

INHERIT

Exploring triple-win solutions for living, moving and consuming that encourage behavioural change, protect the environment, promote health and health equity

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HIGHLIGHTS

Human activity is now damaging the global ecosystems and depleting finite resources at an unprecedented rate, the very resources and systems on which we rely as a species for health, wellbeing and survival. On a daily basis, we are reminded of the urgency of this challenge and its global and societal implications. This challenge calls for a drastic rethink of human society, the economy and our relationship to the natural world. Europe will need to fundamentally transform its systems of production, transport and consumption if it is to achieve its 2050 vision of 'living well, within the limits of our planet'.

The EU funded Horizon 2020 "INHERIT" project seeks to identify effective inter-sectoral policies, interventions and innovations that enable a 'triple win' by reducing environmental impacts, improving health and wellbeing, and generating greater health equity. INHERIT will inform policies and the actions which flow from them. INHERIT's contribution comes from its specific aim to improve understanding of how lifestyle and behaviour creates and shapes the contemporary challenge, the determinants of these behaviours and how behavioural change may be practicably harnessed to deliver the triple win.

In this review, the INHERIT team explores the opportunities for beneficial change across Europe which can facilitate progress towards the triple win. The review investigates the links between behaviour, environmental sustainability, health and health equity for three areas: living (green space, housing), moving (active transport) and consuming (food). These three areas are chosen, in part because they are so central to the lived experience of, particularly, urban dwellers in the Europe of the 21st Century. Each area, in a different way, has a profound bearing on Europe's capacity to deliver the triple win. Nested within each topic are key behavioural and lifestyle levers of change which might be operated to considerable effect by carefully crafted policies based on sound theoretical and empirical knowledge. Below, the highlights of this exploration are presented.

Current transport, food and energy production, consumption patterns and lifestyles in Europe are unhealthy and unsustainable. They generate the pollutants that most significantly affect human health, such as particulate matter, nitrogen dioxide, ground-level ozone, greenhouse gases and noise. The burden of cardiovascular and respiratory diseases attributed to these pollutants in Europe is considerable. Air pollution, for example, contributes to the premature death of about 600,000 people every year in the WHO European Region, with an associated cost of USD 1.6 trillion in 2010, and a dispropor-

tionate disease burden in certain regions and less affluent parts of society, increasing inequalities. Furthermore, overconsumption, lack of green space and limited physical activity contribute to the increase in people being overweight and obese observed in Europe. Globally, two billion people are suffering from the consequences of overconsumption and obesity, in the form of non-communicable diseases (NCDs) such as heart diseases, cancer, diabetes and chronic respiratory diseases.

Moreover, current transport, energy and food production, consumption patterns and lifestyles damage our ecosystems at a global scale, and lead to depletion of natural resources, global warming and climate change with potential disastrous consequences in the long term. If the world population in 2050 - estimated to be ten billion people - were seeking a European lifestyle, this would require, under present production and consumption patterns, the natural resources of at least two Planet Earths. Furthermore, climate change, caused mainly by highly developed economies, will undermine the livelihoods of millions of people in northern Africa, and lead to even larger numbers of social and economic refugees than the numbers generated by the current political crises. This will have grave political and social consequences, and affect health and wellbeing in the EU.

Important drivers of our unhealthy and unsustainable lifestyles are the take-make-consume-dispose models that underpin economic growth, the tendency to prefer convenience and rapidity, and disconnectedness from nature and food origins. At a general level, our unhealthy and unsustainable lifestyles and behaviours are locked in current economic, political and social systems. Thus, a transition to healthy and sustainable societal and individual behaviours is urgently needed, calling for integrated measures both at a system and at a local level. Coherent actions from governments, the private sector and citizens are needed. Actions to change these lifestyles range from bottom-up, local initiatives to upstream measures, aiming at changes in driving forces. Whereas downstream measures focus on directly changing existing behaviours, upstream measures focus on changing the environment in which behaviours occur and promoting alternatives. Creating opportunities, motivating people and building capacities are all relevant entry points for actions to achieve a triple win. For example, creating an accessible, well-maintained green space nearby offers opportunities to socialise and exercise, while at the same time it protects against high temperature and can act as a buffer in case of heavy rainfall. In addition, accessible green space where people can meet may be particularly interesting for low-income groups or people who are do not habitually engage in physical exercise. Moreover, in order to change the food environments of all people, healthy food availability, the price of food in stores and food waste in the whole supply chain must be changed, highlighting the role producers and retailers play and the need for system change to stimulate the development of healthy sustainable behaviours and lifestyles.

To be effective, interventions targeting behavioural change need to take into consideration the characteristics of specific populations. For most people, but especially low-income groups, economic measures, such as financial incentives (e.g. for using the bicycle for work) and fiscal policies, e.g. taxing unhealthy foods and discounts on healthy foods, are attractive. It is effective to lower the costs of healthy foods, to emphasise the money saved from being energy efficient at home and taking the bike instead of the car. Targeted awareness raising, education and training initiatives are essential to change individual behaviours (e.g. Bikeability programmes in the UK and Netherlands), but only if accompanied with changes in the environment (e.g. attractive and safe cycling and walking routes).

Fortunately, there are signs of progress and change. The Sustainable Development Goals, for example, are supported by the majority of countries, and there are initiatives at national and local level calling for more attention to health and sustainability in all policies (e.g. Dutch *Food Agenda for sustainable, healthy and safe food*). Innovations have an important role in catalysing changes in established systems. There are various innovations in the private sector with a potential to change behaviour, e.g. regarding travel and consumption. These innovations consist not only of technological breakthroughs (e.g. electric vehicles, lifestyle coaching applications, mobility services), but also new business and ownership models (e.g. health insurances investing in green space), fuelled by information technology (IT) developments. Other promising developments are a cultural shift towards less car use in economically developed regions, especially among younger generations, and in strategic urban planning, the growing attention paid to stimulating modal shifts towards walking, cycling and public transport, decreasing mobility needs and making sustainable modes of transport safer and more accessible.

The policies, innovations and practices identified in this review need further evaluation to identify the success factors and barriers, the costs and benefits for the environment, health and health inequalities. In the next stage of the project, INHERIT will evaluate whether these practices really reduce inequalities and which of them could be scaled up to ensure a more healthy and sustainable world, in particular for the most vulnerable people.

CHAPTER 1
OBJECTIVES AND METHODS

1.1 INHERIT AND THIS BASELINE REVIEW

There is an intimate link between our health, wellbeing and the environments in which we live. Natural and built environments of good quality have positive effects on our physical, mental and even social wellbeing; therefore, the deterioration of planetary ecosystems is posing an increasing number of challenges to public health. Problems such as pollution, resource depletion, climate change, the growing levels of chronic diseases, and persistent health inequalities, are inter-related. Inter-sectoral approaches are needed to address the drivers of the factors that are leading to environmental degradation and which threaten our health, both in and outside Europe. These approaches must aim to change the patterns of production and consumption that shape our lifestyles and that are also perpetuated by them.

INHERIT[1] aims at identifying effective inter-sectoral policies, interventions and innovations that enable a 'triple win': reduce environmental impacts, improve health and wellbeing, and generate greater health equity. INHERIT will seek to identify, investigate, implement and encourage the uptake of good practices which promote environmental sustainability and health while at the same time enabling and inspiring people across the socioeconomic spectrum towards more sustainable and healthier lifestyles. It will explore opportunities for governments, the private sector and civil society to act.

To detect the most efficient entry points for action and levers for change, this first review of INHERIT describes the links between lifestyles and behaviours, environmental sustainability, and health and equity. It investigates what kinds of measures can be taken (see Textbox 1) to shift society and individual lifestyles towards more sustainability, and improve the environment, health and inequalities across Europe. Furthermore, the review presents an integrated conceptual and analytical framework that has been developed to guide INHERIT's work. It also describes the EU policy context and promising trends and opportunities for action.

Figure 3.1 in Chapter 3 shows the interrelatedness between our current ways of living, moving and consuming, and the impacts on environments and ecosystems and health and wellbeing. Drivers such as economy, culture and demographics influence our behaviour and lifestyles, as well as inequity and inequalities; people have different levels of capability, opportunity (e.g. access to healthcare or green space) and motivation. In addition, people are exposed to different environments and ecosystems, resulting in different impacts on health and wellbeing, both in current and future generations, here and elsewhere in the world.

1 "Inter-sectoral Health and Environment Research for Innovation."

TEXTBOX 1
INHERIT – THEMATIC AREAS

This review investigates the links between behaviour, environmental sustainability, health and health equity for the following topics: living (green space, energy efficient housing), moving (active transport) and consuming (food). These topics have been chosen because each has a profound bearing on Europe's capacity to deliver a triple win. Nested within each topic, are key behavioural and lifestyle levers of change:

- Well-designed and accessible green space offers attractive environments to engage in recreation and sport, to play, and to relax and meet people. Green space can offer protection against heat stress and in that way protect health, in particular for vulnerable populations such as children, older people, pregnant women and lower income groups. Green space also offers protection against other impacts of climate change and enhances biodiversity in cities and allows for urban food production.

- Energy efficient housing reduces greenhouse gas emissions and therefore contributes to environmental sustainability. Improvements in home energy efficiency enhance indoor thermal comfort and may lead to improvements in health, in particular for lower socioeconomic groups who are more likely to live in poor housing. Health, and avoiding unintended consequences to health, must be a key consideration in any measures taken to improve energy efficiency.

- Replacing car use by active transport (cycling, walking) and accessible and efficient public transport improves air quality, offers more (attractive) urban space, increases physical activity and improves social interaction, in particular in lower socioeconomic groups. Therefore, it improves health and wellbeing and reduces health inequalities. It also reduces greenhouse gas emissions and thus contributes to environmental sustainability.

- Eating more healthy and sustainable foods and reducing food waste may contribute to a reduction in health problems related to the consequences of overconsumption and obesity and thus improve health. Unhealthy foods generally have a higher negative impact on the environment. Shifting our diets may therefore also contribute to a reduction in total greenhouse gas emissions and reduce environmental and resource degradation in societies outside Europe. Health inequalities can be decreased through dietary improvements.

1.2 METHODOLOGY

The approach to compiling this review consisted of:

A. Development of a conceptual framework which reflects relationships between drivers (including behaviours), environment and health, as well as health inequalities in the areas of living, moving and consuming. The conceptual framework was used to extract and analyse the literature and to identify gaps in knowledge.

B. Review of the scientific and grey literature:

1. Reviews were selected and evaluated on the topics: i) policy and practice; ii) environment and health; iii) inequalities iv) living; v) moving and vi) consuming. The conceptual framework was used to analyse the information in the relevant reviews that were identified for each topic, to extract what they indicated about the main environmental factors affecting health, their drivers and impacts, also across different subpopulations. Information in the articles on policies, interventions and innovations being implemented to address these factors was included as well. This information was brought together in overview reviews for each of the topics.

2. A search for relevant articles was conducted in the databases Medline, Embase, Scopus, PsychInfo and TRID to supplement the outcomes of step 1 and to fill gaps in knowledge. The focus was on scientific articles published between 2006 - 2016 in English. Multidisciplinary teams focused on each of INHERIT's thematic areas. The teams agreed on the most relevant papers that emerged from the literature search, and extracted information from these using a predefined template.

3. The aim of analysing grey literature was to develop an overview (headlines) of national policies, programs, interventions, and projects that promote healthier and more environmentally sustainable lifestyles and behaviours and health equity. INHERIT partners made an overview of sources and a stakeholder list of key informants in their countries, approached these sources or key informants and collected information from them. They structured the information based on the questions also used for the scientific literature review. Examples of the grey literature sources used were leaflets, factsheets, reports from (national) institutes, action plans, evaluations, whitepapers, folders, and information from databases. Information was collected from the Netherlands, United Kingdom, Greece, Norway, Latvia, Germany, Sweden, the Former Yugoslav Republic of Macedonia, the Czech Republic, Portugal and Spain.

1.3 CONTENT OF THIS REVIEW

Chapter 2 'sets the scene' by elaborating on the challenges that we are facing in relation to environmental degradation, health and health inequalities, as well as the current 'state of play' in relation to public and private sector actions to address these challenges. Chapter 3 introduces the general conceptual framework that was developed to guide and underpin INHERIT's work. The following chapters present the outcomes of the work in the thematic areas living (green space (Chapter 4), housing (Chapter 5), moving (Chapter 6) and consuming (Chapter 7). Each thematic section describes the key trends and factors identified in that area that can be linked to lifestyle and behaviours. The sections discuss how these factors relate to environmental degradation, health and health inequalities. They also discuss opportunities and innovations identified to change lifestyles and behaviours for more positive outcomes, as well as gaps in knowledge. The review ends with an overall discussion on promising policies, interventions and innovations identified, as well as opportunities and barriers for change (Chapter 8), followed by a glossary.

CHAPTER 2
SETTING THE SCENE

2.1 INTRODUCTION

People's health and wellbeing and the places in which they live are intimately linked. Natural and built environments of good quality provide multiple benefits to physical, mental and social wellbeing while, in contrast, polluted and degraded environments damage public health and diminish the quality of life in a variety of ways. Fortunately, most people across the EU are living longer and healthier lives now, under better conditions than ever before. These improvements have been driven by factors like rising living standards, the greater variety of more nutritional foods, improved sanitation and water quality and not least a range of legislative measures aimed at prevention of environmental health risks and health promotion. Yet, as the 21st century progresses, the damage people are doing to the natural environment through their lifestyle choices is becoming increasingly evident. Pollution from industrial, domestic and traffic sources, noise, radiation, the use of chemicals and biological agents are some examples of these choices and their consequences. People's lifestyles are also leading to the depletion of natural resources, to biodiversity loss as well as to climate change, in and outside Europe. These changes to the environment may act directly to affect people's health or indirectly and more subtly through, for example, the damage they are doing to the soil, the marine environment and, through climate change. In addition, choices that people are making in relation to what and how they eat, and where and how they live and travel are leading to overconsumption, a lack of physical activity and reduced opportunities for beneficial exposure to green space and nature. All of these factors have been linked to the leading causes of poor health in Europe, notably cardiovascular and respiratory diseases, cancer, diabetes, obesity and mental disorders, now challenging the trend of continuous improvements in human health.

Compounding the problem are the growing levels of income and wealth inequalities in our societies, which translate into environmental and health inequalities, as low-income and other vulnerable groups are more likely to experience an accumulation of unhealthy living conditions. These inequalities undermine social cohesion and everyone's sense of security and wellbeing.

This complex interplay calls for an integrated analysis of the relations among our current systems of transport, production and consumption, the environment and health (2) (3).

2.2 KEY DRIVERS, TRENDS AND MAIN IMPACTS

The following sets out some of the key drivers of the challenges we now face in relation to environmental degradation, population health and health inequalities, and how these interrelate. The drivers include the economic and financial systems, urban development, food production and consumption systems as well as other demographic, social and cultural factors that are influencing our lifestyles and behaviours.

Economic and financial systems

Despite the clear benefits to health and wellbeing delivered by economic growth, the economic models that have led to this growth have little prospect of delivering health, wellbeing, equity or sustainability in the medium to long term. This is because they are underpinned by 'take-make-consume-dispose' processes. These economic models have nevertheless become prevalent across the world, due to the increase of free trade, and the complex interconnected webs of production and consumption that characterise the global economy.

Overall, the global economy expanded threefold since 1970. This has increased living standards and led to the expansion of consumer societies, in which people use more and more goods and services and define themselves and their communities through what they own. The past four decades have also seen an acceleration in technological change, automatisation processes and the rise of artificial intelligence. The 'digital revolution' or the rise of the Internet and devices like personal computers and smartphones are rapidly changing how we live, move and consume.

These developments underpin the ongoing transition in highly developed economies like the EU from industrial to post-industrial, knowledge based economies. While this opens up new opportunities, it is also brings with it big social challenges. Standards of living are increasing across the world and poverty is declining, but not everyone benefits equally, in the developed and the developing world alike. On a global scale, it means national economies have become increasingly specialised, as knowledge intensive industries remain in developed economies while many developing economies continue to rely on extraction and manufacturing. It also means that there are fewer employment opportunities, particu-

larly for lower skilled workers in developed economies and that education levels are becoming increasingly important. In addition, the highly competitive global economic climate encourages industries to gain competitive advantages by lowering these costs of production as much as possible, often by undercutting environmental and labour standards, or by replacing labour entirely through automatisation processes.

It is increasingly evident that established economic models, which have delivered so much for the developing world cannot serve as a blueprint for development in other parts of the world. This is especially true as we contemplate the prospect of a global population of 10 billion in a matter of decades. It has been observed that, if the global population were to seek a European lifestyle by 2050, this would require, under present production and consumption patterns, the natural resources of at least two Planet Earth's. Thus, changes towards a more sustainable and healthy lifestyle are urgently needed in Europe as well as the rest of the world (4, 5).

It has also, over the past decade, become clearer that the global financial systems, which enable economic actors, are themselves unsustainable. The economic crisis of 2008 revealed how financial products have become more and more disconnected from the real economy. It exposed the growing levels of inequality in current financial and economic systems, as some individuals in the financial sector accrue very large rewards, at the expense of average citizens. The crisis exposed the volatility of the current financial system and the need to increase its transparency and make it more sustainable (6).

Succinctly put, a key problem with our current economic system is that it does not internalize environmental and social costs of production. It relies on an unrestrained resource-intensive economic activity that does not match the finite resources of our planet. Global extraction of raw materials has tripled over the last four decades as our consumer society drives the accumulation of material goods. The reliance on energy from fossil fuels for heat, electricity and to power transportation, remains high. As a recent report by the European Political Strategy Centre (EPSC) (26) states *"We need economic growth largely dematerialised, based on renewables and maintaining materials within the production cycle."*
Ideas for alternative economic systems are emerging, such as circular economy, which closes cycles through reuse, remanufacturing and recycling. This requires local economic activity and leads to reduced emissions at all stages of the product life cycle (7). Such circular solutions for alternative production and consumption systems, are urgently needed.

Because societies across the world are interconnected, the impacts and consequences of environmental degradation on health and wellbeing will not stop at European borders. It has been anticipated, for example, that climate change, caused mainly by highly developed economies, will undermine the livelihoods of millions of people in northern Africa, and lead to even larger numbers of social and economic refugees than the numbers generated by the current political crises (8). This will have grave political and social consequences, and affect health and wellbeing in the EU and other parts of the world.

Social, cultural and demographic factors

Current society places a high value on convenience, speed and efficiency. Rapid personalised transport options (cars), convenient food options (fast-food, pre-packaged processed foods), a host of electrical appliances to make household work easier have changed our way of life in ways that also profoundly affect the environment and our health. Equally, our busy schedules do not always allow enough leisure time spent, e.g. in urban green space and in healthy, restorative recreational pursuits. In addition, commercial and other drivers promote the availability and consumption of unhealthy foods, or unsustainable appliances and give insufficient emphasis to energy conservation. A further driver demanding of attention in considering the relationship amongst environment, health and wellbeing, and equity is the demographic transition now occurring in Western societies including Europe. The European population is ageing, but there are differences in rates of ageing between population groups. The current proportion of people aged 65 years and over, already exceeds 17.5% and is projected to reach 29.5% by 2060 (9). While, in 2013, there were four workers for every one pensioner, by 2060, there will be two workers for every one pensioner (10). The working population will therefore face an increasing burden of caring for its older people. This group is generally more vulnerable to environmental phenomena such as air pollution and extreme temperatures, and there are indications for an association between air pollution and neurological diseases in older people (11). Moreover, the growth in elderly populations will also lead to the need of adapting living spaces, public areas, health and transport services and other infrastructure. It is important to ensure that older people, like other socially vulnerable groups who are less able to participate in fast-paced, information based societies, do not become socially isolated or lonely, which can also be very detrimental to health.

Technology

Industrialisation and technological advances have led to more convenience and have genuinely benefited

humanity in a numerous ways. Yet despite the significant dividends offered by science and technology it is appropriate to observe that their impacts are not universally positive for health, the environment and wider society. Neither are the benefits and harms spread evenly across society. The rapid industrialisation of food production and the emergence of processed food over the past decades, for example, have led to a shift in dietary patterns in Europe (see also Chapter 7). Producing more cheap convenient processed foods that are low in nutrients but high in calories is leading to growing levels of overweight and obesity.

Technological developments have shaped the nature of work today. The fact that Europeans now spend 85-90% of their times indoors is not unrelated. We have also come to rely on motorised vehicles for transportation in ways which impact negatively on health and the environment (globally and locally). The fact that we walk less and otherwise engage less in active travel reduces our connections to natural and green spaces and the advantages these activities confer for health and wellbeing. There is a body of evidence which links a sedentary lifestyle and inactivity to chronic diseases and diminished wellbeing.
The digital revolution is in many ways contributing to health and well being. For example, individuals can now access and use a wide range of applications with potential to inform a healthier lifestyle. Digital technologies that enable new ways of interaction among people, like carpooling, time banks or second-hand trading, also place an emphasis on durability rather than obsolescence of goods. They can support the creation of a sharing economy, based on the sharing and re-use of goods, create more circular patterns. It can also provide solutions to help address challenges posed by ageing populations, such as e-health approaches that make health care services more accessible to older people and their caregivers. Services like e-Health and IT solutions to improve access to public transport are some of the solutions that can help keeping, or increasing wellbeing among senior citizens (12).

At the same time, there is a risk of a growing social divide between those with the capability and opportunity to be 'digitally literate' and those who do not. In addition, the production and use of computers and mobile telephones is energy intensive while the amount of electronic waste is growing annually, with serious consequences for the environment and health in countries outside the EU (13). In addition, the digital lifestyle does not necessarily lead to more sustainable behaviours. We have more opportunities to work and meet virtually, but the number of trips made by car or plane is not decreasing. Smart appliances for facilitating the energy consumption at the household level (i.e. regulation of illumination, air flows, heating) won't work if the consumers aren't aware of how to use them properly. In general, a sustainable and healthy lifestyle also conveys finding a balance between virtual and physical interactions with the environment and other people.

Food production and consumption

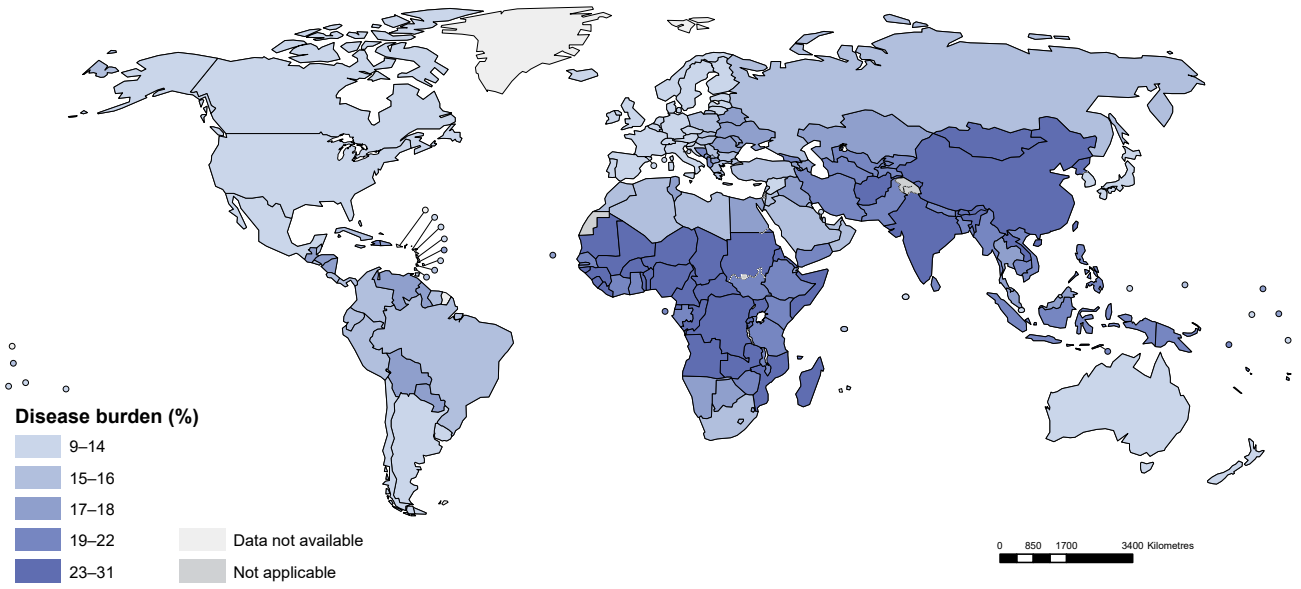
Another key driver of environmental degradation, which also threatens human health and contributes to health inequalities is the modern food production and consumption process. Some 40% of the world's land surface is used for the purposes of food produc-

TEXTBOX 2.1
IMPACT OF AIR POLLUTION IN THE EU

While deaths due to air pollution have decreased in Western Europe, as a result of cleaner energy and transport measures, they remain significant. Around 90% of city dwellers in Europe are exposed to pollutants at concentrations higher than the air quality levels deemed harmful to health. According to a recent OECD-report, outdoor air pollution could lead to 6 to 9 million premature deaths by 2060 worldwide. Ageing populations in particular experience a large number of deaths due to air pollution. Air pollution also negatively influences water, soil and ecosystem quality, and some air pollutants behave like greenhouse gases that cause climate change (19).

tion, and in the EU around half of the land is farmed. The vast majority of this land is used to raise animals for meat and animal products, rather than the production of grains, fruits and vegetables. A 2006 report from the Food and Agriculture Organization estimated that livestock were responsible for about 18% of human-caused greenhouse gases (14). Throughout the EU there has been a reduction in the number of farms and farm employment, with larger, specialised production units, leading to monocultures with considerable impacts on the environment, biodiversity and the quality of food. The vast majority of farms are relatively small (70% of farms are less than 5 hectares) and have a rather low income level per worker, while a small proportion of holdings record a very high income level per worker. High levels of inequalities therefore exist within the sector (15). Modern agricultural practices rely heavily on fertilizers that generate pollution and greenhouse gases and deplete the soil of essential minerals and nutrients. They also introduce hormones and antibiotics into the ecosystem. The globalisation of food production systems has led to a big increase in global transportation systems by air, land and water contributing to air pollution and greenhouse gas emissions and the depletion of fossil fuels (16). Increased consumption levels of exotic products impact on the environment through production, transport, packaging and

TEXTBOX 2.2
THE OVERALL IMPACT OF THE ENVIRONMENT ON HEALTH



A systematic and comprehensive review of the WHO on overall impacts of the environment on health showed that, in 2012, 23% of global deaths were attributable to the environment, amounting to 12.6 million deaths. When accounting for both death and disability, the fraction of the global burden of disease due to the environment is 22%. In children under five years, up to 26% of all deaths could be prevented, if environmental risks were removed. This estimate focuses on the reasonably modifiable environment and data from intervention studies, and the results therefore indicate the potential burden of disease that could reasonably be prevented by environmental interventions (24). Factors included in the calculation were air pollution (including second-hand tobacco smoke), water or soil pollution, ultraviolet (UV), noise, electromagnetic fields, occupational risks, built environments, agricultural methods, climate change and behaviour related to environmental factors (e.g. physical activity related to urban design).

(Source: Pruss-Ustun et al. (24))

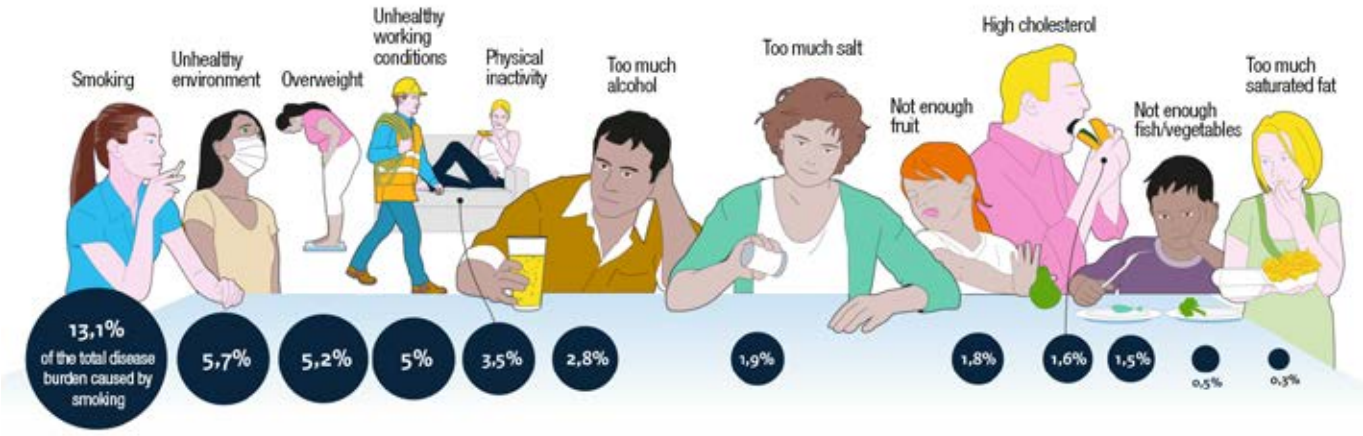


Figure 2.1. Important determinants for public health in the Netherlands (Source: RIVM (25)).

storing. Globalisation allows products to be produced where the costs are lowest, instead of where it can be produced with the lowest environmental impact (16).

Urbanisation

Another development that is contributing to environmental damage, but also offers opportunities, is the rapid rate of urbanisation. It is expected that by 2050, two-thirds of the world population (6.3 billion people) will be living in cities. In Europe, the proportion of the population living in urban areas increased from 51% in 1950 to 73% in 2011, and is projected to reach 82% in 2050 (20). Multiple pressures on the environment coexist in urban areas, as construction and policies promoting densification leads to a loss of biodiversity and reduction of the quality of landscapes. Urbanisation also means that more people live in residential environments with fewer green spaces (21) and more traffic. This leads to e.g. higher levels of air pollution, noise, CO_2-emissions and soil pollution (see Textbox 2.1 for the health impacts related to air pollution). Cities are associated with 60-80 per cent of all greenhouse gas emissions, consume 75 percent of natural resources, and account for 50% of all waste (22). Climate change may exacerbate these environmental impacts through increasing urban temperatures, heavy rainfall, floods, etc. (20). Well-planned processes of urbanisation, however, that facilitate active transport (e.g. by providing enough safe biking and walking paths as well as public transport) and provide easy access to natural, green environments can also deliver health and wellbeing benefits and protection from the impacts of climate change (3) (23). As urban areas grow, the size and number of individual dwellings is increasing and, with it, pressure on public services. In addition, more and more homes in Europe are being occupied by single people or (particularly in Northern Europe) single parents with children. This affects social cohesion, and can lead to social isolation, which has also been linked to negative health impacts.

Health and social impacts

In the past decades, we have seen a decrease in infectious diseases but an increase in non-communicable diseases such as cardiovascular and respiratory diseases, cancer, diabetes, obesity (see Textbox 2.3), and mental disorders. Non-communicable diseases have surpassed infectious diseases as leading causes of death in the EU (24). While the nature of the links between non-communicable diseases and environmental factors is not sufficiently understood, it is clear that exposure to environmental factors plays an important role in their prevalence (20). The global burden of disease due to the environment is 22%, based on recent estimates of the WHO (see Textbox 2.2).

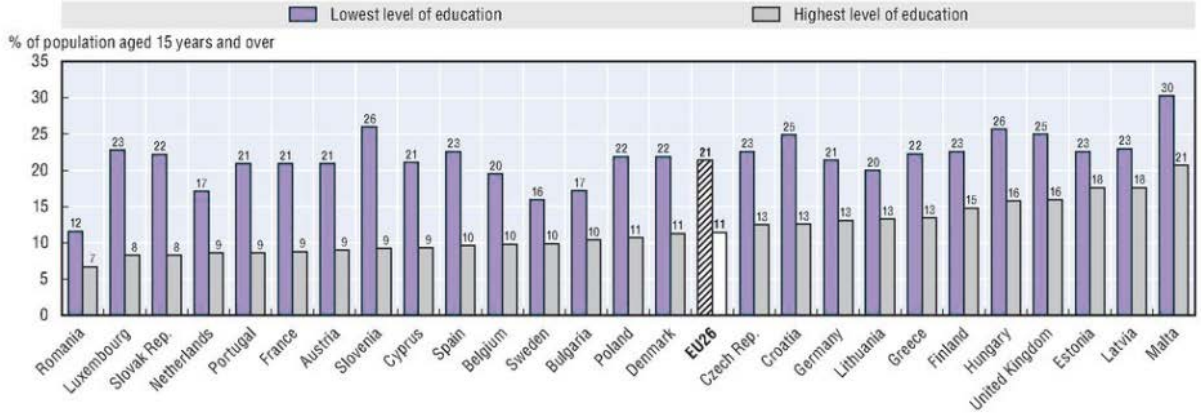
People's lifestyles and the conditions in which they live and work influence their health. Smoking, alcohol use, too much fat in food or too little physical activity, and environmental factors are important determinants of health in Europe. In the Netherlands for example, smoking (13%), unhealthy environment (6%, mainly air pollution and noise) as well as overweight (5%) are the three most important contributors to the disease burden (Figure 2.1). Limited physical activity is also of importance.

Levels of income and wealth disparities are growing in European societies, and translate into environmental and health inequalities (see Textbox 2.4). Low-income

groups are more likely to experience an accumulation of unhealthy living conditions and exposures to environmental threats. Evidence is growing that environment-related inequalities and their potential impacts on health and wellbeing are strongly related to socioeconomic factors, as well as to coping and adaptation capacities (3) (26). Social determinants influence the exposure to and the effect of environmental risks, which consequently lead to illness and disease. When people fall ill, this, in turn, can have multiple repercussions on their socioeconomic status (24). Social, economic and political mechanisms create residential segregation. Segregation is considered an important determinant of environmental inequalities, affecting the quality of schools, homes and transportation (27). Furthermore, poor environmental conditions tend to be associated with social stressors (such as poverty, violence, etc.). While knowledge of the combined effects of stress and pollution is limited, it is widely held that increased stress levels are a material factor in determining levels of vulnerability to external factors. Fragmentary evidence from EU countries indicates that low-income populations often live in areas with higher pollution levels and poor-quality housing, near industrial and waste dumping sites, noisy roads, and have less often access to good quality green space near their homes (28). Disadvantaged groups are often disproportionally affected by the cumulative impacts of overall degraded environments and lack financial, educational and cultural capacities to avoid such exposure.

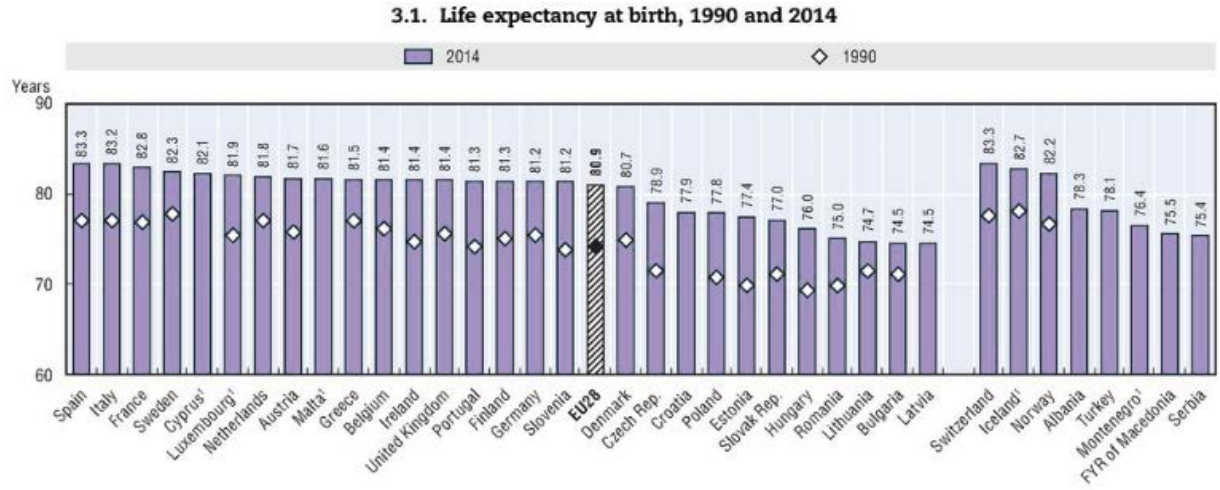
TEXTBOX 2.3
OVERWEIGHT AND OBESITY IN THE EU

4.14. Self-reported obesity among adults in EU countries, by level of education, 2014



Source: Health at a glance, OECD (343)

TEXTBOX 2.4
HEALTH INEQUALITIES IN THE EU



Source: Health at a glance OECD (343)

There are large differences in life expectancy between and within countries, strongly related to socioeconomic status. In the Netherlands, for example, there is a 6-year difference in life expectancy and 19 years in healthy life expectancy between the lower and higher educated people.

Life expectancy at birth in the EU-28 was estimated at 80.9 years in 2014, reaching 83.6 years for women and 78.1 years for men. For men, the lowest life expectancy in 2014 was recorded in Latvia (69.1 years) and the highest in Cyprus (80.9 years). For women, the range was narrower, from 78.0 years in Bulgaria to 86.2 years in Spain (9).

2.3 GOVERNMENT, PRIVATE SECTOR AND CIVIL SOCIETY RESPONSES

There are powerful economic, political and social forces that drive our lifestyles and behaviour and lead to environmental degradation, poorer health and health inequalities. This places a responsibility on us all, where possible, to adapt our behaviours and lifestyles to ensure that they are based upon sustainable practices. At the same time pressure must be applied to governments and businesses to enact policies that support the adoption of sustainable and healthy lifestyles (e.g. by providing the infrastructure or products). Individuals are unlikely to embrace these responsibilities or be effective advocates without understanding the impacts of daily decisions. Governments may contribute by setting up conducive regulatory contexts, facilitating and inspiring better decision making, creating market demand through sustainable public procurement and supporting research and innovation. For the private sector, an appropriate response involves integrating sustainability into their core business strategies and developing innovative products and ways to meet the needs of people in a sustainable way and communicating about this to enhance informed decision making (29).

