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Ensuring a Sustainable Future: Making Progress on Environment and Equity

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Moving Toward Sustainable Urban Transport: How Can We Integrate Environmental, Health, and Equity Objectives Globally?

Chapter: Moving Toward Sustainable Urban Transport
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Transport and travel can bring enormous benefits, as economies have become globalized, and as many transactions are now facilitated through relatively cheap networks and communications infrastructures. In high-income countries and among the growing middle classes of middle-income countries, expectations of travel have accelerated, and aspirations have been raised through media coverage, education, and increasing income.[1] But we also live in a carbon-dependent society, and carbon emissions are affecting the global climate with irreversible long-term consequences. Transport is the one major sector that has not made any contribution to a reduction in energy use and emissions. Equity is also a major issue, as many of the new opportunities for greater mobility have occurred very unequally across the global population, with lower income groups typically suffering more of the adverse consequences without reaping the benefits. The environmental limits and social inequities of the current transport situation make it economically and socially unsustainable and lead to detrimental impacts on population health. Rather than improve, the situation has worsened since global awareness of the potential impact of climate change was recognized at the Rio Summit (1992).

This chapter has two main aims. The first aim is to describe some of the major changes that are taking place in global cities, which with their huge increases in population are the economic powerhouses of the 21st century. Although economic growth and increased wealth is important for development, particularly in lower income countries, it will be argued that cities need to give equal value to issues relating to the environment, quality of life, and the health and well-being of the population. Such a change in thinking can be encompassed within the sustainable mobility paradigm,[2] which links together reduced dependence on carbon-based energy sources with broader societal benefits.

The second aim is to move the debate on sustainable transport forward to cover healthy, equitable, and sustainable transport by arguing strongly for more active transport. High-income countries have long suffered from physical inactivity, which both directly increases the risk of chronic disease and indirectly throws energy metabolism out of balance, thereby increasing overweight and obesity.[3] In the lower income countries, urbanization and motorization are bringing about a rapid increase in diseases associated with inactivity, air pollution, and road traffic injuries. The more active forms of transport (walking, cycling, and bus and rail—where these include a walk or cycle stage) can be at the core of the accessible city, while at the same time contributing to better health, social equality, and reducing emissions of carbon and other more local pollutants. Although investment is required, these options are comparatively inexpensive and can be accommodated in the new megacities that will be a global feature by 2050. However, while the problems of urban growth, traffic congestion, environment, health, and equity objectives could theoretically be resolved at a low cost through initiatives targeting increased use of active transport and decreased dependence on personal vehicles, it seems that in practice there is an inexorable move away from such initiatives.

Cities and Sustainable Transport

Over 50 percent of the world's population are now classified as urban dwellers (2005), and it is expected that this will increase to 70 percent by 2050,[4] as globally, the rate of urbanisation is 3 million per week. These levels of urbanization are already apparent in Europe, North America, and Latin America.[5]

In lower and middle-income countries the largest cities, megacities (population over 10 million) are generally characterized by high population growth, both from natural increase and inward migration, and a huge expansion in the urban area with substantial new requirements for both housing and jobs, in addition to transport. These megacities have tremendous potential for economic growth, but simultaneously they are centers for potential unrest, as there is substantial inequality and poverty.[6,7] The challenges for governments are daunting—with little space for expansion in the original cities, there is extensive urban sprawl with increased distances between where the people live, their jobs, and other facilities. The concept of monocentric cities is becoming less relevant, as they are rapidly developing as polycentric urban agglomerations, often absorbing smaller cities in the process. Many local governments have taken on a leadership role in addressing the transport problems as they relate to carbon emissions, but there is considerable variation between cities. For example, more than half the total energy consumption in Mexico City, Hong Kong, and Cape Town is land transport based,[8] while it remains at approximately one-quarter in many European cities (for example, London and Paris). This reflects the different strategies adopted by city planners, such as promoting the use of the car through investment in roads and free parking, to demand management and constraints on the use of the car, and investment in local facilities and in public transport.

Given the rise in urbanization around the world and the increased access to motor vehicles, the rate of increase in the supply of motorized transport infrastructure will never match the growth in demand. Attempting this would have enormous environmental, social, and health implications and would not “solve” the problem, as can be seen in many cities in high-income countries.

Current investment in transport infrastructure and services does not benefit all groups equally. Typically greater benefits are realized by higher income groups who have the means to take advantage of the improved transportation. In the United Kingdom the Sustainable Development Commission estimated that the richest 10 percent of the population effectively receive four times greater public expenditure on transport than the poorest 10 percent.[9] This inequality is even more pronounced in many lower income cities where investment is spent on infrastructure for cars, access to which is limited to higher income groups. In many low- and middle-income cities, public transport largely consists of informal vehicles, often with little consideration given to safety. The poorest cannot afford public transport and so have no option but to walk.[10] While walking can be a natural, healthy, and pleasant way to travel, it is often experienced as a necessity traversing a polluted and dangerous environment in which the pedestrian is seen as a second-class citizen.[11]

The environmental and public health needs of higher income and lower income cities contain both similarities and differences. In higher income cities quality of life, air pollution, and noncommunicable diseases resulting from excessive energy intake and inactivity are the most pressing burdens. In many lower income cities there remain basic unmet needs for clean water, electricity, waste management, and sanitation. However, it must not be forgotten that in many rapidly motorizing middle and lower income cities, air pollution is worse and the burden from noncommunicable diseases greater than in higher income cities.

All cities contribute, if unequally, to global emissions, and they have a responsibility to reduce these, but the desire for economic growth often takes precedence over other priorities. High-income cities have the opportunity to substantially reduce emissions through investment in clean technology, energy efficiency, and a switch from energy-intensive to lower carbon modes. For low-income cities, the challenges are even greater, as they have other pressing social needs to address, but investment in sustainable transport is still possible. Some of these low-income cities until recently have had high levels of walking and cycling, but this is being rapidly lost through motorization and the increased distances needed to reach desired destinations (Table 7.1); in particular, cycling has suffered as cars and powered two wheelers dominate the roads.

Table 7.1. Modal Split in Some South Asian Cities (2001)

	Total Trips (%)		
Cities	**Private Transport**	**Public Transport**	**Nonmotorized Transport**
Lahore	24	16	60
Karachi	27	23	50
Delhi	18	40	42
Mumbai	18	60	22
Kolkata	5	78	17

Source: A. K. Jain (2011), "Sustainable Urban Mobility in Southern Asia," Regional study prepared for Sustainable Urban mobility, Global Report on Human Settlements 2013, UN Habitat, Nairobi.

