace.

4.5 Summary

This chapter has shown that for CO_2 the substitution of walking by car travel has significantly increased CO_2 emissions and for obesity reduced energy expenditure. At the individual level in the short term both are small and seemingly insignificant changes. Yet, over the long term these changes can lead to greatly increased health risks, because incremental weight gain can lead to obesity and, at a population level, increased driving adds significantly to CO_2 emissions. These effects could potentially be reversed by restoring levels of walking to those of 1975.

5

The potential for change

Summary This chapter addresses where the potential for change to reduce the threats posed by obesity and climate change may be greatest. It identifies that making changes to the physical environment although important would not have a significant impact in the short term. Greater potential is likely to be realised through behavioural change programmes to promote routine walking for short journeys.

5.1 Reducing CO_2 emissions through a more active life style

The first action which would benefit health and the environment would be for more people to transfer from car driving to walking (and cycling) for short journeys. 40 per cent of all journeys are under 2 miles in length and 38 per cent of these are undertaken by car. This distance could by achieved in 30 minutes of brisk walking (Health Development Agency, 2005). Clearly there is a potential here for personal energy expenditure that needs to be increased in order to combat obesity.

Cars consume most fuel and pollute more at the start of their journey when the engine is cold. Therefore walking or cycling for short journeys would be not only good for a person's health, but could also reduce the amount of CO_2 emissions released into the atmosphere by a disproportionate amount (see chapter 4 for potential CO_2 emissions reductions).

There are several initiatives that try to re-build walking into people's normal daily routine. The Energy Saving Trust (2007) suggest a list of practical guidelines, that today seem to be 'lost' due to a perception of 'absence of time'. The activities suggested range from 'go for a walk at lunchtime (it can give you an energy boost for the afternoon)', 'get off the train, bus or tube a stop earlier than usual', to 'walk to the newsagent or post office instead of using the car'.

Shopping and escorting children to school are two possible local activities which could be undertaken by foot, for example. Distances travelled for shopping have increased, typically, by 125 miles per adult per year in the last 16 years (from 319 miles per adult per year in 1989, to 444 miles per year in 2005). Escorting children to school is an activity which is mostly within local range distances that could be carried out on foot, especially at primary school level. An average adult totalled 55 miles per year by car for the purpose of escorting to school in 1989. This figure increased to 82 miles per year in 2005. Are there any alternatives? Some effort is being made through School Travel Plans to replace short car trips for the school journey, but more could be done such as setting car exclusion zones around schools and enhancing positive incentives to walk. Through children, parents and carers could be incentivised to walk for their own health and weight management.

5.2 An environment for active travel - 'unfit for purpose'

Historically, no organisation has been responsible for ensuring that people can get to key services and employment sites.[12] Indeed, transport planning since the 1960s implicitly has given greater attention to mobility by car than for other modes, and probably least consideration to walking and cycling. As a result, services have developed with insufficient attention to accessibility. In addition, too often access to services has been seen as merely a transport issue rather than one that can be solved by, for example, better land-use planning, or through policies to enable safer streets and stations (DfT, 2003).

Our urban built environments have increasingly been manipulated since the 1960s and the Buchanan Report, *Traffic in Towns*, (Ministry of Transport, 1963) tried to set out a way to accommodate more private motorised transport. As was noted by the Buchanan team, the problem of growth in car use in urban areas was seen as how to:

> "Contrive the efficient distribution, or accessibility, of large numbers of vehicles to large numbers of buildings, and to do it in such a way that a satisfactory standard of environment is achieved."

Unfortunately, the environmental standard sought precluded any serious consideration to the needs of pedestrians and cyclists. Indeed, the importance of these active travel modes has only relatively recently been given any serious consideration within town and transport planning. Yet research

[12] Only since 2004 has accessibility planning as an approach been included in the lexicon of the professions associated with transport planning