There is growing awareness amongst citizens, policymakers, politicians and the private sector that current 'take make consume dispose' models of production and consumption are unsustainable and that they are threatening our wellbeing at the individual and global level. The following sets out the kind of measures that governments (particularly at EU level) and the business sector as well as citizens, as consumers and voters, are taking to achieve more sustainable economies and lifestyles. In Europe, broader recognition that we are living beyond the scope

of planetary boundaries and need new approaches, is not necessarily translating into a change of lifestyles. When asked which actions have the greatest impact on solving environmental problems, the largest proportion of EU citizens (30%) selected minimising waste and recycling. Approximately a fifth (21%) of interviewees mentioned buying products produced by eco-friendly methods and a similar proportion (19%) selected buying energy efficient home appliances as actions that could have the most impact. Only 15% of interviewees answered that adopting sustainable modes of transport and travelling less frequently are the most important actions to solve environmental problems and 11% mentioned making efforts to use less water as the action with the greatest impact (30). This lack of awareness is worrying, given the negative impact of motorised transport on the environment and health and the benefits of sustainable modes of transport. Thus, action is needed to raise awareness on the impact that these solutions have on the health of the citizens and the wellbeing of the communities, moreover, it is also an opportunity for businesses to develop partnerships that facilitate these actions. While actions to achieve more sustainable societies can be taken at all levels of governance, those agreed and taken at the supra-national level are likely to be highly effective, since the effects of environmental degradation know no boundaries. That is why there is clear added value for EU action in areas where it has the competencies to act. Many EU Member States and the EU Institutions have been setting up conducive regulatory contexts that encourage investments that de-link economic growth from CO_2 emissions (although it is still emitting 10% of the global greenhouse gases with a world population share of just below 7%) (EPSC) (15). They are also taking measures to inform consumers within different sectors (i.e. Green public procurement practices, European labelling schemes, etc.). WHO Europe, which has a strong influence on health policies of EU Member State, also encourages comprehensive, intersectoral action on environment and health issues, but has no enforcement mechanisms (see Textbox 2.7). The EU has implemented numerous policies that address the environment and its impact on human health, such as the 7th Environment Action Programme (7th EAP), Clean Air Policy Package, Environmental Noise Directive, REACH chemicals policy, and the EU's new energy plans. An EU Environment and Health Action Plan (31) was finalised in 2010 but this was not followed up with a dedicated environment and health policy in the EU. While the implementation of these policies is likely to reduce part of the environmental health burdens, the European Environment Agency (20) has indicated that the current pace of change will not be sufficient to protect our natural environment, and thereby health. The path to an environmentally sustainable and healthier future lies in integrated approaches and stronger collaboration amongst sectors, including the private sector, to achieve common, interrelated goals.
There has been progress on such overarching approach-

TEXTBOX 2.5
PARIS AGREEMENT ON CLIMATE CHANGE

Another promising development is the **Paris Agreement**, which sets out the ambitious goals to combat climate change, which was adopted by 55 countries that were party to the United Nations Framework Convention on Climate Change (UNFCCC) (34). The UNFCCC is the primary intergovernmental forum for negotiating the global response to climate change. 55 parties to the UNFCCC which together account in total for at least 55% of the global greenhouse gases (GHG) emissions ratified the agreement, which entered into force on the 4th of November 2016. The central aim of the Agreement is *"to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius"* and *"to strengthen the ability of countries to deal with the impacts of climate change"*.
The UN Paris Agreement acknowledges the significance of the right to health in the actions to be taken by the Parties in their effort to address climate change. It offers an opportunity to achieve win-win situations by promoting climate change mitigation and adaptation policies that have co-benefits for people's health and the health and wellbeing of future generations. Decarbonisation, energy efficiency and renewable energies are of great importance to reach the goals of the Paris Agreement, also in the transport sector.

TEXTBOX 2.6
UN 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

In 2015, the UN **Sustainable Development Goals (SDGs)** have been adopted. The SDGs are a set of universal goals, targets and indicators to be used as the framework of the United Nations member state's agendas and political policies until 2030 (36). They are part of the wider **UN 2030 Agenda for Sustainable Development**; *"a plan of action for people, planet and prosperity"*. The Agenda includes 17 Goals and 169 targets which aim to end poverty, protect the planet, and ensure prosperity for all. It seeks to balance the three dimensions of sustainable development: the economic, social and environmental. The goals and targets are geared towards establishing relevant and effective links that can bring about the transformational change required to achieve sustainable development. The SDG philosophy recognizes issues related to inequality and discrimination, the need for a cyclical, green economy, and the importance of building resilience to mitigate natural and man-made disasters (24). Environmental improvements for health can make important contributions towards achieving the SDGs, many of which are closely interlinked with the environmental and social determinants of health (Figure 2.2). At the same time, several SDGs address the drivers of environmental health problems. For example, SDG 11 focuses on making cities and human settlements inclusive, safe, resilient and sustainable. Two of the ten SDG 11 targets address transport and access to green space. The SDGs are not legally binding and governments

are expected to take ownership and establish national frameworks for the achievement of the goals and targets. Countries have the primary responsibility for follow-up and review of the progress made in implementing the goals, which will require high- quality, accessible and timely data collection

es. The EU's 1997 Amsterdam Agreement for example declared sustainable development a fundamental objective of the EU, which set the stage for the development of a Sustainable Development Strategy that was implemented in 2001 and renewed in 2006. This Strategy brought together many strands of economic, social and environmental policy under an overarching objective to continuously improve quality of life and wellbeing in Europe for present and future generations. It led to an indicator set that is used to monitor the EU's progress on sustainable development every two years (32). The main objectives of this Strategy have been incorporated into the overarching Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth (33). The Europe 2020 Strategy focuses on sustainability, in the context of promoting a more resource efficient, greener and more competitive economy. It establishes targets for the reduction of greenhouse emissions, for increases in the share of renewable energy and for energy efficiency. The aim is also to decouple economic growth from the use of resources and support the shift towards a low carbon economy and to modernise the transport sector. The targets in the EC's 2030 climate and energy framework are in line with those set out in the Paris Agreement on Climate Change (Textbox 2.5). There has been criticism however that the overall targets are too modest, given that the EU is on target to meet its 20% reduction goal set in 2008 for 2020 (34). The EU is also building a Circular Economy concept that aims at changing present consumption and production patterns by focusing on design of products (durability, reparability, re-use and

recyclability), waste (avoidance, material recycling, energy recovery, avoidance of landfilling) and consumer awareness (35). These measures reflect the importance given by many EU level actors to align EU policy to the UN Sustainable Development Goals (36) (SDG, see Textbox 2.6). As a supporter of the SDG Agenda, the EU must ensure that policy developments and data monitoring systems at the EU level also contribute to the achievement of the goals, and support Member State efforts to implement them. The European Political Strategy Centre (EPSC) (15) states that the UN Sustainable Development Goals *"reflect a broad recognition that the global status quo is untenable and that change is necessary to deal with the negative global trends affecting economic, social and ecological perspectives: growth, jobs, wellbeing, natural capital, social cohesion."* The report states that "*sustainability could well become the rejuvenated brand of Europe: 'living well and sharing fairly within the limits of our blue planet"*. The European Commission recently issued a Communication (37) that sets out concrete approaches to integrating sustainable development approaches in all of its work. However, initial indications are that the EU's plans to align its broad policy objectives to those of the SDG do not go as far as those suggested in the EPSC report. A reason may be the resistance of some EU Member State governments that do not believe this matches with their short-term interest.

There are few enforcement mechanisms to hold signatory countries accountable to international agreements like the recent ones highlighted in this section. On the one hand, such agreements show recognition by many governments as well as the private sector and civil society of the urgency to protect the environment and thereby human health and a willingness to act. On the other hand, prevailing economic forces are strong; many members of society do not benefit from economic and social change in the short run, and have an interest in maintaining the status quo rather than investing in change.

Figure 2.2. Sustainable Development Goals and environmental health links (Source: Pruss-Ustun et al. (24))

Opportunities for the private sector

Whilst the EU and Member States governments may act only incrementally to implement the changes and necessary measures to achieve more sustainable development, there is some evidence that the private sector is also recognising opportunities in the sustainability agenda and is starting to drive change. Some business leaders see significant benefits in achieving the ambitions set out in the Paris Agreement. They are also increasingly recognising the costs of environmental degradation, and the benefits of investing in cleaner energy solutions. A survey of 750 participants at the Davos Summit in 2017, bringing together political leaders, business and finance leaders showed that extreme weather was considered the biggest global risk (39). Businesses are also recognising that, as OECD work has convincingly demonstrated, few challenges pose greater obstacles to better economic performance than the rise in inequalities across societies. Growing inequalities lead to a vicious cycle of individuals with poorer skills and low economic opportunities, reduced purchasing power and ultimately to poorer productivity and growth. In addition, European surveys reflect that citizens place great value on health, with the health and wellness industry being a strong and growing one across the world (40). It is therefore in businesses' interests to recognise and seize opportunities located at the inter-section between environment, equity and health concerns, which will ultimately lead to the adoption of more sustainable lifestyles.

The private sector is evidently aware of this. The sector of environmental goods and services increased by 24% between 2007-2013, at a time of the economic crisis when most sectors were shrinking and losing jobs (15). European enterprises are now more efficient in the use of energy and raw material for their production processes, spearing efforts globally. Green technology capability is therefore becoming one of Europe's competitive advantages. New business opportunities at the inter-section of environmental sustainability and health concerns are quite clear in the ICT sector, which is making information more and more accessible to everyone.

Many large businesses report on their Corporate Social Responsibility (CSR) as part of their business strategy. Many also produce sustainability reports, in reaction to investors demands for more transparency over longer-term risks. The EU has adopted a non-financial disclosure Directive requiring large public listed entities with more than 500 employees to disclose basic information on their exposure to sustainability risks. Such information should increasingly be demanded by citizens to make informed decisions about the goods and services they are purchasing and their impact upon their environment, their health and equity.

TEXTBOX 2.7
WHO EUROPE POLICIES

The World Health Organisation is the UN agency focusing on public health that has a considerable influence on policy making in the field of health. Its health strategy for Europe, Health 2020, considers wellbeing as a possible focus for reorienting 21st century public policy, including its environmental dimension (11). Through its pan-European Environment and Health Process it addresses environment and climate-related threats to human health, particularly to children (38).

The Parma Declaration on Environment and Health and the accompanying Commitment to Act, focusses on key environment and health challenges, including the health and environmental impacts of climate change and health risks to vulnerable groups due to poor environmental, working and living conditions. Governments across Europe that signed the Declaration have agreed to implement national programs to provide equal opportunities for all children by 2020, among other things by guaranteeing opportunities for physical activity and a healthy diet and improving air quality. The agreement is not legally binding though. In 2014 the implementation of the Declaration was reviewed and a new Declaration (containing objectives that have not been met and new challenges) is under development and will be signed in June 2017 (11).

The World Health Organization Regional Office for Europe (WHO/Europe) supports Member States in their efforts to achieve environmental health objectives. It for example also releases numerous reports and guidelines on topics varying from indoor air pollution to health co-benefits of climate change mitigation.

The policies and strategies highlighted in this section can be successful if governments, businesses and civil society work together to address the drivers of environmental degradation that generate ill health and health inequalities. This involves investing in business models that are sustainable and scalable.

In the health sector, the concept of "scaling up" is widely used, to denote multiplication or replication of successful

initiatives, policies and business models that help to improve the health conditions of individuals and societies, as well as the development of the industry itself. Different approaches can be used to scale up successful initiatives to improve sustainable and healthy lifestyles, which build upon each other and engage a large number of stakeholders: the micro (case-studies), meso (development strategies) and macro level opportunities (e.g. policy).

Regardless the path that the private organisations decide to follow, they should have a vision of a society that exists in harmony with the environment. They should also, consider the role they can play in enabling health and equity for both their employees and their consumers. It is important to present examples of how lifestyles and behaviours can be changed through their actions in order to support this. This is where INHERIT can contribute.

TEXTBOX 2.8
INNOVATIVE BUSINESS MODELS FOR SUSTAINABLE LIFESTYLES

The CSCP's study (41) on pathways to scale up business innovations for sustainable living, defines "scaling-up" as activities leading to more quality or environmental and social benefits to more people over a wider geographic area more quickly, more equitably, or over a longer time frame. This definition reflects both a concern for the extent and quality of the impacts that promote respecting sustainability and equity". Scaling up activities is not the sole responsibility of a specific social actor, rather a combination of efforts between policy makers, civil society and businesses. There are three roles that the private sector can play to scale up their impacts on all areas of sustainable living. The first pathway focuses on the organisation itself and consists of scaling impacts by increasing or decreasing the size of the organisation, either from within (i.e. organic growth and acquisitive growth) or by partnerships, networks, franchising, etc. The second pathway is via programs and projects. It can have a quantitative nature (expanding the size of project/program by increasing the membership base), a functional one (diversification of projects/programs and expansion into new types of activities) or a political one (a project/program moves beyond service delivery towards institutional change and policies). It can also be rooted in capacity building (when projects/programs improve their effectiveness and efficiencies) (41) . The third pathway, which has value creation as the focus, comprises cases that range from product substitution, better design, efficient use, shared use, circular approaches, to social interactions to enable more equitable access to health services. This value is expressed beyond economic terms, like improvement in health conditions (reduced stress, higher levels of energy), fewer CO_2 emissions resulting from carpooling and bike sharing schemes, etc. Examples include for instance refurbished medical diagnostic systems. (www.usa.philips.com/healthcare/solutions/refurbished-systems).

CHAPTER 3
CONCEPTUAL FRAMEWORK

3.1 CONCEPTUAL FRAMEWORK

A fundamental component of INHERIT is its conceptual framework. Recognising its importance a) in configuring and facilitating the literature review and b) as an element within INHERIT's forthcoming Common Analytical Framework (CAF), the development of the Conceptual Framework has been an early task for the consortium. The conceptual framework is an enduring point of reference for the consortium throughout the project and indeed for readers as they work through the chapters of this review. As with all conceptual models, the INHERIT model is a focused and simple representation of a complex reality, yet, as a tool to think with, it can help navigate this challenging area. Due to the special role that behaviour and lifestyles play in INHERIT and the conceptual framework, the last section of this chapter focuses on behaviour and how the behavioural dimension is represented within the Conceptual Framework.

How individuals behave and the choices they make in their personal and working lives are not only affected by the physical environment. These behaviours and choices critically affect the local physical environment they experience on a daily basis. Moreover, through their impact on global processes and systems, behaviours and choices can fundamentally change the environment far beyond the boundaries of the neighbourhood or country where they are perpetrated. Many of these changes have implications for health and health equity. Thus, what we do as we go about our lives can threaten medium to long-term prospects for a sustainable, healthy and equal environment in Europe and other parts of the world. Just as health and disease emerge from a complex interaction of factors acting at the level of society with individual characteristics, the behaviours and lifestyles people adopt are the product of similar influences, opportunities and constraints. Building on previous work (42-45) the *"behaviourally enhanced DPSEEA"* or *"INHERIT"* model (see Figure 3.1) provides a tool to think about these complicated issues in ways that point to solutions. The model is a useful way to visualise the interrelationships between health, environment, inequalities, our behaviour and lifestyles and the related drivers. It can be used to evaluate existing knowledge, efficacy of our policies and the opportunities and impediments for beneficial change in the field of health and sustainable behaviours across the social gradient, in the areas of living, moving and consuming.

As can be seen in Figure 3.1, the INHERIT model presents two pathways from interacting macro-level *Driving Forces (Drivers)*, within which there frequently is a behavioural dimension, to the environmental changes which can lead to impacts on health and wellbeing. The proximal pathway represents a traditional environmental health perspective in which the health and wellbeing of individuals or groups in a society is affected by changes to the environment near to them in space and time. Thus, for an individual, the proximal pathway to their health might involve exposure to a busy road with high air and noise pollution levels, or benefits to health and wellbeing from an attractive public park near their home. The distal pathway, on the other hand, reflects the recognition that our activities as European citizens can result in health-relevant environmental changes in other parts of the world, but also that the true environmental, health, and health equality implications may not become apparent for years or even decades. For example, the damage to global ecosystems through the emission of greenhouse gases from cars and buses in Europe contributes to climate change, which may lead to drought or floods in countries far beyond our borders. In addition, our food consumption may lead to overfishing of oceans and food scarcity in developing countries. Although for Europe such changes may appear to be happening elsewhere or seem to be a concern for future generations, they are real and proximal threats to the people in the lands affected. Moreover, in a world connected economically, socially and environmentally, Europeans are never isolated from the environmental, social and health changes occurring now and later elsewhere in the world. For instance, distal climate impacts can affect proximal health and wellbeing (e.g., extreme weather events may destroy crops in Africa, which can lead to rising food prices in Europe). For this baseline review, the focus lies on the proximal pathway, related directly or indirectly to the current behaviours and lifestyles in Europe, while providing information on the effects 'there and then' where available.

The unique, complex and dynamic interaction of many macro-level *Driving Forces* affecting any location creates its own particular *Pressures* on the physical environment in that location. This means that *Physical Environments* are likely to differ considerably between places in ways that can be very relevant to the health of those living there. Secondly, the fact that different individuals or groups may reside in the same area does not mean that their *Exposure* to and *Experience* of the environment is inevitably the same. Many factors, and of particular relevance to INHERIT, individual *Behaviour,* influence Exposure and Experience in health-relevant ways. Thirdly, individuals differ greatly in how an exposure to the environment may affect their *Health and Wellbeing*. Anyone seeking to apply the model to a particular issue is challenged to consider the contextual factors that contribute to inequalities in health and wellbeing and whether any policies or actions exist or

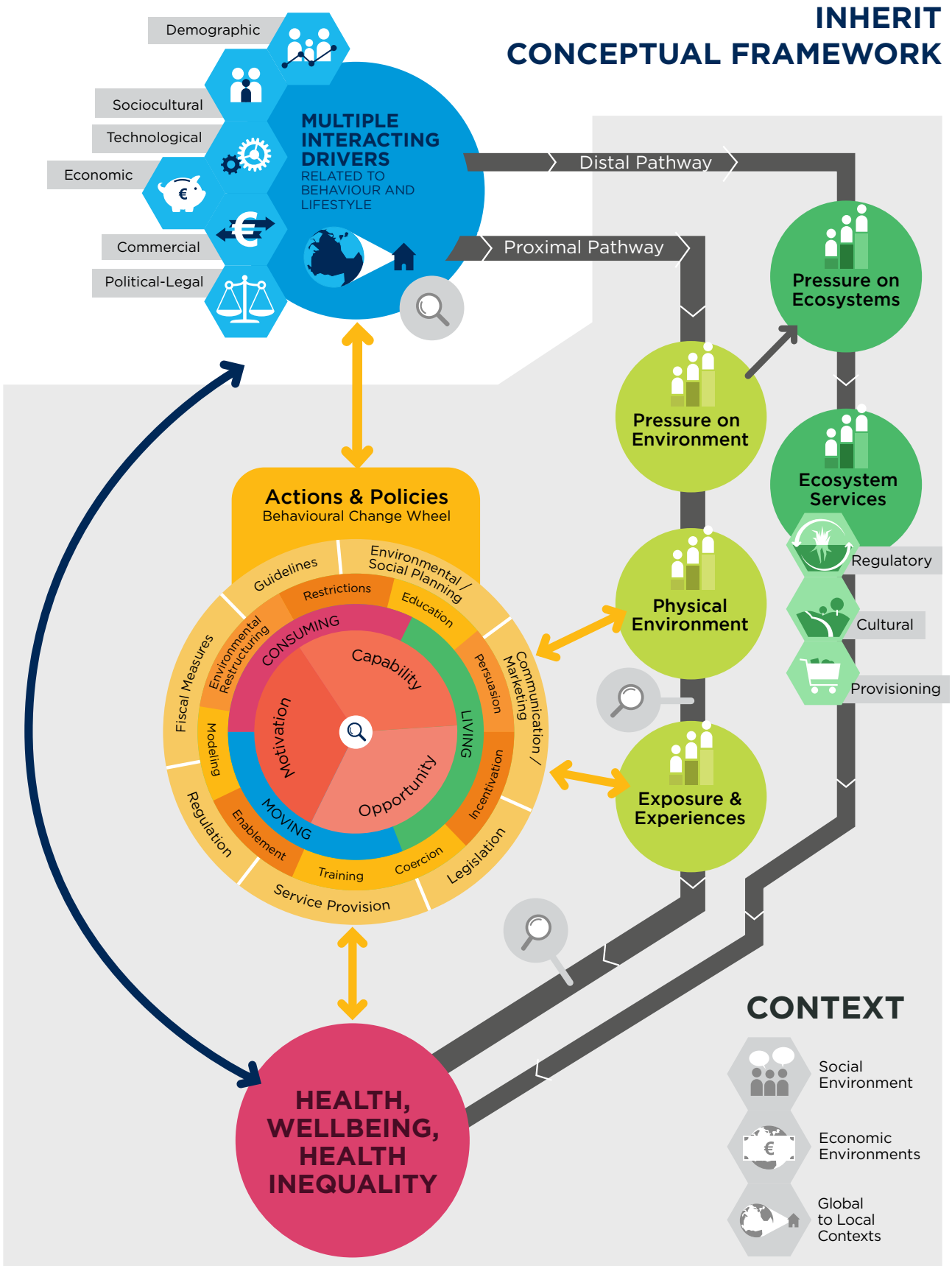


Figure 3.1 Conceptual framework of INHERIT

may be developed to address these. The aspect which most distinguishes the INHERIT model from existing public health or environmental (DPSEEA) models (42-44) is the emphasis placed on those parts of the causal process where human behaviour and lifestyle influence most profoundly. These "behavioural hotspots" are denoted within the model by a magnifying glass symbol implying the need for careful analysis, not just of the nature and impact of the behaviours but the forces that create and sustain them. Only by such an approach can effective policies be developed. Behaviour is represented by elements of the Behavioural Change Wheel, which is further described in section 3.2. An important aspect of the INHERIT model is the recognition of the presence of Inequalities and Inequities between individuals and groups. This is represented in the model by people standing at a podium with different levels.

3.2 BEHAVIOUR

First, what constitutes a healthy, sustainable lifestyle? It is a cluster of habits and behavioural patterns, embedded in society and facilitated by structures such as institutions, social norms and infrastructure that frame and guide individual choice, leading to minimisation of natural resources use and waste generation, whose benefits impact in an equal way for all, while being beneficial for health (46). Since behaviour and lifestyles are such an important part of INHERIT, this section discusses various behavioural models and determinants that are relevant for understanding the role of behaviour in the three topics of Living, Moving, and Consuming. Understanding this role enables a more complete understanding of how people can be persuaded, e.g. to switch transport modes, change eating habits, save energy in a way consistent with health and wellbeing or optimally engage in green space.

Traditional economic theory assumes that human decision making is purely rational, and that people strive for maximal personal gain. By extension, the assumption is that giving them more information or more options will lead to the desired behaviour. For example, a model that has been widely used in health-related contexts is the Health Belief Model, which proposes that perceptions of one's susceptibility to an illness, and perceived severity of a certain illness is balanced against perceived benefits and barriers of a health action. The model thus assumes rational weighting of factors by individuals in decision making (47). However, a growing body of research has shown that people rarely make rational decisions and that behaviour systematically deviates from economic model predictions. Instead, people often use heuristics, or rules-of-thumbs, allowing quick decision making and problem solving, and people are influenced by social and physical environments and social norms (48). Most research on pro-environmental behaviour has been guided by two cognitive behavioural models: the theory of planned behaviour (TPB) and the norm activation model (NAM) (49) (50). These theories have been combined resulting in attitude, subjective norm, perceived behavioural control and personal moral norms as determinants of behavioural intention. In addition, it has been assumed that actually enacting an intended behaviour is facilitated by forming an implementation intention: "If I am in situation X, I will perform behaviour Y". There is little empirical knowledge on the factors that influence these implementation intentions, but coping and recovery self-efficacy (believing that one is able to perform a behaviour and to resume after a lapse), coping planning and action planning have been suggested (being able to imagine possible situations that may be barriers to performing behaviour Y and having plans to handle such barriers) (51).

Although intentions are viewed as the most direct determinant of behaviour, there is an intention-behaviour gap, with intention only predicting about 30% of behaviour (51). This gap can be partly explained by the existence of habits. Whereas certain behaviours can be the result of a conscious reflective process (e.g. choosing a certain diet or actively forming implementation intentions), or social pressures, most of our daily behaviours are performed repeatedly, eventually becoming habitual and part of an automatic process. When behaviour becomes habitual, control of action is outsourced to the environment, which means that when the appropriate circumstances occur, the sequences of actions are triggered automatically by cues from the situation (the so-called automatic system) (52). Moreover, the stronger the habit, the less predictive power behavioural determinants such as attitude, knowledge and intention have. Important for intervention design is the finding that habits can better be broken at moments in people's lives in which contexts and cues change (e.g. moving houses, going to college), during which they are more amenable to change (53) (54).

Considering the influence of both an automatic and a reflective system in health and pro-environmental behaviours, the INHERIT model includes behaviour by using the Behavioural Change Wheel (BCW) (55) (see Figure 3.2). This model incorporates both the reflective system (central route) and automatic system (peripheral route, including habitual behaviours). It consists of three parts that can influence each other, and together influence behaviour - capability, motivation, and opportunity. In

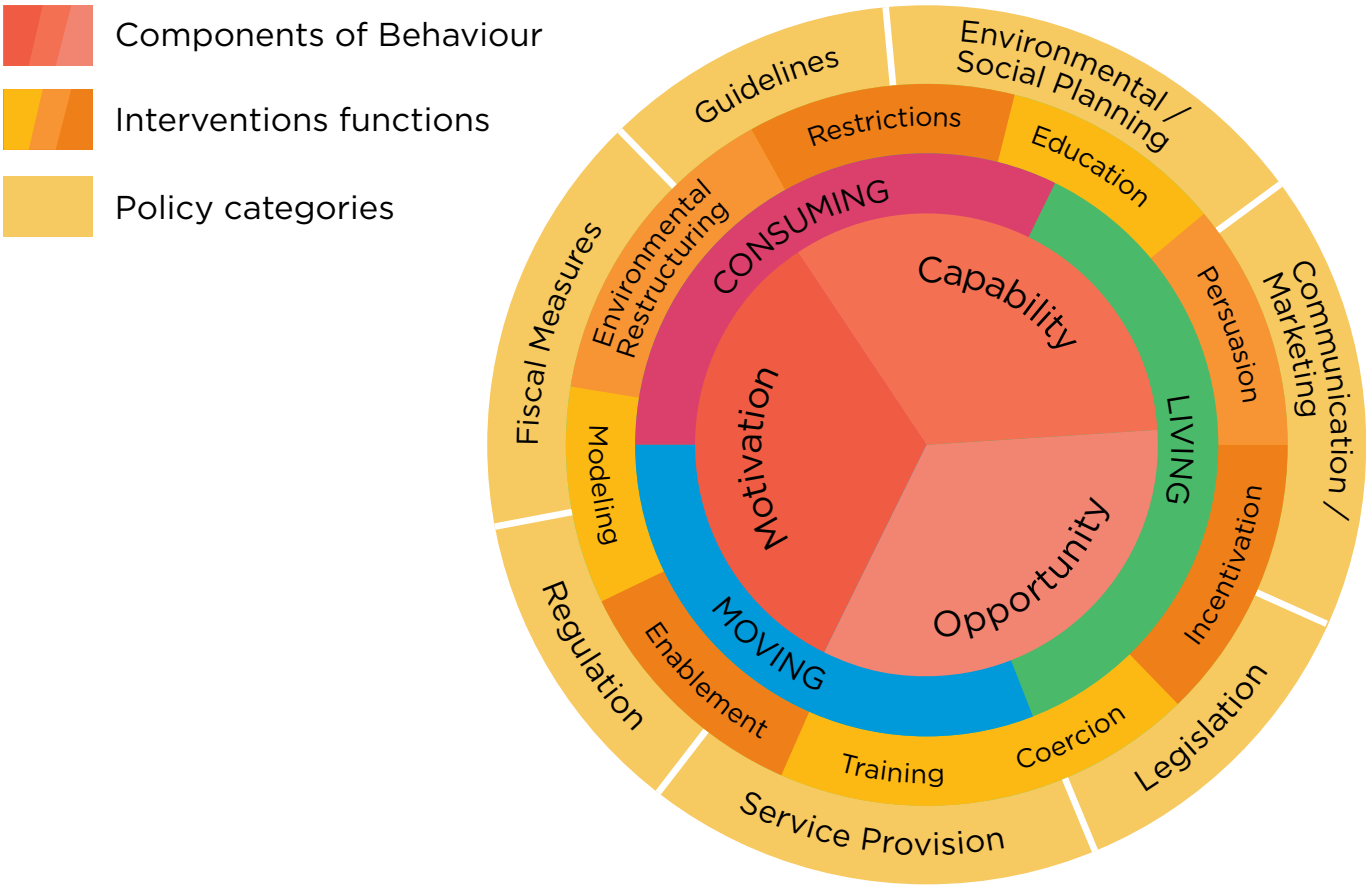


Figure 3.2 The Behavioural Change Wheel, with COM-B in centre (Source: Adapted from Michie, (55))

addition, arguably the most effective interventions use integrated approaches that combine downstream strategies with upstream strategies. Downstream strategies provide informational input at points in people's lives where they experience naturally occurring changes in their everyday environments (points at which habits are vulnerable to change, for example when moving houses). Upstream measures change these environments, allowing new habits to develop (for example changing road infrastructure or providing healthy food subsidies) (52).

Michie (55) discusses the different types of behavioural determinants and suggest ways to influence them. Capability entails being psychologically or physically able to perform a certain behaviour. Psychological refers for example to having the necessary health skills to know what a healthy diet constitutes. Physical capability can be achieved through physical skills development such as training, whereas psychological capability can be realised by increasing knowledge or training behavioural skills. Motivation can stem from the reflective or automatic system, defined as all brain processes that energise direct behaviour, including habitual processes and analytical decision making. Increasing knowledge or changing attitudes towards certain behaviour can realise a change in reflective motivation. Automatic motivation is best achieved using associative learning that elicits certain feelings and impulses related to certain behaviour, or using imitative learning and habit formulation. Finally, opportunity can be social or physical (our cultural milieu may dictate what we define as normal travel or appropriate energy use behaviour, and the presence of a public park offers the opportunity to be in green space or not). An economic situation can also be a barrier or facilitator for opportunities. Physical and social opportunities can be both positive and negative (lack of opportunities such as lack of money, access to green space) and opportunities can be improved through environmental change. According to the BCW, interventions can change one, two or all three components of the behavioural system (Figure 3.3). Interven-

tions and policies that can influence behaviour can be found in the two outer rings of the BCW model (Figure 3.2) and represent the measures that can be taken upstream. It is important to take into account that the behaviours of policymakers and decision makers are also influenced by their capability, motivation and opportunity to act. The COM-B thus also applies to them. In addition to these actions and policies, the INHERIT model highlights the importance of the environmental context on the often habitual nature of health and pro-environmental behaviour by showing a separate arrow from Physical State to Behaviour (Figure 3.1).

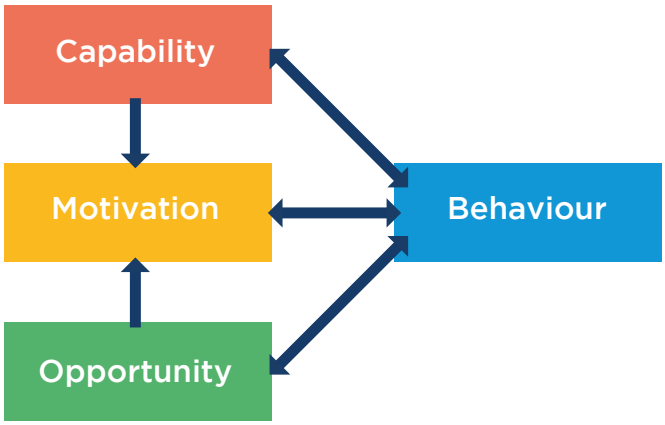


Figure 3.3 The COM-B or Behavioural System (Source: Michie, (55))

The COM-B model also incorporates the differences between socio-economic groups in behaviour. For example, lower socio-economic groups have fewer opportunities to change their behaviour, and may have less motivation to change their behaviour to a more sustainable or healthy life, due to less knowledge of what constitutes sustainable or healthy lifestyles or fewer opportunities. It is important to have insights in the differences in these behavioural aspects between groups, in order to choose the right strategies. It is thus important to focus on disadvantaged groups that have less motivation and fewer capabilities and opportunities, and use strategies that influence the reflective pathway (providing information, change the cost vs. benefits of a good habit, etc.) and/or automatic pathway (e.g. making healthy sustainable habits easier to perform).

Pro-environmental behaviours and sustainable lifestyles

A specific class of behaviours that is of interest for INHERIT, involves pro-environmental behaviours. These are influenced by several factors, including childhood experience, knowledge and education, personality features such as openness, values and worldviews, felt responsibility and moral commitment, attitudes, and behavioural momentum (norms, habits, defaults) (56). Age, wealth, religion, urban/rural residence, and identification with a group have all been related to environmental concern. Older people generally report more pro-environmental concern than younger persons do and environmentalists tend to be middle/upper class individuals (56). Importantly, pro-environmental behaviour is often associated with high personal costs (more time, money and effort). Separating waste, for example, takes more effort than just throwing everything in the same rubbish bin. Therefore, it is important to understand why people would sacrifice personal gains in favour of the common good.

TEXTBOX 3.1
APPLYING THE INHERIT CONCEPTUAL MODEL

The INHERIT Model is a key component of the INHERIT project fulfilling a variety of functions. This so-called "relational model" is concerned with showing the complex and dynamic relationships between the physical environment, human health and wellbeing, health inequalities and environmental sustainability. It facilitates analysis of the central role of behaviour in these relationships and the factors that shape behaviour and lifestyles. The model has been used, thus far, in the analysis of the literature for this review to identify potential triple win solutions. As the project proceeds, the model will fulfil an increasingly operational role, e.g. in framing specific issues and with further refinement, as an evaluation tool for interventions.

CHAPTER 4
LIVING - GREEN SPACE

4.1 INTRODUCTION

Well-designed and accessible green spaces contribute to health and wellbeing by offering an attractive environment to exercise, play, relax and meet people. The benefits of green space can have a positive impact for a range of health outcomes, notably mental illness, obesity, cardiovascular diseases, type 2 diabetes and cancer (57, 58). Through its influence on behaviour green space can play a role in improving, particularly, the health of vulnerable populations such as children, older people, pregnant women and lower income groups. In this way, it can contribute to a reduction in health inequalities (23, 59). Furthermore, green space can help to mitigate some of the negative impacts of climate change, such as heat stress and extreme rainfall. Evidence suggests that green spaces may also reduce air pollution and noise levels (8). For all of these reasons, green space represents a positive influence on environment, health and equity of in our towns and cities in the here and now. The use of urban green space for walking or cycling to school and work can reduce greenhouse gas emissions. Urban green space can make active travel attractive and thereby encourage and support new, environmentally friendly behaviours (60). It may also sequester CO_2 to a certain extent, and thus may contribute to environmental sustainability. Thus the beneficial impacts of green space have potential to impact positively beyond national or European borders and by future generations.

Green space can also change behaviour in more subtle ways. Involving people in the maintenance of green space, and increasing their familiarity with it, may cause people to value their neighbourhoods, and indeed the natural environment more, thus engendering a greater sense of responsibility for it. In combination these factors may nurture healthier and more sustainable lifestyles. Individual and community capital is often built on social interaction and here too, green space can play an important role as a place to meet and communicate. Green space interventions that influence behaviour and lifestyle may constitute inspiring actions for INHERIT, holding potential to offer the 'triple win' of promoting health, environmental sustainability and equity.

Definition of green space

There is no universally accepted definition of (urban) green space. Greenspace Scotland (61) defined green space as 'any vegetated land or surface water body within or adjoining an urban area, including: natural and semi-natural habitats; countryside immediately adjoining a town which people can access; green corridors — paths, rivers and canals; amenity grassland, parks and gardens; outdoor sports facilities, playing fields, and other functional green space e.g. cemeteries and allotments, or even a derelict and vacant land'. WHO (23) indicated that urban green spaces may include places with 'natural surfaces' or 'natural settings', but also specific types of urban greenery, such as street trees, and 'blue space' which represents water elements ranging from ponds to coastal zones. Typical green spaces in urban areas are public parks; other definitions also include private and urban gardens, woodlands, children's play areas, non-amenity areas (such as roadside verges), riverside footpaths, beaches, and so on. In this chapter, both definitions are used.

This chapter focuses on urban green spaces. Paragraph 4.2 describes important trends, drivers and policies in Europe related to green space. Next, the environmental and health impacts (4.3) of green space are presented. Inequalities and the role of behaviour, including factors determining the use of green space, are discussed in respectively 4.4 and 4.5. Paragraph 4.6 provides an overview of opportunities to stimulate the use of green space. Finally, the overall findings are discussed in paragraph 4.7, including gaps in knowledge and recommendations.

4.2 DRIVERS, TRENDS AND POLICIES IN EUROPE REGARDING GREEN SPACES

Drivers for availability of green space

As mentioned in Chapter 2, the available urban green space is under pressure in many European cities due to urbanisation. This urbanisation, combined with a spatial planning policy of densification, means that more people face the prospect of living in residential environments with fewer green resources (21). Another driver limiting the proliferation of green space in the surroundings of our homes is the economic value of land. A landowner profits more from built land than from land with a green space function. Furthermore, the maintenance of green space costs money, and is often limited in times of economic crisis (62). It is also true that green space or nature also has a non-economic value. However, the value that people attach to it has changed over time. Humans are generally less connected with nature than in the past, which may potentially have resulted in a lower valuation of green space. Nevertheless,

house prices are generally higher in areas with more green space in the immediate surroundings (62, 63). Moreover, most people still regard the presence of green space near their homes as (very) important (64).

The current level of urbanisation and densification of European cities is a serious threat to Europe's urban green space. Increasing densification of cities often results in removal or degradation of existing green space in ways that will be difficult to reverse. Loss and degradation of urban green space can contribute to the burden of disease by exacerbating the effects of other adverse factors in the urban environment, such as air pollution, noise, and chronic stress. It also diminishes opportunity for physical activity and aggravates health inequalities (23). Dense, poorly designed, urban settings reduce opportunities for stress-reducing contact with nature and increase exposure to environmental stressors (58). Over time, not only the quantity of green space but also the quality has declined (21). This, together with environmental degradation, and lifestyle changes diminish the possibilities for human contact with nature (58). The share of green and blue areas in the total city surface area inevitably differs between European cities. Sweden has the largest share of green and blue areas within cities, and Hungary has the least (Figure 4.1). Data from OECD on the availability of green space in urban areas showed that Athens is fourth from the bottom of the list, with only 0.96 m^2 of green surface area per person. Similarly, Thessaloniki, while better than Athens, has only 2.14 m^2 of green surface area per person (65).