Climate change and related natural hazards will have a major impact on cities, many of which are located on the coast or along the major rivers, as historically they have been centers of trade. These locations are increasingly prone to flooding, caused by storm surges and high winds, and accentuated by global warming (+2°C) and sea level rise.[12] About 40 percent of the world's cities (1–10 million) and 15 of the 20 megacities lie on the coast. Their vulnerability to flooding has been substantially increased, and some have taken action to reduce the potential impacts, but 40 million or 10 percent of the total population are exposed to a 1 in 100 year coastal flood event, and this is predicted to rise to 150 million in 2070.[13]

Though some cities are moving away from active transport options, there are good examples where development has been seen as investment, with the basic infrastructure such as transportation and improved housing for low-income residents being provided as part of the urbanization process, as in Guangzhou City (Pearl River). Conversely, higher densities can be achieved through compactness and integrated approaches that combine investment in high-capacity public transport and development, as in Hong Kong or Singapore (around their metro systems) or in Curitiba (around its bus rapid transit system). Strong city-level governance is essential, where there is a clear vision about the future of the city, and where there is both the power and resources for action. But above all, there is a need for leadership and for all stakeholders to engage with the process of city building, so that responsibilities and actions are both supported and implemented effectively. This is the only way to move toward the sustainable city. The alternative is one of weak governance, where there is no direction and the consequences are huge sprawling divided cities—this is the inefficient and unsustainable city.

To summarize, there are four major urban transport issues, which impact on its sustainability. First, urban transport is totally dependent on nonrenewable fuels, with about 62 percent of global oil now being used in the transport sector (over 70 percent in the OECD countries[14]). This brings up generic issues relating to the availability of oil, the notions of “peak oil,” volatility in oil prices, the costs of subsidy to oil in some countries, and energy security.[15] Irrespective of the wider environmental imperative, transport needs to diversify its sources of energy and to decarbonize.

Secondly, there are the impacts of urban transport on climate change. Climate change poses a major threat to human health and development. The IPCC fourth report estimates that the resilience of many ecosystems may well be exceeded this century. By mid-century there will be a 10–30 percent decline in water availability in some already water-stressed areas. Even earlier, by 2020, in Africa an additional 75 million and 250 million people could face increased water shortages. As well as increasing water stress, millions of additional people could be affected by flooding every year due to sea-level rise by the 2080s. Low-lying areas with high population density and high levels of poverty are at greatest risk. Africa, the area with the lowest per capita greenhouse gas emissions, is particularly vulnerable to climate change due to the combination of multiple environmental stresses and poverty. There is also a considerable intergenerational inequity with future generations expected to bear the cost of current emissions. Overall the global impact on health is anticipated to be predominately harmful, particularly in developing countries, and is expected to become considerably larger from the middle of the 21st century. In this context there is a strong argument for reducing greenhouse gas emissions in all sectors, including transport.

As one important example, the United States produces over 21 percent (2006) of the carbon emissions from energy (including transport), yet it is not part of any international agreement to reduce its emissions.[16] Over the recent past it has increased its CO_2 emissions by 14 percent, while global levels of CO_2 increased by 24 percent (1995–2005). Although only 5 percent of the world’s population lives in the United States, it has 30 percent of the cars and produces 45 percent of global car-based CO_2 emissions.[17] It is crucial that the United States is fully engaged in the international debates about reducing levels of carbon emissions. Only very recently has the US motor industry seemingly become aware of the need to produce a range of fuel-efficient vehicles. The American Recovery and Reinvestment Act (2009) has allocated more than US$80 billion to the generation of renewable energy, investment in clean technology, advancing vehicle and fuel technologies, and building a smarter electric grid. There are also new efficiency standards for cars and trucks.[18]

Third, urban transport is energy intensive, and one of the principal means by which energy use in transport can be made more efficient is through using the most efficient technologies available and ensuring that all transport is operating at capacity. Running empty cars and buses is not efficient, and full public transport is more efficient than full cars. Table 7.2 shows the typical transport energy characteristics in cities in developing countries where the fuel consumption characteristics of the vehicles are combined with occupancy levels to give the energy intensity figures.

Table 7.2. Energy Efficiency Characteristics for Transport Modes in Developing Countries

	Fuel Consumption (l/100 km)	**Energy Use (MJ/vkm)**	**Vehicle Occupancy (pkm/vkm)**	**Energy Intensity (MJ/pkm)**
Urban bus	23–53	8.2–19	50	0.16–0.44
Motorcycle	2.2–2.3	0.71–0.74	1.5	0.47–0.49
Car	8.5–14	2.7–4.5	2.5	1.1–1.8

MJ, mega joules; pkm and vkm are passenger and vehicle kilometres traveled, respectively.

Fourth, there has been a striking growth in car dependence of cities and urban sprawl. The central issue here is the role that increasing levels of motorization can have in promoting decentralization, and the second round effects that to live in suburban areas requires the ownership of a car. Motorization and congestion can form a vicious circle. In congested streets the car offers more control than public transit to those who can afford it as alternative routes can be used. As the distance between services and facilities (including homes and work) becomes longer, so it consequently becomes more difficult to walk or cycle, further increasing the pressure to use a car.

This chapter now addresses some of these issues from the perspective of health and equity. At one level the alternatives are clear, namely that there should be a much greater emphasis placed on the active forms of transport, for environmental, health, and equity reasons, as well as cost of investments. As the following sections will show, the current reality of transport policies is the opposite. The growth of motorized transport is still totally dependent on carbon energy sources, it is hugely expensive in terms of infrastructure costs, there are substantial negative health implications, and its availability is inequitable. The last sections of the chapter describe potential solutions and recommendations for moving forward toward sustainable transport.

Health and Equity Impacts of Transport

Local Air Pollution

Issue

Local air pollution is a key concern in many cities. Included here are particulate matter ($PM_{2.5}$, PM_{10}); nitrous oxides (NO_x, NO_2); volatile organic compounds (VOCs), which can react to produce ozone; and sulphur dioxide (SO_2). The oxides of nitrogen and sulphur contribute to acid rain, while other pollutants directly and indirectly affect health. A systematic review of the effects of transport pollution found good evidence for an increase in all-cause mortality, respiratory morbidity, allergic illness and symptoms, cardiopulmonary mortality, nonallergic respiratory disease, and myocardial infarction plus a possible link to lung cancer.[19] Long-term decreases in air pollution are associated with reduced bronchial hyperactivity and respiratory and cardiovascular disease, and consequent gains in life expectancy.

According to the World Health Organization (WHO) Global Burden of Disease study, lead exposure, primarily from transport sources, led to the loss of 12.9 million DALYs[20] in 2002.[21] After lead, the strongest evidence for a specific pollutant is for particulate matter (PM) in particular particles with an aerodynamic diameter 2.5 µm or less ($PM_{2.5}$).[22] In addition to tail pipe emissions, motor vehicles can produce particulate matter through resuspension of road dust, and break and tire wear.[23] Recent modeling evidence concludes that anthropogenic $PM_{2.5}$ is associated with approximately 3.5 million cardiopulmonary and 220,000 lung cancer mortalities annually, resulting in an estimated 30 million years of life lost.[24]

The same study estimated that global ozone pollution was responsible for approximately 700,000 respiratory mortalities.[25] Through emission of the precursors, transport indirectly is a source of ozone emissions. Time series studies have linked short-term variation in ozone to mortality, and there is also some evidence on longer term exposure.[26] Rising temperatures from climate change may exacerbate these problems of ozone pollution.