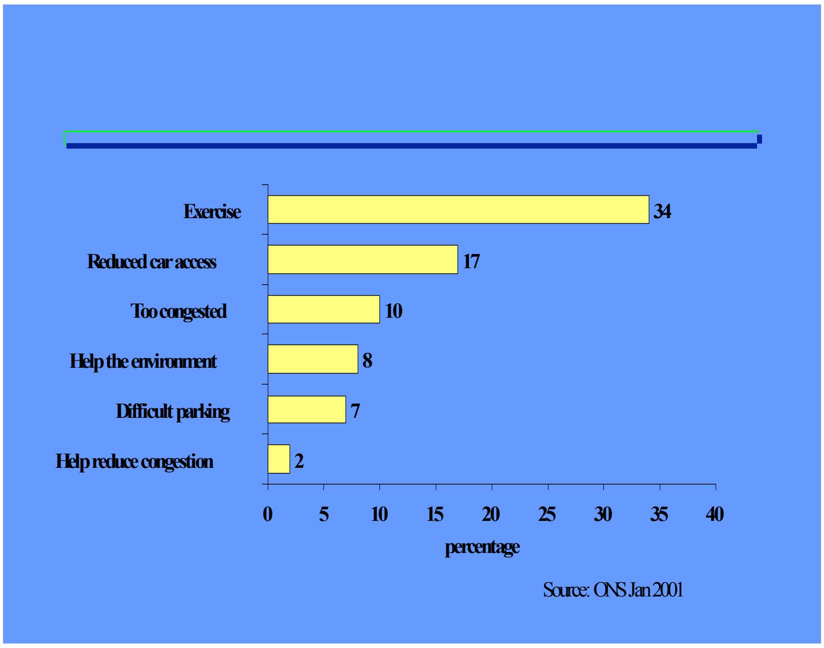
suggests that urban form can significantly influence levels of walking and cycling. High densities, a greater mixture of land uses, a balance between housing and jobs, pedestrian and bicycle-friendly sites and street design, grid street networks, and the presence of separated facilities for bicycles and pedestrians have all been shown to increase walking and cycling (Active Community Environments, undated).

5.3 Helping those wanting to reduce car use to make Smarter Choices

There have been several attempts to give greater prominence to walking in UK transport policy and practice during the time period covered by this report. In 1980 the then Secretary of State for Transport, Norman Fowler, stated that walking was 'going to be an increasingly important central Government objective' (cited in Hillman, 1990). Yet any policy initiatives were later quietly dropped. Another start was made in June 2003 when the Department for Transport issued a discussion paper which sought views on how conditions for pedestrians might be improved and the number of journeys made on foot increased (DfT, 2003a). Since then there has been increased focus on behaviour change in general underpinned by the publication of the Smarter Choices report (Department for Transport, 2004). In the same year the Chief Medical Officer has suggested that routine walking and cycling for short journeys is a key way to improve population health (DH, 2004b). This makes sense because most people will not change into special clothing, travel to a facility, and engage in planned vigorous exercise several times in one week. Moreover, the urgency of a change away from car use to active travel modes has been augmented by the growing evidence as to the impact of climate change and the contribution of road transport to carbon dioxide emissions. Thus, in theory at least, there is some convergence and mutuality of concern from both transport planning and public health in addressing the need to increase population levels of walking and in so doing reduce car journeys.

Physical activity programmes have largely been targeted towards individual behaviour change programmes and promotional campaigns, yet with little evidence of success (Hillsdon et al, 2002). Sport is often held up as a key way to promote physical activity. However, since 70 per cent of the adult population does not participate in sufficient moderate activity to achieve a health benefit the potential for vigorous activity associated with most sports is not plausible. Indeed, in order to make sporting activities a possibility for the majority of the population it is first essential that those with low levels of physical activity build up their activity levels through increasing amounts of moderate activity and then introducing shorter amounts of vigorous activities each week. One obvious way to accumulate physical activity regularly is to commute to and from work by bicycle or on foot (Hardmann, 1999). Across the population, data shows there is evidence of 'demand' for active travel. For example, one main reason for people reducing their car use for short journeys is in order to 'get some exercise' (ONS, 2001), as shown in Figure below.

Figure 12: Reasons for cutting short car trips



Thus, the most important challenge is travel behaviour change in order to adequately address the twin crises of obesity and climate change. Personal behaviour change is critical to the reduction of CO_2 emissions, not least because it can be implemented more quickly than other interventions, and personal energy expenditure increases by substituting walking (or cycling) for local journeys go hand in hand. While motivating people to change travel behaviour is a challenge it is clear that a significant minority of car users wish to reduce their amount of car use. Below we provide evidence for a suppressed demand for reduced car use.