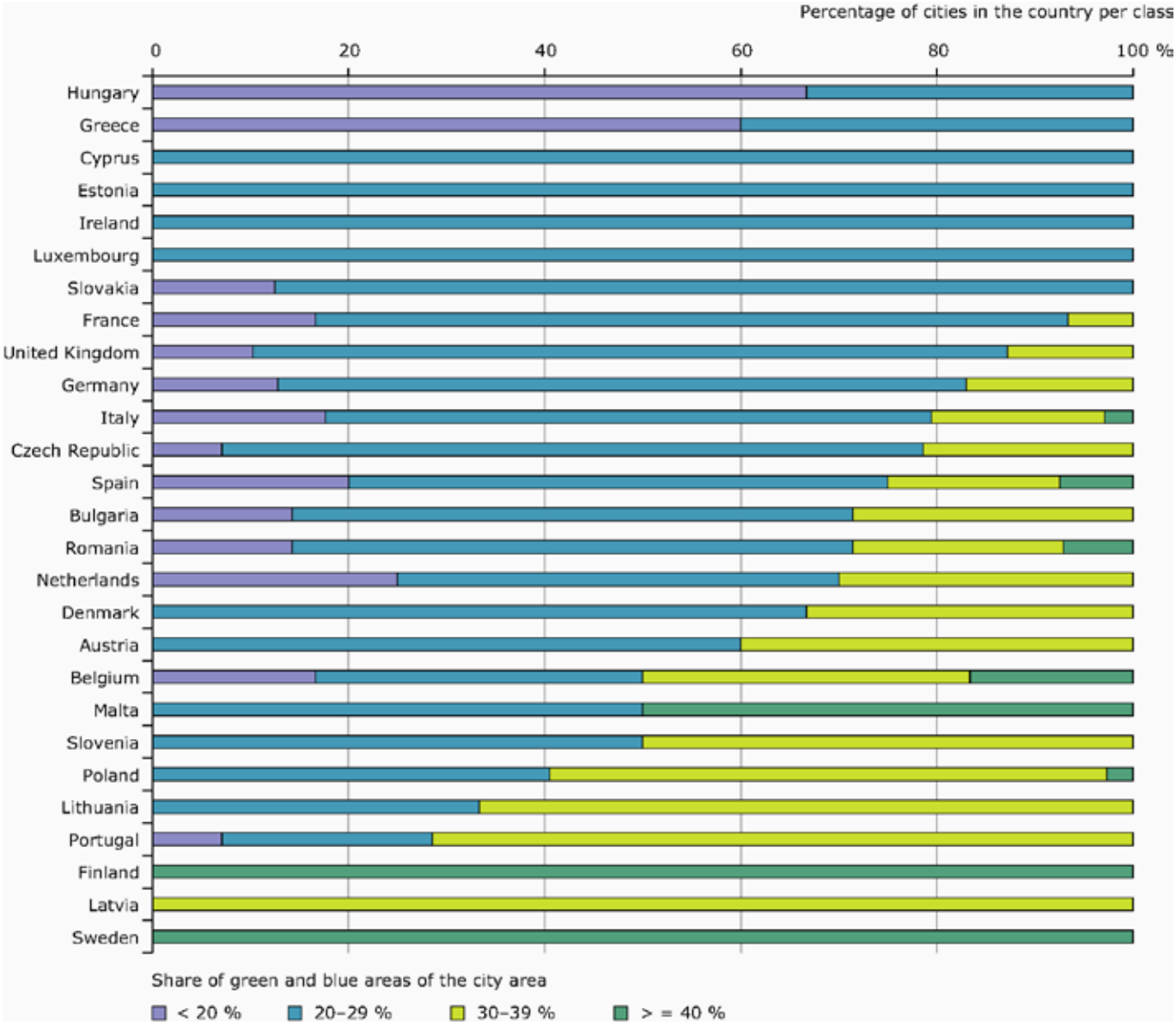


Figure 4.1 Share of green and blue areas of the city area in different European countries (Source: EEA (66))

Renewed focus on green space in Europe

Links between urban green space and health have been recognised throughout history, and were among the driving forces behind the urban parks movement of the 19th century in Europe and North America (23). Also important are the Garden Cities, in which green space was offered to blue-collar workers to improve their living conditions (27).

While the focus has traditionally been on nature conservation (e.g. International Convention on Biological Diversity (CBD), EU-wide Natura 2000 network established under the Habitat and Birds directives), the potential benefits of green space are, today, perceived in broader terms. More recent focus has been on green space to support healthy living in urban areas in Europe. The current EU Biodiversity Strategy (Target II) e.g. commits not only to the better protection of ecosystems, but also to more use of green infrastructure, which can lead to a range of benefits, including health and wellbeing (63). The role of green spaces in the quality of urban life, and in the urban economy, is now widely recognized. The promotion of quality of life is becoming ever more important in a scenario of regional, national and even international competition among cities, triggered by globalization. Public sites, and green spaces in particular, can bring important benefits to urban vitality and, in turn, improve quality of life (67).

Policies that value green space in a broad sense

At the international level, there is growing interest in so-called 'Nature-Based Solutions'. This stems from the realisation that there are a wide range of challenges in current society that could partially be solved by nature. These include unsustainable urbanisation and related human health issues, degradation and loss of natural capital and the ecosystem services it provides (clean air, water and soil), climate change and an alarming increase in natural disasters such as flooding. These nature-based solutions help societies address a variety of environmental, social and economic challenges in sustainable ways, including the improvement of wellbeing in urban areas (68). Nature-based solutions directly link to the concept of ecosystem services and natural capital. Natural capital consists of services (regulating, provisioning and cultural) and stocks of resources that nature provides to us. They fulfil a variety of functions, many of which relate directly to health and wellbeing. These range from benefits such as food and fuel production to climate control and flood protection to less quantifiable concepts relating to education, inspiration and aesthetics (see Figure 4.2) (69). This broader view on nature is also reflected in a recent report by Falkenberg, Senior Advisor for Sustainable Development to the President of the European Commission, in which he stresses the importance of making a link between agricultural policy and health and environment to create economic, social and environmental value, since *"There is robust scientific and practice-based evidence that nature can contribute to addressing the health challenges that EU citizens are facing – from access to Natura 2000 sites and other protected areas, to investments in wider green infrastructure. A more holistic approach in EU policies towards these issues could provide results."(15).* The increased recognition and use of the ecosystem services concept has resulted in a growing interest in the economic valuation of ecosystems and biodiversity (see e.g. http://ec.europa.eu/environment/nature/biodiversity/economics/). The Economics of Ecosystems and Biodiversity (TEEB) is a global initiative assessing the costs of the loss of biodiversity and the associated decline in ecosystem services worldwide. It can help decision-makers recognise, demonstrate and capture the values of ecosystem services and biodiversity in a broad sense (see http://www.teebweb.org/). In the Netherlands, a TEEB for cities tool was developed for local users who want to calculate costs and benefits of ecosystems in a broad sense also taking into account the impact on health (70).

The European Green Capital Award is one of the policy tools of the European Commission to address the environmental challenges that are brought about by urban areas. Every year, the Award is given to 'a city, which is leading the way in environmentally friendly urban living and which can thus act as a role-model to inspire other cities.' The aim of the European Green Capital Award is to support European cities and communities to become more sustainable. At the ceremony in Ljubljana, where the European Green Capital Award for 2018 was awarded to Nijmegen, the Netherlands, Joanna Drake, Deputy Director General of DG Environment at the European Commission addressed both health and sustainability in her speech on green cities: *«Being a 'green city' is about people's health and wellbeing; it is about cleaner air and water, access to green areas, and it is also about cities taking the lead in tackling bigger issues like climate change and biodiversity loss.» (72).*

Other EU Action Plans and Policy instruments promoting the development of sustainable cities include: *Urban Agenda for the EU; 7th Environment Action Program (EAP); Reference Framework for Sustainable European Cities (RFSC); Roadmap for a resource-efficient Europe; Thematic Strategy on Urban Environ-*

Figure 4.2 Overview of ecosystem services (Source: PBL, RIVM, WUR and CICES (71))

ment; EU Sustainable Development Strategy; Green thinking and Best Practice Guides and Reports; Europe 2020 Strategy (Resource efficiency); and *Funding Green Initiatives (73).*

Policies focusing on the health benefits of green space

While it is important to take note of the broader developments and perspectives on nature that are currently centre stage, it should be clear that INHERIT has a rather specific focus on green space. This relates to understanding how green space (quality, quantity and access) and the benefits derived from it may be influenced by lifestyle and behaviour and, by extension, how, through policy and action, lifestyle and behaviour may be influenced so that green space can be better exploited in pursuit of health, environmental sustainability and equity. Of relevance to these more specific aims there are a number of international and national policies that mention nature and green spaces as being important. At the Fifth Ministerial Conference on Environment and Health in Parma, Italy (2010), the Member States of the WHO European Region made a commitment *"...to provide each child by 2020 with access to healthy and safe environments and settings of daily life in which they can walk and cycle to kindergartens and schools, and to green spaces in which to play and undertake physical activity" (38).* Improving access to green spaces in cities is also included in the United Nations Sustainable Development Goal 11.7, which aims to achieve the following: *"By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (36).* Less specifically targeted at green space, but still worth mentioning is the WHO Action Plan for the implementation of the European Strategy for the Prevention and Control of Noncommunicable Diseases in 2012-2016 which includes a call to create health-supporting urban environments (23, 74).

There are several examples of European national policies which aim to use green space for a broad set of societal goals. In Norway, the main goal of the *Ministry of Environment's National Strategy for an active outdoor life* is to increase the number of active outdoor activities in and by cities and towns. The main target groups are children and young people from immigrant backgrounds, persons with disabilities and sedentary people. However, the goal is that the outdoors should be fun for the whole population. Accordingly, areas of value for outdoor recreation must be secured and managed so the natural resource base is being cared for. Planning in municipalities, counties and regions will contribute to promoting an active outdoor life and create health, wellbeing, and an environmentally friendly community (75). In the Netherlands, in the Dutch 'Natuurvisie' ('Nature Vision'), nature has been positioned more in the centre of society and not just in protected areas. The Dutch Ministry of Economic Affairs states that this will be better for the economy and biodiversity. This vision is to offer more opportunities for citizens, companies, municipalities and societal organisations to protect nature (76).

Citizen involvement in public green spaces in European cities

To encourage citizens to engage and to understand the benefits of nature and green infrastructure for e.g. climate change adaptation, there is a need to use language and focus points that make sense for the general population. This is something many local governments recognise and strive to achieve. Several cities have demonstrated success with 'grass roots' initiatives that resonate with communities, such as Arnhem, Glasgow and Dublin. Arnhem's heat mapping exercise has been identified an opportunity to engage the community in understanding the impacts of heat. Glasgow's greening efforts, initiated by the private sector with community participation, have gained a foothold in the city's current planning actions (63). Furthermore, municipalities and citizens are increasingly responsible for developing and maintaining public green spaces in cities and villages. By facilitating green self-maintenance and neighbourhood gardens, municipalities aim to give inhabitants influence on their environment (for a Dutch example, see http://www.atlas-natuurlijkkapitaal.nl/en/home). Initiatives such as green rooftops, citizen maintenance of a community garden or landscape maintenance exemplify this. In 2015, there was 1.5 million Euros available in the Netherlands for these types of initiatives, and this will be amount to 10 million Euros in the next four years (76). Scottish Natural Heritage aims to *"improve Scotland's urban environment, increasing and enhancing green space in our towns and cities, especially close to areas of deprivation. (...) delivered through a small number of high impact improvements to the quantity, quality and accessibility of green space and other green infrastructure in urban Scotland, targeted at our most deprived communities."* with a 15 million pound contribution from the European Regional Development Fund (ERDF) throughout the programme. The first two Green Infrastructure projects were recently announced, both intended to enhance green space in Glasgow. The projects funded by the Green Infrastructure Fund are *"involving communities right from the start, throughout delivery and into the future. (They) should benefit nature, biodiversity and ecosystems, address environmental quality, flooding and climate change, involve*

communities and increase participation, increase place attractiveness and competitiveness or improve health and wellbeing." (60).

Green corridors for clean airflows with potential benefits for physical activity

There are several cities across Europe that use green corridors to promote clean airflows. Since 2012, London's action plan for an All London Green Grid has laid out plans to "enhance London's strategic network of green and open natural and cultural spaces" and to increase the usage of these spaces. In addition, Vienna, Ljubljana and Barcelona refer to the importance of green networks in their city plans. Ljubljana's Environmental Protection Programme presents its spatial plan for a network of green space or "green system", connecting parks in the city with corridors and circular connections to the greener rural spaces outside the city in order to generate airflows of clean air. One of the aims of Barcelona City Council is to develop a number of "Urban Green Corridors" through its Green Infrastructure and Biodiversity Plan 2020. These corridors will include strips with high concentrations of vegetation to be used exclusively by pedestrians and cyclists (63). This will provide an attractive environment for physical exercise and other activities and stimulate active travel.

Legislation and incentives

Some countries and cities have implemented legislation enforcing the provision of green infrastructure. For instance, France recently passed a law that new buildings in commercial zones must include partial cover with either green roofs or solar panels. In 2008, Copenhagen became one of the first cities to have a mandatory green roof policy for municipal buildings. Other cities with legislation to implement or finance green roofs in Europe include London, Stuttgart, Düsseldorf, Berlin, Munich, and Basel. In Manchester, "big green roofs", including a 750 m^2 roof at the Manchester Metropolitan University, and "small green roofs", which promote bottom-up green roofs on small buildings, for instance on garden sheds are supported by the municipality, since even small roofs act as hotpots for biodiversity, provide insulation and absorb radiation. To preserve green spaces and nature, local governments may create incentives for developers to use brownfield sites, such as the "City Deal" in Scotland. Local authorities, such as Glasgow City Council, have invested in infrastructure on brownfield sites through the City Deal, thereby making them development-ready (63).

4.3 ENVIRONMENTAL AND HEALTH IMPACTS

The capacity of green space can have to secure positive, but also to create negative impacts on environment and health is further explored below.

Environmental impacts

Trees, shrubs, and other vegetation may affect ambient air quality, noise, temperature and, through these, human health and wellbeing. Trees and other vegetation may reduce levels of some pollutants, including gases and particulate matter (PM), but they may also contribute to air pollution by releasing hydrocarbons and trapping certain pollutants such as low-level ozone. The overall impact of vegetation on air quality is therefore a function of several processes, operating in opposing directions: hydrocarbon emissions, pollen production, pollutant uptake, and effects on energy demand (see Figure 4.3). Careful selection of species (77), design of planting configurations with regard to airflows, shade, and other impacts, and maintenance of urban vegetation can all optimise the beneficial effects on air quality (58). Furthermore, as illustrated in Figure 4.3, it is important to make a distinction between different spatial scale levels (78). Green infrastructure thus has a natural capacity to directly act as a barrier and remove air pollutants from the atmosphere through gaseous absorption or dry deposition. Carefully designed green infrastructure, such as tree lined street canyons and green walls can positively influence pollutant exposure. Furthermore, green infrastructure can promote emissions reductions through behavioural change, for example by facilitating beneficial mobility choices such as cycling. Secondly, they provide valuable oases where air quality is significantly better than surrounding areas. Access allows individuals to reduce their personal exposure to pollutants, even though surrounding ambient levels may be poor. Thirdly, the cooling effect of vegetation, through providing shade and evapotranspiration, can help to generate airflows, which disperse pollutants reducing their relative concentrations (63).

Evidence suggests that a well-designed urban green space can buffer noise, or the negative perception of noise, emanating from non-natural sources, such as traffic, and provide relief from city noise (57). Vegetation has been considered as a means to reduce outdoor noise levels, mainly in areas with high volumes of traffic. It can impede noise propagation by absorbing or diffracting noise (63). A different, but not unrelated effect of green and blue space on noise perception is the effect of "natural" noises in masking noise from e.g. traffic (23) (e.g. sounds of water fountains or birds).

Green space including parks, street trees and green roofs mitigate Urban Heat Island effects (23). Urban heat islands can increase urban temperatures by up to 12°C compared to non-urban areas, and exacerbated heat stress. Risks include exhaustion, heat stroke and mortality, and it can reduce economic productivity (63). During warmer weather, trees can provide shade and reduce the demand for air conditioning (23) and therefore contribute to more sustainable behaviour. A systematic review and meta-analysis of literature on how urban parks affect the air temperature in urban areas showed an average cooling effect of approximately 1 C° (23). Parks may mitigate urban heat in wider surrounding urban areas, with data suggesting an effect up to 1 km from the park boundary. The inclusion of water bodies within the green space may offer greater cooling effects (23). Harlan et al. showed that densely populated areas, sparse vegetation, and low levels of open space in the neighbourhood were significantly linked to higher temperatures and urban heat islands in Phoenix, USA (23). Furthermore, there is some evidence that tree photosynthesis in urban green space was able to offset a fraction of the CO_2 emitted from traffic combustion engines (79).

Green space is often presented as a solution to problems caused by climate change, but is affected by it as well. Cities may be affected more by temperature increases given the urban heat island effect, and possibly also droughts, floods, storms, and heat waves. Therefore, climate change can be considered an added stressor for urban forests. Stressors such as changed hydrology, low soil quantity and quality, fires and wind events, may all be aggravated by more frequent and intense weather events and some urban tree species may be maladapted to the future climate. Moreover, unhealthy urban trees may be affected more strongly by insects and diseases (80).

Health impacts

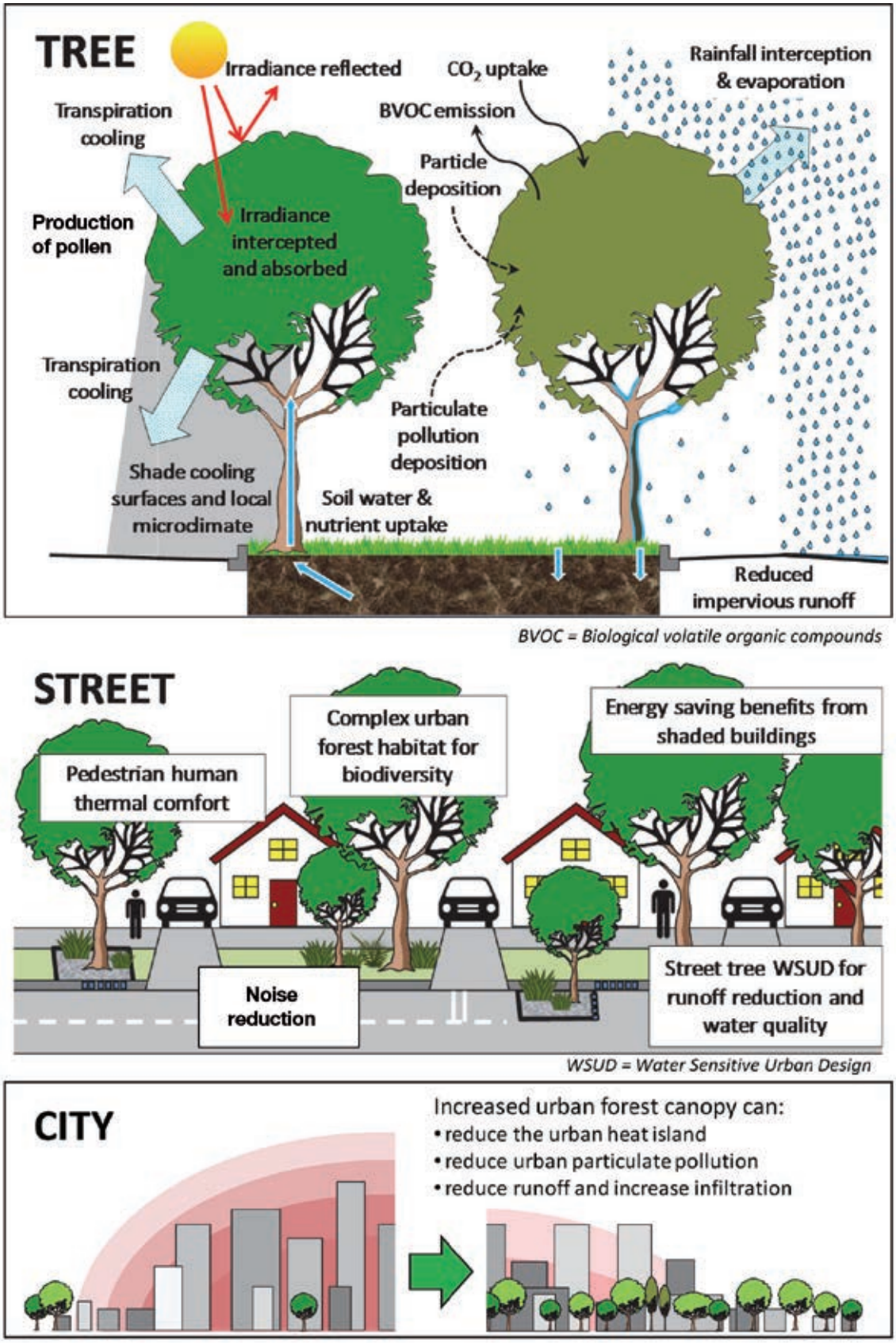


Figure 4.3 Environmental impacts of urban green space (Source: Livesley et al. (79)(adapted))

A recent review from Van den Berg et al. (81) showed strong evidence for significant positive associations between the quantity of green space and perceived mental health and all-cause mortality, The review showed moderate evidence for an association with perceived general health. Another large review of 60 studies conducted in different continents showed that green space is also associated with reduced obesity. However, the relationships could be modified by age and socioeconomic status (23). WHO mentions improved mental health and cognitive function, reduced cardiovascular morbidity, reduced prevalence of type 2 diabetes, reduced adverse pregnancy outcomes and reduced all cause and cardiovascular disease mortality as positive health effects in relation to green space (23). Presence of green space could have benefits in terms of slower biological ageing, but, as yet the evidence for that is weak (82).

Contact with nature may affect both physical and mental health via multiple pathways (Figure 4.4). Pathways that have received relatively large amounts of research attention involve air quality, physical activity, social cohesion, and in particular stress reduction (58, 83). While many studies on green space and health use amount of green space as the key indicator, there are more and more indications that the type, quality and context of 'green space' should be considered in the assessment of relationships between green space and human health and wellbeing as well (e.g. (84). People's perception is another important indicator (64, 85). Green spaces have different meanings for people, both positive, related to identity, community, restoration, safety, and freedom/unity, and negative, related to maintenance, crime and conflicts associated with inequality and access (86).

Stress restoration

There is substantial evidence of the potential benefits of contact with nature for avoiding health problems related to chronic stress and attentional fatigue - the latter being characterised by difficulty concentrating, suffering from increased irritability, and being prone to errors on cognitive tasks. For example, a study of Stigsdotter et al. among 21,832 Danish adults showed that respondents living more than 1 km away from a green space had 1.42 higher odds of experiencing stress than do respondents

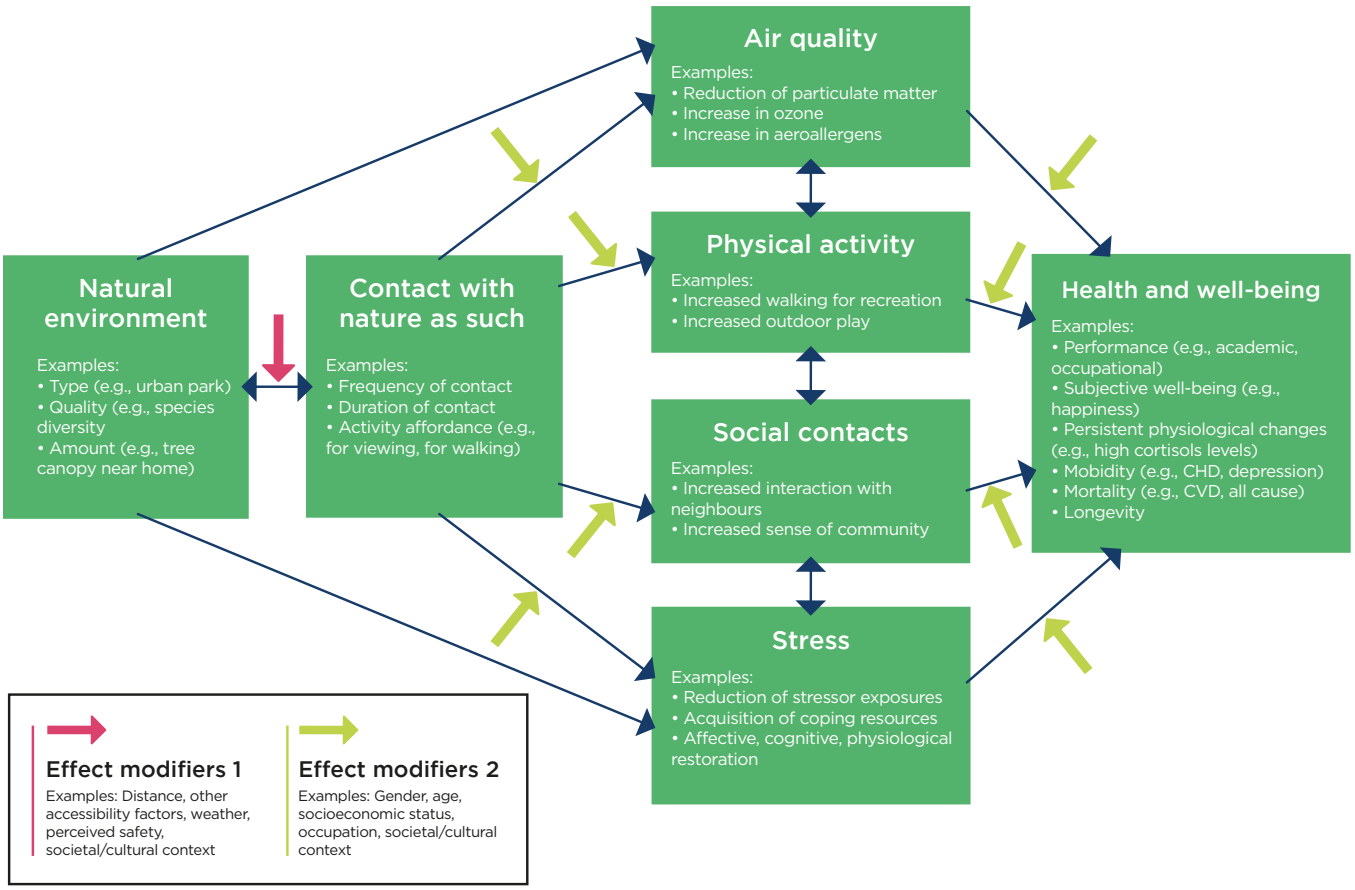


Figure 4.4 Framework green space and health (Source: Hartig et al. (58))

living less than 300m from a green space. They also reported poorer health and health-related quality of life than respondents living nearer by (87). Another study of Van den Berg et al. among 4529 Dutch respondents of the second Dutch National Survey of General Practice (DNSGP-2) revealed that respondents with a high amount of green space in a 3-km radius were less affected by experiencing a stressful life event than respondents with a low amount of green space in this radius (88). However, the greater part of this evidence concerns the short-term restorative benefits of single encounters with or experiences in nature. Several studies describing experiments with people in their natural, daily environment provided evidence for this. For example, from studies among 17 and 23 men, respectively, conducted by Song et al., heart rate was significantly lower while walking in an urban park than while walking along a city street. Furthermore, the urban park walk led to higher parasympathetic nervous activity and lower sympathetic nervous activity compared with the walk through the city street. They exhibited significantly lower levels of negative emotions and anxiety after the walk through nature and felt more relaxed, comfortable and natural (87, 89, 90). Green space can reduce stress and increased subjective well-being in two general ways. First, natural areas and features can reduce exposure to challenging environmental conditions by increasing distance to stressors and/or decreasing their perceptual salience. For example, green spaces between dwellings and heavily trafficked roads can reduce noise annoyance for residents, vegetation can conceal displeasing structures, and landscaping around housing can help residents maintain privacy and avoid feelings of crowding. Second, nature can help people restore their adaptive resources. Escape from physical and social stressors has long been described as an important motive for recreation in natural areas. Appreciation of nature — for its beautiful scenery, symbolic qualities, and other valued attributes is another important motive (58).

Physical activity

The outdoor environment may influence physical activity by offering suitable spaces for certain types of activities. It may also attract people outdoors because of the experiences it offers. Several studies in various countries have demonstrated that recreational walking, increased physical activity and reduced sedentary time were associated with access to, and use of, green spaces in working age adults, children and senior citizens (23). Green space is however only one aspect of the physical environment relevant for physical activity. Several studies show that exercising in green space may have more and/or stronger positive effects than exercising in other types of environments. Running in a park is associated with a more restorative experience when compared to the same exercise in an urban environment (23). Barton and Pretty's (23) analysis of ten United Kingdom studies showed multiple mental health benefits from physical activity in green environments. Mitchell's study of the Scottish population showed an association between physical activity in natural environments and reduced risk of poor mental health while activity in other types of environment was not linked to the same health benefit (23).

Which environmental characteristics promote or hinder physical activity may depend strongly on the type of activity involved. Three broad activity domains may be identified: work (including study), active transport (walking, cycling), and leisure (recreation, sport). Within the work domain, the greenness of the setting is thought to be of little importance for the amount of physical activity, when active transport is not taken into account. Natural features may lead people to favour walking or cycling over other transport modes by making routes to destinations more attractive; however, distance to destination, availability of suitable infrastructure (e.g., sidewalks, bicycle paths), and safety are more important factors. The evidence for the association between green space and active transport (walking and/or cycling) is mixed, and this heterogeneity has been well summarised by recent systematic reviews (8, 44, 63). Reasons for (non-causal) negative associations may be that large amounts of green space tend to go together with (a) greater distances to destinations, (b) higher levels of car ownership, and (c) better availability and lower cost of car parking spaces near one's home. Physical activity promotes physical and mental health across the life span. Recent evidence suggests that the health benefits of increased physical activity are largest among those who initially had the lowest levels of physical activity (58). Although physical activity in green spaces can have many positive benefits, it can also be associated with an increased risk of accidents and injuries, such as falls and drowning (23).

White et al. estimated the total annual amount of adult recreational physical activity in England's natural environments, and assessed implications for population health. These calculations revealed that approximately 8.23 million adults (19.5% of the population) made at least one 'active visit' (i.e. ≥30min, ≥3 METs) to natural environments in the previous week, resulting in 1.23 billion 'active visits' annually. An estimated 3.20 million of these adults also reported meeting recommended physical activity guidelines (i.e. ≥5x30min a week) fully, or in part, through such visits. Active visits by this group were associated with an estimated 109 Quality Adjusted Life Years (QALYs) annually. Assuming the social value of a QALY to be £20,000, the annual value of these visits was approximately £2.18 billion. Results for walking were replicated using WHO's Health Economic Assessment Tool (91). These

findings do not include an analysis on socio-economic differences.

Social cohesion

The few available studies on this topic suggest a positive relationship between natural environments and social cohesion. Sugiyama et al. (92), for example, found perceived social coherence and local social interaction to be associated with the perceived greenness of the neighbourhood. De Vries et al. (93) found an association between streetscape greenery and perceived social cohesion at the neighbourhood scale, both for the quantity and, even more strongly, for the quality of greenery. Community gardens may also increase the social ties in a neighbourhood (58). A study of Maas et al. using data of 10,089 Dutch residents found that less green space in people's living environment coincided with feelings of loneliness and with perceived shortage of social support (94). Social wellbeing may not be beneficially affected by green and open space that is perceived as unsafe or where people engage in antisocial behaviour, although these problems can be addressed by proper management and maintenance. There is also some evidence that provision of new green spaces in disadvantaged neighbourhoods (e.g. greening of vacant lots) can reduce crime (23).

Immunological pathway

Kuo suggests a central role for enhanced immune functioning as a pathway between nature and health. Japanese studies have demonstrated associations between visiting forests and beneficial immune responses, including expression of anti-cancer proteins (23). This suggests that immune systems may benefit from relaxation provided by the natural environment, or through contact with certain physical or chemical factors in the green space. It has been shown that children with the highest exposure to specific allergens and bacteria during their first year were least likely to have recurrent wheeze and allergic sensitisation (57). Another suggested immunological pathway is through exposure to diverse microorganisms in the natural environment which can play an immunoregulatory role (23).

Exposure to sunlight

The WHO (23) mentions the health effects of increased exposure to sunlight by spending time in green space. This may have both positive effects (vitamin D from sunlight, improved sleep) as well as negative effects (exposure to dangerous levels of ultraviolet (UV) light causing skin cancer). Exposure to sunlight is especially important for northern Europeans whose environment lacks high levels of sunlight for significant parts of the year, and for older people, since the ability to synthesise vitamin D decreases with age. De Rui et al. found that vitamin D levels were significantly higher in older people who engaged in outdoor activities, than in those who did not. The levels were particularly high for those who cycled or gardened (23).

Adverse health impacts

Living close to green spaces may be associated with elevated exposure to pesticides and herbicides especially if they are used in inappropriate ways and at excessive levels. The insecticides malathion and diazinon and the herbicide glyphosate, which are used to control weeds in urban parks, may be carcinogenic in humans (23). Health risks from green space include vector-borne diseases, which are transmitted by arthropods, such as ticks (e.g. tick-borne encephalitis and Lyme disease), mosquitoes (e.g. Chikungunya fever and Dengue fever), or sand flies (e.g. visceral leishmaniasis). Lyme disease in particular has increased in Europe in the 21st century, and this has been associated with urban green space and increased populations of animal hosts, such as deer, as well as with climate change and milder winters in northern Europe (23). Some trees and plants release pollen which can aggravate allergies. An increasing proportion of the urban population is susceptible and allergic to tree-derived pollen. Therefore, identifying tree species that are most responsible for allergic reactions is important. Cariñanos and co-authors presented a practical allergenic index based on factors such as the period of pollen emission and allergenic intensity. Application of this index can help urban forest managers to improve human health and wellbeing by making good choices when selecting and removing different tree species (79).

Another health concern that often gains public attention is the contamination of urban green space with dog or cat faeces. Ingestion of dog faeces by young children can lead to toxocariasis, with serious illness and blindness possible in rare circumstances. Cat faeces may cause severe neurological damage in children born to mothers who were infected for the first time during pregnancy (23).

4.4 DIFFERENCES BETWEEN SUBPOPULATIONS AND INEQUALITIES

Some researchers have hypothesized that people who spend more time in the vicinity of their home (children, youth, older people and men/women who run the household), may benefit more from green space in their living environment (21, 57, 95). Other researchers have explored whether socioeconomic status influences the relationship between green spaces and health (59, 96). However, findings so far have been mixed (81). In its recent report, WHO observed that many studies showed differences in health outcomes depending on demographic factors, including gender, age, pregnancy, ethnicity and socioeconomic status (23). They stated that it is essential for all populations to have adequate access to green space, with particular priority placed on provision for disadvantaged communities. In general, the studies appearing in this chapter describe a specific subpopulation rather than comparing different subpopulations or describing a socioeconomic gradient.

Socioeconomic differences

Mitchell and Popham demonstrated that health inequalities related to income deprivation are lower in populations who live in the greenest areas compared to those who have less exposure to green space (59). However, data from Europe indicate that socially disadvantaged people often live in places with less access to public green space (97, 98). Surprisingly, higher educated people complained more often about lack of access to recreational or green areas than lower educated people. In several individual countries the prevalence of complaints about lack of access to recreational or green areas was much higher among the less-educated than the better-educated, as one would expect. This was the case in Finland (17% versus 6%), the former Yugoslav Republic of Macedonia (63% versus 46%), Ireland (50% versus 20%), Italy (81% versus 66%), Malta (67% versus 50%) and the Netherlands (40% versus 19%) for females, and in Finland (20% versus 5%), France (43% versus 32%), Germany (50% versus 14%), Malta (60% versus 53%) and the United Kingdom (28% versus 14%) for males (97). A recent study of Ward-Thomson et al. (99) in Scottish deprived areas showed that access to green space in neighbourhoods - including gardens - were significant predictors for stress reduction. Provision and maintenance of appropriate green space in urban areas may make an important contribution to reducing health inequalities, through all pathways mentioned above (23). Another study from Wilkson et al. showed that among participants from low socioeconomic status neighbourhoods, the likelihood of walking more than 150 minutes per week was 3 times greater for those individuals who reported they used trails. Similarly, for participants from higher socioeconomic status neighbourhoods, not using parks reduced the likelihood of reporting high levels of walking by more than half (100).

Children

A study of Lachowycz et al. (101) showed that whilst children gained the majority of their activity in non-green environments, urban green spaces, both public and private, are valuable resources for children's play and physical activity. Adequate exposure to green space for children may not only facilitate healthy development in childhood but also provide long-term health benefits through adulthood. It may stimulate the development of gross and fine motor skills as well as cognitive, emotional, social and physical development in children (23). In this way, it may lead to better health and better ability to maintain healthy lifestyles in adulthood. Contact with nature may improve attentional function in children with Attention Deficit Disorder and enhance self-discipline in children without a diagnosis (58). Dadvand et al. (23) found that living in greener residential areas and proximity to forests was associated with less sedentary time and reduced risks of children being overweight or obese, but for other green space measures the effect was weak. For asthma, the authors found both positive and negative associations with green space indicators. A study of Flouri et al. using data from 6384 children participating in the Millennium Cohort Study revealed that access to garden and use of parks and playgrounds were related to fewer conduct, peer and hyperactivity problems. Furthermore, poor children in urban neighbourhoods with more greenery had fewer emotional problems from age 3 to 5 than their counterparts in less green neighbourhoods (102). Markevych et al. also found that more access to urban green spaces was associated with less behavioural problems in a study population of 1932 10-year old children living in Munich, Germany (103). More generally, understanding links between green space and children's health includes consideration of risks and the importance of learning to manage risk in general as children develop into adults, through learning to deal with the physical risks of nature. Public urban green spaces play an important role in children's and young people's social networks, including friendships across cultures, thus promoting social inclusion (23). Some research suggests that restorative childhood contact with nature can provide cumulative benefits with far-reaching developmental significance (58).