Road transport produces approximately 20 percent of black carbon emissions, a type of particulate matter,[27] which is of increasing concern to both climate scientists and epidemiologists. Its color and distribution make it a significant short-lived greenhouse gas pollutant,[28] while it might be more harmful to health than other types of particulate matter.[29]

The health impacts of local air pollution are linked to socioeconomic equity. Since traffic-related air pollution is unevenly distributed, exposure varies and lower income urban populations tend to live in the more polluted environments. For example, a recent study in London found that mean air pollution concentrations were generally higher in areas of low socioeconomic position.[30] There is also evidence that people of lower socioeconomic status living in the most deprived areas suffer more from the same exposure.[31]

Response

In the transport sector in Europe, the main policy mechanism to tackle air pollution at the local level has been through regulations on emission standards, set by the European Union (EU) through a gradual increase in the quality of fuel used and through the increased effectiveness of add-on technologies.[32] In large part due to these standards, the EU-27 managed to achieve considerable reductions in transport-related emissions of NOx, CO, and VOC, with a small reduction in $PM_{2.5}$, between 1990 and 2005.[33]

However, since 2000 there has been no overall fall in the population-weighted exposure to the two pollutants most strongly associated with adverse health impacts, PM_{10} or ozone.[34] The steps from emissions to exposure are complex, but much of the explanation lies with urbanization combined with increasing vehicle distance traveled and dieselization of the vehicle fleet. It is predicted that compared with 2008 levels, EU-27 emissions of primary $PM_{2.5}$ are currently similar or even slightly higher, although substantial reductions could be achieved. To achieve the hoped-for reductions, some cities have designated areas as low emissions zones where only “clean” vehicles are permitted to enter, and these areas are now being used to meet air quality obligations as nonconforming vehicles are either excluded or charged for entry.

Although low-emission zones are likely to benefit all city populations, there is conflicting evidence as to whether they disproportionately benefit lower income or higher income groups. A health impact modeling study of the socioeconomic distribution of mortality benefits from reduced air pollution due to the London Congestion Charge estimated the largest health benefits in the most deprived areas of London.[35] On the other hand, a study of the effect of the low emission zone in Rome found that it benefited people in the highest socioeconomic group (1,387 years of life gained per 100,000 people) more than those in the lowest group (340 years of life gained per 100,000 people).[36] Low emission zones have been found to be cost effective in terms of health benefits. For Germany it was estimated the health benefits of low emission zones (based on statistical value of a human life) were around double the cost (of replacing vehicles).[37]

Trends in emissions are largely determined by the competing trends of cleaner vehicles and longer distances. In the case of particulate matter even when tail pipe emissions have been reduced, tire and brake wear contribute to emissions. If strategies can actually halt the rise in vehicle distances in lower income countries and reduce distances in higher income countries, then it becomes far easier to see substantial improvements in air quality.

Although regulations and standards have costs associated with them, the benefits to the local affected population are seen to outweigh those costs. The main benefit is from the direct improvement in population health, but there could also be fewer working days lost due to sickness, and benefits from a more general increase in the attractiveness of city living. Attention needs to be paid to ensure that those benefits reach the entire population, particularly lower income groups that are disproportionately affected by local air pollution.

Road Traffic Injuries

Issue

The WHO World Report on Road Traffic Injury Prevention estimated that 1.2 million people were killed and 50 million people injured in road traffic crashes in 2002.[38] Although road traffic injuries have been falling across many higher income countries (10.3 fatalities per 100,000 population), within the more populous lower to middle-income countries rates have generally been on the rise (21.5 in lower income and 19.5 in middle-income countries), and road traffic injuries feature among the leading causes of disease burden in many developing countries. The global status report suggests that these impacts equate to US$518 billion or about 1–2 percent of global gross domestic product.[39] In the United Kingdom, the total impact of road crashes (2009) has been put at equivalent to £15 billion per year, with 78 percent of this figure being attributed to urban areas (with speed limits under 40 mph). Much of this cost is quantifying the loss of human life in monetary terms; the rest relates to the casualty in terms of loss of output, medical and ambulance treatment, and the costs of dealing with the crash, including policing, administration, and damage to property (33 percent of total).

The highest road death rate is in the African continent (28 deaths per 100,000 population per year), and the highest national rates are in El Salvador (42 per 100,000 per year) and the Dominican Republic (41 per 100,000 per year).[40] In India the rate of road traffic fatalities increased by an average of 5 percent per year between 1980 and 2000. Since then the rate of increase has accelerated to around 8 percent per year, with, in 2006, 105,725 people killed.[41]

In lower and middle-income countries, the majority of those killed are pedestrians, cyclists, and users of two-wheeled motor vehicles, in other words, those less likely to have the means to have access to a car. A recent systematic review found that 45 percent of road traffic fatalities in low-income countries were among pedestrians, compared with an estimated 29 percent in middle-income countries and 18 percent in high-income countries. In absolute terms an estimated annual total of 228,000 pedestrians die from traffic-related injuries in low-income countries, 162,000 in middle-income countries, and 23,000 in high-income countries.[35] Current policy is inadequate to protect these road users, with only 29 percent of countries meeting basic criteria for reducing speed in urban areas, and less than 10 percent rating their enforcement of traffic laws as effective.[42,43] High-income countries also present inequalities in traffic-related injuries and deaths. In the United Kingdom among children these are over 20 times higher in the lowest socioeconomic group for pedestrians and cyclists.

The differing trend in the direction of road traffic injuries between the high- and lower income countries is part of a global picture in which road traffic injuries rise and then fall with increasing motorization and economic growth. Cross sectional and time series studies have found that at low levels of motor vehicle ownership road traffic fatalities increase, while at higher levels of motor vehicle ownership road traffic deaths decline in absolute terms, giving an inverse U-shaped relationship (see Fig. **7.1**).[44] Recent models have tended to focus on the relationship between per capita income and road traffic injuries and deaths, and have found a similar inverse U-shaped relationship.[45]

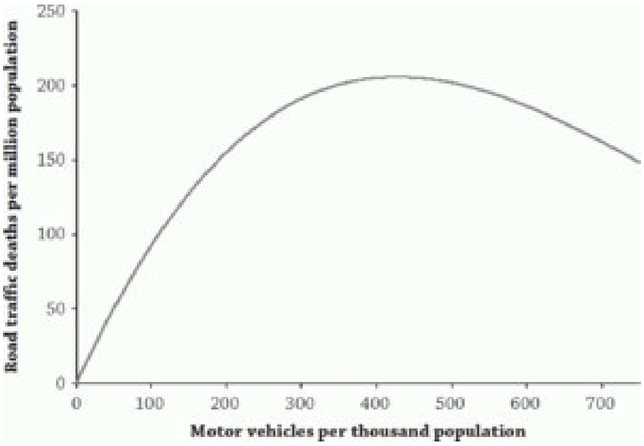

Figure 7.1:
Inverse U-shaped relationship between motor vehicle ownership and road traffic deaths. (From C. Koren and A. Borsos, “Is Smeed’s Law Still Valid? A World-Wide Analysis of the Trends in Fatality Rate,” *Journal of Society for Transportation and Traffic Studies* 1, no. 1 (2010): 64–76.)