An early UK study on car dependence reported on a '20-60-20 society' wherein 20 per cent of car journeys are absolutely necessary and unavoidable, 20 per cent are of marginal value and 60 per cent are somewhere in between (RAC Foundation, 1995). Since then there have been a number of UK studies reporting similar findings as to a willingness to change (Anable, 2005; Scottish Executive, 2006) but without support to change it is unlikely that behaviour will change. In addition, strong habitual behaviours can over ride intentions to change where intentions are relatively weak (Verplanken *et al*, 1998). Thus, it is important to address and tailor support as much as possible to individuals in order to help them avoid relapse and override ingrained habits while trying to change (Fergusson *et al*, 1999).

A range of tools to deliver travel behaviour change are available, focused on improving individual knowledge, perceptions, attitudes, and choice of alternatives to single occupancy car use. These "Smarter Choice" measures include workplace travel plans, car sharing, teleworking, teleconferencing and personalised travel planning (DfT, 2004). A major expansion of travel behaviour change programmes is required if we are going to tackle the two crises of obesity and climate change.

It seems that the critical approach for transport planning to take in delivering travel behaviour change away from car use is to target such resources towards the 20 per cent plus of the population who may be interested in travel behaviour change. Critically, considering the issue of obesity the key task must be to help many adults to introduce or re-introduce walking back into their lives for routine activities which can be habitualised and to do so before many people become obese and physically find walking (or cycling) problematic. Naturally occurring breaks in habit such as house moving offer significant potential for behaviour change. A systematic review of interventions targeted at increasing walking has concluded that interventions tailored to people's needs, targeted at the most sedentary or at those most motivated to change, and delivered either at the level of the individual or household or through groups, can increase walking by up to 30-60 minutes a week on average, at least in the short term (Ogilvie *et al*, 2007). This roughly equates to the walking time lost per week to car travel in the past three decades covered by this study.

5.4 Changing the built environment

In addition and supportive of behaviour change, town planning and urban redesign offer significant opportunities for urban dwellers through creating streets that are worthwhile places to be in. The key principle of the Manual for Streets (DfT, 2007) is the creation of a sense of place so that the layout of a street reflects all its functions, not just that of moving vehicles. Although residential streets are the main focus of the Manual, local authorities are encouraged to consider applying the guidelines to other suitable streets, such as high streets. A new hierarchy of road users with pedestrians and cyclists at the top is one of the Manual's key recommendations. The Manual also advocates the reduction of traffic speeds to 20mph on residential streets through the design of street space.

People who live in neighbourhoods with 'traditional' or 'walkable' designs report about 30 minutes more walking for travel each week, and more total physical activity including among older residents, compared to those who live in less walkable neighbourhoods. The potential is likely to be for a transfer of car trips to walking and cycling for short trips, rather than for commuting trips in compact mixed use neighbourhoods (Cervero and Radisch, 1996; Khattak and Rodriguez, 2005).

The built environment is constantly being renovated and rebuilt and new developments are being constructed; these changes provide opportunities to incorporate more activity-conducive environments (Transportation Research Board/Institute of Medicine, 2005). Therefore, it is quite possible to redesign the built environment in ways which make active travel the default means by which to access goods, services, facilities, and people. Talk of integrated public policies has been a feature of the current UK government. However, the realities of operationalising the links between policy sectors and getting planning and transport guidance to direct local implementation to reflect the need for health promoting physical environments has not reflected the rhetoric. Actions have been few and far between. As the Commission for Architecture and the Built Environment has noted:

> "While the link between public health and the built environment may be recognised, it is still regarded by many as tangential, or the responsibility of the other side to deal with." (Commission for the Built Environment, 2006)

Another parallel approach to achieving a built environment favouring active travel is through urban regeneration. A case in point is that the Urban Task Force has noted that transport lies at the heart of urban regeneration. In the original Urban Task Force report of 1999 a vision was presented of how this should be done: road space would be planned, as it is in the most advanced European cities, to give priority to walking, cycling and public transport (Urban Task Force, 2005). The recent report of the Royal Commission on Environmental Pollution echoes such thinking. Again the links have been hard to translate from theory into practice in helping transport planning to move from a profession largely servicing car use to one promoting accessibility through a focus on the local environment and encouraging use of the most health promoting and environmentally sustainable modes of travel.

5.5 Summary

This chapter has addressed the potential for travel behaviour change and identified the importance of short journeys in reclaiming some time for walking. In order to facilitate this there is a need for a major increase in motivational behaviour change programmes. These are likely to work best if they are tailored to individual needs and may be targeted at individuals or households. Changing the built environment will take longer, but because it is constantly being changed such changes are important and should give prominence and priority to walking and cycling.