Older people

Positive effects of green space in older people were reported by Sugiyama and Ward Thompson (23). They demonstrated an association between the quality of neighbourhood open space and increased walking in older people (65 years and older) in the United Kingdom. In a large Australian study among 260,061 Australians over 45 years old, those in the greenest neighbourhoods were at a lower risk of psychological distress (Odds Ratio 0.83, 95% CI: 0.76, 0.92) and were less sedentary compared to residents of the least green areas (Odds Ratio 0.81, 95% CI 0.77, 0.87). Furthermore, the effect on mental health was strongest among the most physical active people (104). Older people derive considerable pleasure and enjoyment from viewing and being in nature which, in turn, has a positive impact on their wellbeing and quality of life (105). For people with mental illness who live in urban areas, physical activity in green space may be particularly beneficial (23). A review from Whear et al. showed that people with dementia living in care homes, but also their family, and staff, alike, appreciated the presence of a garden that both allowed for relaxation, and could stimulate activities and memories. The presence of a garden may be relaxing and calming, while also providing an opportunity to maintain life skills and habits. In addition, physical activity may have a role in slowing cognitive decline and in reducing falls. It also provides a normalising context for interactions with staff and visitors (106).

Older adults living in inner-city neighbourhoods also benefit from the presence and use of green spaces, which promote social ties and a sense of community (23). Social contact is known to be important for health and wellbeing, especially for older people, where social isolation has been significantly associated with increased mortality (23). Bell et al. pointed out that older age is associated with periods of significant change, particularly relating to retirement, personal and spousal health, caring duties and bereavement (107). Green spaces can alleviate some of the negative influences of these transitions on personal wellbeing (e.g. (108). For example, studies have highlighted that older participants in group-based nature conservation and gardening activities appreciate the opportunities gained for structure and routine; meaningful social interaction and the development of stronger communities; a sense of achievement, pride and ownership; and the forging of new social identities (107).

Table 4.1 Overview of determinants of use of green space

DETERMINANT OF USE	EXPLANATION	Reference
Physical environment		
> availability of physical community resources such as the provision of green space	> formal green spaces more likely to be used because of features that encourage their use e.g. good path networks and perception of safety. > greater benefits associated with larger green spaces.	Seaman et al. (109)
> connectedness of space ('walkability'and 'bikability')	> presence of cycle paths and minimal obstruction (crossing, amount of traffic)	Lee et al. (110)
> characteristics of urban green space such as: • form and size of green space • ease of accessibility • green space nearby optimal distance often mentioned: 0.3-0.5 km or 5 minutes' walking time) • good quality green space • presence of environmental features and subjective awareness • (perceived) walking distance • attractiveness • (perceived) level of maintenance • naturalness	> people living close to a green space are more likely to use it and to do so more frequently In particular important for people: • who have a child under 6 • who own a dog • who have poor self-rated health > walking paths, shade and shelter, water features, irrigated lawns, birdlife, lighting, sporting facilities, playgrounds and sportsfields, type of roads in the vicinity and presence of water nearby	Mowen et al. (111) Leslie et al. (112) Gardsjord et al. (113)
Social environment		
> levels of felt integration and shared values		Lee et al. (110)
> perceptions of community cohesion (social cohesion)		Leslie et al. (112)
> opportunity for socialisation		Seaman et al. (109)
> absence of (perceived) **anti-social behaviour**		Ou et al. (114)
> (perceived) safety	> linked with unsupervised, older children and adolescents	
> security		

DETERMINANT OF USE	EXPLANATION	Reference
Life-stage factors	> parents of young children: safe and pleasant spaces to play > people without dependent children: spaces for socialising with others and enjoyment of nature. > young people: places to 'hang out' without being moved on by the police or other adults	Seaman et al. (109)
Lifestyle & individual values	> spending time with children > enjoyment of nature/affinity with nature > perceptions of environmental hygiene, security, and safety	Seaman et al. (109) Lin et al. (115) Lee et al. (110)
Socio-demographic characteristics: **> gender, ethnicity and age:** differences in park use intensity **> household income:** differences in frequency and length of visits	> children/males/whites more often vigorous activity compared to other subpopulations > majority of park users white, children, engaging in vigorous activity with equal percentage male/female > participants from high socio-economic status (SES) areas used the local park more frequently than those from low SES areas; Residents in high SES areas also perceived higher levels of park safety, maintenance, attractiveness, opportunities > results for differences in length of visits were mixed between SES groups > differences between ethnicities in use of parks	Lee et al. (110) Reed et al. (116) Kaczynski et al. (117) Leslie et al. (112) Lin et al. (115) Mowen et al. (118) Casper et al. (119).

4.5 THE ROLE OF BEHAVIOURS

Green space has an effect on behaviour, by increasing physical exercise, by increasing the social contacts people have, and by offering a place to relax. The factors that determine actual use of green space are relevant for designing strategies to increase people's interaction and engagement with green space. Table 4.1 (p.43-44) provides an overview of these determinants.

Considering these determinants in the context of the Behavioural Change Wheel described in Chapter 3, one could state that people need to have the opportunity to use green space. Therefore, the physical and social environment related to green space needs to be suitable for the activities people want to undertake. It is important to have accessible, well-maintained green space nearby that offers opportunities for socialisation, where people feel secure (81).

Creation, maintenance and use of green space are directly connected with each other. If people start to reduce public space usage, then there is less incentive to provide new spaces and maintain existing ones. With a subsequent decline in their maintenance and quality, public spaces are less likely to be used, amplifying a vicious spiral of decline. This emphasises the need to create safe areas, maintain the presence of others, and reassure users that there are always an adequate number of "eyes on the street" to deter criminals and maintain a safe environment (67). A successful example of the effect of renovation of parks on use was described by Tester et al. Two parks were renovated in San Francisco in resource-poor neighbourhoods, with the goal of increasing access to quality playfields for youth and families on physical activity levels. Both intervention park playfields saw significant increases in visitors, with over a 4-fold increase in the average number of visitors per observation among most age groups. There was a significant increase in sedentary, moderately active, and vigorously active visitors to the intervention park playfields. The authors suggested that both the structural and programmatic changes led to increased park visitation (120). Another example concerns the refurbishment of a park in Australia, with the establishment of a fenced leash-free area for dogs; an all-abilities playground; a 365-m walking track; a barbecue area; landscaping; and fencing, to prevent motor vehicle access to the park, showed increases from pre- to post-improvement in the number of park users (T1 = 235, T3 = 985) and the number of people observed walking (T1 = 155, T3 = 369) and being vigorously active (T1 = 38, T3 = 257). At the control park, counts of usage decreased over the same period and no differences in walking or vigorous activity were observed (121). To what extent these results can be upscaled to comparable European interventions is not known.

Attractive, easily accessible, well-maintained and safe green spaces nearby may motivate people to undertake these activities in green space ('automatic motivation'). It has been asserted more recently, that green space may 'seduce' people to exercise more, by offering an attractive environment, aiming at the peripheral, automatic route of behaviour of people, which may result in physical exercise as a more habitual behaviour. It may particular provide additional interest for people who are difficult to motivate. Moments in people's life in which contexts change, for example when they move home or they have children, seem especially to offer opportunities to influence habits in the use of green space. For example, when someone has recently moved to a different area, it may be especially useful to inform him or her about the green space availabilities in their neighbourhood. Alternatively, when people have children, it may be of use to inform them about available children's activities in green space. It is at these moments in people's life, that old habits can best be broken and new habits can be developed (51).

The use of public (green) spaces varies to the time of day and day of the week, and is affected by what is on offer in a particular place at a particular time. For example, children and young people tend to use it at the end of the school day, while young adults use it also at night (67).The activities people want to undertake in a green space and what makes the space attractive depend on several individual factors, such as their life stage, lifestyle factors and individual values. Being nature oriented appears to be a stronger predictor of park use than having a park nearby. Park users with stronger nature orientation also appeared to: (i) spent more time in their garden, (ii) travelled further to green spaces, and (iii) made longer visits than park visitors with weaker nature orientation (115). Furthermore, childhood experiences in nature also seem to be a motivator for people to use green space or not. From that perspective, it is important to bring children in contact with nature. Moreover, this may enhance pro-environmental behaviours and probably also more sustainable attitudes and behaviours in adults (23). Lastly, people need to be (or feel!) capable to use green space. This may depend on sociodemographic variables such as income, age and gender, or on their health status. It is important that people are aware of green space in their surroundings and that they see the value of it for their activities. Several studies showed that the majority of park users are white, have or are children, and engage in vigorous activity. Furthermore, participants from high socioeconomic status areas used the local park more frequently that those from low socioeconomic status areas. Actions to stimulate the use of green spaces should therefore be focused on the people who do not use them so often now, being in particular the female, non-white, lower socioeconomic status populations.

4.6 OPPORTUNITIES TO STIMULATE USE OF GREEN SPACE

The focus of this paragraph is on identifying actions and interventions which potentially can improve opportunities, motivation, and capability for changing behaviour. This is illustrated with examples of inspiring actions from the grey literature from different European countries. Most actions described in the grey literature have not been evaluated, but in cases in which they are, the impacts are described here.

Improving opportunities and motivation

Opportunities and motivation to use green space can be improved by providing green space, while taking into account features of the physical environment, such as availability, size, connectedness of space, ease of accessibility, distance, quality, attractiveness and maintenance (see Table 4.1). Furthermore, the presence of walking paths, shade, water features, lawns, birdlife, lighting, sporting facilities, and playgrounds are also important to increase use. What people need to conduct the activities that they want to do in green space may differ. For example, parents of young children want safe and pleasant spaces for their children to play, people without dependent children want spaces for socialising with others and enjoyment of nature, while young people want places to 'hang out' without being moved on by the police or other adults. Therefore, it is important to consult or involve potential users in the design of green space. From a study investigating the association between frequency of participation in volunteer events related to green space, it appeared that the most frequent volunteers indicated the highest degree of attention to environmental issues, environmental identity, and self-reported pro-environmental behaviours. Frequent volunteers also felt personally more attached to their local environment, believed that their efforts helped to solve environmental problems, and enjoyed being part of community efforts (122). Involving people in the design and maintenance of green spaces may therefore not only contribute

TEXTBOX 4.1

In a Swedish project, different preschools with diverse preschool environments were selected and the outdoor environment was related to children's physical activity, body weight, sun exposure, concentration and night sleep. Children in outdoor environments with large undulating surfaces with resistant vegetation that children use in their games were significantly more physical active and less exposed to the sun than children in flat, narrow outdoor environments with little vegetation. There was a reduction of 35-40 percent of the relative exposure to the sun's ultraviolet radiation. In such environments, the children spent significantly more time outdoors. Children in preschool outdoor environments of high quality, compared with children in environments with a low quality, had less difficulty concentrating and slept longer at night. After the study began, municipalities started applying the criteria in their safety inspections according to a developed checklist, which has led to measurable improvements in the outdoor environment combined with more protection from the sun.

Reference: folkhalsoguiden.se/amnesomraden/fysiskaktivitet/informationsmaterial/forskolans-ute-miljo/

TEXTBOX 4.2

In Spain, green belts promote ecological values related to restoration and preservation of ecological areas, but another important variable is that they are integrated in the urban landscape through sport and education facilities, providing new recreational areas. One example is the interior Greenbelt of Vitoria-Gasteiz, European Green Capital in 2012.

Reference: www.vitoria-gasteiz.org/wb021/http/contenidosEstaticos/adjuntos/es/50/71/45071.pdf

to higher quality green spaces, but can also have positive effects on attitudes towards the (local) environment, and can improve social cohesion. In addition, it is important to combine actions to develop and maintain green infrastructure (both in terms of quantity and quality) with promotion of awareness of availability, location, accessibility of local green space (51). Hunter et al. concluded from their review on the impact of interventions to promote physical activity in urban green space that interventions that involve the use of physical activity programs combined with a physical change to the built environment are likely to have a positive effect on physical activity (123).

Furthermore, it is important that people feel safe, and that there is a sense of social cohesion and perceived integration. For example, the presence of unsupervised older children and adolescents may be linked with antisocial behaviour, and this may be a reason not to use green space. Therefore, creating social cohesion in a neighbourhood can also increase use of green space.

Improving capability

Not all people are equally capable of using green space, either because of sociodemographic characteristics, because they are not aware of the presence of green space, do not see the benefit of it, they are not interested in it, or they are not able to (e.g., disabled people and inaccessible parks). To make people aware, clear signs and (route) information helps. Furthermore, organising activities in green space can stimulate people to go there (124, 125) and help to improve health (126). For example, Bang et al. evaluated an urban forest walking program in which 50 office workers performed 5 weeks of walking exercise.

TEXTBOX 4.3

The Green Gyms scheme is run by the Conservation Volunteers, who specialise in reclaiming green spaces across the United Kingdom. The idea is to improve health and physical activity while doing something beneficial for the environment at the same time. Special guides assist and support participants in a range of projects that give people the opportunity to engage in physical, outdoor activities in local green spaces. A cost–benefit analysis of the effectiveness of the Green Gym project between 2005 and 2009 estimates that the scheme generated savings to health services of £1,359,453 (based on cost averted savings) and indicates that for every £1 invested in Green Gyms, £2.55 will be saved in treating physical inactivity related illness. Furthermore, analysis of the cost-effectiveness over the same period estimates that the scheme delivered 132 QALYs at a cost of £4,031 per QALY based on participation in one Green Gym session per week.

www.tcv.org.uk/greengym

They showed that that this program had positive effects on the physical activity level, health promotion behaviour, and quality of life. However, there were no statistical differences in depression, waist size, body mass index, blood pressure, or bone density between the case and control groups (127). Nature education may also stimulate people to use green space. It may also enhance pro-environmental behaviour and sustainable attitudes in adults. Examples of how being in green space can be 'fun', and bring children in closer contact with nature include guided group walks and school gardens (see also Chapter 7 for the latter).

Another use of green space that receives a lot of attention in several European countries is urban gardening. City-dwellers are increasingly using derelict land to cultivate vegetables together with other local residents. Like the more traditional allotments, these non-commercial 'community gardens' can contribute to public health and the quality of the neighbourhood, next to advantages related to local food production and food consumption (Chapter 7). Urban gardening may benefit health because of stress reduction, increased physical activity, increased consumption of vegetables and fruit, and more social contacts, particularly in the elderly. It provides the opportunity to alter and selfmanage the environment. It may also affect neighbourhood characteristics favourable to community health, such as social cohesion. Incidentally, effects on violence rates, inclusion of vulnerable or minority groups, and improvement of the physical and ecological quality of the area are described. However, it is likely that urban gardening selectively attracts people who like gardening, healthy food or social contacts, for example. Therefore, studies might overestimate the role of urban gardens. Urban gardens are part of a general trend towards more parks and green areas in cities, consumption of organic, locally grown products, and a closer relationship with one's own living environment. These gardens are therefore relevant to government policy on public health and the human environment, and can help to address societal challenges such as healthy ageing (128), since they can, for instance, help to keep older people active by working in the urban gardens.

TEXTBOX 4.4

There is a long tradition of urban leisure gardening in Czech town suburbs that was hugely promoted from 1950s until the end of the communist regime in 1989. In subsequent years, some garden colonies were converted to built-up areas and leisure gardening lost economic importance for gardeners as well as its appeal as a leisure time pursuit. Nevertheless, the membership of the Czech Union of Allotment and Leisure Gardeners (www.zahradkari.cz) amounts to some 160 thousand people even today. In recent years there has been a steady excess of demand for allotment gardens in Czech cities (especially in Prague). A recent study on allotment gardens in Prague claims that with respect to the historical roles and values they can hold for both gardeners and the wider urban (community) context, garden colonies could be a glimpse of the environment-friendly urban future (Gibas et al. 2013). A revived interest in urban gardening also brought a concept of shared urban gardens and is now promoted by several civic organizations. Kokoza, a Prague based social initiative, is building its own community gardens, shares experiences and knowledge and encourages others to build their own community gardens. It aims to integrate urban gardening, local produce and composting in a food loop and to engage socially disadvantaged people in their activities.

www.kokoza.cz/en

TEXTBOX 4.5

Stadsbruk is a form of urban agriculture and a new way of farming in the Swedish city. By cultivating land that is not used, growers have the opportunity to start up a company and develop their horticultural business idea. The concept has been developed in a project financed by the Swedish Innovation Agency Vinnova. Stadsbruk is not traditional farming or vegetable production. There should be a connection to the city, and the farmed plot should have a connection with urban residents and a business model which is suitable for cultivation close to urban areas.
Partners involved are the social company Xenofilia, the Swedish University of Agricultural Sciences (SLU), the cities of Malmö and Gothenburg, and the municipalities of Växjö and Kristianstad. There are many possibilities and challenges with Stadsbruk. Cultivation activities in and around the city can create economic gains and new employment opportunities. In addition, growing crops can create added value through positive health effects, improved ecology of the urban environment as well as social integration in the public space. Stadsbruk can enhance the multifunctionality of land use, combining food production with social interaction, learning opportunities and a sharing economy.

www.stadsbruk.se/
www.slu.se/globalassets/ew/org/inst/lapf/stadsbruk/stadsbruk.pdf

4.7 DISCUSSION AND CONCLUSIONS

Well-designed and accessible green spaces offer an attractive environment and good opportunities to exercise, play, relax and meet people, offer protection against heat stress and in this way may improve health, in particular for vulnerable populations such as children, older people, pregnant women and lower income groups. They may also reduce air pollution and noise levels. Furthermore, green spaces may sequester CO_2 to a certain extent and thus contribute to environmental sustainability. They may also enhance pro environmental behaviour. Green space interventions therefore have the potential to offer a 'triple win' for individuals and for society in terms of health, environmental sustainability and equity.

Whether people actually use green space is determined by a wide range of environmental and individual factors (see Table 4.1 for an overview). These include characteristics of the physical and social environment. Furthermore, there are individual differences depending on life stage, lifestyle and individual values, and sociodemographic characteristics.
Opportunities to use green space and people's motivation to use it can be improved by providing or creating a green space, taking into account features of the physical environment such as availability, size, connectedness of space, ease of accessibility, within (perceived) walking distance, of good quality, attractive and well maintained. Furthermore, it needs to be safe, and there needs to be a sense of social cohesion. For the design of green space, it is important to take into account these variables and involve people in the design. Furthermore, by involving people in the maintenance, they may feel more responsible for the green space and in a broader sense for their living environment. Providing accessible maps and information on the available green space and the activities that take

place there, as well as educating people about the value of green space may increase the use of green space, and may show people that it is fun to go there.

Although there are many examples of inspiring policies and interventions, only a few of them have been evaluated. Therefore, the effect of these policies and interventions and (economic) benefits are largely unknown. This is unfortunate, since evidence-based arguments are powerful tools for bringing in new stakeholder groups, particularly politicians and authorities (63). Given the intransigence of inequalities in health and wellbeing, there is a need to understand and communicate the contribution of green spaces for society's poorest citizens and in tackling the social gradients in health and wellbeing experienced across Europe, within countries and even within cites. Tackling inequalities is a moral imperative but can offer huge benefits to society and economies. Green space has a plausibly significant role to play.

Creating green spaces that are being used by people in a healthy and sustainable way requires working together of several stakeholders- from protected area authorities and green NGOs, to city or regional authorities, a spectrum of health sector stakeholders (whether ministries, national bodies (such as the NHS in the UK), doctors associations, NGOs and academia), a range of social stakeholders and policy makers and funders at all levels. In the Netherlands it is often proposed that health insurance companies should contribute financially to development and maintenance of green space, since they potentially profit from the health benefits gained by people who exercise, relax and meet in green space. However, this is not a common trend as yet. Action at all levels, by all stakeholders is needed and where possible building on multi-disciplinary collaborations. Defining clear and common objectives, empowerment and building trust, agreeing on a common language, persistence and ensuring continuity, and ensuring long term funding opportunities are important for successful cooperation. Having the support of a governmental body often stimulates action, either through the implementation of a policy or strategy (e.g. health strategies that integrate nature, green infrastructure strategies that recognise air pollution or heat island mitigation benefits), the availability of funding schemes for health/social/nature initiatives or a political champion that plays an important role in awareness raising and putting nature-based solutions on the policy agenda. Effective dissemination of information and evidence among people working at the grass-root level as well as policy makers may help to increase the motivation and capability of people (63).

The current green space interventions are often focused on one dimension of the broad set of potential benefits (e.g. physical activity, biodiversity, playgrounds for children), and do not mention the reflection and, better still, evaluation of the broader benefits, and not the least the potential economic dividends. If this were done, also in terms of economic benefits, this might provide stronger support for providing provision and maintenance of green space against a backdrop of economic crisis and seemingly relentless urbanisation. Gaining more insight into the costs and benefits and the related business models is therefore important. Such information can speak to a wider policy constituency, which may be more inclined to think solely in terms of an economic bottom line and whose appetite for "softer" more qualitative evidence is often quite limited.

TEXTBOX 4.6
LINK WITH INHERIT GOALS

Among the most significant developments in the field of environmental health in recent years has been the rediscovery of the potential for good environments to deliver better health and wellbeing. Renewed interest in urban green space exemplifies this trend. Although many questions remain to be answered, the proliferation of research in this area is now building a reservoir of policy-relevant evidence which suggest it may also contribute to a more sustainable future and reduced inequalities. Much of the accruing evidence suggests green space to be amongst relatively few urban assets with true potential to deliver the triple win. In short, creating and protecting green space in our towns and cities can be important levers for the changes the Europe of the 21st century urgently requires. This only applies however if we understand how to create the right kind of green places and exploit then effectively through policy and action. Work in the preparation of this baseline review only serves to further reinforce the importance of a clear focus on behaviour in relation to green space in realising the potential of the INHERIT approach.

CHAPTER 5
LIVING - ENERGY EFFICIENT HOUSING

5.1 INTRODUCTION

The availability and quality of housing and its distribution across society have been key concerns since the inception of the modern public health movement in the 19th century. Houses form much of the physical context for people's lives and, today, with 85 to 90% of time spent indoors (3), the indoor environment of houses (and other buildings where time is spent) profoundly affects health and wellbeing. Moreover, the energy efficiency of Europe's housing stock and the energy consumption of households is not only an economic and a health issue for occupants, it is also a key driver of climate change, a global health threat. This means that policies and programmes to improve home energy efficiency and reduce household energy consumption are pivotal in promoting greater sustainability, delivering health gains and reducing health inequalities – the INHERIT "Triple Win".

A number of observations are relevant when selecting a blend of measures to deliver the triple win in the field of housing. The first is that robust measures to improve insulation levels in new and existing housing are an essential and, invariably, also an effective low-cost route to conserving energy. Together with efficient heating and cooling regimes that deploy energy derived from renewable sources, thermal insulation is a prerequisite for healthy sustainable living now and in the future. The second observation concerns the importance of ventilation. Self-evidently too much ventilation wastes heat (and the energy used to produce it). However, air exchange rates must always be maintained at levels sufficient to remove or dilute indoor pollutants, which may be derived from building materials, furnishings, products and human activities. Another important function of ventilation is to remove water vapour produced by activities such as cooking, the washing and drying of clothes and human respiration. Ventilation is essential to secure humidity levels that do not encourage the proliferation of fungi or house dust mites, which are important sources of respiratory allergens.

Thus, from one perspective, the business of delivering a healthy indoor environment without jeopardising environmental sustainability, can be viewed as one of achieving a balance between insulation, ventilation and heating/cooling whilst remaining alert to wider sustainability of the energy source itself. However, and of particular relevance to INHERIT, energy efficient structures and effective heating and ventilation are necessary but seldom sufficient, themselves, to deliver the triple win of human health, equity, and a healthy and sustainable environment. Also important are the behaviours, lifestyles, circumstances, attitudes and knowledge of occupants and the factors that influence these. Behaviour plays an important role when it comes to energy efficiency of homes. Even the most carefully designed heating and ventilation systems can be subverted or rendered suboptimal by occupants. Consumers are also free to choose their energy sources and, by their choices and their behaviours in the home, can conserve energy in a variety of ways. It is often the home occupants, particularly if they are owner occupiers, who decide whether and in what way a home is insulated and the arrangements for lighting, heating and cooking. It is thus of great importance to consider consumers' behaviour when improving energy efficiency of the home. They hold many important levers in the field of sustainability and health. Carefully crafted policies will enable and encourage occupants to exercise these levers for the benefit of all.

This chapter addresses these topics under a number of key headings, examining, first, the trends related to domestic energy consumption and efficiency, housing, and EU policies (5.2). Next, the environmental and health impacts of housing and related energy consumption are discussed (5.3). The differences between subpopulations and inequalities are then described (5.4). The important role of behaviour in the home concerning energy efficiency is then outlined (5.5) followed by the opportunities which exist to increase energy efficient housing in a way that is both healthy and sustainable (5.6). Finally, the different strands are drawn together in the discussion and conclusions (5.7).

5.2 DRIVERS, TRENDS AND POLICIES REGARDING HOUSEHOLD ENERGY CONSUMPTION AND EFFICIENCY, AND EUROPEAN HOUSING

Household energy consumption

There are two main drivers of household energy consumption. The first driver is the increasing number of dwellings. This results from population growth and lower occupancy levels, notably an increase in the number of one person households (129). The second driver is a move towards greater comfort and convenience, meaning homes are getting larger and contain more household appliances (129).

Households account for ca. 25% of final energy consumption (the total energy consumed by end users, including households, industry and agriculture). In terms of final energy consumption, households come a close third behind transport (33%) and industry (26%) (130). Thus, there is an urgent need to make dwellings more energy efficient, especially in Central and Eastern Europe, where the housing stock shows poor energy performance and a need for renovation (131).

However, there are also positive messages about energy consumption in Europe's homes. Final energy consumption of households in the EU-28 is now decreasing (see Figure 5.1). Since 2000, it has fallen at an average rate of 1.5%/year (132). Energy efficiency improvements driven by various types of policy measures, such as those within the framework of the EU Energy Efficiency Directive, partly explain this trend. Also influential have been higher energy prices since 2004 and, since 2008, economic recession (132).

Furthermore, the share of energy from renewable sources (mainly biomass) is increasing rapidly (+5 percentage points since 2000). In the EU, households now derive, on average, 14% of their energy consumption from renewable sources. The largest shares of renewables are found in countries with low income and/or large wood resources, such as Latvia, Romania and Estonia. Denmark has shown the greatest progress (+13 percentage points since 2000) (see Figure 5.2).

Household energy efficiency

Household energy efficiency at EU level improved by 1.8% per year between 2000 and 2012. Over the same period, two-thirds of EU countries showed a decrease in household energy consumption per dwelling (1.5% per year) (132). This was mainly due to improvements

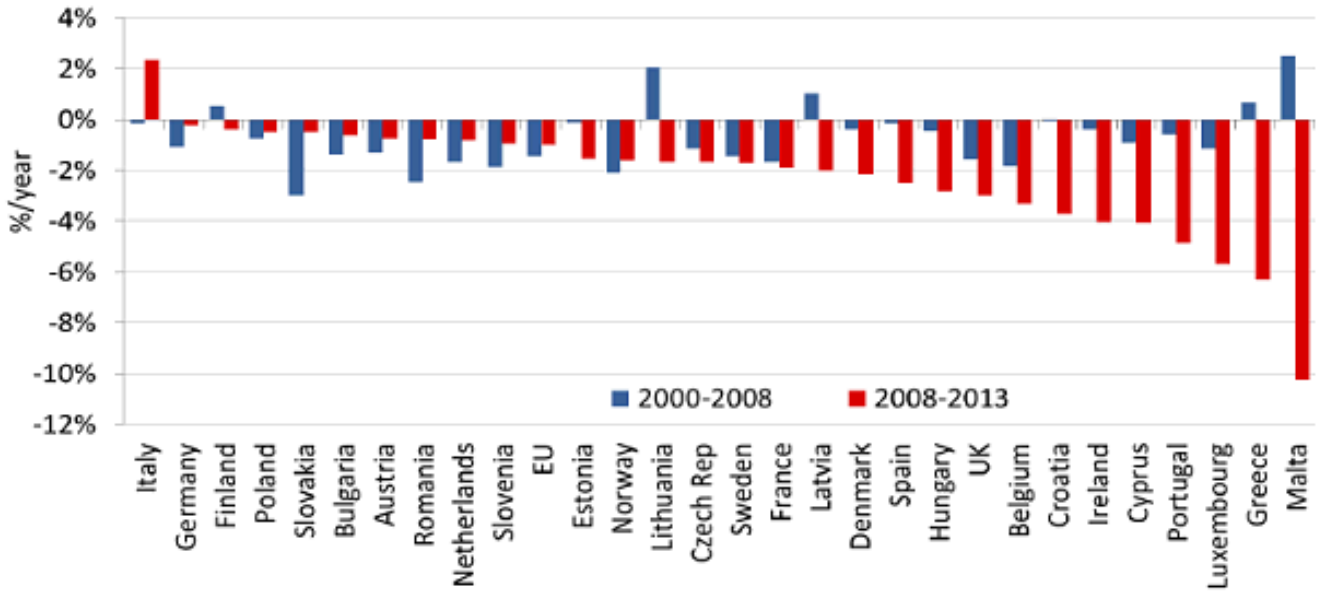


Figure 5.1. Trend in household energy consumption per dwelling in EU (Source: Odyssee-Muree (129)).

in energy efficiency of space heating and the adoption of more efficient electrical appliances. However, about 25% of increased energy efficiency of space heating has been offset by larger dwellings and a wider diffusion of central heating (129).

Up to 2007, the electricity consumed by small electrical appliances grew rapidly. As a result small appliances now form a greater share in the total energy consumption of appliances than large appliances (132). This increase, together with an increase in the number of dwellings, resulted in greater total household energy consumption. However, this consumption is counterbalanced by improvements in energy efficiency. Large appliances have become more efficient since the 1990s. For example, 90% of refrigerators, washing machines and dishwashers sold in 2009 were in the highest efficiency class (129). The savings due to these energy efficiency improvements meant that the energy consumption of households in the EU was 60Mtoe (million tonnes of oil equivalent) lower between 2000 to 2012 than it would have been without these savings (129).

An important effect that should be considered in policymaking has been termed the "rebound effect". This occurs when energy savings achieved through energy efficiency measures are, in effect, taken back by consumers in the form of higher consumption (133). Recent data indicates that the increase in the number of appliances in people's homes and the size of dwellings may offset as much as 70% of the energy efficiency progress achieved in the EU (129). However, reduced heating behaviours by occupants have had a significant effect on decreasing space heating consumption since 1997. There is also increasing awareness and behaviour change among consumers regarding energy conservation. For instance, many private homeowners invest in making their homes more energy efficient, for example by retrofitting their homes with double or triple glazing. Many also indicate an intention to continue such investments in the future (134).

Quality of EU housing stock

Within the EU, there are differences between Member States in both the quality and availability of the housing stock and there are also large differences within countries in the quality of housing. This has been exacerbated by the global economic crisis in 2008, which has been linked to housing problems, with many having to reconsider the standard of accommodation they could afford (135). This may have led to a decline in the standard of accommodation and in the levels of maintenance and home improvements. Some aspects of declining standards and maintenance have a direct bearing on the energy efficiency of the housing stock. Moreover, inadequate housing conditions (such as damp and/or cold homes) are health-relevant and disproportionately affect certain vulnerable population groups (135).

Those at risk of poverty or social exclusion are more

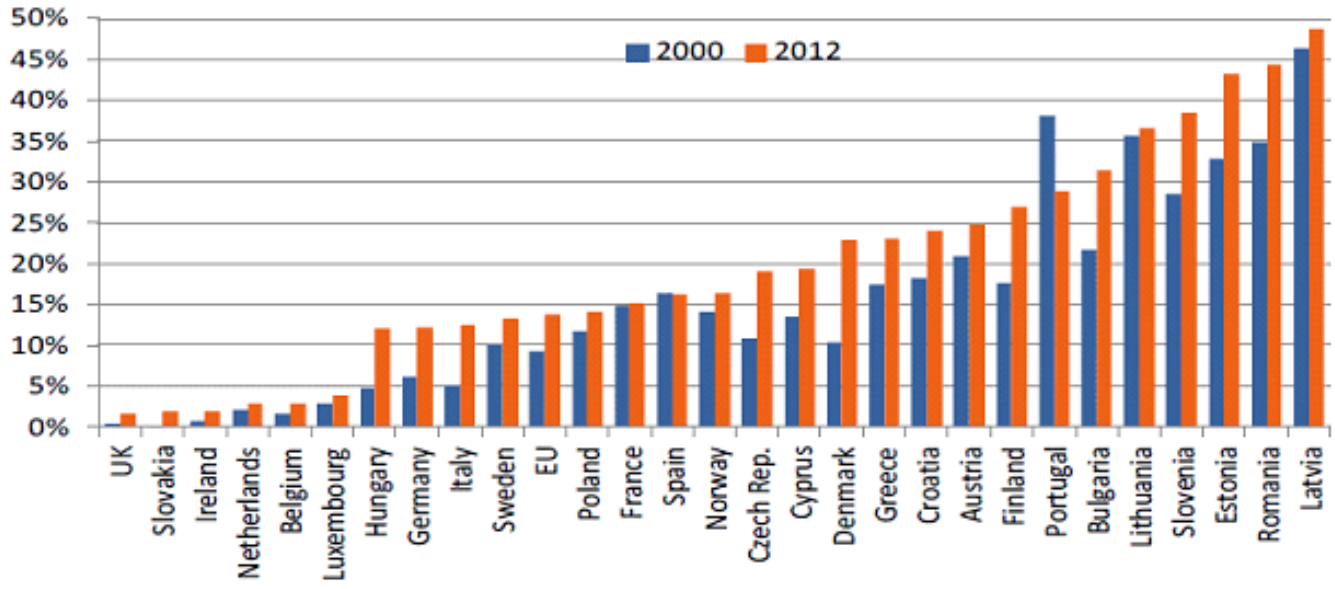


Figure 5.2. Share of renewables in household consumption (direct use) (Source: Odyssee-Muree (129)).

likely to live in inadequate housing, with large differences between countries, mainly related to policy traditions. For example, in countries where housing policy was not an integral part of the post-war welfare state, housing problems are a dominant feature of everyday life for poor people (135). Income inequalities within a country also play a role, as both homeowners and those renting property are more likely to experience housing deprivation in countries with more income inequality (135). In several northern and western European countries, low-income homeowners can experience relatively good housing conditions, whilst most inadequate housing is concentrated among the lowest income groups in southern European countries. For example, structural housing problems (such as damp or leaks, rot in windows, doors or floors and cold homes) are on average most common in Cyprus (51%) and least common in Austria and Sweden, where about 8% indicate having structural dwelling problems (135).

In 2014, on average, 5% of EU residents experienced severe housing deprivation (defined as the percentage of the population living in a dwelling which is considered overcrowded while also exhibiting at least one of the measures of housing deprivation, such as a leaking roof, no bath/shower) (136). For those within the EU population defined as being at risk of poverty, the rate of severe housing deprivation was around 13%. There are big differences between countries with severe housing deprivation still most commonly seen in Eastern EU Member States. However, it is important to note that there have been improvements in this area in recent years (3, 135, 137).

Policies on energy efficiency, housing and health

At EU level, action is being taken to improve energy efficiency and combat climate change. In October 2014, European leaders adopted the 2030 Climate and Energy framework, setting three targets for the year 2030: 40% cuts in greenhouse gas emissions, 27% share for renewable energy and 27% improvement in energy efficiency. The targets for greenhouse gas emissions and renewables are binding, and will allow the EU to make an adequate contribution to the goal of the Paris Agreement on climate change, that takes effect in 2020. This requires that global temperature change be kept below 2 degrees Celsius (138). The energy efficiency target may not be binding, but it

does build on the 2012 Energy Efficiency Directive that contains a set of binding measures for the EU Member States to make sure the EU reaches a 20% energy efficiency target by 2020 (139). Moreover, the energy efficiency target will be reconsidered in 2020 and is likely to be increased to 30% (138).

Overall, the Climate and Energy framework helps to drive progress towards a low-carbon economy, and besides the long-term and distal benefits that will accrue, it also has more short-term and proximal benefits for health and the environment, most notably through reduced ambient air pollution (138). In addition, on November 2016, the European Commission presented its 'Clean Energy for All Europeans' package, which is a set of policy initiatives and legislative proposals aiming to help the EU reach its 2030 40% decarbonisation target. This package, inter alia, consists of proposals to deliver 27% renewable energy by 2030 and proposals on how to redesign the electricity market. It additionally presents initiatives that aim to boost clean energy innovation (140).

In terms of building policy, the recast EU Energy Performance of Buildings Directive (EPBD; 2010/31/EC) requires, inter alia, that all new buildings will have to consume 'nearly zero' energy and use 'to a very large extent' renewables in 2020. The Directive requires that EU countries draw up national plans to increase the number of nearly zero-energy buildings (141).

In terms of housing policy, in 2015, the Eurofound Network of European correspondents defined the three most important objectives of housing policy in their countries. The most common housing policy objective (mentioned by 11 Member States) was better accessibility to affordable housing, followed by provision of accessible housing for the most vulnerable population groups (9 Member States). The third major theme was sustainability, with policy documents pointing to a need for more energy efficient dwellings, with both environmental and economic motivations (housing affordability). These policy documents primarily came from central and eastern European countries (135).

Various EU policies address indoor air quality. For example, from 2004 to 2010, the EU Action Plan on Environment and Health recognised the importance of indoor air quality for human health, and several initiatives were undertaken to improve air quality in the indoor environment and to address health risks. These included establishing guideline values for key indoor air quality pollutants (3). However, there remains no dedicated European legislation on indoor air and health effects. Moreover, health is often missing in resource/energy efficiency policies, including in the new 'Clean Energy for All Europeans' package (142).

The WHO has developed guidelines for the protection of public health from health risks due to dampness, associated microbial growth and contamination of indoor spaces: 'WHO guidelines for indoor air quality: dampness and mould'. These guidelines offer guidance to public health and other authorities planning or formulating regulations, actions and policies to increase safety and ensure healthy conditions of buildings (143). In the guidelines, the WHO points out that 'building standards and regulations with regard to comfort and health do not sufficiently emphasise requirements for preventing and controlling excess moisture and dampness' (143). This is an important point that needs careful consideration when implementing energy efficient measures in the home (3).

The 'WHO guidelines for indoor air quality: household fuel combustion', include general policy considerations, four specific recommendations and a best practice recommendation that links health impacts to climate impacts. The guidelines are aimed at informing public health policymakers, as well as specialists working on energy, environmental and other issues about the best ways of reducing household air pollution. WHO works closely with countries to support implementation of the guidelines. Recommendation number 5 'Good practice: securing health and climate co-benefits' addresses linked health and climate impacts (144). Even though the main focus of the guidelines is low and middle-income countries, where indoor air pollution has the highest disease burden, higher income countries, where biomass is used for heating in mainly rural areas, are considered too.