One recent cross sectional study, including data from 44 countries, found that mortality peaked among low-income countries at about 100 motor vehicles per 1,000 people and a per capita income of US$2,200.[46] It found that most of the increase in deaths below 100 motor vehicles per population was due to increasing occupant, pedestrian, and motor cyclist deaths, with the decline at higher rates coming mainly from decreasing number of pedestrians. Many countries are still in the upward phase of this trend, and it is likely that road traffic injuries will continue to increase with the rise in motor vehicle use. However, if injury rates start to fall because modal shift from walking to motor vehicle has passed the threshold described earlier, then the environmental effects are likely to be devastating, as this implies a vast increase in motor vehicle use. The resulting effects on physical activity levels would also be extremely detrimental for population health.

However, not all the fall in injuries in higher income countries can be attributed to less walking and cycling. In the EU, 57,691 people died in road traffic collisions in 1999, but by 2008 the number of fatalities had fallen to 38,875.[47] This huge reduction in road deaths can be attributed to a range of factors, including improved health care and the taking of concerted action at the European level.

Responses

Policies can play a vital role in decreasing road traffic accidents and deaths, as seen in the case of European standards and regulations. To begin with, cars are now safer for their occupants due to their heavier construction, crumple zones and airbags, and driving tests, and standards are considerably higher. The introduction and enforcement of severe penalties for drinking and driving, the use of penalty points for driving, enforcement of speed limits, the compulsory use of seat belts, and more general education programs have all helped. The explanation for the fall in fatalities among pedestrians and cyclists is less clear than that for motorists. Although danger reduction (e.g., lower speeds and less drunk driving) has played a role, there is also likely to have been a contribution from behavior modification on the part of the pedestrians and cyclists. In some countries this has meant less total walking and cycling and in many countries activity restriction, such as reduced independent mobility of children has continued (see section on “Physical Activity, Overweight, and Obesity”). In some countries, such as the United Kingdom, fewer young drivers may also have reduced the injury burden. It should also be noted that even in countries where overall injuries are falling the number of injuries is still sensitive to changes in traffic volume.[48]

Within the EU, fatality rates vary greatly by country. The lowest death rates from road collisions are in the Netherlands, Sweden, and the United Kingdom, with rates in Italy and France twice as high, and rates in Greece, Poland, and Latvia more than three times as high. It is interesting to note that there may be different ways to achieve a low rate. The two countries with the lowest overall road traffic fatality per million population in Europe are the Netherlands (39 deaths per million people) and the United Kingdom (38 deaths per million people) in 2009, despite the much higher rates of cycling in the Netherlands.[49] Although the United Kingdom has taken steps to reduce road danger (e.g., speed cameras and 20 mph zones[50]), it appears to be much safer to cycle and to walk in the Netherlands. The low injury risk in the Netherlands for cyclists is a result of a number of factors, including provision of a high-quality infrastructure for cyclists, priority for cyclists at junctions, and strict liability legislation in favor of cyclists and pedestrians.[51] The large number of cyclists has acted both as a spur for better provision for cyclists and itself increases the awareness of drivers of cyclists. Safety in numbers may play a part in making walking and cycling safer, but the relative contribution of direct measures to reduce risk compared with a pure safety in numbers effect is not yet clear.[52]

The aim of policy should be road danger reduction rather than an approach to safety that restricts the mobility of pedestrians and cyclists. Speed reduction is a vital policy tool for reducing road danger. At 20 mph the risk of a pedestrian fatality in a collision with a car is 5 percent, while at 40 mph it is over 80 percent. The WHO advocates a combined approach to speed reduction and lays out practical measures for measuring and tackling the problems in its manuals. Tackling speed involves appropriate speed limits starting from a safe system approach; considering the safety of the most vulnerable road users, roads with large numbers of vulnerable road users should not exceed 20 mph. Limits need to be enforced both through legislation but also through design. Low- to medium-cost engineering options have demonstrated benefits. A UK study found that 20 mph speed zones with physical enforcement reduced overall road traffic injuries with the greatest benefit in younger children.

Other measures include provision of high-quality infrastructure for pedestrians and cyclists and legislation and enforcement to stop drunk driving.[53] Speed cameras can also play an important role. A systematic review of speed cameras demonstrated effectiveness in reducing crashes (from 8 percent to 49 percent for all crashes) and fatal and serious injuries (11 percent to 44 percent).[54] Educational campaigns can have a positive effect in some circumstances. Public education campaigns to win community support by highlighting the dangers of speeding and drunk driving and promoting support for enforcement can be effective. However, providing more training for drivers is unlikely to work.[55] School-based driver education has been found to lead to an increase in injuries by leading to people driving at a younger age, while in existing drivers increases in skill can lead to taking of greater risks.

Physical Activity, Overweight, and Obesity

Issue

Physical activity arises from two sources, bodily movement and resistance activity. Walking is perhaps the most obvious form of bodily movement, while cycling combines both bodily movement and resistance activity. Over the past century, in many settings, oil has displaced food as the main energy source for human movement with the subsequent danger from motor vehicles acting as an additional disincentive to active transport.[56] Lack of physical activity is a risk factor for many chronic diseases and obesity and comes with wider social and economic costs.

The Global Burden of Disease (GBD) study estimated that 17 percent of the global population was inactive[57] and that this ranged from 10 percent in Africa D region[58] to 25 percent in the European C region,[59] while 41 percent of the world’s population was insufficiently active, varying between regions from 32 percent to 52 percent.[60]

This study was not able to estimate inequalities based on socioeconomic group. It is likely that in lower income countries high-income people are less likely to be active, because lower income groups have to walk for transport and are more likely to be working in manual jobs, while in higher income countries the picture is different as higher income populations have better access to sports and leisure facilities and are more attuned to health promotion messages. However, the picture in many lower income urban environments is changing with the rapidly growing obesity epidemic and burden of noncommunicable diseases.

The example of the United Kingdom gives a clear indication of what has happened in terms of the move from active to motorized transport, and this picture is reflected in most other rich countries, and increasingly in the poorer countries as well. In the United Kingdom in 1949 the total distance traveled by bicycle was greater than the vehicle distance traveled by car but, while the distance traveled by car has subsequently increased 20 fold, the distance cycled fell by a factor of 6 between the early 1950s until the early 1970s,[61] and the distance cycled has not risen substantially since (Fig. **7.2**).

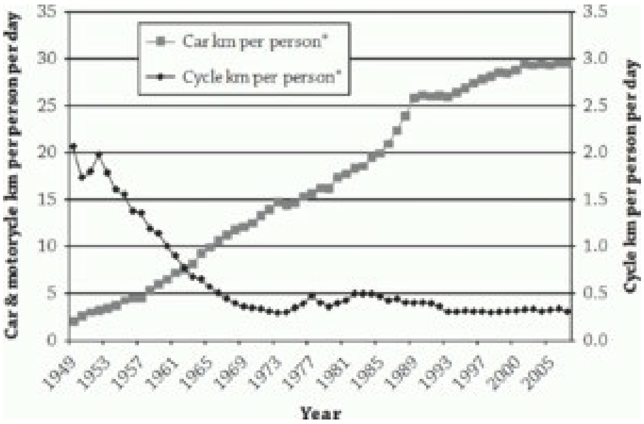

Figure 7.2:
Comparison of trends in distance cycled and driven in the United Kingdom. (Department for Transport, “National Travel Survey: 2007,” [London: National Statistics; 2008].).