6

Conclusions

6.1 Declining physical activity as a contributor to obesity

In 1995 Prentice and Jebb, while acknowledging the interrelationship between energy intake and expenditure between 1950 and 1990, proposed that physical activity had probably played the dominant role in the development of obesity by greatly reducing energy needs for food. With the notable exception of these two nutritionists, scientific opinion as to the relative importance of energy intake and energy expenditure in relation to obesity appears to be largely divided along professional lines. Many nutritionists place greater emphasis on energy intake and many physical activity researchers place greater emphasis on energy expenditure. Most if not all accept the general view that there is a mismatch between energy intake and energy expenditure and that both diet and physical inactivity have played their part.

Importantly, though, recent evidence is that energy intake has actually *declined* by 20 per cent between 1974 and 2004 (for England). Even allowing for the fact that there is some under-reporting of food consumption in all dietary surveys, such a large reported decline in energy intake strongly suggests that Prentice and Jebb are correct in their analysis. There is a dominant factor at work, and this dominant factor is a decline in energy expenditure, through declining levels of physical activity, which is driving the rise of obesity in the UK. This is not to make a claim that diet is unimportant nor that physical activity alone causes obesity. It is rather that the case for physical inactivity taking a dominant role in weight gain is strong. At a population level the increase in obesity among individuals caused by substitution of walking for car use has contributed to a public health shift in the BMI distribution which significantly increases the prevalence of obesity.

At the individual level, in terms of full car licence holding's impact on energy expenditure, car ownership is not likely, in the short term (eg 1-5 years), to have increased body weight to the level of obesity, but rather to have contributed to an incremental transition to overweight. Over a longer term this can lead to obesity given the impact of even a small energy imbalance contributed to by the replacing of some walking with car use.

It is likely that over a longer period of time rising car use, with increasing habitual use even for short journeys among owners during the last 25-30 years, can help explain the contribution of car travel to increasing adult obesity. Specifically, time spent in cars as a proportion of daily travel has over many years gradually replaced physically active modes, and this appears to be a key determinant of the rise in adult obesity. A reduction of walking of just eight minutes a day may be sufficient over the long term to increase body weight from a BMI of between 20-25 to over 30.

6.2 Increased CO_2 from the switch from walking to driving

From the data provided by the NTS, it appears that time spent in cars as a proportion of daily travel has increased at the expense of physically active modes, therefore representing an important determinant of the rise in adult obesity (Mason (2000); Frank *et al* (2004); Frank and Niece (2005); Norberg-Hodge *et al* (2002); Rychetnik *et al* (2002); Wen *et al* (2006); Bell *et al* (2002)). As well as assessing the impact of car ownership on the declining level of physical activity and energy expenditure, we have analysed the relative changes in travel patterns and their impacts on CO_2 emissions.

In order to estimate the emissions deriving from the loss in energy expenditure, in particular from the decline in walking, we have used time budgets (i.e. time spent travelling per person), which over the last 30 years have not changed significantly. Attributing the hours lost from walking to modes of transport operating at the local level (i.e. local buses and cars), we have identified the proportion increase in car driving and estimated CO_2 emissions from the shift from walking to driving:

- The time spent walking per person per year decreased by 23 per cent from 1975/76, from 87 to 67 hours per year by 2005 (i.e. in 2005 an average individual walked 20.2 hours less than it used to in 1975/76). Of these, approximately 16.46 hours have been shifted to driving, corresponding to additional 251.44 miles by car per person. Therefore, in comparison to 1975, an *average adult* in the UK emitted an additional 0.07 tonnes CO_2, as a consequence of giving up walking and using a car.
- In total, over the last 30 years, an additional 4.1 Mt of CO_2 were emitted as a result of the average adult in the UK population reducing their walking. This equals to almost 15.7 per cent of the total CO_2

emissions increase from passenger cars over the last 30 years. Therefore, if today we reverted to the typical walking patterns of 1975, we would save at least 5.7 per cent of present-day emissions from passenger cars.