In 2011, the WHO released the report 'Health co-benefits of climate change mitigation - Housing sector' as part of a series of reports 'Health in the Green Economy'. This report reviews scientific evidence on potential health gains and health risks of climate change mitigation strategies in the residential housing sector. The intention is to inform policy makers and the broader public about how investing in climate change mitigation measures in housing can improve human health (145). One of the key messages is that good ventilation is essential to ensure health gains from energy efficient housing. WHO also emphasises that health can be a driver of cost-effective housing climate change mitigation strategies as, in economic terms, financial savings due to less illness associated with poor energy inefficient housing may be far larger than energy savings.

5.3 ENVIRONMENTAL AND HEALTH IMPACTS

Environmental impacts

Within the home

Poor housing (design, construction and maintenance), too little ventilation and inefficient energy use can lead to increases in concentrations of indoor pollutants, such as formaldehyde, carbon monoxide, polycyclic aromatic hydrocarbons, nitrogen dioxide, particulate matter and radon. Furthermore, poor housing and limited ventilation can lead to dampness and mould growth in the home. Dampness has been estimated to affect 10 to 50% of indoor environments in Europe and dampness and insufficient ventilation are key conditions for microbial (including fungal) growth indoors (143). High internal humidity levels also support the proliferation of house dust mites, which have recognised allergenic potential. Poor housing and ventilation can also lead to indoor temperatures which are too low in colder months and too high in hotter months. About 20–50% of energy use in buildings is related to heating and cooling, of which about 30% (and up to 50% in modern well-insulated buildings) is used to compensate for ventilation loss (146).

Beyond the home

In 2014, households in the EU-28 countries accounted for 19% of greenhouse gas emissions by these countries, with a reduction of 11% taking place between 2009 and 2014 (147). Globally, it is estimated that fuel combustion in residential and commercial buildings and transport together account for approximately 80% of anthropogenic black carbon emissions. As a result, cleaner household fuels and energy efficient measures (together with transport) have been identified as priorities for reducing emissions that contribute to climate change (148). A greater use of renewable energy sources in generating electricity (and more efficient combustion of fossil fuels) will not only lead to reductions in greenhouse gas emissions but will also decrease ambient air pollution. Fossil fuel combustion has substantial negative effects on the environment, such as air and water pollution, biodiversity loss and global warming. However, producing power from renewable sources such as wind, solar, geothermal, biomass or hydropower may also have environmental impacts which need consideration and mitigation.

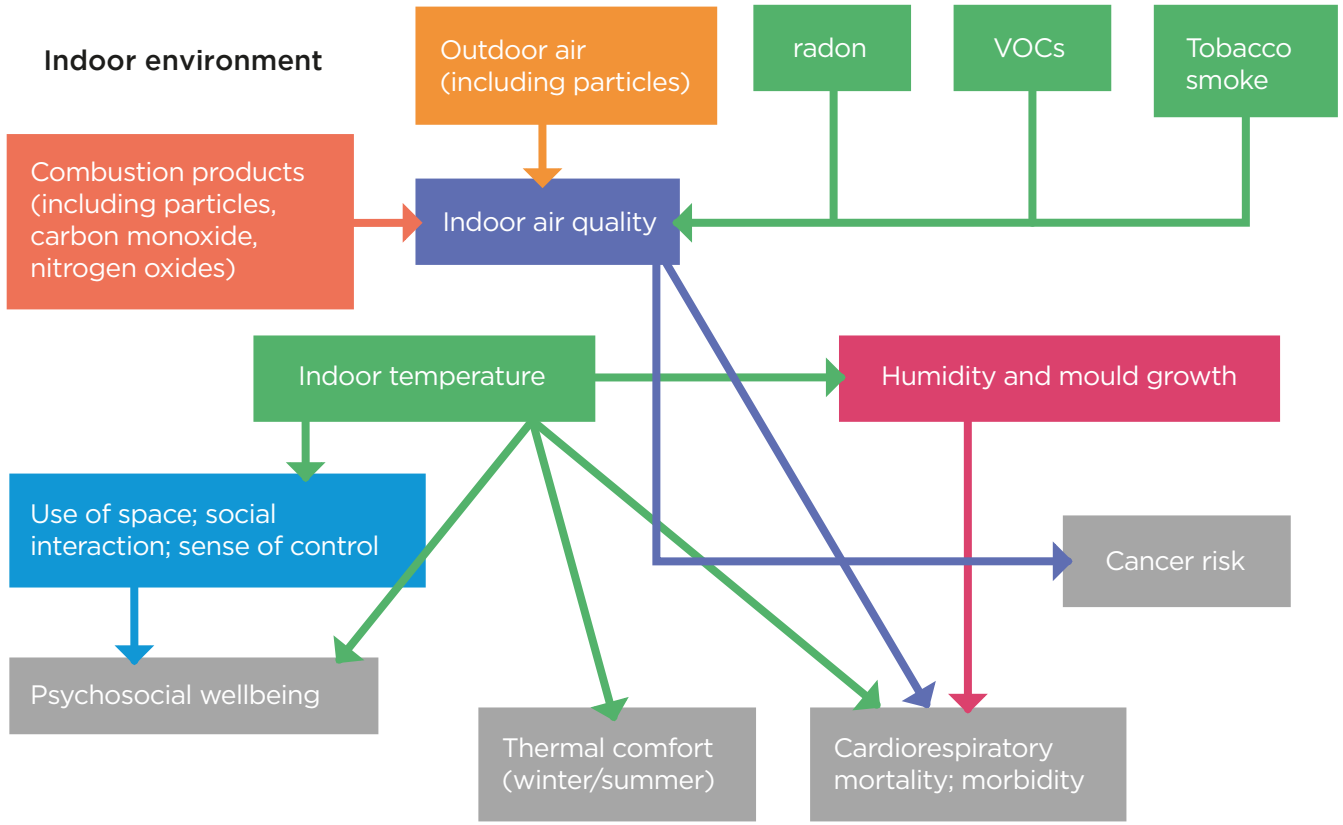


Figure 5.3 Relationships between indoor environment and health. VOCs = volatile organic compounds (Adapted from Wilkinson et al. (149)).

Health impacts of the indoor environment

As Europeans spend more than 85 to 90% of their time indoors (3), the indoor environment is an important source of exposure to contaminants that can cause a number of negative health effects. Figure 5.3 shows the relationship between different aspects of the indoor environment and health. As can be seen, indoor air quality will be affected by, inter alia, combustion products, volatile organic compounds (VOCs) emitted from household products and furnishings, radon emitted from building materials or from the ground, and the quality of the outdoor air. Exposure to these substances can lead to health effects such as cardiovascular and respiratory morbidity, and lung cancer. For example, indoor smoke from solid fuel or heating in open fires, and poor ventilated dwellings produce a high concentration of air pollutants, which are linked to chronic obstructive pulmonary disease and lung cancer in adults and to pneumonia in children (28). It has been calculated that for Euro B and Euro C sub regions of Europe (covering mostly Eastern European countries), 14,280 deaths and 394,600 disability adjusted life years (DALYs) per year are related to exposure to solid fuel use indoor pollution (28). See Figure 5.4 for an illustration of the large differences in disease burden from indoor air pollution between regions. Nevertheless, assessment of direct health impacts of indoor air pollution remains challenging, and existing information in Europe is partial and inconclusive (3).

Indoor temperature and humidity are also important factors which can impact on health. High humidity levels can lead to indoor dampness, mould growth and higher levels of allergens, such as house dust mites. These conditions are associated with respiratory diseases, such as asthma onset in children. It was been estimated that indoor mould exposure is responsible for 12% of new childhood asthma in Europe, which means 55,842 potentially avoidable DALYs and 83 potentially avoidable deaths per year. Additionally, indoor dampness causes 15% of new childhood asthma in Europe, which represents approximately 69,462 potentially avoidable DALYs and 103 potentially avoidable deaths per year (28).

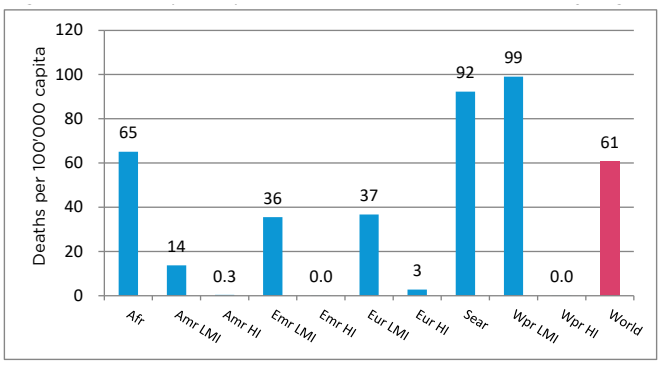


Figure 5.4 Deaths per capita attributable to household air pollution in 2012, by region (Source: WHO (150)).
Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Eur: Europe, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and Middle-income; HI: High-income

Low indoor temperatures for long periods are directly linked to deaths from cardiovascular and respiratory diseases. It has been estimated that 38,200 excess winter deaths each year in 11 European countries are related to low indoor temperatures, representing 12.8 excess deaths per 100,000 population due to indoor cold (28). Although it would seem counterintuitive, rates of excess winter mortality are higher in countries with less severe, milder winter climates, such as Greece, the UK and Spain (151). This could be explained by the fact that countries with milder climates often have the worst domestic thermal efficiency and colder countries have higher building standards (151).

Furthermore, inadequate housing can have effects on mental health. Occupants may experience stress due to concerns for safety and worries about rent payments. In addition, low-income residents may feel a greater lack of control over their home environment, which is also linked to stress (28).

Eurofound has calculated that if all severe inadequacies in the housing stock (e.g. mould, dampness and cold or structural damage) across the EU could be reduced to an acceptable level, the total investment would amount to ca. €295 billion (2011 prices). This would be balanced by a saving in the annual total societal medical costs for EU Member States of almost 194 billion Euros, meaning that every 3 Euros invested in reducing housing hazards would save 2 Euros in medical costs within a year (135). As the effect of home improvements are expected to last much longer than a year, the savings in terms of medical costs will ultimately be higher, with a breakeven on investments expected within 1.5 years on average over all EU countries, with big differences between countries.

Health considerations specific to energy efficient housing

A healthy home should be dry, clean, pest-free, safe, contaminant-free, ventilated and well-maintained (135). Adequate ventilation is essential to achieve a healthy indoor air quality and hygrothermal comfort, as it allows the dilution and removal of indoor air pollutants and reduces moisture and allergens (152). Many energy efficiency measures, such as installing double or triple glazed windows and insulating walls and attics, have the effect of making homes more airtight. This reduction in natural ventilation results in poorer indoor air quality when coupled with

indoor sources of air pollution (e.g. household products, building materials and combustion processes). If no compensatory ventilation measures are taken, poor indoor air quality may then impact on the health of residents as described above.

To ensure sufficient ventilation, mechanical ventilation systems may need to be installed. However, these need to be correctly installed and maintained, and occupants must be educated in their use if the potential positive impacts are to outweigh the negative impacts. Moreover, the health benefits of good ventilation can be undermined by living in an area with high outdoor levels of pollution. In these circumstances, homes fitted with mechanical ventilation systems with higher air exchange rates can lead to an increased entry of outdoor particle pollutants unless there is effective filtering of air (149). This illustrates the delicate balance between ensuring adequate levels of ventilation and improvements in energy efficiency.

Shrubsole et al. (153) performed a literature review to elucidate the consequences of the following energy efficiency measures: increasing airtightness, purpose provided ventilation systems and insulation. The study outlines a number of ways that these measures can have positive impacts on health and sustainability, but also lists some of the ways in which these interventions may have unintended negative impacts, see Table 5.1 (153).

In order to avoid negative health consequences, Kuholski et al. (154) argue for a "one-touch approach" for home interventions that strategically integrates public health and energy efficiency programmes rather than working in silos. This holistic approach would reduce the unintended consequences of separate programmes and could avoid some of the unintended negative impacts energy efficiency measures discussed by Shrubsole et al. (153).

Despite the potential negative effects of energy efficiency measures on health, energy efficient housing also has a number of health benefits. Countries which have more energy efficient housing have lower excess winter deaths and there is a relationship between excess winter deaths, low thermal efficiency of housing and low indoor temperature (151). Furthermore, housing interventions which are aimed at improving warmth and energy efficiency (e.g. upgrading heating and installing insulation) can lead to improvements to health. A Cochrane review of the health and social impacts on residents following these interventions found that improvements in general health, respiratory health, and mental health are possible, especially when the housing improvements are targeted at those with chronic respiratory disease and inadequate warmth (155).

Table 5.1 Possible unintended consequences of energy efficiency measures (Source: Shrubsole et al. (153))

Energy efficiency measure	Positive impacts	Negative impacts
Increasing airtightness	Reduced heat loss, lower energy consumption, GHG emissions; noise reduction = more peaceful, secure good for mental health and improvements in child development; properties are more water tight to avoid water damage, mould, rot; reduced pollutants from external sources.	Absence of sound can lead to negative mental health impacts, such as a sense of isolation or disconnect; Lower air change rates can lead to a rise in relative humidity, leading to dust mites, mould, severity of asthma and allergies and fabric decay; Increase in exposure to internal pollutants, including radon.
Purpose Provided Ventilation Systems	Well installed it could lead to a reduction in most indoor sourced pollutants, good air exchange and quieter environment leading to a reduction in household accidents and greater mental alertness.	In practice many ventilation systems do not preform to their design standards due to poor installation and maintenance; Installing only PPV systems could lead to energy efficiency gains being offset by ventilation heat losses and increased fuel bills; Can increase outdoor sourced or indoor pollution and microbiological growth if not installed or maintained properly.
Insulation	Warmer environments and higher air temperatures can reduce winter mortality; Higher temperatures associated with infant weight gain and development status; More room availability in houses and changes in occupant/family patterns; Increase in immunity and less time off work, reduced injuries for old and infirm; Increases in bedroom temperatures linked to improved mental health across life-time and specifically in adolescent mental health; Cost savings can lead to increased financial control and reduced stress, with extra income used for e.g. improved food.	Summertime overheating, particularly in top-floor apartments with warmer climates may make some homes uninhabitable; May encourage sedentary behaviour, overeating, changes to occupant patterns may also lead to reduced social cohesion; Higher indoor temperatures can increase the severity of skin infections and reactions to allergies and attract pests and vermin, spreading disease; increased income from costs savings can lead to greater consumption of other polluting goods that lead to increases GHG emissions.

5.4 DIFFERENCES BETWEEN SUBPOPULATIONS AND INEQUALITIES

Subpopulations

Certain subpopulations spend more time indoors. These include older people, those with pre-existing illness, the unemployed, mothers and young children. Increased duration of exposure to indoor environments which may be polluted, cold, damp and mouldy, coupled with increased vulnerability, make housing conditions a key factor in the health of these groups (3) (156). Older people are also especially susceptible to cold housing, resulting in increased winter mortality (157). Differences in vulnerability are aggravated by the fact that those groups most at risk occupy older homes with poor insulation and higher energy demands (155).

Socioeconomic differences

Poorer people are more likely to live in more deprived neighbourhoods and these neighbourhoods are more likely to be characterised by poor housing. This can present risks to health (26). Generally, low-income populations are exposed to higher concentrations of pollutants indoors due to the proximity of their dwellings to industry and traffic (causing poorer outdoor air quality), indoor tobacco smoke, and adverse building conditions (137).

People living in poverty are more likely to spend a large portion of their income on housing (135). The burden of high housing costs has been associated with lower general health and malnutrition (154). When a large share of income has to be used for energy bills, this can ultimately lead to fuel poverty, a situation in which people are unable to afford adequate heating for their homes (135). Fuel poverty is defined in different ways in different parts of Europe. For example, in the UK, households are considered by the Government to be in 'fuel poverty' if they would have to spend more than 10% of their household income on fuel to keep their homes adequately heated. However, wherever it occurs, fuel poverty is a significant public health problem. There is considerable variation in the percentage of the population spending more than 20% of their income on heating, a situation sometimes termed "severe fuel poverty". Figure 5.5 showes the percentage of Europeans who cannot keep their home adequatly warm (344). In 2012, 11% of EU residents indicated that they were unable to keep their homes adequately warm. This number was more than doubled (24%) amongst the low-income population. Some country-level examples include the six percent of the Czech population who were unable to keep their home adequately warm in 2013 (158), and in Greece, 23.7% of the non-poor population and 50.8% of the poor population do not have adequate home heating (159). Furthermore, eleven percent of UK households experience fuel poverty (160).

Health benefits that stem from energy efficiency improvements to homes of disadvantaged populations can therefore be significant due, inter alia, to the resulting savings being available for other essential needs such as food and health care (154).

In their report on the health impacts of cold homes and fuel poverty, the Marmot Review Team concluded that cold housing and fuel poverty not only have direct and immediate impacts on health, but also indirect impacts and a wider effect on wellbeing and life opportunities, as well as on climate change (151). The Marmot Review Team conclude that *"Addressing energy inefficient housing and bringing all homes up to a minimum standard of thermal efficiency would have the strongest positive impact on the poorest households, even though households from a variety of socioeconomic backgrounds are likely to be residents of such properties."*

5.5 THE ROLE OF BEHAVIOUR

Consumer energy efficiency refers to the effort by users in a household to reduce energy consumption and to use appliances that are energy efficient (161). Several behaviours can be identified that influence energy consumption and related health effects in the home. This section addresses the role of these behaviours when it comes to ensuring healthy, sustainable energy efficient housing.

Energy saving and efficiency

Although many people report concerns about climate change and understand the importance of saving energy, this does not seem to translate, reliably, into taking practical steps to reduce household energy consumption (48). Indeed, very few people seem willing to drastically change their energy consumption behaviour in line with their ecological values (162). This may be

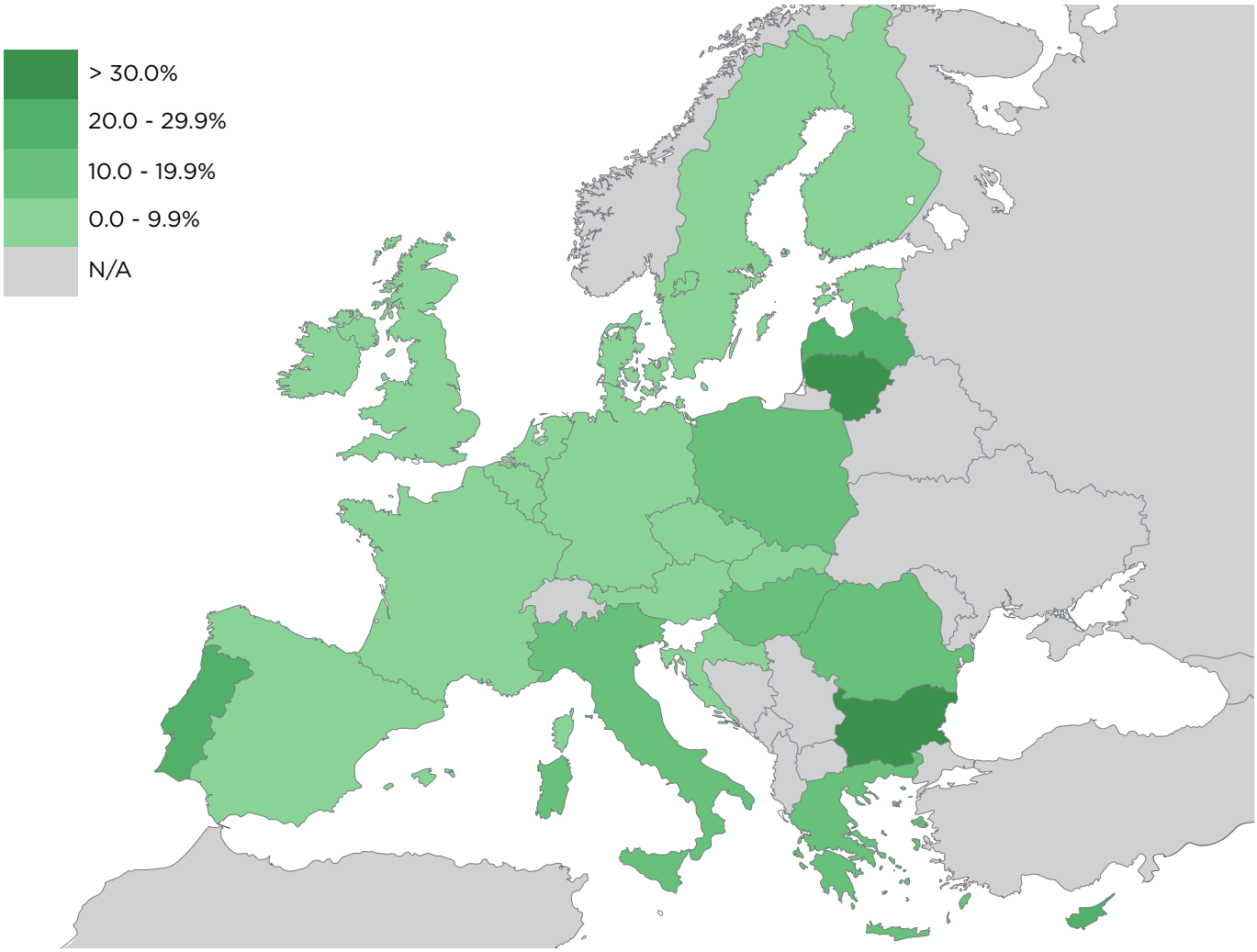


Figure 5.5. Percentage of households unable to afford to keep their home adequately warm (Source: EU SILC (344))

because energy demanding behaviours are habitual and often performed automatically (autonomous motivation). Many people do not consciously think about behaviours such as turning the light off when leaving a room or switching off appliances when not in use.

When motivation to change is high, habitual behaviour can be changed. However, motivation to change may be low simply because people do not, themselves, experience the environmental consequences of their energy consumption. The savings on energy costs may be small in relation to behaviour changes, and, as yet, only a small group of people have strong ecological values (162). Therefore, traditional education programmes and mass media campaigns that spread information to promote pro-environmental behaviours often fail to produce sustained behaviour change. Electricity is relatively cheap and electricity meters are often hidden away with hard to interpret information displays, making it unlikely that people perceive great financial benefits of behavioural change. Increasing the usability and visibility of electricity meters would increase the opportunity for people to engage and become aware of the financial benefits.

Even when energy-saving measures, such as insulation, are clearly cost-effective, many people still seem reluctant to implement them. An important barrier may be the conflicting interests of landlords and tenants, with the former bearing the cost of energy efficiency measures, but the latter benefitting from them. This leads to rented houses lagging behind owner-occupied houses. Even if landlord-tenant challenges are not the main barrier, a number of cognitive biases or heuristics, such as status quo bias and loss and risk aversion can influence consumers' patterns of energy usage. See Table 5.2 for a more detailed explanation and policy implications. In addition, psychological phenomena such as normative social influence, intrinsic and extrinsic rewards, and trust may also play a key role (48).

Van Geelen et al. (161) argue that introducing energy efficient technology into a household can only be effective when behaviour is aligned, implying that end users should adapt their behaviour to technology, but also that technology should fit end users' needs, wishes and ability. In this way, technology is a means to increase user capability and motivation, providing an opportunity for more sustainable, healthy energy use in the home.

Adequate ventilation and healthy environments

Although there are obvious benefits from improving energy efficiency in a home, householders must adapt their habits and routines to take into account the changed indoor environmental and physical conditions after these improvements have been implemented (163). Householders need help and advice if they are to increase capability and motivation. Advice on how to manage their improved homes to avoid health problems related to the new indoor environment help in understanding that living in a house with improvements to energy efficiency requires new routines and some lifestyle changes. Richardson and Eick outline some simple and practical actions that can be taken to reduce problems such as condensation dampness, mould and dust mites (163). They also highlight the importance of ensuring that householders have appropriate technical guidance after energy efficiency measures have been installed to ensure that the benefits can be maximised. In their analysis of UK schemes in which health professionals had been asked to promote grants for insulation and heating in their clients' homes, Richardson and Eick (163) suggest that front-line health professionals are in a unique position to help families increase the 'healthiness' of their homes and they can encourage householders to take responsibility for their indoor living conditions. Ideally, these professionals would also incorporate energy efficiency in their advice.

As highlighted by the aforementioned study, it is evident that home occupant behaviour can influence the effectiveness of energy efficiency measures and their impacts on health, such as regulation of indoor temperature and ventilation. In another study illustrating the role of behaviour, the indoor air quality in six apartment buildings was evaluated (146). The lowest ventilation rates were recorded in homes where trickle vents were installed, but were closed as occupants did not seem to be aware of their presence or operation (146). This illustrates the importance of ensuring that residents are provided with adequate guidance on the use of their ventilation systems and that these are designed to be easily used.

5.6 OPPORTUNITIES TO STIMULATE HEALTHY ENERGY EFFICIENT HOUSING

To ensure energy efficiency measures are implemented in a way that promotes health, it is important to understand behaviours and lifestyles of residents and what influences them when designing interventions. This is true whether the intervention focusses on housing improvements, promoting energy saving of residents, or both. This section discusses several promising interventions intended to achieve healthy energy efficient housing and explores opportunities for actions than influence energy efficient behaviour.

Improving health and reducing inequalities

A large study in low-income communities in New Zealand investigated the effects on the quality of the indoor environment and on health of insulating 1,350 houses. The intervention led to a significantly warmer, drier indoor environment and less energy consumption. Furthermore, the occupants of the insulated houses had improved self-rated health, less self-reported wheezing, fewer days off school and work, and fewer hospital admissions for respiratory conditions (164). In a further study, more effective heating was installed in 409 of the previously insulated houses where a child with doctor-diagnosed asthma lived. The results were significant, with nitrogen dioxide concentrations being halved and indoor temperatures increased. Moreover, children reported less poor health, lower levels of asthma symptoms and less disturbed sleep through wheeze and dry cough. The children also had fewer days off school (165). Improving home insulation can also be beneficial in terms of reducing inequalities, with low socioeconomic groups having more control over fuel bills, increasing financial opportunities for these groups.

A Cochrane review on the health and social impacts on residents following housing improvements noted that improved health is most likely when the housing improvements are targeted at those with inadequate housing conditions and poor health (155). Examples of improvements include, inter alia, energy efficiency measures such as insulation and upgrading of heating of existing houses. In particular, improvements in warmth and affordable warmth may be important reasons for improved health. Improvements in warmth were associated with increased usable space, increased privacy, and improved social relationships. Absences from work

or school due to illness were also reduced (155). However, the authors noted that delivering a housing improvement does not necessarily lead to improved living conditions for the residents. Improvements in warmth may be counteracted by occupants' concerns about heating costs or confusion about operating a new heating system. This again advocates for delivering a combination of downstream measures (increasing capability and motivation by targeting knowledge and providing guidance on how to use a system) and upstream measures that change the environments and provide opportunities

An important issue that should not be overlooked is the potential increase in rent when a house is upgraded. This may force the occupants to move out as they can no longer afford to pay the rent, which means the full potential for the housing improvements to create positive health impacts may not be realised. Thus, it may be important to combine these upgrades with financial aid for occupants or secure agreements with landlords (155).

Kolokotsa and Santamouris (137) suggest several actions to tackle inequalities in the area of housing. They list reducing energy prices for households, improving energy efficiency of buildings occupied by vulnerable households (including necessary commitment and effort in educating households to the rational use of energy and energy saving), and working in the social field by strengthening low incomes as far as possible. They further suggest that users' engagement and awareness raising campaigns can contribute to energy efficiency for low-income households, improving capability and motivation. There is a recent trend in distributed energy production whereby consumers are in closer physical proximity to energy production and resource management which may allow for increased awareness and engagement. Kolokotsa and Santamouris also emphasise the importance of energy pricing to increase willingness to change energy use behaviour among low-income population groups. They highlight demand-response programmes as a potential successful solution if active engagement of end-users can be ensured. This may be achieved by giving real time information on energy use and bills. Demand response is a change in the power consumption of an electric utility customer to better match the demand for power with the supply. This requires that consumers have real time information on energy use and bills. In essence, consumers are enabled to change energy usage from their normal patterns in response to changes in energy pricing over time, reducing energy use during peak hours. This is more cost-effective than adding generation capabilities to meet the peak demands. It can also be easily integrated in low-income households by energy companies.

Wilkinson et al. (2009) investigated how household energy efficiency schemes can engender co-benefits for the environment and for human health (149). The authors examined the effects of hypothetical strategies to improve energy efficiency in UK household stock and to introduce 150 million household cook stoves in India. They concluded that both these programmes have the potential to significantly reduce both DALY and carbon dioxide emissions. For UK housing, interventions were generally beneficial for health but the magnitude and even direction of the changes in health depended on details of the intervention. These health benefits mainly arise from improved indoor air quality and control of winter indoor temperatures. The authors conclude that household energy interventions in low-income countries have a greater potential to improve public health than those in high-income countries. Nonetheless, household energy interventions in high-income countries can also benefit human health. Furthermore, they have a greater effect on greenhouse gas reduction per dwelling and thus are vital for reaching worldwide climate abatement targets (149).

Changing energy-related behaviours

There are many energy efficient appliances or measures that save energy once they are installed (e.g. insulation).

However, other measures require the active participation of residents (e.g. turning down central heating when leaving the home). Frederiks et al. (48) describe key insights from behavioural economics and psychology which can guide effective design and delivery of interventions to improve residential energy conservation. These strategy suggestions are relevant for promoting in-home energy-saving behaviours, promoting the switch to green energy or installing energy efficient devices. These approaches include, for example, the use of status quo bias and defaults. For instance, it can be productive to focus on those behaviours that can easily and effortlessly be modified by using a default setting (e.g. setting one's dishwasher to a cold-water program). Also, energy consumption habits can be broken when there are changes in the so-called stable context that provides cues that trigger the habitual behaviour. An example of this is where people move house, because at this point of transition, they are more amenable to change. Such strategies can increase the autonomous motivation to behave more energy efficiently in the home, and by changing certain cues, they can increase the opportunity for people to engage in energy efficient behaviours.

When developing and implementing actions, one should exploit the fact that people engage in 'satisficing' (i.e. aiming for a satisfactory instead of optimal result). This might mean making the desired energy saving behaviour easier, quicker and more convenient (e.g. keep information short, simple and easy to understand to effectively increase capability and motivation). This can be done by smart meters (see below). In addition, fram-

TEXTBOX 5.1
CLEAR: ENABLING CONSUMERS TO LEARN ABOUT, ENGAGE WITH AND ADOPT RENEWABLE ENERGY TECHNOLOGIES

www.clear-project.eu

2.5 million consumers in Spain, Italy, Portugal, Netherlands and Belgium are going to be informed about and engage with renewable energy technologies, leading to the purchase of more than 80 000 installations.

The key steps are:

1. Creating a renewable energy web community which will provide consumers with innovative ways to share experiences and know-how.

2. 'Hooking' consumers with independent and expert information gained from laboratory tests on micro-generation technologies (Solar thermal, PV, heat pump for domestic hot water, heat pump for heating and cooling).

3. Raising the consumer's capacity to take informed decision with personalised decision-making tools. These will range from an interactive tool enabling consumers to find out which technologies are suitable for their needs and property, to investment tools enabling householders to find out how long it might take for a system to pay for itself and how much money and energy they could save

4. Gaining attention and getting consumers involved in the CLEAR renewable energy web community, through existing well-established communication channels.

5. Activating consumers to purchase renewable energy technologies through incentives that bring down cost, such as group purchase schemes.

6. Transforming adopters of renewable energy systems into ambassadors to convert more consumers.

ing messages in terms of avoiding or minimising prospective costs and losses can be effective, since loss aversion framing makes information more salient, memorable and motivating ("You are now losing 20 Euros due to not turning off your lights"). This may be especially effective on low-income groups who experience a relatively larger financial benefit of energy saving. Focusing on the low risks of energy saving measures, using risk relievers for financial risks such as discounts and giving money-back guarantees may promote the uptake of energy efficient devices. For example, the Green Deal approach in the UK provides financial support for anyone choosing to install renewable heat technologies instead of fossil fuel alternatives, by means of Renewable Heat Incentives (166). Framing energy saving measures as common and socially desirable, using normative social influence and creating a shared group identity (e.g. 'X% of your neighbourhood has switched to green energy' or 'your energy use is X% above your neighbourhood's average') can be used to promote switching to green renewable energy or lowering energy consumption. This strategy can change motivation by making the existence of an energy efficient social environment clear. People use what are known as availability heuristics, which are mental shortcuts that rely on immediate examples that come to mind when they evaluate a topic or make a decision. This makes simple prompts and reminders, or nudges, important ways to make sure that energy-saving motives come readily to people's mind when making a decision. For example, a prompt to switch off a light when leaving the room can be given by a small reminder below the switch.

The CLEAR project (see Box 5.1) aims to encourage citizens to adopt renewable energy technologies through inter alia creating a renewable energy web community, which will provide consumers with innovative ways to share experiences and know-how. The project also aims to raise consumers' capacity to take informed decision through personalised decision-making tools.

Table 5.2 Cognitive biases and heuristics and how to use these in energy efficiency policy making (Source: Frederiks et al. (48))

Heuristics/biases and how to use them in energy-saving policy		
Heuristics/ Cognitive biases	**Detail on bias**	**Policy implications**
Status quo /sticking to default setting	People tend to resist change and go with pre-set options, this bias has been observed with residential energy consumption	Target those energy-related practices that can easily and effortlessly be modified using default settings (washing clothes cold by default or opt-in as default option for energy related programs, using changing points in people's lives)
Satisfice	Aiming for a satisfactory instead of optimal result	Simplification strategies to reduce cognitive overload, such as automating relevant technology, minimizing demand on people, keeping information simple)
Loss averse	Losses are weighed more heavily than same sized gains (focus on risks of a new behaviour and greater willingness to accept than to pay)	Focus on costs related to energy-wasting practices instead of on payoffs of saving energy
Risk averse	Risk averse when faced with certain gains and uncertain losses, risk seeking when certain losses and uncertain gains	Market and communicate to alleviate perceived risks of energy efficient action (relieve financial risks, time risks, effort risks, for example using money-back guarantees)

Sunk cost effect	People tend to become fixated on recovering losses already suffered (time, money, effort in buying dish washer), discounting future costs and benefits (buying the dishwasher may lead to using it more, even if not required)	Reduce salience of large costs that people already invested in old energy-inefficient items and draw attention to costs of ongoing actions
Temporal /spatial discounting	People view things as less valuable or significant if further away in time (may avoid actions that are costly in short term such as buying new energy efficient appliance, although it may save money in long term)	Draw attention to longer term payoffs of energy conservation
Social norms	People make social comparisons and conform to social norms, people evaluate energy use behaviour not in terms of absolute terms, but relative to others	Frame energy efficiency practices as common and socially desirable (they use less than you)
Rewards /incentives	Intrinsically and extrinsically (money), the larger the incentive, the larger the response. However, financial incentives are often short-lived, especially if intrinsic motivation is low	Monetary rewards may undermine intrinsic motivation, so make sure people are also intrinsically motivated (energy saving should make them feel good about themselves)
Free riding effect	Contribute less to common good if they can gain same benefits without paying for them or if they believe others are enjoying but not contributing	Create shared group identity, give idea that many other consumers are also saving energy
Trust	Trustworthiness of a message or informational appeal can determine effectiveness of a message	Use high credible sources such as public service commission instead of local electricity utility to promote energy conservation behaviour
Availability bias	People tend to draw on readily available information	Refer to energy-saving behaviours that are well-published in media, use basic visual/auditory reminders to prompts consumer to act

Frederiks et al. (48) mention the energy reduction effects of an in-home light bulb that changes from green to red when energy consumption is high, reducing energy consumption by 40% at peak levels. As people tend to discount future gains and focus more on direct costs, it may be important to provide an upfront incentive when offering energy efficient measures, to increase motivation to engage with these measures. This is part of the Green Deal approach used by UK Government, which aims to introduce energy efficient measures in people's homes without any upfront costs. They also aim to reduce the "hassle factor" in making energy efficient changes to one's home, such as the fact that insulation often involves the clearing out of rooms. In so-doing, it is hoped that resistance to change will be reduced (166). See Table 5.2 for a detailed description of each heuristic, and what this means for policy.

As mentioned above, daily energy-saving behaviours are largely habitual, and motivation to change may be low because electricity meters are hard to interpret or hidden away from sight. Thus, people are not aware of the financial or energy consumption consequences of their behaviours. This argues for more direct feedback to consumers, giving them a better grasp of the price or volume of their consumption. This is confirmed by literature, with prior studies on lowering demand for household energy consumption finding that frequent, immediate feedback and goal setting strategies lead to consumers reducing their energy consumption, by increasing capability and motivation (162).

Shrubsole et al. (153) suggest the need for a broader approach to policy decisions that integrates multiple objectives about housing, includes consideration of a wider range of outcomes and involves multiple stakeholders in decision-making so that co-benefits may be optimised, negative impacts reduced and trade-offs made more explicit. The authors call for more intersectoral, holistic approaches to policy making, such as 'Participatory Systems Dynamics', that take into account different potential impacts on different population groups, and involve multiple stakeholders.

Innovative solutions

Frejus and Guibourdenche (167) suggest that, rather than directly influencing behaviours, a new situation must be created which is more conducive to the desired behaviour of residents. This provides the opportunity to practice the desired behaviour. The focus is more on domestic activities than purely consumption behaviours, because energy consumption is a result of daily activity, and not its purpose. In other words, energy consumption is not a behaviour in itself, but rather a result of behaviours whose purpose and contexts generally do not relate to energy savings. Preferable approaches to achieving energy savings include designing efficient sustainable solutions (an intelligent system turning off forgotten lights), and interactive systems displaying feedback on how a situation affects energy consumption (information on which behaviours lead to a certain level of consumption).

The use of real-time information can be implemented using smart meters or energy management systems. Smart meters are digital electricity meters that measure occupant energy consumption (and production) and communicate data to both energy user and supplier. Using smart communication protocols, and energy feedback information, smart meters can make consumers aware of their energy use and allow them to adjust their consumption accordingly (161). A related measure is a programmable thermostat, which has been found to reduce energy consumption by 5 to 15%, but due to incorrect installation, misunderstanding or poor usability, these reductions are often not realised in practice (168). Usability is key and some guidelines to achieve this include visibility of available options, consistency and standards, feedback, broad and shallow decision trees, simple navigation, clear hierarchy, and error prevention and recovery. It is also very important to tailor the device to specific populations. For instance, certain populations may not wish to control thermostats via smart phones or tablets, and prefer a simple, offline device.