These figures show the total distance traveled by each type of vehicle in the United Kingdom in 1 year divided by the population in that year. On the right-hand axis we see the distance traveled per person by bike and on the left-hand axis (using a 10 times greater scale) we see the distance traveled by car and motorcycle.

For walking, national statistics for the United Kingdom are only available since the 1970s. These figures indicate that since the mid-1970s there has been a decline of around a third in minutes per day walking for transport (Fig **7.3**). Given longer term trends in availability of motorized transport, it is likely that time spent walking has fallen over a much longer period. There are few good-quality direct data on long-term trends in physical activity, but many other trends in physical activity are likely to have exacerbated declining physical activity from active transport. Walking provides an important contribution to children’s physical activity, with walking to school expending more energy than from organized sports and physical education.[62] Children are more likely to be taken by car to structured activities, while they are more likely to walk to unstructured activities. With rising motorization children’s independent mobility has been radically curtailed.[63] Even in the short period between 2002 and 2008, the percentage of children aged 7 to 10 years in the United Kingdom not allowed to cross the road alone increased from 41 percent to 50 percent.[64] In 2008, 58 percent of adults gave traffic danger as the reason for accompanying their children to school.

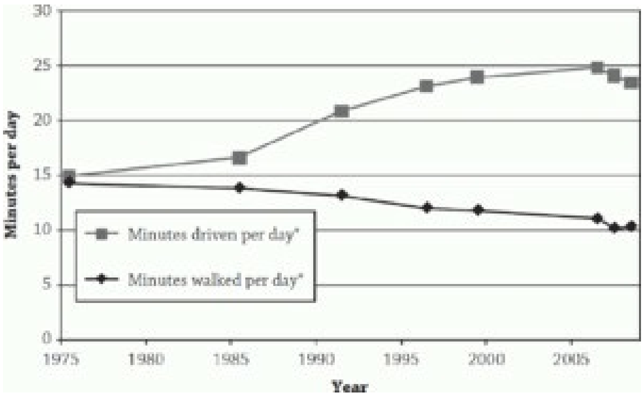

Figure 7.3:
Comparison of trends in time spent walking and driving in the United Kingdom. (Department for Transport, "National Travel Survey: 2007," [London: National Statistics; 2008].)

Estimate of total time spent walking or driving for transport in the United Kingdom per day divided by the population size (does not include time spent as a car passenger).

Though there are fewer data available on walking and cycling in low- and middle-income countries, similar trends away from active transport are becoming evident. In many cities in developing countries, cycling rates have fallen substantially. Urban India has seen a substantial drop in cycling,[65] while in Nairobi bicycle share fell from 20 percent in the 1970s to 0.5 percent in 2004.[66] Even where cycling has fallen many lower income cities retain a large, captive, walking population who do not have the option of using motorized transport, particularly if public transport systems are unavailable or expensive.[67] As discussed in a previous section, though more physically active, this population is often at greater risk of injury.

The GBD study estimated that compared with a scenario in which everyone was active, current levels of inactivity and insufficient activity were responsible for 3.3 percent of deaths and 19 million (DALYs) worldwide. The condition-specific burden was estimated at 21.5 percent of the burden from ischemic heart disease, 11 percent of ischemic stroke, 14 percent of diabetes, 16 percent colon cancer, and 10 percent of breast cancer. A more recent systematic review found strong evidence of links between physical inactivity and the risk of diabetes, heart disease, colon cancer, strokes and breast cancer, depression, dementia, hypertension, and osteoporosis.[68]

Health burdens associated with inactivity are not just problems in high- but also in lower income countries. In low-income and middle-income countries, urbanization is associated with an increased health burden from noncommunicable diseases.[69] The prevalence of Type 2 diabetes in urban adults in India is reported to have increased from less than 3 percent in 1970 to around 12 percent by 2000.[70] Cardiovascular disease accounts for 27 percent of deaths in low-income countries. By contrast, HIV/AIDS, tuberculosis, and malaria combined account for 11 percent of deaths.[71] In China, a recent study found that the age-standardized prevalence of diabetes was 9.7 percent, equivalent to 92.4 million adults.

Physical activity is not only directly beneficial to human health but also forms one side of the energy equation. According to the GBD study, obesity accounts for 30 million DALYs lost,[72] and it accounts for an additional health burden beyond that of physical inactivity. If energy consumption exceeds energy expenditure, then an increase in body mass index (BMI) is the result. Conversely, increasing physical activity increases energy expenditure; and if energy intake remains constant, then mass will fall until energy balance is restored at a new lower mass. Because for many people food-energy intake has not fallen in line with declining physical activity, many countries are experiencing an epidemic of obesity.[73,74] A cross sectional study in Atlanta (Georgia, USA) found that each additional hour spent in a car per day was associated with a 6 percent increase in the chances of obesity.[75]

Studies have linked the rise in obesity to the level of inequality within a country[76] and to the market-liberal welfare regimens.[77] These studies have focused on the energy side of the equation, but the rise in obesity is always a result of the imbalance between the inputs and outputs. In addition to these between-country differences, within a country obesity tends to follow a socioeconomic gradient.

The problem is not just those who exceed the threshold for obesity but a population BMI distribution that has shifted to the right due to the changing nature of the environment. A focus on the obese can lead to questions on why they are obese and not others. This means that factors such as genes are likely to play a role, while a focus on the shifting distribution leads to an understanding of the social and environmental causes.

Responses

Recommendations for a healthy life focus on achieving four or five sessions per week of at least 30 minutes of moderate or vigorous physical activity, with greater amounts of physical activity likely to be required to avoid the build-up of obesity. Brisk walking and cycling both count as such activity. However, all walking appears to be beneficial. The relationship between physical activity and all-cause mortality appears to be nonlinear, with the greatest gain coming from moving from a sedentary lifestyle to a small amount of activity, although there is no obvious threshold.

Policy responses need to address inactivity by making walking and cycling a viable option, and ensuring that the benefits of active transport are not outweighed by the risk of injury or death. Research has found that increased levels of walking or cycling are associated with safer walking or cycling.[78,79] However, uncertainties remain about the causal direction of this relationship, the scale at which it occurs, and whether a threshold in cycling levels is needed to realize it.[80] Increasing the attractiveness of cycling requires making cycling both objectively and subjectively safer. Well-designed segregated infrastructure with attention to junction design is likely to play an important role in making cycling feel safer, particularly for more marginal cyclists, and may make cycling objectively safer.[81] The low injury risk in the Netherlands and in Copenhagen, where there are high rates of walking and cycling support this view.[82,83] The high expenditure and focus on a continuous and integrated network for cyclists, particularly in the Netherlands, is likely to have played a major part both in the safety of cyclists and in increasing cycling.

It has been suggested that across Europe replacement of short trips in cars by walking or cycling would enable most motorists to achieve the recommended levels of physical activity described earlier. In London (2001), 16 percent of car trips were shorter than 1 km, 67 percent shorter than 5 km and 80 percent shorter than 8 km. There may also be a benefit from replacing car trips with public transport as public transport trips usually include a walking component.