Moreover, NTS data suggest that the shift from walking to driving might be partly explained by a change in travel behaviour directly brought about by car ownership: NTS data reveal that car ownership is associated with substantially higher mileage by car and a substantial decrease in mileage on foot. Further narrowing the scope from the time budget analysis, using more 'bottom up' data from NTS, we were able to estimate CO_2 emissions deriving from behavioural change brought by car ownership and also to identify more precisely the link between rising levels of car ownership and decline in walking and the relative emissions. In particular, *main driver*s walk half the distance in a year of people with no car:

- In 2005, a main driver drove 7,663 miles per year by car: as a result of driving, the average main driver in the UK emits 2.23 tonnes of CO_2 per year. These emissions represent approximately 20.3 per cent of the total annual carbon footprint of the average individual in the UK.
- As a result of car ownership, people who became main drivers walked half the distance per year of people with no car. In 2005, each main driver contributed 0.42 additional tonnes of CO_2 as a consequence of giving up half of his or her walking. Therefore, if today's main drivers reverted to the walking patterns they had before owning a car (ie. as people with no car), 11.13 Mt of CO_2 could be saved.
- Over the last 30 years (1975 – 2005), the cumulative impact on CO_2 emissions from *new main drivers* halving their walking, contributed 5.80 Mt CO_2, equal to approximately 22.2 per cent of the overall increase in CO_2 emissions deriving from passenger cars in the last 30 years.

From the perspective of health and obesity threats, frequency (i.e. regularity) and distance of journeys on foot are the most important factors. There will be for example quite a significant difference in impact on energy expenditure if someone walks for infrequent leisure purposes, or if he, or she, walks to work on a regular basis. Census data (2001) show, consistently with the above analysis, that of people living in a household with a car the proportion *walking to work* is less than half that in households without a car (i.e. 25 per cent of people living in a household without a car walk to work, compared to 9 per cent of those living in households with one car, and 7 per cent of those with two cars).

In summary, the two results of the CO_2 estimation exercise, although hampered by the difficult task of finding data which represent the shift from walking to car driving in particular, has produced two results: a *'top down'* estimation (as it distributes the shift to all adult population, i.e. average adult population), achieved using shifts in time budgets for the average adult population, which represents the *'lower bound'* of our estimations (i.e 4.10 Mt CO_2 over 30 years and 0.07 tonnes CO_2 per person in 2005); and a *'bottom up'* analysis, which focuses on *main drivers* giving up walking, resulting in higher emissions and representing the *'upper bound'* (i.e 5.80 Mt CO_2 over 30 years and 0.42 tonnes CO_2 per main driver per year).

6.3 How can society achieve reduced car use and so contribute to a reduction in obesity levels and carbon dioxide emissions from road transport?

Is it possible to reverse the trends which have led to approximately a quarter of adults being obese and carbon dioxide emissions levels from road transport of over twenty per cent? A reduction can only be achieved by comprehensive action. Firstly, there is a need to provide travel behaviour change intervention programmes tailored to individual needs which help those interested in change to find ways in which to make walking behaviour a routine activity in their lives and lifestyles. This underscores the fact that the public significantly undervalues the importance of physical activity in maintaining health. Large scale behaviour change interventions will cost millions of pounds and will need to be maintained over the long term. However, the costs are dwafted by those incurred by the NHS and society through inactivity, ill-health and premature death.

Secondly, there is a need to utilise the continual redesign of the built environment to create environments positively discriminating in favour of walking and cycling. Implementing a road user hierarchy where pedestrians and cyclists are truly given priority would be an important change manifested in the environment to challenge the obesogenic environments to which previous transport policies and plans have contributed.

As a technological intervention the car's arrival in many homes will have occurred at a similar time as televisions and a range of other labour-saving devices. All of these may have contributed to declining energy expenditure although the replacement of walking, the most available form of routine physical activity may prove to be critical and most damaging to health. Car use is clearly an important contributor to the decline in physical activity through the replacing of walking trips and the consequent weight gain of roughly 2lbs per year. That the change from a healthy body weight to that of obesity typically takes place over many years may be an important reason why individuals often find tackling weight gain and obesity difficult to address. Understanding that habitual car use poses a significant health risk, in the sense that the behaviour has become automated and thus without conscious thought, poses a challenge. A first step may be to increase understanding as to the central importance of physical activity for health and encouragement through local programmes to 'commit' to walking, such as setting up 'exclusion zones' for driving to school, or to local facilities which are routinely accessed such as local shops and other services.

This is certainly a challenge; but the potential benefits of simultaneously cutting obesity and greenhouse gas emissions surely makes it a worthwhile one.