Home energy management systems are a related technology, being intermediary devices that can visualise, monitor and/or manage energy consumption in the home. This gives users direct and easily accessible insight into their energy consumption, using real-time feedback via in-home displays. This has been found to be more effective than other ways of feedback that are less visible and direct (161). Kobus et al. (162) investigated the effect of energy management systems in households, and found several system variables to support energy reduction behaviours, such as feedback, trustworthiness and rewards. Feedback on the results of one's actions provides insights and a sense of control over consumption.

Trustworthiness of a system must be high, as information displayed must be believed. Rewards for the desired behaviour make using a system fun and provide a sense of acknowledgement for the effort made. In general, a design that is high in convenience and easy to use is important, especially when motivation to change is low, as is often the case. Another im-

portant personal factor was found to be self-efficacy: people must believe they are able to successfully interact with energy management systems. However, downstream measures need to be accompanied by upstream measures in order to facilitate and induce behavioural change, especially for those groups that need it the most. For example, financial opportunities/subsidies to purchase a smart meter may be necessary for low-income groups, who may not be able to afford a smart meter without financial aid. In addition, they may require additional assistance in using these smart meters. Box 5.2, below, presents an inspirational project called SMART-UP which encourages the active use of Smart Meters and In-House Displays by vulnerable customers.

TEXTBOX 5.2
SMART-UP, A EUROPEAN PROJECT

SMART-UP
CONSUMER EMPOWERMENT IN A SMART METER WORLD

The overarching aim of SMART-UP is to encourage the active use of Smart Meters and In-House Displays by vulnerable customers, in those Member States where the roll-out of Smart Meters has been embarked upon. The project has developed a training program for installers, social workers and other frontline staff in contact with vulnerable people so they can inform them about the benefits of smart metering and advise them on how to use their Smart Meter and In Home Display units (where fitted) to best effect.
Besides empowering vulnerable consumers, the project will serve to get feedback on their specific needs and on the ways to appropriately communicate with them and help them benefit from smart metering.

smartup-project.eu/about

5.7 DISCUSSION AND CONCLUSIONS

The literature clearly shows that improving the energy efficiency of homes through building restructuring, installing renewables and efficient appliances, or through energy-saving behaviours must be combined with commitment and effort in educating occupants on energy saving. In improving energy efficiency, attention must also be paid to health, to avoid unintended health consequences and ensure a healthy, energy efficient home. In particular, adequate ventilation systems must be properly installed and guidance given on their use and maintenance.

When improvements in energy efficiency are targeted at poorer people, the potential health benefits will be greatest. This can help reduce health inequalities and alleviate fuel poverty. When implementing home improvements in order to make houses more healthy and energy efficient, it is also important to consider the health impacts of other associated factors, such as increased housing costs, possible relocation of residents and changes to the neighbourhood.

Of particular relevance to INHERIT is the pivotal contribution of behaviours and lifestyles that people adopt when using their homes and the behaviour/choices of those who shape and implement policy. These matters must be accurately informed by knowledge and insight from many fields, not least the behavioural sciences. Regarding behavioural strategies to improve household energy efficiency, low-income households may be more willing to change energy behaviour in response to pricing incentives. Furthermore, the use of innovative in-home technology appears promising in reducing energy consumption as long as it is easy and convenient to use.

There is a wealth of policies and programmes at many different levels (regional, national, EU) aimed at increasing energy efficiency via housing improvements, awareness raising and engaging with consumers in innovative ways. However, there is a dearth of such policies and programmes that have health aspects integrated into them. Likewise, public health programmes are unlikely to incorporate household energy efficiency into their programmes. As the interaction between health, fuel poverty and energy efficiency is complex, it is important that the different sectors developing these policies and programmes work more closely together to ensure a more holistic approach. It is only thus that the INHERIT triple-win of improvements to health, health inequalities and sustainability can be achieved.

TEXTBOX 5.3
WHY HOME ENERGY EFFICIENCY IS CRITICAL TO THE INHERIT PROJECT

There is huge variety in the quality and energy efficiency of homes occupied by Europe's citizens. Implicitly these differences can underpin significant and hitherto intractable health inequalities within and between countries. In terms of health and environmental impacts, the promotion of energy efficient housing is promising, when making sure that occupant behaviour is taken into account. This can be established by combining upstream measures that change the quality of home construction or the availability of energy efficient alternatives, with downstream measures that aim to promote healthy energy efficient behaviour in the home. Since they lie at the root of many of the problems which INHERIT seeks to address, homes offer a unique opportunity to secure the triple win of health, well-being and sustainability. Research, summarised in this chapter, reveals the existence of many interventions of proven efficacy which can deliver INHERIT's aspiration of a triple win. It is about well crafted and integrated policies and, in large part, dependent on facilitating behavioural change amongst home occupiers and of course those who shape and execute policy.

CHAPTER 6
MOVING - ACTIVE TRANSPORT

6.1 INTRODUCTION

The number of cars in Europe is high and still increasing. The growing dependence on the private car and motorised transport damages people's health and wellbeing through air pollution, noise, accidents, division of communities by roads, sedentary behaviour and less social interaction. Traffic-related air pollution and noise contribute significantly to the disease burden in the WHO European Region, with a disproportionate disease burden in certain regions and less affluent parts of society (169) (170). Furthermore, motorised transport is an important source of greenhouse gas emissions, it causes congestion, temperature rise and puts a pressure on green and urban space (20, 171).

Available data show an average journey length for motorised transport between 9 and 22 km per day. These distances provide many opportunities to substitute motorised transport with more environmentally friendly modes of transport, such as cycling or walking, especially in urban areas. In the EU the mean proportion of the population using the bicycle is 8%, with 36% for the Netherlands (172). More physically active transport (cycling or walking) helps citizens to stay fit and enables them to remain self-sufficient and socially active. Importantly it is affordable and accessible for (almost) all helping them to increase physical activity, which, in turn helps to combat obesity, diabetes and cardiovascular disease. Where car trips are replaced by cycling or walking there is also a beneficial reduction in greenhouse gas emissions (GHG).

Investments in public transport and infrastructure, urban and transport planning, topography, socio-economic circumstances, cultural norms and individual preferences all influence how people move around. In order to shift away from a car-focused urban development towards active modes of transport, there is a need to change in policy, as well as individual be-

haviour. Policies and interventions which stimulate active transport via changing societal and individual behaviour hold potential to achieve 'the triple win' of promoting health, environmental sustainability and equity at the same time.

In this chapter, we will examine what the environment and health impacts of a modal shift towards active transport are, and how this can be promoted and implemented in practice by changing behaviours, taking into account differences between socio-economic and cultural groups. For the purpose of this review, active transport is defined as walking or cycling to and from work, school, shops/services, and leisure activities or to and from public transit stops. Cycling or walking for recreation is excluded. Neither will we address alternative transportation technologies, such as electric vehicles (except e-bikes), car sharing services or cleaner fuels, since these solutions do not stimulate physical activity.

This chapter starts with a description of important trends and drivers of motorised and active transport, as well as EU and national policies (6.2), followed by the environment, health and economic impacts of (active) transport (6.3). Inequalities and the role of behaviour with regard to developing interventions to promote active mobility are discussed in 6.4 and 6.5, respectively. Section 6.6 contains an overview of the effectiveness and impacts of policy strategies and interventions aimed at promoting active transport. Finally, potential levers for change and important success factors are discussed in 6.7.

6.2 DRIVERS, TRENDS AND POLICIES REGARDING (ACTIVE) TRANSPORT

By the year 2030, there will be an anticipated two billion vehicles worldwide (173). The number of cars on European roads is growing and leisure trips by road are becoming more frequent, longer in distance and shorter in time. The number of kilometres travelled by 32-EEA countries increased by 20% between 1995 and 2007 (2). Passenger cars accounted for 83.2% of inland passenger transport in the EU-28 in 2013, with motor coaches, buses and trolley buses (9.2%) and trains (7.6%), both accounting for less than a tenth of all traffic as measured by the number of inland passenger-kilometres (174). Figure 6.1 shows that car travel has increased significantly in the decade to 2012, but by 2012 had fallen below its 2009 peak (20).

Analysis of a nationally representative survey of UK residents in 2009/2011 showed that 69% of participants travelled to work using private transport, with public transport, walking, and cycling used by 16%, 12%, and 3%, respectively (175). The most used modes of transport on a typical day for EU28 are: car (54%), public transport (19%), walking (14%), bicycle (8%). Walking constituted the highest percentage share in Bulgaria and Spain (each 25%), while biking was most common in the Netherlands (36%) (172). Transport is responsible for a quarter of the EU's present-day GHG emissions and is also the only major economic sector in Europe where GHG emissions are higher than their 1990 levels. GHG emissions from transport increased slightly in 2014, following a period of decreasing emissions between 2008 and 2013 (171).

Important drivers for the ongoing growth in motorized transport and the small share of cycling are economic (work patterns, increase in distribution of goods by road), spatial planning (urban sprawl and development), distance to work and services (schools, health care), social (travel for family purposes, leisure activities) and behaviour. Below, we describe some of these driving forces in more detail.

The pattern of urban development over the past century has created a physical and social environment where dependence on car use has become the norm for accessing essential goods and services, as well as recreational opportunities (176). Urban sprawl and urban planning that favour shopping facilities in the urban periphery stimulate people to use their cars instead of other more sustainable options. Car traffic density is inevitably high in cities as a result of economic and social activities and urban planning patterns. This exacerbates the health concerns for visitors and residents particularly when there is little public or active transport provision (173).
Urban infrastructure which favours car use cars with a low number of cycling and walking- paths, impacts negatively on levels of physical activity. Residents of high-walkable areas were 1.8 times more likely to walk for transport than residents in low-walkable areas (177). The amount of walking has "declined in recent decades in parallel with the growth of car use" (178). Rates of active transportation to school have also declined dramatically over the past 30 years. Cross-sectional studies consistently show that distance is the strongest predictor of active transportation to school among children, with longer distances associated with lower rates of active commuting (179). Perceived

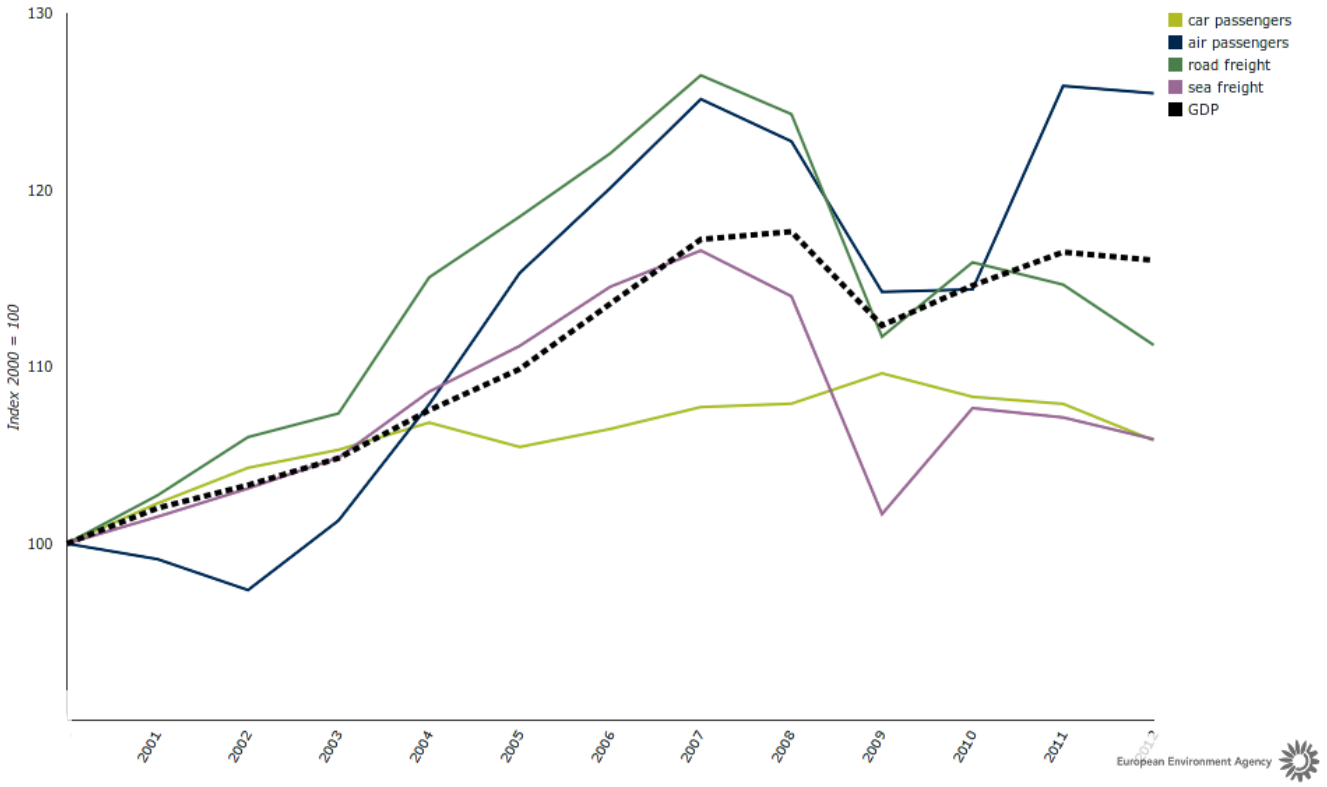


Figure 6.1 Growing demand for transport modes (EEA, (20))

safety risk is also a barrier to active transport for some parents (176). Individual behaviour is also an important driver. People's 'need' for convenient, comfortable, safe and fast transport is the main reason for the enormous increase in car use in recent decades (see also 6.5). However, there is evidence that the average speeds of cars in cities do not differ much from average speeds of public transport modes (173).

Overall, road transport imposes several negative externalities on society including inequalities, accidents, road damage, congestion and oil dependence. The costs of environmental externalities such as climate change are not reflected in current market prices in the road transport sector (173) (180). The total bill for traffic congestion, pollution and accidents for example has been estimated at EUR 502 billion per year across the EU Member States (173). Cars, and related roads and parking space, use up a large amount of the already limited space in cities that could arguably be used for other purposes such as trees, parks and green/natural spaces. Such spaces are frequently in short supply in cities despite offering considerable benefits for population health and wellbeing (173).

Despite the above, there is some indication of a parallel trend in the opposite direction. A cultural shift towards less car use in economically developed regions , especially with younger generations has been observed (Goodwin (181), in EEA, (20)) in some countries. In the Netherlands and Germany, for example, younger generations are less interested in owning a car or obtaining a driver license than their parents (345). Growing attention to strategic urban planning as a means of stimulating modal shifts towards walking, cycling and public transport to decrease mobility needs and to make sustainable modes of transport safer and accessible is another promising development (134) which will be addressed in the next section (see below).

EU transport policies

This section describes how existing policies and initiatives in the EU and INHERIT countries address active transport and seek to stimulate it. The EU Transport White Paper states that "facilitating walking and cycling should become an integral part of urban mobility and infrastructure design" (182) . As the ten-year period covered by the White paper drew to an end, the European Commission adopted a Communication, titled, 'A sustainable future for transport: towards an integrated, technology-led and user friendly system' (183). The

communication underlined the need to reduce greenhouse gas emissions from transport by 60 % in 2050. One of the key goals is no more conventionally fuelled cars in cities in 2050. The Roadmap to a Resource Efficient Europe describes how the European economy can be transformed in a sustainable economy by the year 2050. It presents complementary actions in the areas of nutrition, housing and mobility, the sectors that have most environmental impact. Sustainable Urban Mobility Plans (SUMPs) are emphasised in the Urban Mobility Package of the European Commission (184) and are now almost mandatory for EU cities (185). SUMPs are local level transportation plans that must contain a long-term and sustainable vision for cities, based on extensive processes of participation of citizens and stakeholders, and serve as a vehicle for the coordination of policies across sectors, in order to respond effectively to the mobility needs of people. SUMPs are expected to remain part of the policy agenda of Member States in Europe and contribute to achieving the European climate and energy targets. Nevertheless, the role of SUMPs to meet social equity issues (i.e. accessibility distribution) is less clear and there are some questions about potential tensions between social and environmental aspects (180).

In SIGNALS 2016, the EEA discusses ways in which Europe can be encouraged to choose greener transport modes (186). These measures include building infrastructure and creating common technical specifications for alternative fuels, so car users feel confident enough to use them; pricing, such as higher taxes for more polluting modes or subsidies and tax breaks for less polluting options; charging for infrastructure in the form of road charges, etc. Examples are introduction of bicycle networks in urban centres (a 100 km cycle ' Autobahn' in the Germany's Ruhr region), and 'smart mobility', linking mobility needs to IT and apps (186).

The WHO emphasises the importance of thinking beyond improved fuels and vehicle technologies when developing climate mitigation measures in the transport sector. They suggest a greater emphasis on land-use planning, making cities more accessible by walking, cycling and improved rapid transit/public transport. This will also enhance the mitigation potential of transport strategies. In addition, there is a need for land-use strategies that reduce the need for motorised travel, particularly by private modes, while promoting better access, especially for vulnerable groups (187). The topic of green and healthy transport, especially cycling, is also taken up by the Transport, Health and Environment Pan-European Programme (THE PEP), a joint initiative of WHO/Europe and the United Nations Economic Commission for Europe (188). THE PEP functions as an intersectoral and intergovernmental policy framework to promote mobility and transport strategies that link environment and health. Currently, it advocates a European Masterplan for cycling.

Policies and initiatives in EU countries and cities

The Netherlands has a rich tradition of policy to promote active transport modes. Since the seventies, there have been many investments in bicycle infrastructure and safety and programmes to improve urban and national bicycle conditions. Since 2010, there has been no national biking policy and municipalities and the provinces have the responsibility for the bicycle and pedestrian infrastructure. The national government promotes cycling and walking through bicycle measures in the programme Beter Benutten/Better Use. This programme is about innovative measures taken by state, region and industry to improve the accessibility of the busiest regions (see also figure 6.2). Through this framework, 300 km of bicycle 'highways' have been created. In 2016, a new national Agenda Bike was issued which aims at increasing the number of kilometres travelled by bicycle with 20% in 2027 (189). In the Programme 'Tour de Force' the Ministry of Environment and Infrastructure, provinces, municipalities and health services work together to develop vital municipalities and citizens by stimulating cycling (see also 6.6).

In *Norway*, the national walking strategy aims to make walking attractive for all groups and enabling the population to walk more as part of their daily lives. The national cycling strategy aims to promote cycling as a mode for transport and as an everyday activity and this strategy has its origins in the government's goal of more environmentally friendly transport. In the UK, there has also been increasing attention for active transport. The UK Department of Transport published a Cycling and Walking investment strategy 2016, in which they state the ambition to *"make cycling and walking the natural choice for shorter journeys, or as part of a longer journey"*. They aim to double cycling activity by 2025 (as compared to 2013); reverse the decline in walking activity; reduce the rate of cyclists killed or seriously injured on England's roads; and increase the percentage of children aged 5 to 10 that usually walk to school. Several measures have been implemented since 2008, including record investments in cycling to promote less polluting forms of travel. For 2012 until 2020, several additional measures have been confirmed or implemented, including extra low emissions zones (for central London), more cleaner buses, cleaner taxis, and measures to support adaptation, public health and to raise awareness. Interventions to encourage active travel include Beat the Street in Norwich, which aimed to encourage children aged 8-10 to walk and cycle around their local environment via the use of walk tracking technology linked to a reward scheme (191). National schemes such as Bikeability have trained children in cycling safely to encourage active travel – with those receiving such training being more likely to engage in cycling on a regular basis (192).

The *Swedish* National Board of Housing, Building and Planning, addresses physical activity and built environments in its "Vision for Sweden 2025" and in particular issues relating to urban planning, car-free zones and walkability; and, finally, transport policies (governed by the Swedish Transport Administration), affecting opportunities for physical activity and active transport, including children's travel to school. The needs of certain target groups – such as older people and those from lower socioeconomic groups – are primarily mainstreamed in

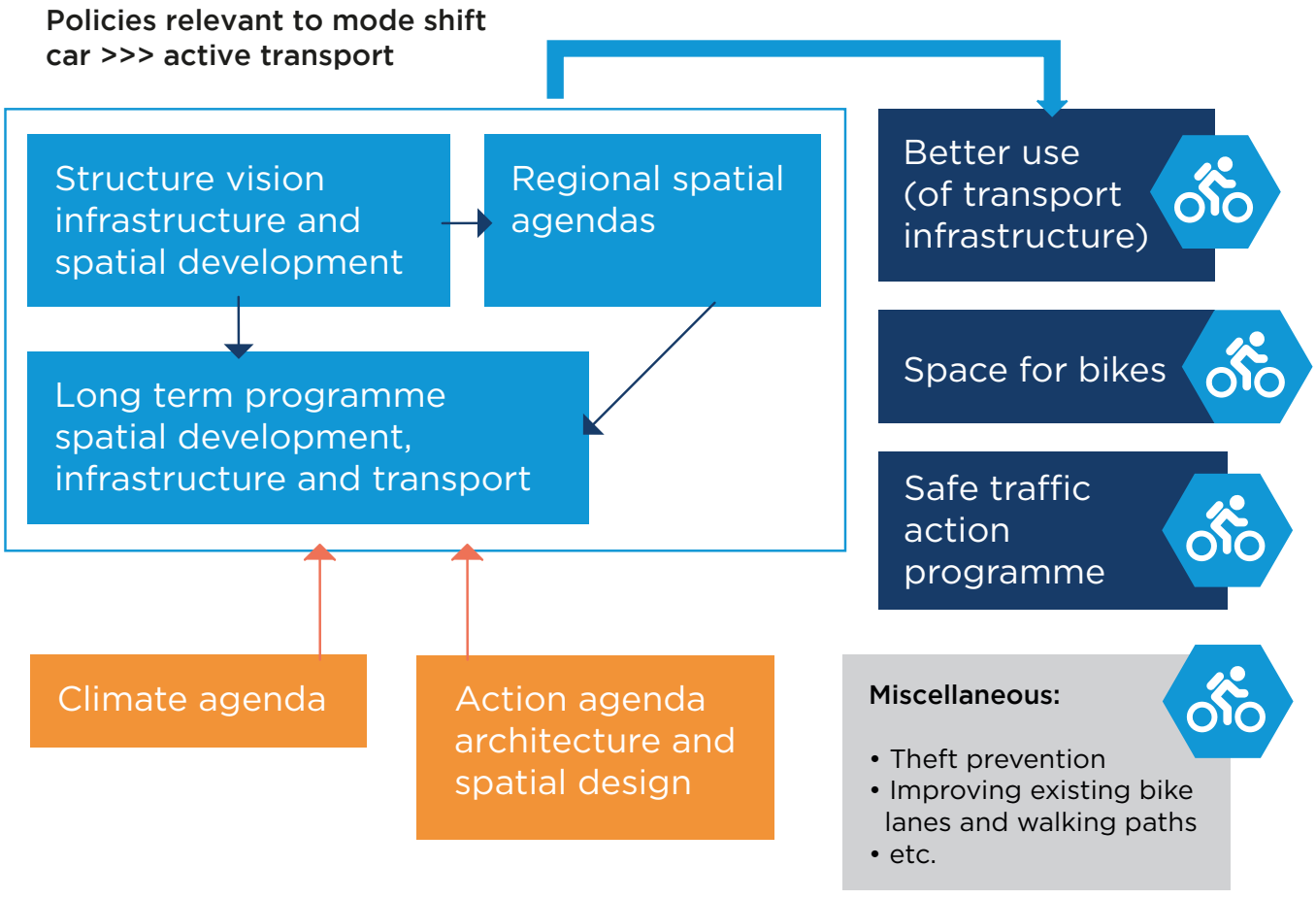


Figure 6.2 Transport policies in the Netherlands aimed at stimulating active transport (Source: Den Broeder et al. (190)).

Bikeability cycle training, UK.

these documents, rather than addressed separately. The *Macedonian* government's National Transport Strategy 2007-2017 aims to promote economic growth by improving the transport system. It includes the following objectives: improving safety of integrated and interconnected transport systems; improving public transport access and mobility and access to public facilities and services, especially for older persons and persons with special needs; improving road safety and improving the individual safety of road users. The *Czech* National strategy for Cycling Development aims to popularise the bicycle and to make it an equal, integral and inherent part of transport systems in "short-distance" cities. Strategic goals are to increase the modal share of cycling to 10% by 2020, to decrease the number of (fatal) accidents, to support cycling infrastructure construction, support a Cycling Academy project aimed at cycling in cities and agglomerations, and to support a cycling tourism initiative "Česko jede". At the local level, the strategy aims to increase the share of cycling in flat cities to 25% by 2025, to improve cycling paths and routes and remove existing obstacles, to improve safety and barrier-free access to cycling routes, and to improve accessibility of facilities in destinations for parking, storage and dressing and hygiene.

Hamburg, Helsinki, Madrid and Oslo have recently announced their plans to become partly private car free cities. Other cities like Brussels, Copenhagen, Dublin, Milan and Paris have different measures that aim at reducing motorised traffic including implementing car free days, investing in cycling and walking infrastructure, restricting parking space and securing considerable increases in public transport provision. Such plans and measures are being implemented with the aim of reducing greenhouse gas emissions (346). Hamburg, for example, plans a car-ban on a number of urban roads which will be transformed into routes for pedestrians and bikes that link parks and open spaces (about 40% of the city). These plans are being implemented accompanied with substantial green infrastructure investments with the aspiration of absorbing CO_2 and bringing the city closer to its goal of an 80% greenhouse gas emissions reduction in the next three decades.

6.3 ENVIRONMENTAL AND HEALTH IMPACTS

Environmental impacts of motorised transport and the shift to active transport

Motorised transport is one of the most important sources of air pollution (including particulate matter, ozone, nitrogen dioxide and polycyclic hydrocarbons), noise and greenhouse gas emissions in Europe. Forty one percent of the European (EU 27) urban population lives in areas where the EU air quality 24-hour Limit Value for particulate matter (PM10) was exceeded in 2010, while 7% lives in areas where the annual EU Limit Value for nitrogen dioxide (NO_2) was exceeded in the same year (20). Car traffic contributes to ambient air pollution in cities to an extent which varies depending on factors such as the car fleet make up, car density, traffic conditions and city lay out. Urban transport in European cities has been estimated to account for around 23% to 25% of the CO_2 transport emissions responsible for climate change (180) (20). Overweight or obese drivers in the UK were found to have cars that emitted higher levels of CO_2 because they travel further and tend to have larger cars (193).

Car drivers usually have higher levels of exposure to air pollution levels than bicycle users, but this is dependent on whether cycling takes place on busy or quiet roads. The TRAVEL study examined air pollution exposures of different groups of commuters in the city of Arnhem, the Netherlands. The air pollution exposure of cyclists was 40 and 35% lower on a low-traffic route compared to a high-traffic route for ultrafine particles and soot, respectively, but not for PM10 or PM2.5. PM10 and soot exposures of cyclists were lowest in comparison to drivers. However, because of their elevated minute ventilation, the inhaled doses of all air pollutants studied were higher for cyclists. (194, 195).

In 2011, 125 million citizens in Europe were exposed to traffic noise levels above 55 dB (20). Another, less direct, environmental impact of transport is temperature rise. The urban heat island effect is often observed where open, wooded or green areas have been replaced by concrete and asphalt for roads (173).

Replacing car trips by cycling or walking can positively affect air quality and noise levels (196,197). Airparif, which measures city pollution levels, showed that levels of nitrogen dioxide dropped by up to 40% in parts of the city on Sundays when cars were banned. When the Tour de France cycling event came to Leeds, NO_2 levels dropped by 20% on the day of the Grand Départ when cars were banned from the center and cyclists took over (http://airquality.thecitytalking.com). There are significantly fewer studies on noise and no studies on urban temperature changes due to car free interventions (173).

Health impacts of motorised transport

Motorised transport is associated with numerous adverse health outcomes through a variety of pathways. These include physical inactivity and accidents, as well as traffic-related environmental exposures including air pollution, noise, green space reduction, and local temperature rises. Motorised transport contributes to sedentary behaviour. Physical inactivity remains a common public health problem in high, middle and low-income countries, and in some cases, has even increased in recent years. In a review by McCormack and Virk (198) 8 out of 10 studies found a statistically significant positive association between time and distance travelled in a motor vehicle and weight status. Air pollution contributes to the premature death of about 600 000 people every year in the WHO European Region, with an associated cost of USD 1.6 trillion in 2010, and a disproportionate disease burden in certain regions and less affluent parts of society, increasing inequalities (11). There is substantial evidence showing that air pollution is associated with respiratory and cardiovascular diseases, even at very low exposure levels suggesting the absence of a threshold of no-effects. In addition, there is emerging evidence for other health impacts of air pollution like atherosclerosis, adverse birth outcomes (same magnitude as reported for passive smoking) and neurodevelopmental disorders (199). Recent calculations show that current air pollution levels (Particulate Matter) in the Netherlands lead to nine months loss in life expectancy, and 4 months due to NO_2 exposures (200). Also, at least one million healthy life years are lost every year from traffic- related noise in the western part of Europe (169). Health impacts of road traffic noise include sleep disturbance, annoyance and an increased risk of hypertension and coronary heart disease. Approximately 1.8% of all myocardial infarctions are attributed to road traffic noise in Western European countries. Road traffic accidents are the leading cause of death worldwide for children and young people. Between 2001 and 2013 road fatalities in the EU more than halved (from 54,900 to 26,000) but the trend has halted between 2013-2015 (201). Transport mode can also affect mental wellbeing; car commuters have reported higher levels of stress than train commuters and walking and cycling have been linked to greater levels of travel satisfaction than driv-

ing or public transport (202). Mobility and accessibility are the primary mechanisms through which the transportation system influences social wellbeing; the more difficult it is to travel (such as might be the case for older adults with impaired mobility), the more difficult it will be to develop social connections (202). On the other hand, high-volume roads can make activities more unpleasant and provide a physical barrier to social interaction. Replacing car trips by walking and cycling trips reduces CO_2 emissions, and would reduce air pollution and adverse noise effects. A negative consequence, however, may be an increase in traffic accidents.

Health benefits of active transport

Recent health impact assessments have shown great potential health benefits of switching to active transportation through increased physical activity and minor risks through air pollution and accidents (203). The greatest benefits are obtained when people switch from being non-active to doing some physical activity because the dose response relationship is steeper in low levels reaching a plateau at the highest levels of physical activity (204). Active transport will lead to more physical activity, unless already active people replace their physical exercise by e.g. cycling. Very strong scientific evidence based on a wide range of well-conducted studies shows that physically active people have higher levels of health-related fitness, a lower risk profile for developing a number of disabling medical conditions and lower morbidity and mortality rates form cardiovascular disease, obesity, diabetes, certain cancers, musculoskeletal and mental health problems than people who are inactive (205),(206). Numerous researchers have also examined the ways in which active transport can enhance physical wellbeing. Active transport has been linked to a lower body mass index (BMI) and decreased odds of hypertension, diabetes, and cardiovascular disease, even after controlling for sociodemographic variables and non-travel-related physical activity (202). Similarly, systemic reviews have demonstrated an inverse relationship between walking/bicycling and rates of obesity (175), although the results of other studies have been inconclusive (202). The Xu review found that active transport to work or school was significantly associated with improved cardiovascular health and lower body weight. However, the strength of the evidence varied from weak (mental health and cancer), moderate (body weight), to strong (cardiovascular health) (206,207). Active transportation to school may have important health implications for young people (179). Yet, in a review by Faulkner et al. (208) only one of ten studies that examined body weight reported significantly lower body weight in children who actively commute to school. Another study found that active transport is inversely associated with Body Mass Index (BMI), obesity, triglyceride levels and insulin levels (207). The odds of being obese or overweight were 1.4 times larger in low-walkable neighbourhoods than in high-walkable neighbourhoods. Residents of highly walkable neighbourhoods walked 80 min per week more than residents of a low-walkable neighbourhood (177). Active commuters have reported higher levels of satisfaction, less stress, more relaxation and a sense of freedom than car drivers (173). Active travel and public transport use can strengthen social capital by providing a safety net of transport options for (economically) disadvantaged groups and enabling social interaction with fellow-users during trips. Much like active travellers, it appears that public transport users have significantly higher levels of physical activity than car drivers. Most transit trips comprise a walking or cycling trip to or from the stop, which can help riders reach daily recommended physical activity levels. Saelens et al. in (202) reported that all public transport users attained similar activity levels on days when they did not use public transport, providing evidence for the direct effect of public transport on physical activity behaviour.

While the health and wellbeing benefits of walking and cycling are well-recognised, they must simultaneously be weighed against their attendant health risks. Even so, the risks of walking or bicycling appear to be far outweighed by their health benefits. A review of 28 studies around the theme of reduced car use and increased active transport showed that great benefits may be obtained for health, particularly through physical activity and that they outweigh the risk of air pollution and accidents (203). De Hartog (209) for example investigated the health impact of a substitution of 12.5% of the short-distance car trips by bicycle trips. Main results were a gain of 3-14 months in life expectancy as a result of increased physical activity, a loss of 0.8-40 days due to increased inhaled air pollution doses and a loss of 5-9 days due to increased traffic accidents. The estimated health benefits of increased physical activity due to cycling are substantially larger than the risks of increased inhaled air pollution and accidents (209). Van Kempen et al. (197) found similar results. Both studies observed a small increase in traffic accidents. Earlier research studies though point to the existence of a 'safety in numbers' effect, resulting in a rapid decline in accidents when the numbers of cyclists and pedestrians increase (202). This suggests that the continued encouragement of active travel modes will only serve to enhance their net health benefits (202). Woodcock

et al. (210) modelled the benefits of health improvement as well as CO_2 emission reductions for three future scenarios targeting an increase in walking and cycling and lower car use. This study uses an Integrated Transport and Health Impact Modelling tool (ITHIM) to evaluate the health and environmental impacts of high walking and cycling transport scenarios for English and Welsh urban areas outside London. Three scenarios were generated based upon the Visions 2030 Walking and Cycling project, but exactly how this change toward active travel could be achieved was not considered. Woodcock et al found considerable reductions in disease burden under all three scenarios. The largest health benefits were attributed to reductions in ischemic heart disease. Reductions in disease burden ranged from 1.8-4.1%, and reductions in CO_2 emissions, from 26-83% for the least and potentially most effective scenarios, respectively. The pathways that produced the largest benefits were, in descending order, physical activity, road traffic injuries, and air pollution.

Cost-benefit analysis

Recent research shows considerable health and economic benefits from active transport suggesting that these benefits outweigh the rather low costs of cycling promoting measures (237, 247). Grabow et al. (196) modelled the benefits from reducing automobile usage for short (≤ 4 km one-way) urban and suburban trips in cities in the Midwestern United States. Eliminating short car trips (<4km one-way trip) and completing 50% of them by bicycle would result in mortality declines of approximately 1295 deaths/year, including 608 fewer deaths due to improved air quality and 687 fewer deaths due to increased physical activity. The combined benefits from improved air quality and physical fitness for the region would exceed $8.7 billion/year. An added benefit of removing 20% of the vehicle miles travelled from the region is reduced emissions of GHG that cause global climate change (annual reduction >1.8 teragrams CO_2. WHO developed the HEAT–tool to calculate the economic value of health benefits that occur if more people cycle or walk (211). It is based on the value of a statistical life. Using the HEAT method, Rabl and De Nazelle (in (204)) found that, for a driver who switches to cycling or walking for a commute of 5 km (one way) 5 days/week 46 weeks/year, the health benefit from the physical activity is worth about 1200 €/year. It may be questionable though, whether a person would actually walk 10 km/day for commuting purposes (204). Based on a sample of 1209 respondents surveyed over a 12 month period (Feb 2010-Jan 2011) in East Belfast, UK, Longo et al. (204) found that a policy that increased walkability and people's perception of access to shops and facilities would lead to an increase in walking of about 36 min/person/week, valued at £13.65/person/week. Their results show that a policy that would produce an increase of about one quarter of the recommended amount of moderate-intensity physical activity (150 minutes per week of moderate-intensity activity) has an average annual value per resident of about £710. Public bicycle sharing initiatives such as Bicing in Barcelona (see textbox 6.1) show benefits outweigh the risks to health and also included reduced carbon dioxide emissions. The results of Bicing are in line with other assessments of risks and benefits of active transportation (197, 209, 210). These studies looked at hypothetical changes in choice of travel modes. Bicing built on previous studies by linking a specific and newly introduced policy in a real life setting to the effects on health.

Götschi, et al. (212) show that large, population level shifts in travel behaviour in England and Wales (comparable to the Netherlands or Switzerland) would translate into health impacts of significant magnitude. They estimated the health impacts from changes to physical activity that would arise if adults in urban areas in England and Wales adopted travel patterns of Switzerland, the Netherlands, or California. All else being equal, adoption of high rates of active travel comparable to Switzerland (walking) or the Netherlands (cycling) would result in the prevention of approximately 6–10% of all deaths caused by diseases associated with physical inactivity, and about 3–4% of all deaths due to all causes. Conversely, a shift towards somewhat lower levels of walking similar to California would result in up to 3000 additional premature deaths annually. The analysis presented uses empirical travel survey data to inform scenarios of shifts in travel patterns. The scenarios provide realistic population wide distributions of active travel by age and gender. For example, older age groups have higher health risks and therefore benefit more from relative risk reductions due to active travel. Increasing cycling to levels of the Netherlands means substantial increases in cycling in elderly and women (212).

Other economic impacts of a change to active transport

Lawlor in (173)) found a positive impact of active transport measures on business performance. Investing in better streets and spaces for walking can provide a competitive return compared to other transport projects. According to WHO, up to 435 000 additional jobs in green and healthy transport might be created every year and 10 000 lives would be saved if 56 major European cities reached the same modal share of

TEXTBOX 6.1
BICING IN BARCELONA

Public bicycle sharing initiatives such as Bicing in Barcelona have greater benefits than risks to health and reduce carbon dioxide emissions (213).