The differences in walking and cycling between countries can make an important contribution to the physical activity of the population. Comparison of travel surveys from Germany and the United States found that in 2008/2009 in Germany 21.2 percent and 7.8 percent achieved more than 30 minutes walking or cycling compared to 7.7 percent and 1.0 percent in the United States. In both countries differences in walking and cycling by household income were not substantial, with some tendency for more walking and cycling among lower income groups in both countries. This indicates the potential for walking and cycling as an inclusive form of physical activity, more so in Germany than the United States. Perhaps of particular benefit for health, activity among older adults was notably higher in Germany than in the United States (29 percent vs. 6 percent walked for more than 30 minutes per day).[84]

Other Health and Equity Effects

Health could be affected by changes to traffic noise. There is an extensive scientific literature on the health effects of noise. Although the health evidence is not as strong as for air pollution, the evidence supports an impact on cardiovascular disease, in addition to other harms, including sleep disturbance, reduced cognition, and annoyance.

Achieving high levels of access to retail, employment, education, health services, and social and community networks is vital for health, quality of life, and social inclusion. However, transport policy often promotes mobility rather than accessibility. High motor traffic volume can act as a barrier to access to services, employment, and social support networks. Urban sprawl can negatively impact community cohesion, reducing social capital and further impinging on the access of those without private motorized transport.

Economic and resource use effects of climate change mitigation in the transport sector may also have implications for health. Private motorized transport is highly resource intensive. This resource use can be conceived as having a health-related opportunity cost, as the resources could in theory be spent in other ways that would benefit health. On a macro scale, indirect effects are possible through resource-use-related conflict and effects on socioeconomic development.[85] Climate change is occurring in the context of wider ecological stresses,[86,87] which are also affected by transport-related resource use, in particularly oil production.

The Role of Research in Planning for Sustainable Transport

Health Impact Modeling of Increasing Active Transport and Reducing Greenhouse Gas Emissions from Transport

Modeling has indicated the potential for substantial health benefits from greenhouse gas mitigation in the transport sector. Studies initially focused on the link between greenhouse gas emissions and air pollutants harmful to human health.[88,89,90,91] However, more recently a number of studies have considered the impact on health from increases in physical activity and changes in road traffic injury risk from increases in walking and cycling and less use of cars.[92,93,94,95,96] These studies have consistently found that the health benefit from increasing physically active travel and reducing car use are likely to be greater than the effects from changes to air pollution or injury risk. Studies have modeled for Delhi (India), London (England), the Netherlands, New Zealand, Midwestern United States, Barcelona (Spain),[97] and Paris (France).[98] For physical activity, all the health gain is experienced directly by those who change their behavior, whereas for air pollution and road traffic injuries, although the total level of air pollution and road danger may be reduced, those changing their behavior may face a higher risk. Taking the differential impacts into account, studies have modeled the impact on whole population health,[99] the impact on the population of people who change their behavior,[100,101] and both.[102]

A range of studies, from modest to ambitious, have assessed the impact of increased physical activity on health outcomes.[103,104] For physical activity studies most studies have used a version of or values from the WHO HEAT tool[105] calculating changes in premature deaths, in some cases using the values from HEAT in a more sophisticated life table analysis to estimate changes in life expectancy. Another approach by Woodcock et al.,[106] using a comparative risk assessment method, compared changes in age- and sex-specific population distributions of walking and cycling times and estimating changes in disease burden (premature mortality and morbidity).

For road traffic injuries most studies assumed that the risk per distance faced by cyclists and pedestrians remained constant and estimated the change in injuries based only on the change in internal risk for those that changed their mode.[107] This approach is suitable if only small changes in driving are envisaged, but if large changes in driving are modeled, then an approach should be used that also allows for the external risk, that is, the change in risk faced by other road users due to reductions in distance traveled by motor vehicles.

Studies comparing the health impact of active transport to the impact of changes to air pollution have consistently found that the health benefit from increasing physically active travel and reducing car use are likely to be greater than the effects from changes to air pollution or injury risk. Studies have modeled for Delhi (India), London (England), the Netherlands, New Zealand, Midwestern United States, Barcelona (Spain),[108] England and Wales,[109] and Paris (France).[110]

One study that compared some of the most ambitious scenarios directly compared the health impact of lower emission motor vehicles with that from substituting car travel with active travel.[111] It found that in both Delhi and London an increase in active travel and less use of motor vehicles had considerably larger health benefits per million population than from the increased use of lower emission motor vehicles. However, achieving the substantial reductions in emissions climate scientists argue are necessary would require implementation of both strategies. The largest health gain would be from substantial reductions in ischemic heart disease (10–19 percent in London, 11–25 percent in Delhi). In London the vast majority of the benefit came from the increases in physical activity. In Delhi although again the largest benefit was from increased physical activity, there were also large benefits from reductions in air pollution, and from reduced road traffic injuries. This study was also the only to specifically include the health impacts of change to freight.

In all cases the studies have found the health benefits from increased physical activity were larger than those from changes to air pollution or injury risk both at the whole population level and for the population of those changing behavior. However, the contribution of these three pathways to health impacts appears to vary by setting.

The potential for reduction in greenhouse gas emissions depends on the reduction in vehicle distance and the use of cleaner fuels, but reducing shorter trips may have a larger than anticipated impact due to the higher emissions from cold starts.[112] Achieving large reductions is likely to also require changes in land use that reduce travel distances. As of yet studies have not considered the potential for second-order effects as money saved on petrol is spent in other activities with emission factors.

Including a Cost–Benefit Analysis

Estimating the economic and social effects of a move toward a physically active, low-carbon transport system is difficult and to some extent notional, for a number of reasons. First, the attempt to place a real economic cost on the changes in lifestyle and physical activity remains controversial. This is both because of the controversies on valuing human health and life but also because the positive health effects of greenhouse gas reduction strategies have appreciable macroeconomic impacts, which vary by sector, rapidity of implementation, and other factors. Second, investment studies have found that fiscal instrument and regulation with stringent climate targets can induce investment and lead to more rapid technological change toward a low-carbon society.[113] In this context a narrowly considered cost–benefit analysis will not provide the right evidence for social decision making. Third, cycling is a low-cost transport mode for the user and for society more broadly. Investment in infrastructure in cycling is likely to be considerably cheaper than investment in infrastructure for motor vehicles, and it often gives benefit–cost ratios over 10 to 1.[114]

Fourth, further controversy also exists over how to value changes in travel times. Travel time savings traditionally provide a large proportion of the benefit from schemes for motorized road transport, but these benefits may be transient as changes to speed can lead to increased geographical separation of activities with no limited appreciable benefit. A shift to walking and cycling could mean slower transport, but it could also mean reduced congestion. This introduces the dampening loop on mode shift that reduced congestion could make driving more attractive and increase injury risk from higher speeds. Fifth, in the context of economic crises and high unemployment facing many countries, the potential for job creation in the move to a more active travel can be seen as a benefit, not a cost. However, active travel jobs are frequently marginalized, the UNEP (2008)[115] stating that walking and cycling are overlooked by most traffic planners and economists. In particular, it is important to note that investment in active travel is more likely to be more labor intensive than investment for private motorized travel (hence creating more jobs) and is more likely to create local jobs.