Annex 1

Obesity data, adults by sex in England, Scotland and Wales

The prevalence of overweight and obesity in Scotland is similar to that in England and Wales (Scottish Intercollegiate Guidelines Network). The proportion of adults in Scotland who were either overweight or obese increased significantly between 1995 and 2003, from 56 per cent to 64 per cent in men, and from 47 per cent to 57 per cent in women (Scottish Executive, 2005b). Similar trends occurred in England and Wales. In England, 66 per cent of men and 56 per cent of women were reported as overweight or obese in 2003 (Zaninotto *et al*, 2006). In Wales, in 2004/05 55 per cent of adults were overweight or obese (ONS, 2006).

Table 4: Obesity data, adults by sex in England and Wales, and Scotland

	1980	1986-87	1991-92	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Change 1980-04
England and Wales																
Men	6	7	13	13	14	15	16	17	17	19	21	21	22	23	23	17
Women	8	12	15	16	17	18	18	20	21	21	21	24	23	23	25	17
Scotland																
Men	6 [a]	7 [a]	13 [a]	n/a	n/a	16	n/a	n/a	18	n/a	n/a	n/a	n/a	22	23 [a]	17
Women	8 [a]	12 [a]	15 [a]	n/a	n/a	17	n/a	n/a	21	n/a	n/a	n/a	n/a	26	26 [a]	18

Sources: England: Health Survey for England from 1993 (and predecessors); Scotland: Scottish Health Surveys; Wales: heartstats (Wales-03 excel).
Notes: [a] = derived from survey data for England.

Note: In England, Wales and Scotland the increases in obesity levels since 1980 have been very similar in that there has been a 17-18 per cent increase in the intervening 24 years.

Annex 2

Defining obesity

Obesity is defined by body mass index (BMI), a mathematical calculation. BMI is calculated by dividing a person's body weight in kilograms by their height in meters squared (weight [kg]/height [m]2). A BMI of 30 or more is considered obese and a BMI between 25 and 29.9 is considered overweight (WHO Expert Committee, 1995: WHO/FAO, 2003). The WHO classification for obesity is set out in Table 1.

Table 5: WHO classification of obesity

Classification	**BMI (kg/m^2)**	**Risk of comorbidities**
Underweight	< 18.5	Low (but risk of other clinical problems increased)
Normal range	**18.5 to 24.9**	**Average**
Overweight	$\geq$ 25	
Pre-obese	25.0 to 29.9	Increased
Obese class 1	30.0 to 34.9	Moderate
Obese class 2	35.0 to 39.9	Severe
Obese class 3	$\geq$ 40.0	Very severe

	Waist circumference (CM)	
Comorbidity risk	**Women**	**Men**
Above action level 1	$\geq$ 80	$\geq$ 94
Above action level 2	$\geq$ 88	$\geq$ 102

Source: James et al, 2001

Annex 3

Data Sets

Obesity

Over the past decade or so, Great Britain has relatively comprehensive national health surveys that focus regularly on specific demographic populations and health indicators. These include the annual Health Survey for England (HSE) series (1993–2004), the Scottish Health Surveys (1995, 1998 and 2001, 2003), the Health in Wales Survey (five surveys in 1985–96), Welsh Health Survey (1995, 1998, 2004/05). Measured weight and height data from these allow the secular trend in the prevalence of obesity to be calculated in a nationally representative sample. The earliest data sets for obesity commence in 1980 and in that year 6 per cent men and 8 per cent women were classified as obese whereas by 2002 the proportion of the population obese had trebled (16 years to 75 + years) (Rennie and Jebb, 2005). See Annex I.

Emissions

Table 6: UK emissions from passenger cars and per vehicle (CO_2)

	1975	1980	1985	1990	1995	2000	2004
Emissions Carbon ('000 tonnes)	12,528.94	14,882.18	15,888.27	19,411.73	19,068.79	19,928.36	19,658.89
Emissions CO_2 ('000 tonnes)	45,939.44	54,568.02	58,257.00	71,176.36	69,918.90	73,070.67	72,082.62
Billion vehicle kilometre (car and taxis)	181.6	215.0	250.5	335.9	351.1	376.8	398.1
gCO_2/ vehicle/mile	407.11	408.44	374.33	341.04	320.47	312.08	291.42

Source: IEEP elaboration on National Atmospheric Emissions Inventory on carbon emissions from passenger cars to 2004 (accessed May 2007)

Time budgets

Table 7: Total time spent travelling by main mode (hours/ year/ adult)

	1975/ 1976	1985/ 1986	1990/ 1992	1995/ 1997	1998/ 2000	2005
Walk	87	84	80	73	70	67
Car/van driver	91	101	127	141	146	151
Bus in London	8	7	7	7	8	10
Other local bus	42	33	28	26	25	24