Bicing was introduced in 2007 to promote cycling as a common means of transport. By August 2009, 182,062 people had subscribed to Bicing (11% of the population in Barcelona municipality), with 68% of trips being used for commuting to work or school and 37% combined with another mode of travel. The mean distance travelled by Bicing on a working day was 3 km .The Bicing initiative is a policy measure that has been highly successful in terms of number of subscribers and led to a large increase in trips on bicycles, which would otherwise be hard to achieve. A previous study showed that interventions generally led to an average 3% increase in the prevalence of cycling in the population. Bicing so far has increased the number of cycling trips by 30%. Whilst subscribers to the scheme constitute an impressive 11% of Barcelona's population, this is tempered by the fact that only 1.7% are regular users.
A health impact assessment was carried out to estimate the potential effects on health of the scheme. Compared with car users the estimated annual change in mortality of the Barcelona residents using Bicing (n = 181 982) was 0.03 deaths from road traffic incidents and 0.13 deaths from air pollution. As a result of physical activity, 12.46 deaths were avoided (benefit:risk ratio 77). The annual number of deaths avoided was 12.28. Also, the potential reduction in carbon dioxide emissions from cycling instead of travel by car represented 0.9% of emissions from all motor vehicles in Barcelona in 2009.

cycling as Copenhagen already achieves. These long-term jobs would result from infrastructures and maintenance specific to active transport. WHO emphasises that *"Public Authorities play a major role in creating green jobs related to cycling"* (170). House prices in more walkable neighbourhoods are about US$4000 – US$34,000 higher than houses located in areas with average levels of walkability (204).

6.4 DIFFERENCES BETWEEN SUBPOPULATIONS AND INEQUALITIES

The levels of physical activity related to active transport (cycling and walking) vary substantially between countries, regions, and cities (212). Levels of cycling and walking vary depending on geographical and weather conditions, culture, age and gender (212, 214). A survey among schoolchildren in Norway showed large seasonal variances, with a high percentage of children cycling to school in autumn and spring (50%) and a low percentage in winter (348). Girls were less likely to be cyclists than boys. Children of parents with higher education were also more likely to cycle in autumn and spring (348). Modes of travel behaviour in major cities with good transport systems differ from that in regions and cities that are less well served by public transport. Laverty et al. (175) conclude that there are wide variations in the mode of travel to work across regions and socio-demographic or ethnic groups in the UK. A qualitative survey in France involving a small sample of households indicates that households in larger towns are less inclined to alter their mobility behaviour than those in cities. Explanatory variables are more limited access to services, insufficient public transport, professions which encourage car use and positive perceptions associated with cars (215). Differences can be observed in levels of physical activity, transport mode use and related health impacts across the socio-economic gradient. Low-income adults have the highest rates of physical inactivity; people at the top of the socio-economic scale appear to perform more leisure-time activity than those at the bottom of the scale. In addition, physical activity levels differ between age-groups and gender (205). Taylor argues that the availability of recreational facilities, the presence of sidewalks and bicycle lanes,

nearby parks and playgrounds, street connectivity, and accessible and safe places to be physically active differs by income level and race/ethnicity. The author reported a study finding that low-income and ethnic minority populations have limited access to physical activity-friendly environments (including safe, affordable, well-maintained, and appealing environments) compared to other populations. Higher median household income and lower poverty rates were associated with increasing levels of available activity-related settings (216).

It appears that interventions that improve the walkability of an area are particularly effective in increasing walking among already active citizens, and, among inactive citizens, the best response is found among healthier, younger and wealthier citizens. Longo et al. found that only 12.8% of the population, who were previously inactive, achieved the recommended levels for physical activity when a policy aimed at improving the walkability of areas in Belfast was implemented. Nevertheless, those who undertake low levels of physical activity (as compared with completely inactive adults) already have a reduced mortality and cancer risk. Thus, policies to improve walkability resulting in an increase in moderate-intensity physical activity by about 30 minutes would already contribute to widespread health benefits (204).

People with lower educational attainment, income and employment status are more likely to live near main roads with heavy traffic (30% compared to 15%). Subjects with low socioeconomic status are more often exposed to traffic and traffic-related air pollutants and, in consequence, more susceptible to experiencing related health effects (3, 217). Children, older people and people with chronic lung and heart disease are more vulnerable to air pollution. Predictably, those who exercise outdoors are also, but, depending on the air pollution levels, negative impacts are outweighed by the positive impacts of physical activity (209). In addition, children of low socioeconomic status and from less affluent areas tend to sustain traffic injuries to a greater extent than others. Vulnerable road users are most adversely affected by road traffic accidents. The highest accident rates in cities are generally for motorbike commuters, followed by pedestrians and cyclists. Thereafter, public transport commuters are most at risk and, finally, car commuters (Rojas-Rueda et al., 2012 in (173)).

Climate change mitigation strategies, such as reducing car use, may significantly affect accessibility levels, especially for vulnerable population groups, such as low income and single parent households, and persons with travel-related impairments (173)(180). Lee reported a higher risk of social exclusion among those who conducted fewer trips or activities. Similarly, a

decline in mobility has been associated with reductions in social integration and community activity. Given the declining functional capacities associated with the latter years of life, older adults are especially susceptible to mobility-based reductions in social wellbeing (202).

6.5 THE ROLE OF BEHAVIOUR

Significant improvements in health and carbon (CO_2) impacts from transport in the EU are only likely be achieved through behavioural change. Travel behaviour is not simply determined by price, speed and convenience but is also related to attitudes, status, and preferences and is conditioned by specific lifestyles (218). In analysing the determinants of behaviour, it is important to distinguish between individual and social factors (influencing capabilities & motivation), and between opportunities (physical environment) and motivation (see Chapter 3).

Individual and social factors

An analysis of mobility data showed that gender, age, education and neighbourhood typology are important factors influencing transport mode choices. Based on questionnaire data in the Netherlands, it was found that trips were more likely to be made by car if people had children and if a primary trip purpose (shopping etc.) was combined with other trip purposes, e.g. commuting (207). Another finding was the importance of individual perceptions of the environment. Irrespective of objective accessibility, perceived accessibility was strongly associated with transport choice (207). Based on these findings, Scheepers concludes that transport choice and route choice are habitual behaviours. Individual habits become representative of particular consumption settings and reinforce existing routines thus reducing the likelihood of change. Issues like expressions of personal identity, the perceived necessity of the car, and its role in maintaining convenience and time-saving, are all expressions of social practices, which have developed through both personal and social spaces of interaction. Barr argues that to answer the basic question of how we understand specific travel behaviours, we must first appreciate the driving forces for such behaviours at the level of social interaction and exchange (219). The results of an attitudinal retrospective survey show that there is a relationship between travel behaviour during childhood and walking behaviour during adulthood (349). These results suggest that an enlightened transportation policy at the childhood level could result in benefits not only during childhood but also throughout the life cycle of the individual.

Opportunities: Physical and social environment

When behaviour is habitual, people in general do not make rational or conscious decisions. Successful habit change interventions involve disrupting the environmental factors that automatically cue habit performance. Van Dyck et al. (220) studied walking behaviour of adult women in socio-economically disadvantaged neighbourhoods in Australia. Results indicate that transport-related walking time is significantly positively associated with the neighbourhood destination/connectivity (walkability) score, and significantly mediated only by the perception of the physical activity in the neighbourhood. In order to get socioeconomically disadvantaged women to spend more time walking it is important to improve objective walkability-related characteristics as well as perceptions of personal safety, favourable aesthetics, and neighbourhood social cohesion (220). A travel survey among a relatively affluent sample of commuters in Cambridge showed strong positive associations between short distance to work and not having access to a car and walking and cycling. Furthermore, those who reported that it was pleasant to walk were more likely to walk to or from work and those who reported that it was convenient to cycle on the route between home and work were more likely to do so. Strong perceived behavioural control associated with car use was negatively associated with walking. Taken together, these findings suggest that social and physical contexts of travel decision-making are each important and that a range of influences may require to be addressed to bring about behaviour change (221). In a follow-up study, Panter et al. (222) found a lack of empirical support for many of the putative predictors of travel behaviour change which had been suggested by findings from cross-sectional studies. Only interventions restricting workplace parking, providing convenient or pleasant routes for cycling or walking to work and convenient public transport were able to promote uptake and maintenance of active commuting (222). Prins et al. (223), in a natural experiment study, observed that changing the environment led to changes in health-related behaviour via use of the new cycling infrastructure but some commuters may actually have spent less time cycling due to improved accessibility.

Pro-environmental behaviour

Kahn and Morris (224) observed that people with 'green' values are more likely than others to be located in communities with high population densities and proximity to city centres and rail transit stations. These are all attributes conducive to environmentally friendly travel. Residents of green communities engage in more sustainable travel than residents of other communities, even controlling for demographics and the effects of the built environment. Green ideology may initiate and sustain green travel behaviour because greens derive utility from conservation or because greens locate in, or create, areas with characteristics that promote sustainable travel (224).

6.6 OPPORTUNITIES TO STIMULATE ACTIVE TRANSPORT

This section provides an overview of intervention strategies and measures to stimulate a shift from motorised transport towards active transport. It is based upon evaluations of interventions from the scientific literature, illustrated with examples from different INHERIT countries. The central questions are 1) how can people's transport behaviour be influenced in an effective way, and 2) what would be the impacts of these strategies on health, equity and environment (specifically, climate).
The Toronto Charter for Physical activity (226) stated that transport policies and systems that prioritize active transport are amongst the best investments for stimulating physical activity since active transport is the most practical and sustainable manner to increase physical activity on a daily basis. Measures to reduce car use and promote active transport can be broadly characterised as structural or psychological. Structural interventions involve modification of the physical and/or legislative structures that regulate travel behaviour in order to decrease the attractiveness for car travel and/or offer incentives and opportunities for use of non-car transport. Psychological interventions are designed to change perceptions, beliefs and attitudes and, thereby, motivate voluntary change in transportation choices.

Structural measures

Improving the infrastructure for walking and cycling has recently been identified as one of the most important policy recommendations for stimulating physical activity and tackling obesity (225). Such recommendations are largely based on evidence from cross-sectional studies (see 6.3) showing that certain characteristics of the physical environment—such as the design of residential neighbourhoods and the availability of routes for walking and cycling—may be associated with patterns of physical activity in general, and walking and cycling in particular (225). There is (scarce) evidence on the effectiveness of bicycle infrastructure on bicycle use. Scheepers showed, in a systematic review of 19 interventions promoting cycling that nearly all studies (except three) showed positive effects concerning a mode shift. However, information about the statistical significance of these results was often lacking and the study methodologies used were not

of high quality (207). Evidence on the beneficial effects on total physical activity through provision of traffic free walking and cycling routes is emerging from several European countries (204, 230, 347; see figure 6.3) Studies have shown a positive increase in cycling following city level programmes in England (193). The level of cycling is higher in countries that have a more cycling-friendly policy, dedicated investments and a safe cycling infrastructure. Developments of walkable streets and neighbourhoods, connected sidewalks, adequate lighting and visibility, restrictions and good access to public transport have all been shown to increase regular physical activity (50)(227).

Compact urban development can reduce commute distance and provide opportunities for active transport. According to Banister (228) main factors influencing travel distance are: size of the city, density (car use in high density location is half of that in low density locations), mixed use developments (facilities in proximity of housing), developments near public transport. Urban forms which enhance active transport would keep average trip lengths to below the thresholds required for maximum use of cycle and walk modes. It would also permit innovative mobility services and public transport priority, so that the need to use the car would be minimised. The effects of land use on travel behaviour tend to be cumulative and mutually reinforcing. A doubling on local density

TEXTBOX 6.2
BEHAVIOURAL CHANGE AND SOCIAL INNOVATION THROUGH REWARD: AN INTEGRATED ENGAGEMENT SYSTEM FOR PERSONAL MOBILITY, URBAN LOGISTICS AND HOUSING EFFICIENCY

The Behaviour Based Social Market (BBSM) game has been developed to stimulate (and measure) behavioural change through reward (232). The BBSM game engages three main groups of players: citizens and their families, local businesses, and public administration. Players choosing bike, public transport, or carpooling instead of taking a private car will be rewarded with points These points can be used to get energy benefits or vouchers for shops. Rewards for business could be more clients or advertising opportunities. The game is currently being developed and tested in a pilot project in the Municipality of Milano, where the focus is on citizen engagement and behaviours in the domains of personal mobility and energy. The system, by enabling mechanisms of collaboration, sharing and human capital generation, tackles the objectives of lowering energy consumption and promoting sustainable mobility and helps to create a more cohesive social fabric. The pilot is part of the Horizon 2020 project 'sharing cities'.

reduces car trips by 5% per capita (228).

The term 'travel plan' refers to behaviour change programs that aim to reduce single-occupant car use, and increase the use of alternatives such as walking, cycling and public transport, through a variety of structural and behavioural interventions. Hosking (176) reviewed 17 studies of travel plans. A shift towards less car use was reported in 10 of 17 studies. Travel plans and related interventions could potentially increase health inequalities, particularly if the success of their implementation differs between socioeconomic groups. Despite this, no studies presented data on the social distribution of effects, e.g. whether the effects of these interventions differed by ethnicity or socioeconomic status.
Goodman et al. (229) integrated self-reported questionnaire data and in-depth interviews from participants in a commuting study in Cambridge. The study showed the importance of combining individual-level healthy-travel interventions (e.g. restricting workplace parking) with broader measures aimed at making environments less car-oriented.

Psychological and behavioural measures

Arnott (230) found no conclusive evidence for behavioural interventions in a meta-analysis of 13 studies to reduce car use frequency. The evidence relating to efficacy of behavioural interventions to reduce car use distance and duration is limited and inconclusive. Results of this meta-analysis showed that studies which include more be-

TEXTBOX 6.3
PRACTICES IN THE NETHERLANDS AT LOCAL LEVEL TO STIMULATE BIKING

In the Programme 'Tour de Force' the Ministry of Environment and Infrastructure, provinces, municipalities and health services work together to develop "vital" municipalities and citizens by stimulating cycling. Information about 14 recent cycling projects has been collected.

Only a limited number of these projects have been evaluated (Van der Vliet et al, in preparation):

- Bicycle highway F35 in Twente (7% less car use)
- IJmond Accessible (2600 workers cycle one or more days per week to work; incentive was used)
- Rotterdamse Doortrappers (percentage children biking to school in low SES neigbourhood increased from 20 to 35% in one year; self-reliance played a role).

Factors for success were: a good connection to the world and culture of the target group, a smart link with ongoing projects (social, health or spatial plans) and local stakeholders, enthusiastic ambassadors, the use of incentives, fun and play aspects as well as innovative apps.
Conditions for successful cycling promotion projects are: financial (sufficient budget e.g. for incentives, bicycles, infrastructure), availability of good infrastructure (fast, direct, short, safe and attractive routes to work or school, bicycle parking), empowerment (teach target group to cycle and repair) and sustainability (maintenance of bicycles, train the trainer).

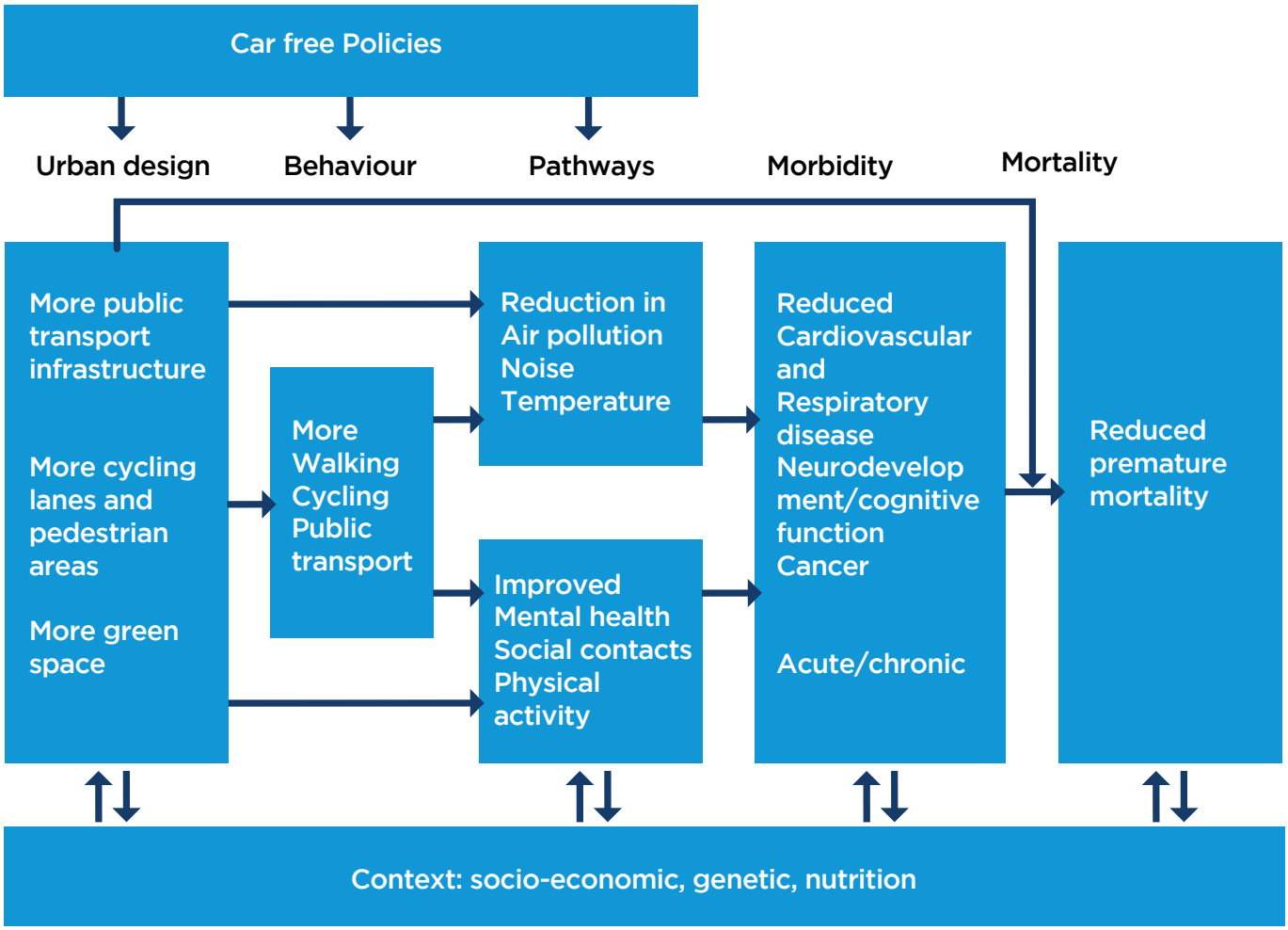


Figure 6.3 Linkage between urban and transport planning, active transport and health (Source: Adapted from Nieuwenhuijsen and Khreis (173)).

haviour change techniques have larger effect sizes. One promising technique may be to 'prompt generalisation of the target behaviour; this encourages individuals to generalise behaviour to new settings. So for example if they do not use the car for journeys to work they may be encouraged to no longer use the car for going shopping or to visit relatives. Other promising individual techniques are: 'providing information on consequences of the behaviour in general', 'goal setting', 'planning', 'barrier identification', 'problem solving', and 'information when and where' and 'how' to exercise a particular behaviour.

Interventions *changing beliefs and intentions* (such as travel-awareness campaigns) are unlikely to be an effective means to change behaviours that people have already formed into habits. The efficiency of awareness-raising campaigns can thus be unclear although still showing some effect (214). An intervention to increase walking, consisting of three motivational techniques, designed to increase self-efficacy, and three volitional techniques, which was designed to help translate intentions into action suggests that use of both motivational and volitional components is optimal in changing walking behaviour (231). Chillon identified 14 interventions that focused on active transportation to school (179). The interventions with the highest effectiveness shared two common elements: a strong involvement of schools through principals, teachers.

Ogilvie shows that targeted and tailored interventions are most effective. For example, subsidies to promote active travel, which focus on the most sedentary, and potentially include individual counselling (178). In order to be effective, interventions should target behaviours that have large and negative demonstrated impacts but are amenable to change. One should also take the demographics of the key group into account (see (220)) and use this to carefully select the type of intervention (56).

Mobile *lifestyle coaching applications* or other digital services can be developed which will help citizens make beneficial choices around mobility. The Behaviour Based Social Market game has been developed to stimulate (and measure) behavioural change through reward, making use

of digital services (see textbox 6.2). Citizen engagement tools like this can be used for co-designing mobility services and awareness raising (232).

Delivering lifestyle coaching messages through mobile phone applications helps people in adapting their behaviour in such a way as to lower risk factors (e.g. weight, inactivity) (350). All of the technology interventions that were supported by education or an additional intervention demonstrated a beneficial impact of mobile applications on reduction of physical inactivity, overweight or obesity. More rigorous trials that determine what parts of the technology or intervention are effective as well as establishment of their cost-effectiveness are necessary for further evaluation of smartphone and text messaging interventions (350). Recent systematic reviews have suggested that pedometers may be effective motivational tools to promote walking. However, studies tend to be of a relatively short duration, with small clinical based samples. Further research is required to demonstrate their effectiveness in adequately powered, community based studies. A 12-week pedometer-based walking program in a Scottish community sample found a positive impact on walking, but no significant changes in health outcomes (233).
Laschke and Hassenzahl (234) have developed "KeyMoment", a fun device that reminds and persuades users to take the bicycle instead of the car.

Martin et al. (235) explored the potential for *financial incentives* to encourage physical activity through active travel and influence related health outcomes. Results of this review show that more robust evidence is required if policymakers are to maximize the health impact of financial incentives to encourage physical activity. Most studies which were evaluated present evidence for a particular micro-environmental scheme, predominantly involving free bicycles or local road pricing at specific locations and generally within particular population subgroups. Negative financial incentives such as congestion charges are also described.

Training schemes, like Bikeability in the UK or the Rotterdam Wheelers in the Netherlands (see Textbox 6.3), can help encourage active travel. Bikeability aims to train younger children on how to cycle safely, confidently and frequently by a 3 tier training style (from cycling in a traffic-free environment, to single lane and multi-lane roads). Johnson et al (192) found that 58% of children who participated in a Bikeability survey in London claimed to cycle at least once a week, with 5% more trained than untrained pupils cycling frequently (more than once a week).

Impacts of promoting active transport on the 'triple win'

Graham-Rowe concludes in a review of the effectiveness of transport policy measures that complementary application of structural and psychological approaches may optimize effectiveness. Two of the interventions evaluated, which used psychological intentions or information to increase awareness on alternative modes for pre-planned trips, were particularly effective at reducing car driver or car passenger trips for those with a strong car habit. However, overall, the evidence base on interventions, which aimed to reduce car use, was found to be weak. Only 12 of the 77 evaluations were judged methodologically strong, and only half of these found that the intervention being evaluated reduced car use (236). The most effective interventions use integrated approaches that combine downstream strategies (for example teaching self-regulation skills) with upstream measures (for example changing

TEXTBOX 6.4
THE CONNECT2 -INITIATIVE IN THE UK

Connect2 consists of a programme of projects to build or improve local walking and cycling routes at 79 sites in the United Kingdom. The initiative is led by Sustrans, a charity that promotes sustainable transportation in various ways, including building infrastructure such as the National Cycle Network. Each Connect2 project involves a core landmark engineering project such as a bridge or crossing over a busy road, railway line, or river, which—together with the development or improvement of feeder routes—is intended to make it easier for pedestrians and cyclists to reach destinations in the local area. The Engineering and Physical Sciences Research Council is funding this 5-year research program to measure and evaluate the effects of Connect2. This program will enable the collection of consistent longitudinal data at multiple sites with which to assess, for the first time, the effects of an infrastructural intervention on outcomes of interest across the 3 domains of travel, physical activity, and carbon emissions. Subsequent articles will address more specific issues of sampling and measurement and the development of a complementary economic evaluation framework (225). http://www.sustransconnect2.org.uk).

cycling infrastructure or public transport subsidies) (51). In addition, policies designed to promote active transport will be more effective when they target important antecedents of behaviour (by changing perceptions, motivations and norms) as well as consequences that follow behaviour (by e.g. financial incentives) (56).

There is limited evidence from the study of interventions that shows that altering transportation infrastructure, or indeed other aspects of the built environment, has led to an increase in walking or cycling or a modal shift away from car use, let alone changes in overall physical activity or carbon emissions (225). The Connect2-initiative in the UK (see Textbox 6.4) is one of the few ongoing programmes studying the long-term (quantitative) impacts of infrastructural interventions on active transport, physical activity, and carbon emissions.

The benefits of stimulating healthy mobility (walking and biking) are much larger than the costs of intervention measures (29). The European Cycling Federation estimated the benefits of cycling based on the development of the active mobility agenda during the last years (237). According to their estimates the benefits are higher than Belgium's GDP. The ECF identified nine 'key issues' where the benefits of cycling become tangible, based on the three dimensions of sustainable development: the environment, the economy and social affairs (see Figure 6.4). Several cost-benefit analyses (CBAs), using different methodologies, including real-time travel surveys, show a large population health benefit if people assume the same active transport levels as in Switzerland (walking) of the Netherlands (cycling) (204)(212). Few studies have conducted a detailed CBA of cycling interventions implemented in practice (see 6.3). One example is the Bicing-initiative in Barcelona (see Textbox 6.1) which shows that implementation of bicycle sharing has greater health benefits than costs, and reduces carbon dioxide emissions. The EU-funded project TRANSPHORM found that the most efficient transport policies for improving air quality in urban areas and protecting climate are more use of bicycles and e-bikes (15-30 % of all trips in cities) leading to 30,000 DALYs gained per year in EU (238) (239). Economic benefits of several less-car mobility options including cycling, bicycle-sharing and walking were collected in the EU-funded project Evidence (evidence-project.eu).

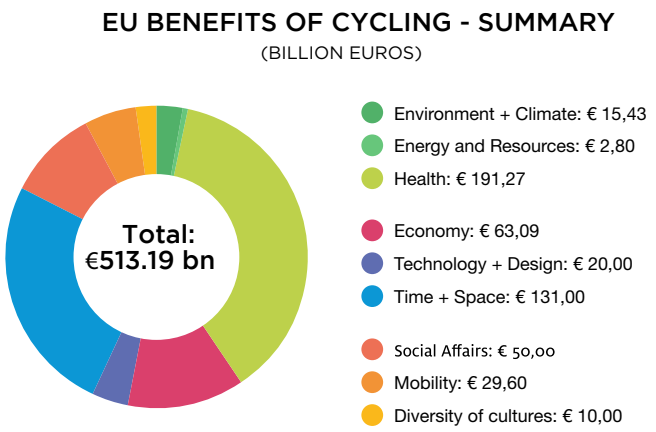


Figure 6.4 EU benefits of cycling (Source: Adapted from ECF (237))

The extent to which, and in what way, active travel patterns such as those in the Netherlands or Switzerland could be adopted more widely remains uncertain (212). Climate does not provide a good explanation of the differences in active transport levels across Europe. Although the Netherlands has a favourable topography for cycling, there are many flat areas in other European countries without much cycling. Probably of greater importance are a high quality, safe infrastructure which does exist in the Netherlands for cycling. Also, good synergies with public transport are important, as in Switzerland where public transport is fed by a huge number of walking trips and a generally supportive culture towards active travel (212). The advent of electric assist bikes also offers the potential to reduce the burden of cycling in hillier areas, cover longer distances to work and keep elderly people more active for longer. Gotschi, however, warns that higher levels of active transport do not automatically correspond with less car driving (212). Both the Swiss and the Dutch spend similar amounts of time driving as people in England and Wales, but less so for short trips. The concept of modal shift may oversimplify complex travel behaviours. Travel behaviour surveys suggest that "trip chaining" using multiple transportation modes is very common, particularly in large urban centres. Fuller observed that users of a Public Bicycle Share Programme (PBSP) in Montreal integrated walking, public transportation, and cycling and were unlikely to 'shift' entirely from one mode to another. Transportation engineers suggest that PBSPs are most advantageous for short trips in densely populated areas. Public health practitioner's promoting active transportation should encourage people to integrate multiple active modes of transportation rather than adhere strictly to walking or cycling (240). Thus, achieving high levels of active transport by reducing short car trips is not likely to be sufficient, alone, to lower carbon emissions, unless there is also a policy to tackle longer car trips. Technological solutions alone will not be enough to achieve the carbon dioxide emission goals set worldwide or to solve other sustainability issues such as traffic safety and traffic congestion. The necessary transition also demands behavioural changes, including reductions in car use (241).

Policies to enhance walking and cycling, reduce car use and mitigate climate change may also have negative impacts on equalities. These policies may well help to change the modal split away from the car, but may do little to enhance the accessibility levels for (e.g. elderly) persons who are unable to cycle or walk (180). Martens et al in (180) proposed the incorporation of an explicit equity principal in the goals of transportation planning. According to them, equitable transportation planning would maximize the average level of accessibility for all citizens while constraining the range or gap between citizens with the highest and lowest level of accessibility. An analysis of Sustainable Urban Mobility Plans (SUMP, see 6.2) shows a wide variation in the way climate change goals and equity were addressed. According to Arsenio, guidance is needed on methods to properly account for GHG emissions from urban transport and to balance social equity in accessibility (e.g. a common equity evaluation framework) through the SUMP process (180). Perceived risks are a major barrier to cycling and to some extent, also to walking. Increasing objective and subjective safety in a manner that does not detract from mode convenience should be considered by all policies to promote active travel. Also, increasing total travel times may be seen as undesirable and changing the relative time spent in active transport might be a more appropriate policy target.

Thus, a transition towards environmental and socially sustainable mobility is needed. The EEA shows, using the 'Avoid, Shift, Improve' framework, that this transition brings considerable environmental benefits as well as a major opportunity for jobs and growth in the transport sector. The 'improve' section of the framework notes that better efficiencies and technological factors have already affected the environmental performance of transport more than expected. However, greater benefits are only possible if 'shift' (towards other transport modes) and 'avoid' policies are also applied (171).

6.7 DISCUSSION AND CONCLUSIONS

Transport is responsible for a quarter of the EU's present-day GHG emissions and is also the only major economic sector in Europe where GHG emissions are higher than their 1990 levels. Motorised transport is associated with numerous adverse health outcomes through pathways of physical inactivity and accidents, as well as traffic-related environmental exposures including air pollution, noise, green space reduction, and local temperature rises. It also contributes to congestion and stress. If no additional measures are taken beyond those currently planned, it will be difficult for the EU to reach its targets for CO_2 reductions as well as its ambition 'living well, within the limits of our planet'. A transition to sustainable mobility is urgently needed. This literature review shows that measures to promote active transport should be accompanied by measures reducing car use and improving access to public transport in order to achieve the 'triple win' of improving health, environment and equity. Interventions that tackle the environmental, structural, and financial barriers to active transport have considerable potential to increase population levels of physical activity globally. In addition to the potential benefits of getting the sedentary active, increased active transport will lower air pollution, noise, and the likelihood of anthropogenic climate change, if accompanied by a reduction in car use. Stimulating of active transport also offers many opportunities for businesses and more jobs. Combined with good access to safe and efficient public transport, it will also enhance social interaction and wellbeing.

Strategies to promote active transport should be a mix of structural and behavioural measures:

1. *Pricing or other incentive based policies* (effective, incentive to use the bike to work or school, or not use the car)

2. *Legal measures* (only effective if these laws/regulations are accepted by most people and enforced, and violations are met with sanctions)

3. *Increase availability and quality /safety of bicycle and walking paths and change services* (closing city centres to motorized traffic, bicycle parking, better connection biking/walking-public transport, improved green infrastructure)

4. *Support people in adopting more active lifestyles by means of providing lifestyle coaching and training* (awareness raising campaigns are less effective but should still be included)

The literature review shows that the evidence base for effective interventions stimulating people to shift from car use to active transport is based mostly on cross-sectional studies. There are only a few studies of actual interventions showing the impact of changing transportation infrastructure or other aspects of the built environment on walking or cycling or a modal shift away from car use, let alone changes in overall physical activity or carbon emissions. This lack of evidence reflects several unresolved challenges in this area of research, including problems of measurement and evaluation.

The difficulty of measuring changes in walking, cycling, and physical activity is compounded by the difficulty of applying robust study designs to the evaluation of complex infrastructural interventions (225). Existing research in this field has an evaluative bias in favour of interventions targeted at individuals.

Innovations are needed with a potential to change travel behaviour in a fundamental way. These innovations consist not only of technological breakthroughs, such as electric vehicles and self-driving vehicles, but also new business models, fuelled by information technology (IT) developments (web applications, new mobility services, lifestyle coaching). Authorities at national, regional and local should pay more attention to policies that would make the built environment more conducive to integrating physical activity into daily life (e.g. infrastructure for cycling, facilitating walking to school, reducing speed limits, traffic calming measures in school proximity) (227). The transport, urban planning, environmental and health sector should work more effectively together in an early stage of planning in order to improve health and environment, in such a way that all population groups can benefit. It is necessary to do this on different levels, from the EU-level, e.g. with reference to the Roadmap to a Single European Transport Area (182), to the local transport and spatial planning policy levels (184). As transport policy and environment and health matters fall under the responsibility of different sectors and administrations at Member State and EU levels, it requires strong cooperation between and within these sectors to ensure that environment and health is fully taken into account (2). In closing, certain observations demand special emphasis, which are key to success in delivering the triple win through action on transport. Bannister has argued that, to create change, there needs to be an alternative that is strongly supported by both the politicians and the public. Leadership and strong governance structures are essential, so that longer term priorities are matched up with short term gains, and that investment and positive actions can be taken consistently over time. The basic dilemma facing cities in terms of mobility and climate change is that "we all like travelling and we are doing much more of it. Yet we are also aware of the environmental costs of travelling and our responsibilities both locally and globally. Our social networks are increasingly international and the global economy is also dependent on long supply chains. To some extent individual behaviour can be modified and we can substitute travel with technological communication. But in many cases there is no substitute for face to face communication, and we want to see the world and to meet people. It presents a classic case of the conflict between individual preferences and choices, as opposed to the wider needs of society to protect the environment and future generations" (228).

TEXTBOX 6.5
WHY TRANSPORT IS CRITICAL TO THE INHERIT PROJECT

Promoting active transport can lead to considerable benefits for health, environment, economy and equity in a very cost-effective way. Significant reductions of CO_2 emissions by transport in the EU can only be achieved through behavioural change. Accordingly transport deserves to be an important focus for INHERIT and its desire to deliver the triple win and where its contribution in informing policy may gain real traction. Measures to promote walking and cycling should be accompanied by structural and behavioural measures to change habits and reduce car use. Investments in e.g. public transport and bicycle and pedestrian infrastructure combined with tailored and targeted behavioural change techniques can help achieve the behavioural change towards less polluting modes of transport. Sustainable transportation strategies should also maximize the average level of accessibility for all citizens, thus ensuring equity.

CHAPTER 7
CONSUMING (FOOD& BEVERAGES)

7.1 INTRODUCTION

Globally, two billion people are suffering from the consequences of overconsumption and obesity typically manifesting as non-communicable diseases (NCDs), such as heart disease, cancer, diabetes and chronic respiratory diseases (242). Current diets often contain a large number of animal products, highly processed foods and little fruit and vegetables. This type of diet plays an important role in the development of NCDs (243). Global Burden of Disease studies estimate that nutrition-related risk factors such as overweight/obesity and inadequate fruit and vegetable consumption cause 25% of disease and disability each year (244). Importantly, human food consumption and environmental sustainability are closely connected, with current levels of (over)consumption having a large impact on our planet. Agricultural intensification, globalisation of our food systems, population growth, urbanisation and an increase in average wealth with accompanying lifestyle changes have altered food production and consumption in ways that negatively affect our health and our planet (245). Current food production and consumption contribute to 20-30% of the European Union's total greenhouse gas (GHG) emissions, with production and consumption of meat and dairy products having the largest environmental impact. The global population is expected to rise to over 9 billion people by 2050, with escalating demands for the most-resource intensive food types (meat and dairy). A troubling forecast is that our demand for animal-based products will increase by 70 to 80% between 2012 and 2050 (246). Because food is imported from around the world, with an increasing number of 'food miles' (the distance between where foods are produced and eaten), the impacts of European consumption patterns extend beyond European borders, causing environmental and resource degradation to societies outside Europe (134). A related unsustainable consumption behaviour is the enormous amount of food waste: in developed countries, the major contribution to food waste comes from households (247). Changing food and food waste behaviours is challenging, due to the complex nature of these behaviours and the many factors that influence them (54). The current food system fuels inequity, with obesity and related health impacts being more common among minority and low-income groups, due to inter alia, differences in diet and caloric intake (248). The close relationship be-

tween socioeconomic status and health and the greater divide between those with low and high socioeconomic status presents a threat to social cohesion (249). In addition, lower income groups are affected more by adverse effects on sustainability now and in the future (e.g. food scarcity and rising food prices) (134).

Consequently, there is a high need for a shift towards healthier, more sustainable diets and lifestyles: *"Those diets with low environmental impacts that contribute to food and nutrition security and to healthy lives for present and future generations"..."These diets do not damage biodiversity and ecosystems, are culturally acceptable, accessible, affordable, healthy, and optimise resource use"* (245).

This chapter will focus on the consumption of food and non-alcoholic beverages. In section 7.2, important trends and drivers of food consumption and food waste in Europe are described, including policy developments. Section 7.3 describes the components of a healthy and sustainable diet, discussing health and environmental impacts of our current diets and alternative diets, including food waste. Sections 7.4 and 7.5 discuss the issue of inequity and the behavioural aspects of food consumption and food waste. In 7.6, theoretical and practical solutions to change these behaviours are presented. Finally, potential levers for change and important success factors are discussed.

7.2 TRENDS, DRIVERS AND POLICIES REGARDING EUROPEAN FOOD CONSUMPTION AND WASTE

Current food production is highly globalised and industrialised, with intensive agriculture and steeply climbing yields per hectare, standardised products and availability of food throughout the seasons. Most European countries have relatively low food prices and high access due to these changes in food production and globalisation. This allows us to have an extensive choice in foods, including a variety of fruits and vegetables throughout the year (249, 250). Current food supply is one third higher than required for a healthy diet, stimulating overconsumption (249). In the EU, the caloric intake has increased by 17% since the 1960s, with Mediterranean countries catching up or even overtaking Central and Northern European countries (251).