The WHO HEAT tool is specifically designed to monetize the reductions in premature mortality using the statistical life and to feed into cost–benefit analyses. Three of the modeling studies[116,117] mentioned earlier have included some form of economic evaluation. Rabl suggested that the Paris bike hire scheme (Vélib) would be cost effective based on assumptions that 14,500 out of 160,000 daily trips by Vélib represented a shift from cars to bikes. It suggested that in economic terms the largest benefits would come from reductions in noise pollution and congestion, and increases in physical activity. However, in no case was a full cost–benefit analysis attempted.

The greater issue is not the affordability of the change but how to achieve it. Beyond changes to the built environment an equal or greater focus on culture is imperative.[118] The cultural changes required may not be costly and are certainly very difficult to cost, but they may still be difficult to achieve.

Turning Research into Policy

Health impact models have the potential to effect change by strengthening the case in the mind of the public and policy makers. Future studies will be expected to improve the modeling methods and parameterization. Important questions include further considering the impact of changes in behavior of different population groups, the choice of dose–response function, and inclusion of the impact of additional pathways.

Improving the methods for estimating potential gains from physical activity is important because the impact may well be considerably larger than for air pollution or for injuries.[119] In quantifying the potential health impacts of climate change mitigation, the size of the effect is sensitive to the potential for active travel to replace motorized travel, including whether travel distances remain constant. If it is to be assumed that people transfer from faster to slower modes, then a reduction in travel distances is required to compensate for an increase in travel times.[120] Another important variable is on the takeup of active travel at different ages. It might be anticipated that increasing activity among older adults is more difficult, but these groups have higher health risks so have the greatest potential absolute benefits from increasing their activity. Estimating the size of the health benefits and the beneficiaries is important, primarily in its own right but also for the wider economic and social impact.

For injuries the most important issue may be how to reduce the road traffic danger that currently acts as a disincentive to walking and cycling. It is possible for the risk faced by pedestrians and cyclists to go down, while injuries to go up if there are many more pedestrians and cyclists on the roads. However, in some settings it may be the case that the reduction in danger, if accompanied by strong policies to improve the active travel environment and limit speeds, is sufficient to lead to an actual absolute reduction in the number of injuries.[121] The effect may well depend on baseline walking and cycling levels; the higher these are, the more people will benefit from danger reduction. The inclusion of additional health impact pathways is also important. The study by Rabl,[122] although not doing a full noise analysis, suggested the value of the social benefits may be particularly large from reductions in noise.

One area of future research will be around the effects on health inequalities. In lower income cities it might be anticipated that the main physical activity benefits would be to higher income groups who currently are less active, while the lower income groups might benefit more from reduced road injury risk as they are still walking for transport and leading more physically active lives. In higher income cities the potential for reductions in air pollution to reduce inequalities has already been noted.[123]

Modeling of the health impact of scenarios is important because it shows what potentially could be achieved if the political and social will were there. The potential size of the benefits (and on the downside the size of the harms) makes a strong case for looking for ways to move toward these scenarios. Furthermore, as the modeling methods improve, it allows policy makers, researchers, and the public to answer more detailed, “What if?” questions.

A review of evidence to support integrated health impact assessment of transport policies recommended that future modeling and evaluation should consider in more detail the kind of policy packages required to achieve the scenarios, both to increase realism and to allow the assessment of a wider range of potential harms and benefits.[124]

However, the impact modeling studies cannot, on their own, answer the question as to how we make the changes. There is good evidence from international and interurban comparisons of large differences in levels of walking, cycling, and car use between areas at similar levels of economic development.[125] In locations with high walking and cycling populations, such as the Netherlands, inequalities in transport-related physical activity are low (inclusive). The differences between the best European cities and many North American cities are large and have been associated with differences in the built environment. Although causality is difficult to establish, issues of culture and habit clearly also play an important role. For example, deeply rooted negative perceptions of cyclists in many low-cycling countries act as a barrier to normalization of cycling.[126] The evidence from well-conducted studies on what interventions can achieve is modest.[127] Well-conducted prospective evaluation of changes in the built environment (e.g., construction of new infrastructure) is vital for improving the evidence base.[128] However, it is only possible to evaluate interventions once they have been implemented. It is imperative, therefore, that strong interventions on a sufficient scale are implemented and evaluated over a period of time, linking together the goals of reducing car use and increasing physically active travel. An analogy can be made with the bans on smoking in public places. In this case strong measures were adopted, following campaigns to raise public and political support, and when these measures were evaluated over a period of time large benefits were found.[129]

The Sustainable Mobility Paradigm as the Way Forward

The sustainable mobility paradigm provides a framework within which to investigate the complexity of cities, and to strengthen the links between land use and transport.[130] Such urban forms would keep average trip lengths to below the thresholds required for maximum use of cycle and walk modes. It would also permit high levels of innovative services and public transport priority, so that the need to use the car would be minimized. Cities would be designed at the personal scale to allow both high-quality accessibility and a high-quality environment. The intention is to design cities of such quality and at a suitable scale that people would not need to have a car.

This approach (Fig. **7.4**) requires clear and innovative thinking about city futures in terms of the reality (what is already there) and the desirability (what we would like to see), and the role that transport can (and should) play in achieving these objectives. The sustainable city must balance the requirements along the physical dimensions (urban form and traffic) against those concerning the social dimensions (people and proximity). The sustainable mobility approach requires actions to reduce the need to travel (fewer trips), to encourage modal shift, to reduce trip lengths, and to encourage greater efficiency in the transport system. A sustainable transport system means that overall we need to travel less and inequalities in travel patterns are reduced.

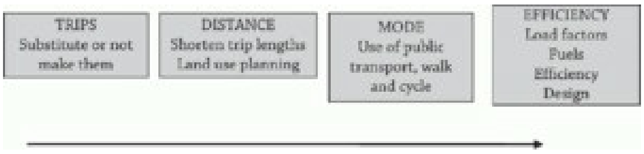

Figure 7.4:
The Sustainable Mobility Paradigm.

The key to such a shift in thinking is the creation of spaces and localities in the city that are attractive and affordable, as neighborhood quality is central to sustainable mobility. Transport planning must involve the people, so that there is an understanding of the rationale behind the policy changes and an increased likelihood that behavioral change follows. Public acceptability is central to successful implementation of radical change, and it must involve community and stakeholder commitment to the process of discussion, decision making, and implementation.

The sustainable mobility paradigm has been designed to provide a platform against which the conventional transport planning model that has been in use for the last 50 years can be reassessed, and to use the same arguments to question the need for such high levels of motorized mobility, as this has substantial environmental, safety, and health outcomes.[131] It challenges the importance of speed and travel time savings, through emphasizing the need for sustainability, which means slower travel, reasonable travel times, and travel time reliability.

Within this paradigm, health is affected in three main ways, as less motorized traffic and “cleaner” vehicles improve local air quality, as slower travel leads to road danger reduction, and as more active transport results in increased physical activity. In addition, these improvements are likely to have a positive effect on climate change through reductions in the use of carbon-based fuels and fewer CO_2 emissions. Priorities for sustainable transport in cities need to be reconsidered within the framework of the sustainable mobility paradigm, and its extension through the health and equity agendas.