Source: data provided by NTS, 2007

Table 8: Distance per person per year by mode (miles)

Persons in households with a car /main driver						
	1975/76	1985/86	1989/91	1995/97	1998/00	2005
Walk	128	153	160	144	143	149
Car driver	7,281	7,145	7,927	8,387	8,261	7,663
Car passenger	835	1,202	1,413	1,543	1,441	1,433
Other private transport	174	214	187	181	183	178
Bus and coach	104	139	141	132	145	116
Taxi and minicab	9	19	31	40	48	49
Other public transport	455	470	510	565	614	684
All modes	8,986	9,341	10,369	10,992	10,837	10,270
Males	9,612	10,055	11,162	12,014	11,784	11,149
Females	6,856	7,759	8,876	9,385	9,434	9,185
Persons in households without a car						
Walk	302	318	325	296	281	273
Car driver	207	64	134	154	105	81
Car passenger	655	599	793	830	880	812
Other private transport	265	234	217	195	209	163
Bus and coach	763	703	760	697	776	846
Taxi and minicab	19	42	63	71	95	87
Other public transport	300	325	485	386	481	692
All modes	2,510	2,285	2,778	2,629	2,827	2,954
Males	3,044	2,554	3,135	2,855	3,181	3,258
Females	2,111	2,090	2,532	2,469	2,589	2,736

Source: NTS 2006

Car access

Table 9: Percentage of population with car access

		Persons in households with a car			
	Persons in households without a car	Main driver	Other driver	Non driver	All
All adults					
1975/1976	41	31	9	20	59
1985/1986	31	41	12	17	69
1989/1991	26	46	12	16	74
1992/1994	25	48	13	14	75
1995/1997	23	50	13	13	77
1998/2000	21	53	13	13	79
2002	20	54	13	13	80
2003	21	55	13	13	79
2004	20	54	13	14	80
2005	19	55	13	13	81

Source: NTS 2006

Table 10: Local activity - Trip distance per year by main mode and purpose (miles person per year)

	1989		1993/1995		2005	
	walking	**car driver**	**walking**	**car driver**	**walking**	**car driver**
Education (children school and college) + escort education (miles)	11	55	10	74	28	82
Shopping (miles)	25	319	17	352	31	444
Factor		**10.38**		**15.77**		**8.91**

Source: IEEP elaboration of NTS 2006

Annex 4:

Methodology Note for CO_2 Calculations

Method 1

Accounting only for the proportional increase in car driving,[13] the time lost from walking resulted in additional miles by car calculated using the average car speed on local distances.[14] In detail, in 2005 an average individual walked 20.2 hours less than they used to in 1975/76. Of these, approximately 16.46 hours have been shifted to driving, corresponding, at an average speed of 15 mph, to additional 251.44 miles by car per person.

Table 11: Estimate of CO_2 emissions from the shift in time budgets from walking to car driving (hours/miles/tonnes CO_2)

	1975/ 1976	1985/ 1986	1990/ 1992	1995/ 1997	1998/ 2000	2005
Reduction in walk vs 1975/1976 (hours)						
						hours/year/adult
Walk	0	-2.75	-7.03	-14.11	-16.39	-20.24
Increase car driving vs 1975/1976						
						hours/year/adult
Car/van driver	0	1.97	5.52	11.41	13.40	16.46
						miles/year/adult
Car/van driver	0	30.12	84.40	174.24	204.68	251.44
						total additional miles (m)
Car/van drivers	0	1,323.27	3,792.35	7,889.94	9,456.40	12,024.97
Increase CO_2 emissions vs 1975/1976						
						individual additional CO_2 from driving (tonnes CO_2)
Car/van drivers		0.01	0.03	0.06	0.06	0.07
						total additional CO_2 (M tonnes CO_2)
Car/van drivers	0	0.49	1.36	2.78	3.15	4.10

Source: IEEP elaboration on NTS 2006 and National Atmospheric Emissions Inventory on carbon emissions from passenger cars 2004

[13] In order to capture the impacts on CO_2 deriving from this reduction in walking, we distributed the reduction between the parallel increase in car use and local buses (substitutes for local distances). For the purposes of this report we focused only on cars' proportion, as it follows: *Hours shifted from walking to car*= Reduction hours walking * [Hours car driving/ (Hours car driving + Hours bus in London + Hours local bus)].