At the same time, the transition to an active, low-carbon transport system has the potential to improve social and health equity through linking affordable and inclusive transport to affordable and inclusive opportunities for physical activity, while at the same time reducing the inequality in direct and indirect harms from transport. Such an approach has strong benefits for improving health and in reducing levels of inequality in cities.

The CO_2 and other emissions reductions will be contingent upon the reduction in car use and the uptake of lower emission motor vehicles. The health benefits will primarily come through increases in active travel, even though this is unlikely to be achieved without measures to reduce road traffic danger. How each part of the sustainable mobility paradigm might be anticipated to play out in terms of health effects is shown in Table 7.3.

Table 7.3. Linkage Diagram between Components of Sustainability and Health Outcomes

	Fewer Trips	**Shorter Distances**	**Modal Shift**	**Efficiency**
Physical activity	—	—	⇧	—
Air pollution	⇩	⇩	⇩	⇩
Road traffic injuries	⇩	⇩	?*	—
Greenhouse gas emissions	⇩	⇩	⇩	⇩

* The effect of modal shift on road traffic injuries is unclear because there are different potentially conflicting factors at play. Increased walking and cycling means greater exposure to road vehicle danger, although there could be a safety in numbers effect, while reduced motor vehicle use reduces the source of danger. Policies to induce modal shift may also have the effect of making walking and cycling safer.

Concerted actions are needed across all policy dimensions that are both consistent and mutually supporting, so that a change in culture is developed that places equal importance on the accessibility for all within the urban area to services and facilities. Although the evidence on how to achieve large-scale changes is limited, the most effective approaches are likely to combine strong implementation of a wide range of measures. In the Netherlands, the country with the highest levels of cycling, the focus has been on providing integrated and continuous networks for cyclists.[132] However, there is clearly also a cultural component that may be harder for policy makers to act upon. Transport mode choice is strongly affected by both habit[133] and cultural norms. Provision of high-quality infrastructure without also changing these social norms is likely to have modest effects. However, encouragement can be drawn from the number of major cities that have recently seen substantial increases in cycling, including London, Paris, Barcelona, Berlin, and Copenhagen. Only in the last two (and particularly last one) can this increase be attributed to an already strong cycling culture. Unfortunately, even in the Netherlands with high cycling rates greenhouse gas emissions from transport are far above sustainable levels. To achieve the largest gains, strong measures should be implemented and simultaneously rigorously evaluated, thereby improving the evidence base and allowing for further implementation of the most effective measures.

Central to the success of any scheme must be the reallocation of space in the city to pedestrians and cyclists—this is the key to sustainable mobility. Cities provide us with the best opportunity for moving toward sustainable transport. The starting point needs to be a view as to the sustainable city of the future, in terms of its economic functions (e.g., employment, government, housing, education, and health), as well as its attractiveness (e.g., cultural, social, and community). The city should be inclusive and cater to all sections of the population. The quality of life should be high, with city living based around good-quality affordable housing, strong neighborhoods, and good facilities that are easily accessible. The city must be seen as a place for people, providing opportunities for all, in a safe and secure neighborhood, with green space and other recreational facilities accessible to all. It is then that we consider what sort of sustainable transport system might be most appropriate to fit this vision of the city, following the idea that transport serves the city.

Effective leadership must look at new visions of the city and implement effective strategies that are both politically and publicly acceptable. It is unlikely that there is going to be any substantial increase in the supply of city infrastructure for transport, and so the biggest challenge for urban planners is to decide how that infrastructure can be managed in the most sustainable way. This includes the allocation of space to different types of use (perhaps by time of day and day of week), substantial increases in the costs of access by car to that space, and decisions about who actually owns that space.

In many lower income countries urbanization and motorization are leading to a rapid increase in both the burden of diseases associated with inactivity and in road traffic injuries. While here a large majority cannot afford access to private motorized transport, road traffic danger and social stigma are leading to use of private motorized transport when it can be afforded. Walking and cycling could provide the opportunity for equity in access to high levels of physical activity. Achieving this in practice will require provision of urban environments that are conducive and inclusive to these activities. To encourage real change requires a well-connected and safe network of routes for cyclists and pedestrians that are of a sufficient quality, and this physical infrastructure needs to be supported by skills and awareness programs to teach drivers that the responsibility for safety lies with the user of the most dangerous vehicle, not with the most vulnerable. The links between health and active transport need to be emphasized through education programs and the involvement of doctors. Copenhagen is often cited as a good example of a cycling city; 68 percent of Copenhagen residents cycle at least once a week. While cycling has increased, the number of cyclists seriously injured has fallen by more than 60 percent since 1996, and over 90 percent of the population think of the city as good place for cyclists.[134] Both subjective and objective safety of cyclists is measured and acted on. New cyclists cited speed, convenience, health, and cost as their main reasons for starting cycling.

The basic dilemma facing society in terms of climate change and sustainable transport is that many people like traveling, particularly to distant locations (by air), and much more travel is being undertaken. Yet there is also an awareness of the environmental and social costs of traveling, and individual responsibilities, and this is present in many actions that are now being taken in cities to reduce travel distances and even the need to travel, as well as investing in the low-carbon infrastructure (for walking, cycling, and public transport). This chapter has clearly outlined the range of solutions that are available to creating sustainable transport within world cities, and there are many examples cited of good practice that make sense in economic terms, as well as improving the health of people and in reducing inequities caused by limited access to transport. The best practice needs to be rolled out in all cities, and cities need to learn from each other so that society can benefit from sustainable urban transport.

Notes:

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5. Ibid.

6. UN Habitat, *State of the World’s Cities 2010/2011—Cities for All: Bridging the Urban Divide* (Nairobi, Kenya: UN Habitat, 2010).

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12. CO_2 concentrations are currently about 385 ppmv and with other greenhouse gases being included, this value increases to 430 ppmv CO_2e (2009). A level of 450 ppmv CO_2e means that there is a 26–78 percent chance of exceeding 2°C. A level of 550 ppmv CO_2e means that there is a 63–99 percent chance of exceeding 2°C. If global concentrations of greenhouse gases stabilize at 560 ppmv CO_2e, it is “likely” that global mean surface temperatures will rise by 3°C above preindustrial levels.

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16. European Commission (EC) DG for Energy and Transport, *EU Energy and Transport in*

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17. J. DeCicco and F. Fung, F. *Global Warming on the Road: The Climate Impact of America's Automobiles* (Washington, DC: Environmental Defense, 2006).

18. The National Fuel Efficiency Policy (2012–2016) requires an average fuel economy standard of 35.5 mpg in 2016, and it will save 1.8 billion barrels of oil over the life of the program. The fuel economy gain averages more than 5 percent per year and will result in a reduction of approximately 900 million metric tons in greenhouse gas emissions.

19. M. Krzyzanowski, B. Kuna-Dibbert, and J. Schneider, eds., *Health Effects of Transport-Related Air Pollution* (Geneva, Switzerland: World Health Organization, 2005).

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58. Countries of the Africa D region include Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, and Togo.

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