[14] *Additional miles (adult car driver)*= Hours shifted from walking to car * Average car speed for local distances (i.e. 15mph).

Therefore, in comparison to 1975, an individual emitted in 2005 an additional 0.07 tonnes of CO_2, which was derived from giving up walking and using a car instead (see table 11).[15] In total, additional 4.10 Mt CO_2 were emitted in 2005 by individuals as a result of walking less than in 1975.

Method 2

In order to map out the shift from walking brought by car ownership in the last 30 years, we developed a table summarising the differences in walking patterns between a person in households with no car and the main driver in a household with car access. We then applied the results to the *increasing number of car drivers in the UK* and estimated the increase in CO_2 as a consequence of more people becoming main drivers between 1975 and 2005. Note that, even though, as we can see from table 12, the difference in walking patterns between the two categories of people has decreased over these 30 years (i.e. as a result of persons in households without a car walking less and main drivers walking more, in respect to 1975), the difference between the two remains very significant.

Table 12: Change in walking patterns as a result of car ownership and main driver status

Difference in walking patters by car access (miles per person per year/ percentage/g CO_2/year)						
	1975/76	1985/86	1989/91	1995/97	1998/00	2005
Persons in households without a car	302	318	325	296	281	273
Persons in households with a car (main driver)	128	153	160	144	143	149
Difference in walking distances (main driver/ person in household with no car - %)	-58%	-52%	-51%	-51%	-49%	-45%
Additional emissions from non walking (tonne CO_2/ person/ year)	0.82	0.72	0.65	0.57	0.50	0.42

Source: IEEP elaboration on NTS 2006 and National Atmospheric Emissions Inventory on carbon emissions from passenger cars 2004

The assumption which underlies our analysis (i.e. a main driver that gives up walking prefers to use the car to travel for the same local purposes) is

[15] *Additional CO2 emissions* = Additional miles (adult car driver) * Annual average gCO2/mile.

supported by the drop in walking by main drivers, which we consider directly related to a behavioural change brought by car ownership. Therefore, in order to estimate the contributions of CO_2 derived from giving up walking by main drivers, we assumed that all the 'non walked' distance (i.e. calculated as the difference with walking patterns of persons without car access) will be undertaken by car instead. Since 1975, the cumulative impact on CO_2 emissions of *new main drivers* halving their walking reached 5.80 Mt CO_2 in 2005 (see table 13).

Table 13: Estimate of CO_2 contributions derived by main drivers shifting from walking to driving (cumulative 1975 – 2005)

	Persons in households with a car	% main driver	main drivers	new main drivers (cumulative)	reduced walking miles drivers	reduced walking miles drivers*factor	CO_2 emissions (m tonnes)
1975/1976	24,613,604	0.52	12,780,740				
1985/1986	30,324,800	0.59	17,803,335	5,022,595	828,847,385	9,692,519,472	3.63
1989/1991	33,390,032	0.62	20,803,237	8,022,497	1,325,257,367	15,497,524,708	5.29
1995/1997[1]	34,789,080	0.65	22,748,136	9,967,396	1,517,681,285	17,747,724,929	5.69
1998/2000	36,441,891	0.67	24,534,946	11,754,206	1,616,220,642	18,900,041,574	5.90
2005	38,723,266	0.68	26,510,833	13,730,093	1,702,620,861	19,910,403,455	5.80

Source: IEEP elaboration on NTS 2006 and National Atmospheric Emissions Inventory on carbon emissions from passenger cars 2004

An increasing factor has been used to calculate CO_2 emissions deriving from the shift from walking to car use in order to take into account that main drivers travel further distances at the local level for the same purpose than persons with no car. We compared miles travelled by foot and by car (i.e. car driver) for the same purposes (we have chosen as representative of local level activities shopping, education and escort to education). With the limited comparable data available (i.e. 1989, 1993/1995 and 2005) we have calculated an average factor (i.e. 11.69) which takes into account the increase distances travelled as a consequence of driving instead of walking.[16]

Note: in both cases the method used is quite conservative in that it assumes average CO_2 emissions per mile for the car journeys that displace journeys that would formerly have been walked. In practice the majority of these journeys will tend to be in urban areas, and over relatively short distances, where car engines may often be running cold and operating at their least efficiency. Hence in practice, the additional emissions may well be greater than those calculated here.

[16] *CO2 emissions from substituting the car to walking* = (Miles walked by person(s) without car - Miles walked by main driver(s)) * Annual average g CO2/mile/year * 11.69.

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