In addition, there are some general food-consumption trends in most EU countries, which have both negative health and environmental impacts. The increase in meat and dairy consumption is one of the most important developments. In most Western industrialised societies, including European societies, eating large amounts of meat is a widespread, shared and valued practice to which consumers feel entitled. In addition, some developing countries have a cultural history of high meat consumption, and other developing countries appear to be moving towards this meat-eating standard, with income increase being a key predictor of the amount of meat consumption of a country (252). Besides this high consumption of animal products, Reisch et al. (249) identified two other main drivers of our unsustainable food consumption, namely high loss of biomass from field to table (including food waste) and the great distance between consumer and producer, both in transport distances and in perception. Farmers sell their products to large supply chains instead of providing local markets, causing consumers to feel a great distance from how and where their food is produced. This reduced familiarity with how food is produced and how it impacts the environment, leads consumers to value food less than in the past, which, in turn, makes them more apt to throw food away (253).

In addition, shelf life and preservation of the quality of foods have been improved by food processing, with highly processed foods contributing between 60 and 80% of average energy intake in some European countries (254). However, many processed foods contain high levels of fats and sugars. This is a function of demand for convenience by consumers and desire to offer a lower price to consumers: fats and sugar have a relatively low price per energy unit, compared to healthier and more sustainable fruit and vegetables (254). Energy-dense foods may be preferred because they are cheaper than the more nutritious foods. Horgan et al. (255) point out that high fat and sugary foods are often eaten for sensory pleasure, making it challenging to remove them from current dietary intakes for health and environmental reasons. This is also one of the challenges that the food industry faces: providing what consumers want to buy (they need to make a profit) versus what is important from a public health and sustainability perspective, and recognising that there is tension between these two (256). There are initiatives such as the Responsibility Deal from the UK Department of Health, which focuses on development of partnerships with food industries to more effectively exploit the large influence the industry can have on consumers. However, not all food industry companies are committed to

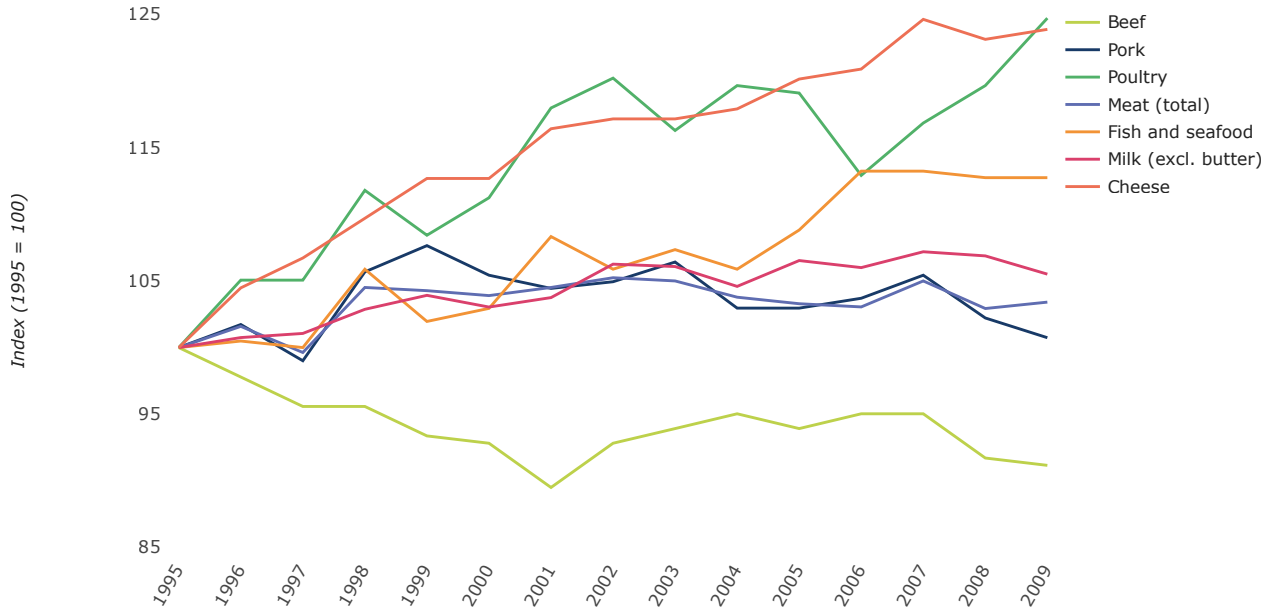


Figure 7.1 Per capita EU-27 consumption of meat, fish and dairy (by weight) (Source: EEA (258))

health and sustainability goals and, instead, are mainly motivated by profit making. World Health Organization (WHO) estimates show that inhabitants of more than half of European Region countries consume less than the recommended 400 grams of fruit and vegetables per day (257). See Figures 7.1 and 7.2 for EU food consumption, including meat, fish, dairy, fruit and vegetables.

Another noteworthy development relevant to health and environmental impacts is increasing portion size. Although food portions in the US tend to be larger than those in Europe, an increase in portion size is now evident in Europe. Portion size has reportedly been shown to increase consumption levels by at least 30%, which presents both a threat to health and the environment (260). According to Drewnowski (261), the general rule to achieve a more sustainable diet is the reduction of food intake (by consuming less energy-dense foods, caloric beverages and alcohol). Moreover, overconsumption, combined with a tendency to throw food away when it is still edible, leads to a global food waste contribution of 17% by EU-27 countries (whose population represents 7% of the world population) (262).

In addition, there is a growing demand for processed or pre-cooked meals as people are less willing to spend much time on buying and cooking food. Moreover, people eat more fast foods, they eat more, and they also eat outside the home more often. On the other hand, there is greater interest in health-oriented, organically grown and fair-trade foods (however, purchasers often come from higher educated, higher income groups). In reality however, the market share of such foods remains relatively small, comprising about 1% of global agriculture production (249) (263). The Chicago Council predicts that diet-related NCDs will rise by 15% by 2020 if people continue to over-consume highly processed foods and adopt increasingly inactive lifestyles (245). Population growth forecasts make clear that there is a need for improving both the

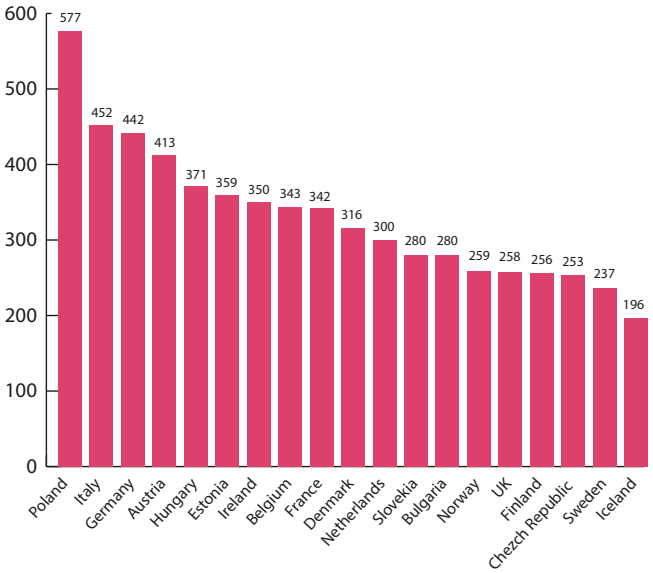


Figure 7.2 Mean fruit and vegetable intake per country (in grams per day), excluding juices. (Source: EFSA (259))

quality and environmental sustainability of our food system (245). Currently, the global food system is producing enough food to feed the planet. However, issues of accessibility, affordability, cultural acceptability and nutritious food represent an abiding challenge (245).

Policy developments

Clonan and Holdsworth (264) advocate a broader view on nutrition interventions and policies, which integrates the eating, growing, purchasing and cooking of food. This, they argue, will lead to a better link between healthier diets and attitudes towards sustainable food. Focusing only on healthy diets does not substantially reduce the average GHG emissions of food consumption. For example, new dietary guidelines are needed that incorporate recommendations that will reduce environmental impacts (255). This section will present some of the European food policies and strategies that integrate health and sustainability.

> In a recent report, Karl Falkenberg, Senior Advisor for Sustainable Development to the President of the European Commission, addressed sustainable agriculture and sustainable and healthy food as follows: *"European citizens should all have the right to quality food produced with environmental, social and economic considerations in mind. There are plenty of successful examples of producing in a more sustainable way: food production that provides jobs, that is economically profitable, that supplies food that is healthy for people and nature".*

The 'Strategic Note' Sustainability Now! A European Vision for Sustainability was issued by the European Political Strategy Centre (EPSC) in July 2016. This paper *"seeks to assess the stakes, argues for new forms of governance and addresses a limited number of sustainability hotspots"*, including economics, agriculture and the blue economy, which emphasises access to necessities such as health and education through implementing a local system of production and consumption based on what is locally available. Within the agriculture 'hotspot', Falkenberg discusses that *"Healthy choice is about ensuring the existence of healthy options for the consumer.* He refers to the Commission's Strategy on Nutrition, Overweight, and Obesity-related Health Issues adopted in 2007 and points out that the agricultural sector is also focusing their debate on nutrition, health, environment/ climate impact and consumer perception. *"These are key elements to be integrated on equal footing in the shape of the next reform of the Common Agricultural Policy."* (15). He refers to the second Sustainable Development Goal, which explicitly refers to ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture.

The Common Agricultural Policy (CAP) is one of the oldest EU policies and regularly undergoes reforms to adapt it to ever changing needs in the field of food production and rural development. It is also a significant policy in terms of budget; in 2014, almost 40% of the total EU budget was spent on the CAP (265). In 2013, the last reform of the CAP was accepted, which aimed to strengthen the competiveness of the sector, promoting sustainable farming and innovation and supporting jobs and growth in rural areas (266). An example of a regulation of the European Union under the CAP that integrates health promotion and environmental sustainability is the scheme for school milk, fruit and vegetables ((Regulation EU No 2016/791; (267)). It will apply from the 1st of August 2017 and aims to increase children's milk, fruit and vegetable intake and it promotes healthy eating habits early in life (268). The Regulation obliges Member States to choose products based on *"health and environmental considerations, seasonality, variety and the availability of local or regional produce, giving priority to the extent practicable to products originating in the Union"*. The Member States also have the possibility to *"encourage in particular local or regional purchasing, organic products, short supply chains or environmental benefits."* The distribution of the products has to be accompanied by educational measures with a view to reconnecting children with agriculture. These educational measures may also address healthy eating habits, local food chains, organic farming, sustainable production and food waste (269).

Food waste and the sustainable production and consumption of food are also central themes in the EU's seventh Environment Action Programme (7th EAP) and the European Commission Communication Roadmap to a Resource Efficient Europe (see also Chapter 2). The Roadmap to a Resource Efficient Europe highlights the food sector as the priority area for action on sustainability. The Commission calls for: *"...incentives for healthier and more sustainable production and consumption of food and to halve the disposal of edible food waste in the EU by 2020."* (270). Some European countries, such as Germany and Sweden, have already integrated health and sustainability in their dietary guidelines. In Sweden, the new 2015 guidelines from the National Food Agency (271) are about both healthy and sustainable food. It gives advice on how to adopt successful eating habits that are both sustainable and healthy (*"Eat greener, not too much and be active"*). The guidelines recommend

choosing seasonal, local, and, if possible, organic fruit and vegetables; consuming less meat and fish; and considering packaging. The German advice also advocates purchasing fair trade certified produce wherever possible (264). In 2015, the Dutch Food Agenda for sustainable, healthy and safe food was released. With this agenda, the Dutch Parliament aims for a more sustainable food policy, in which public health, ecological sustainability and safety are central. To implement this policy, cooperation with business and society is needed (272). Moreover, the RIVM recently published a report about safety, health and ecological sustainability of foods in the Netherlands, pleading for integrated food policy and an encouraging, facilitating role for the government regarding initiatives from citizens and companies (16).

However, there remains a need for a coherent policy framework, as health and environmental policies seldom link to one another. Especially given the power and dominance of the European industry, governments now tend to restrict themselves to play only a marginal role and to use non-interventionist measures. They typically stay away from implementing strict national food policies that incorporate sustainability. An example is the European Union's request to Sweden to withdraw their climate-friendly food choices as they are at odds with EU trade goals (249).

7.3 ENVIRONMENTAL AND HEALTH IMPACTS

What constitutes a healthy and sustainable diet? Based on a substantial body of research, Garnet et al. (242) suggests that healthy sustainable diets are centred on tubers, whole grains, legumes, fruit and vegetables, with small amounts of animal products such as meat and dairy, and only small quantities of fish from certified resources. In addition, they recommend a very limited consumption of processed foods high in fat, sugar and salt and low in micronutrients (snacks and sugary beverages). In this section, the health and environmental impacts of current and alternative healthier and more sustainable diets are presented.

Environmental impacts

The global food system currently accounts for 30% of all anthropogenic GHG emissions (245). The greatest environmental impacts from food stem from the primary production stage of agriculture, which amounts to 30% of the food sector's total energy demands. Nearly half of GHG emissions from primary production for food consumption is due to the production of cattle feed (249). Our food production and consumption contribute 20 to 30% to the European Union's total GHG emissions. Considering total food production and consumption, meat and dairy products have the largest en-

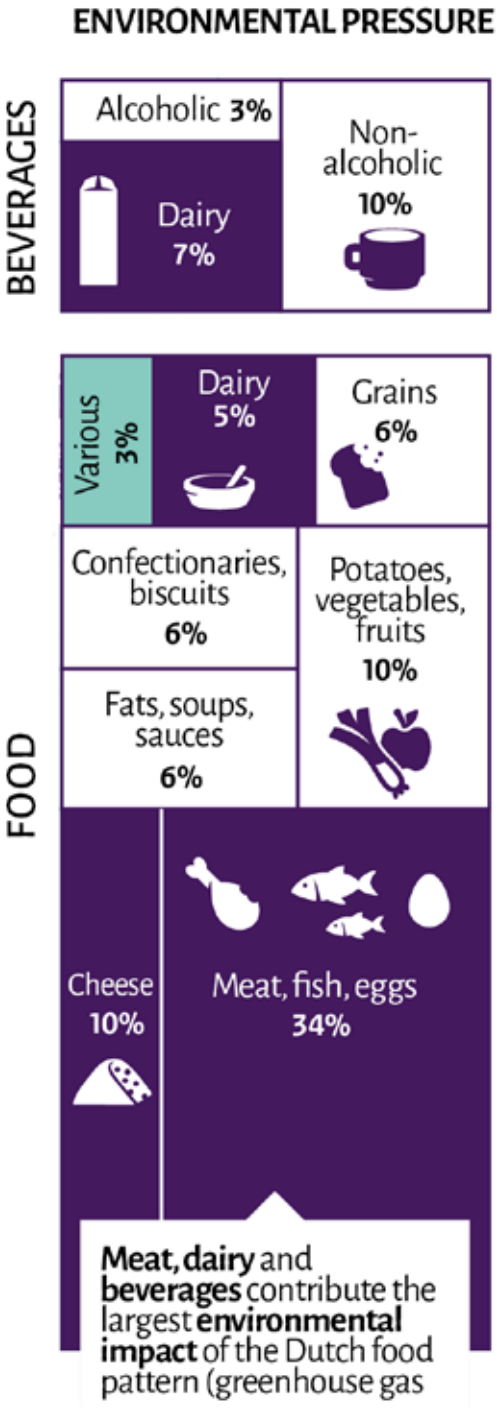


Figure 7.3. Environmental impact of food groups of the Dutch diet. (Source: RIVM (16))

vironmental impact, comprising 50% of GHG emissions, 80% of land use, the bulk of global water use and contributing to biodiversity loss (243, 249, 273). See Figure 7.3 for the environmental impact of Dutch food groups in terms of greenhouse gas emissions. Climate change effects will result in adverse weather conditions. In this regard, complex supply networks allow access to food all seasons of the year, but this infrastructure and its primary producers (farmers) may be damaged by adverse weather conditions. In developing countries, staple crops can fail or be destroyed, pushing their food security status into crisis (274).

One of the largest contributors to global warming is the expansion of agricultural acreage by land clearing (246). Meat-centric meals have been found to generate about nine times higher GHG emissions than plant-based equivalents, and beef and cheese have even been found to be 10 to 20 times higher (275). In European life cycle assessment studies, meat-free scenarios were found to be between 18% and 31% lower in GHG emissions than the average diet (275). In addition, it requires a lot less agricultural land to produce foods such as lentils, peanuts and beans compared to sustaining cattle (276). However, as Drewnowski pointed out (277), when taking into account the nutritional value and not just carbon footprints of diets, there appear to be some differences in what exactly constitutes a sustainable diet, as the most nutrient-rich diets are not the most sustainable, and the most sustainable diets are not necessarily the most healthy (from a nutritional point of view). For example, ingredients (e.g. vitamins, micronutrients) found in meat and dairy products may be of higher nutritional value per calorie compared to more sustainable diets. However, protein-rich alternatives such as lentils, beans, peanuts, soybeans and tofu have been suggested to contain the necessary micronutrients to make them good meat alternatives, but with lower carbon footprints (276). An alternative protein source for human food and animal feed is edible insects. In Western countries, consuming insects as food is not (yet) generally accepted, but there is a growing interest in edible insects (278). The substitution of meat by edible insects will have positive environmental impacts, with lower GHG emissions, higher feed conversion efficiency and lower land use.

Regarding fish consumption, there is a conflict between health and planetary benefits. As mentioned above, the beneficial health effects of fish consumption lead to fish being recommended in diets (although Brunner (280) doubts these beneficial effects and mentions risks of fish contamination, for example, from mercury. However, if all Europeans consumed the recommended amount of fish that is good for health, this would result in depletion of fish stocks and harm to the marine ecosystem (280). Fish is therefore not an ideal substitution for meat and to minimise environmental damage, only small quantities of fish from certified sources should be eaten.

Westhoek et al. (281) studied the large-scale effects of replacing 25 to 50% of animal-based products with plant-based products in the European Union, and found that halving the consumption of meat, dairy products and eggs would result in both positive health and sustainability effects. Because of a decrease in livestock production following the reduced demand for meat, there would also be a reduced demand for animal feed and land use needed for forage. If global dietary patterns changed in this way, only 30 to 40% of the currently cultivated crops would be needed (282). In addition, estimates show that a non-vegetarian diet requires 2.9 times more water, 2.5 times more primary energy, 13 times more fertiliser and 1.4 times more pesticides than a vegetarian diet (283). Adopting either a Mediterranean, pescetarian (eating fish, but no meat) or vegetarian diet may reduce these impacts per capita by 30%, 45% and 55% (283).

Seasonal foods

Another strategy enabling more sustainable food consumption, is to eat foods that are produced in season or produced and consumed in the same climatic zone and season (global or local seasonality). Consumers appear more willing to eat only seasonal fruit and vegetables than to reduce meat intake, believing the former will have greater environmental benefits. It is important to realise this when designing interventions (284). However, many trade-offs need to be considered when addressing food consumption and seasonality. Relying on local seasonal food year-round could reduce fruit and vegetable consumption, but the environmental impacts on water stress, land use change and biodiversity could be fewer than for a globally seasonal diet. However, local seasonality could limit international trade with implications for economic stability and resilience within the global food market (284). Moreover, locally produced foods do not always have a lower carbon footprint than imported foods, depending on production, transportation and storage processes which can raise GHG emissions significantly (local in-season fruit might also be stored and eaten out of season) (285). Regarding food mile reductions, it is important to take into consideration that consumption of local goods only reduces emissions when the region of production has relatively low emission intensity, because transport emission reductions can be counteracted completely when emission intensity of production is high in a local region (286).

Food waste

Another sustainable food behaviour, is reducing food waste. Reducing food waste can reduce the environmental impacts from our food consumption (287). About 20% of total food produced is wasted in the EU and households contribute the most, 53%, to this food wastage (288). Large parts of the food waste generated in the world contain food that is still suitable for human consumption (289). Although meat and fish have lower avoidable waste rates than other foods such as fruit and vegetables, Coelho et al. (287) found that animal foods dominate environmental waste impacts from average diets. Regarding nitrogen losses to the environment, food waste contributes about 12%, of which 50% is lost due to the waste of meat (262). This enormous amount of food waste stems from several factors, including poor menu planning and lack of knowledge of efficient buying, storing and preparing food on the side of consumers, to the large package sizes and quantity discounts by producers and retailers (249). In addition, the rising number of one-person households drives food waste, because food is often only available or is cheaper if purchased in larger quantities, stimulating people to buy too much. Additionally, recipes are often written for multiple people (247). Estimates about avoidable emissions from end-consumer food waste range from 0.8 to 4.4 kg CO2 equivalents per kg (the extent to which a gas contributes to global warming) of prevented food waste. These benefits stem mainly from avoided food production and related services, as opposed to reduced waste (289).

Health impacts

Our high meat consumption has great health impacts such as an increased risk of cancer, diabetes and heart disease. Globally, close to a million premature deaths are attributable annually to the high levels of processed meat consumption, and tens of thousands more premature deaths are related to the overconsumption of red meat (11). Vegetarian diets have been shown to have significant benefits on blood pressure, blood sugar levels and body weight and cardiovascular disease risk (290). Furthermore, fish is an important source of protein and essential nutrients such as omega-3 fatty acids. However, most Europeans eat fish below health recommendations (242, 276). Fruit and vegetables are full of healthy fibres, contain fewer calories and less fat than other food products (242). The current low levels of consumption of fruit and vegetables are associated with increased mortality risks from all causes and from cardiovascular diseases (291). Moreover, processed, energy-dense products contain high levels of sugar, fat and salt, which are damaging to health and lead to overweight and obesity and diabetes (242).

7.4 DIFFERENCES BETWEEN SUBPOPULATIONS AND INEQUALITIES

There are great health differences between and within populations, with those having low socioeconomic status often having less healthy eating behaviours. European countries with higher levels of income inequality have higher levels of obesity, and the fastest rise in obesity prevalence is among low socioeconomic groups (292). Available evidence suggests that the main driving force behind the obesity epidemic in lower socioeconomic groups is increased energy intake (rather than decreased physical activity) (292). This is partly due to the relatively higher costs of healthy foods. This relates in part to the fact that fruit and vegetables are more likely to be imported, increasing prices of these products, making them less affordable to low-income populations. Literature consistently shows that healthier diets are more expensive than unhealthy diets, with a systematic review concluding this difference in costs at about $10.50/week (293). People with low incomes are unable to purchase more expensive dietary products that are recommended by nutritional policies (293-295). Moreover, more highly educated and higher income groups are more likely to consume organic products and replace meat products with more sustainable products (296, 297). The consumption of organic products is related to neighbourhood availability of these products and how consumer perceive the local food. Low-income neighbourhoods often have lower availability of healthy (and sustainable) foods (296). In addition, evidence suggests that accessibility is a key determinant of consumption, and can either hinder or facilitate healthy eating (298). Neighbourhoods with higher levels of deprivation generally have greater access to fast food outlets, less access to affordable, healthy foods. At the same time, energy dense unhealthy food options are heavily advertised (292) (299). The result is that so-called 'food deserts' are more likely to appear in low-income areas or in neighbourhoods with a high level of minorities. This has been observed throughout Europe and beyond (298, 300). An important, more distal, concern is that in the future, climate change is likely to promote an increase in food prices, disproportionally affecting lower income groups as healthy food becomes scarce and more expensive (134).

It has been found that low-income populations have a lower consumption of fruit and vegetables (216, 301), which can also be related to price: vegetables and fruit can be 30 to 40% more expensive in low-income neighbourhoods (292). In addition, in high-income settings, those with lower socioeconomic status have higher intakes of red and

processed meats (302). Moreover, the poor are adversely affected because energy-rich, low-nutrient foods (such as processed snacks) are becoming more affordable to the poor around the world (245). Gilbert (303) showed that dietary habits of certain ethnic groups in Europe are likely to become less healthy as they adopt new food habits in their acculturation process. They replace their healthy dietary components (fruit, vegetables, nuts and grains) with energy dense processed foods high in fat, sugar and salt. This results in a higher consumption of "empty" calories by lower groups of lower socioeconomic status (304). To summarise, it appears that aspects of the environment people inhabit influence affordability, accessibility and availability of foods, creating barriers that prevent low-income Europeans consuming a healthy diet (292).

TEXTBOX 7.1
ECO-CHEF PORTUGAL

The Eco-Chef program aims to raise awareness among elementary school students about healthy food choices and simultaneously protect the environment. The promotion of healthy eating is associated with the promotion of behaviours (and habits) that contribute to environmental sustainability, based on an eco-nutrition approach, both economic and ecological.

www.vitamimos.pt/eco-chefs

7.5 THE ROLE OF BEHAVIOUR

Ultimately, current food systems need to change in order to produce foods more sustainably and consumers can drive demand for different food production by their preferences and behaviour. Thus, there is a high need to change people's diets, inter alia, because it allows development of a more healthy and sustainable balance between supply and demand (245). As MacDiarmid (284) concludes, *"probably the most important part in moving towards more sustainable consumption patterns is to understand how the proposed changes could fit in today's society and change social norms. The greatest challenge is to engage the population, whether it is to eat seasonal food, to eat less meat and dairy products, not to over consume energy or to reduce food waste"*. In this way, bottom-up approaches can eventually influence the development of top-down measures. In this section, several important determinants of food behaviours are discussed.

Personal factors

In recent decades, attitudes and consumption of sustainable food has been studied and many determinants have been identified. These include having certain social and personal norms, knowledge about sustainability and food, involvement with and positive attitudes towards sustainable foods, and having health, environmental motives or taste motives (297, 305). Lack of awareness about food's environmental impacts and external factors such as lack of availability and high price can be barriers to purchasing sustainable food products. People differ in their food choice motives (e.g. motivation), and these motives appear related to most of the basic human values. Having a universalistic value (e.g. being concerned with the welfare of all people and nature, social justice, unity with nature) was the only value found to be related to favouring less meat or choosing free-range meat (306). People who are highly involved in food and are prevention-oriented (i.e. they avoid risks and seek control over their lives) and more reflective food consumers, may combine avoiding risks for their health with moral responsibilities (306). Verain et al. (297) found that there are significant differences between consumer segments in terms of sustainable food consumption and types of behaviour: some buy sustainable products, whereas others substitute unsustainable products with other more sustainable product categories (e.g. they may substitute meat with plant-based products). It appears that most consumers are reluctant to change their eating habits, especially regarding meat

consumption and substitution (252). Important barriers include the lower sensory attractiveness of these products and the fact that accustomed meal patterns shape food choices, making consumers unable or unwilling to shift from existing patterns. As mentioned in Chapter 2, higher income groups generally have higher education, which may be related to more knowledge and awareness of healthy eating, and healthier eating habits (257). There are differences between countries in degree of health literacy, which is the ability to obtain, read, understand and use healthcare information to make appropriate health decisions and follow instructions for treatment (e.g. capability). Being able to effectively use food labels to improve one's dietary quality, it is required that one has sufficient health literacy. Within countries, higher socioeconomic status and being female are associated with greater knowledge and interest in healthier eating. However, most people in Europe, including low-income people, know what a healthy diet entails, but still do not bring this into practice (292). Instead of consciously overthinking every meal, people use several heuristics that guide them in food choices, for example health halos (e.g. when the word "light" appears on a product, this leads to underestimation of nutrition value) and vice and virtue biases (e.g. including one healthy 'virtue' food leads consumers to include and consume unhealthy 'vice' foods in their diet) (307).

Dietary habits and the physical and social environment

Furthermore, the discrepancy between knowledge of what constitutes a healthy, sustainable diet and actual dietary behaviour may be partly explained by the fact that food waste and food choice behaviours have a strong habitual element: they are frequently and often automatically performed. This means that these behaviours are performed without much conscious thought, making behavioural change challenging and merely educating people insufficient (54). In fact, of the approximately 200 daily food decisions people make, about 14 on average are made on a conscious level (256). Habits have been found to predict eating behaviour over and above other psychological determinants such as attitude and intention, with habit strength predicting fruit, vegetable, meat, fish, and snack consumption.

This habitual nature of food consumption behaviour means that the influence of the physical and social context is of special importance, as habits can be triggered by cues of the social, psychological and physical environment and thus the environment provides opportunities to perform certain behaviours (54). Nudging, or changing the cues from the environment, appears to be an effective means to steer people's behaviour in desirable directions (249). Research shows that habits can also be triggered by cues in the social or psychological environment (51, 54). Having more social networks and social cohesion in your neighbourhood is linked to higher fruit consumption and a lower risk of being obese (308). Moreover, people learn from others what to eat and what not to eat and eating is something people do together (309). This makes the home environment, with parents as role models and food purchasers, a powerful influencer for children's eating behaviour, especially since small children are not autonomous in their choice of foods yet (310-312). In addition, home availability of fruit and vegetables is one of the most consistently supported determinants of fruit and vegetable consumption of children and adolescents (313). Social norms are important as well, as they are often embedded in every eating practice (e.g. eating breakfast cereal would reduce GHG emissions, but it is often consumed together with the high GHG emission product milk) (264). School programs are promising ways to reach children and raise awareness early on. Box 7.1 shows an example of such a school program called Eco-Chefs program in Portugal. In her dissertation thesis, Mackenbach (308) studied the role of the environment in the development of obesity, and concluded that neighbourhoods with few facilities, limited social cohesion, poor public transport and little affordable, healthy food, increased the risk of people developing obesity. She advocates for an upstream approach to tackle obesity, with a focus on the high-level determinants in the obesogenic environment. For example, giving people lifestyle advice if there are fast-food outlets around the corner is not effective. People are generally aware that these outlets exist and this awareness is linked to actual higher consumption of fast food.

Food Waste Behaviour

The link between food waste and environmental impacts is not firmly established in people's minds, making it important to increase the public understanding of the environmental impacts of food choices and food waste (314). However, the factors that motivate consumers to reduce their food waste vary widely and cover a range of motivations and themes. An interesting finding is that many people relate eating healthily to reducing food waste, and eating a healthy diet is more likely if it's perceived as reducing food waste than if it's perceived as reducing environmental impacts (247).

7.6 OPPORTUNITIES TO STIMULATE HEALTHY AND SUSTAINABLE FOOD CONSUMPTION

This section present several strategies that can be implemented in order to change current food behaviours into healthier and more sustainable ones. In other words, how can people's food behaviours be influenced in an effective way? Moreover, how can this be done effectively for disadvantaged groups, in order to reduce (or not increase) health inequalities? In Table 7.1, potential methods and strategies for change are presented.

Reducing inequities

Taxing of foods high in fat, sugar and salt and removing tax on vegetables and fruit are likely to reduce health inequities, because low-income groups are more price sensitive than those with higher incomes, leading them to experience a disproportionate increase in dietary quality. Another effective strategy would be to restrict marketing of unhealthy foods to children, since disadvantaged children are currently highly exposed and vulnerable to marketing (292). It may prevent them from becoming overweight and this could reduce health inequalities in the longer term. In addition, it should be made less easy to buy unhealthy food and more feasible to buy healthy foods for those with a low income. Loring et al. (292) suggest this can be done by increasing social protection and income support in order to cover the costs of healthy foods, increasing accessibility of food (vouchers or discounts on fruit and vegetables), reducing the availability and marketing of unhealthy foods in disadvantaged areas and schools, and promoting the local supply of vegetables and fruit through initiatives in which disadvantaged groups can actively participate. The local community level can be an effective starting point to change local dietary habits, especially when targeting specific population groups (315). Tackling health inequalities in terms of improving the diets of those with lower socioeconomic status can result in both positive health and environmental effects, if healthy and environmentally friendly foods are promoted.

Habits

Van 't Riet et al. (54) proposed several strategies to create healthy eating habits, which can be made sustainable by focusing on foods and food related habits that are both healthy and environmentally friendly (e.g. plant-based foods, reducing consumption). Nudging, or using the situational environment to guide behaviour is especially useful regarding habits, by making food consumption and food waste behaviours that are the most healthy and sustainable the easiest, most convenient and cheapest options. For example, changing the choice architecture by replacing unhealthy snacks near cash registers with (pre-sliced) fruit.

In addition, Bos et al. (316) suggested three groups of measures that can be conducted to enable dietary change. Using laws and regulations, less healthy food can be made more expensive and healthy foods can be made cheaper. Using marketing, healthier products can be promoted and made more accessible, whereas unhealthier products can be made less accessible. Through education, calorie consumption information comparing people's choices, food labelling and information about healthy food habits can be provided. However, education combined with training in self-regulation has been shown to increase fruit and vegetable intake more than educating alone, supporting the notion that merely changing attitudes and knowledge is not enough to change these habits (54). Besides that, a downstream strategy that is especially useful for the formation of new food and food waste habits involves forming implementation intentions, or helping to make specific plans concerning when and how one will implement a specific behaviour (using an if-then format). This can stimulate the formation of habits, by coupling a certain context to a certain behavioural response. A systematic review and meta-analysis by Adriaanse et al. (317) showed that forming implementation intentions are an effective tool to promote the inclusion of healthy food items in one's diet, but less effective for reducing consumption of unhealthy foods.

Availability and environment

The importance of the physical environment in relation to availability and affordability of healthy foods was made clear above, especially for disadvantaged groups whose environment is often unhealthy. The TEENAGE project is a good example of the positive effects of increased availability of fruit and vegetables: when these foods were provided at schools, free of charge, this increased healthy food intake in student groups of both low and high socioeconomic status after two years. Providing a free breakfast resulted in an enduring increased intake of healthy food only among the group with low socioeconomic status after one year (301). Furthermore, in certain areas, fruit and vegetables are not available in great variety in corner shops, and increasing this variety is associated with increased fruit and vegetable purchases among residents with low-income or food-insecurity (with limited or uncertain avail-

ability of nutritionally adequate foods) (318). A systematic review found that the most successful supermarket strategies to change people's consumption patterns towards more healthy and sustainable ones include using point-of-purchase as the location of an intervention, and using promotion, advertising, economic incentives, availability of healthy foods, and community features (319). An example is the Healthy Kids campaign that used a point-of-purchase kiosk with fruits, vegetables and healthy snacks and an option to sample. This 12-week campaign increased sales of healthy foods in the supermarket used in the campaign (320).

The information environment presented by media and marketing plays an important role in food behaviours and patterns. Nowadays, people are highly exposed to advertisements promoting unhealthy products, and marketing aimed at children is highly prevalent (292). However, this information environment can also be used in a positive way: studies have found an increase in willingness to pay for fruit and vegetables after exposure to advertisements for these healthy products (321). However, framing of sustainable food consumption news was found to be important: food expenditure in supermarkets increased when proposed uncritically, but negatively when put as a structured debate (322).

Food Pricing Strategies

Taxes and subsidies on food and beverages can improve consumption and have potential to impact both health and sustainability, but they must be substantial to have a detectable effect on health outcomes (323). Currently, most taxes and subsidies differentiate between foods that are healthy or unhealthy, but including sustainability in deciding which foods to tax or subsidise may be very important to ensure both positive health and environmental impacts. Importantly, food-pricing strategies have the potential to reduce inequities, as they increase the capability of low-income groups to afford healthy products (324). Evidence shows that short-term interventions, like monetary incentives such as discounts, coupons, vouchers and loans, seem to be

effective in increasing purchase and/or intake of healthier food options, particularly when the intervention is applied in stores or supermarkets. Studies on behaviour and interventions suggest there is a need to combine both environmental (such as monetary incentive) and behavioural (such as nutrition education) approaches in interventions (325). Focus groups of low socioeconomic status suggested that farmers' markets and community-supported agriculture were considered expensive and that mainstream food retailers offered better value for money. Offering promotions or vouchers to increase affordability of these initiatives may make them more attractive for these low socioeconomic groups (326). A study on price manipulations in vending machines concluded that if these price manipulations are large enough, use competitive pricing, and increase healthy item supply, they can lead to a higher number of healthy items bought (327). However, pricing strategies are not always considered desirable: the fairness of increasing the price of less healthy items has been questioned, as low-income groups consume these more and therefore are impacted more when they cannot afford desired products. Decreasing the price of healthier foods was considered fair, effective and generally acceptable (316).

Labelling

Labelling is also perceived as an acceptable, fair and effective strategy by consumers (316). Calorie or nutrient labelling is intended to help consumers make informed choices, and currently these labels are mostly concerned with health impacts. However, this could be expanded to include sustainability information of a product. Importantly, this strategy appears more effective for individuals with higher education, who are more interested in health, or who have previous experience with reading food labelling. Research suggests that about 20% of consumers are ready to use environmentally labelled food products, and that subjective knowledge was more important than objective knowledge in this relationship. Subjective knowledge of about 10 to 20% of consumers can be enhanced using, for example, targeted marketing campaigns (328). The familiarity, trust and fit between different types of labels on a product are also very important to consumers, as is an association of a label with a brand (329, 330). In addition, although menu labelling has been found to make caloric information salient to purchasing decisions among disadvantaged groups, this information does not always translate to reduced consumption. This could depend on how and what information is provided on labels, since information per serving can be misleading if packages contain multiple servings (321). It is especially important to consider the type of label information as health literacy among disadvantaged groups is generally lower, and this literacy is related to the ability to interpret labels.

In recent decades, more sustainability information has appeared on labels, such as the Fair Trade logo and the Carbon Footprint logo. Research shows that although consumers are generally better aware of these types of labels than of the concept of sustainability, they show low use of the labels. Applying the COM-B to labelling, motivation and capability (understanding) both influence and are influenced by food labelling. If one is motivated to read labels, one is more likely to understand sustainable choices. Also, how much someone understands can mediate the relationship between motivation and use of labels (see Figure 7.4). Using labels appears related to motivation and understanding, factors that are related to demographic characteristics (331). Another important aspect is that people have to make trade-offs between different product attributes when buying a product, such as price, brand, use-by-dates and nutrition information. To increase use of sustainability information on products, combining both nutrition and sustainability information might be a way to reduce the number of trade-offs and make food labelling easier. The way choices are presented, the design of the "choice architecture" affects consumers' choices: making healthy and sustainable product options more visible, convenient, attractive and norm fitting will increase consumer acceptance (332).

In addition, it is important to make green shopping options clear to consumers, and to highlight direct benefits for them, to increase their willingness to become more environmentally friendly (333). There are different types of consumers to which educating strategies should be tailored. For example, strategies to reduce frequency of meat consumption and reduce meat portion sizes appeal to overlapping but different consumer segments, and it appears that a substantial number of consumers do not appreciate the idea that they should reduce their meat eating exclusively or primarily for environmental reasons (334).

Urban farming, school vegetables gardens, community gardens

A potential solution to create increased awareness of where food originates from in order to reduce food waste and promote purchasing of local foods, is introducing urban farming or community gardens. (See Chapter 4 for more detail about the health and physical activity aspects of green space). These types of initiatives can reduce the great physical and perceived distance between food production and consumption and increase availability of healthy sustainable products. This provides people with an increased physical opportunity

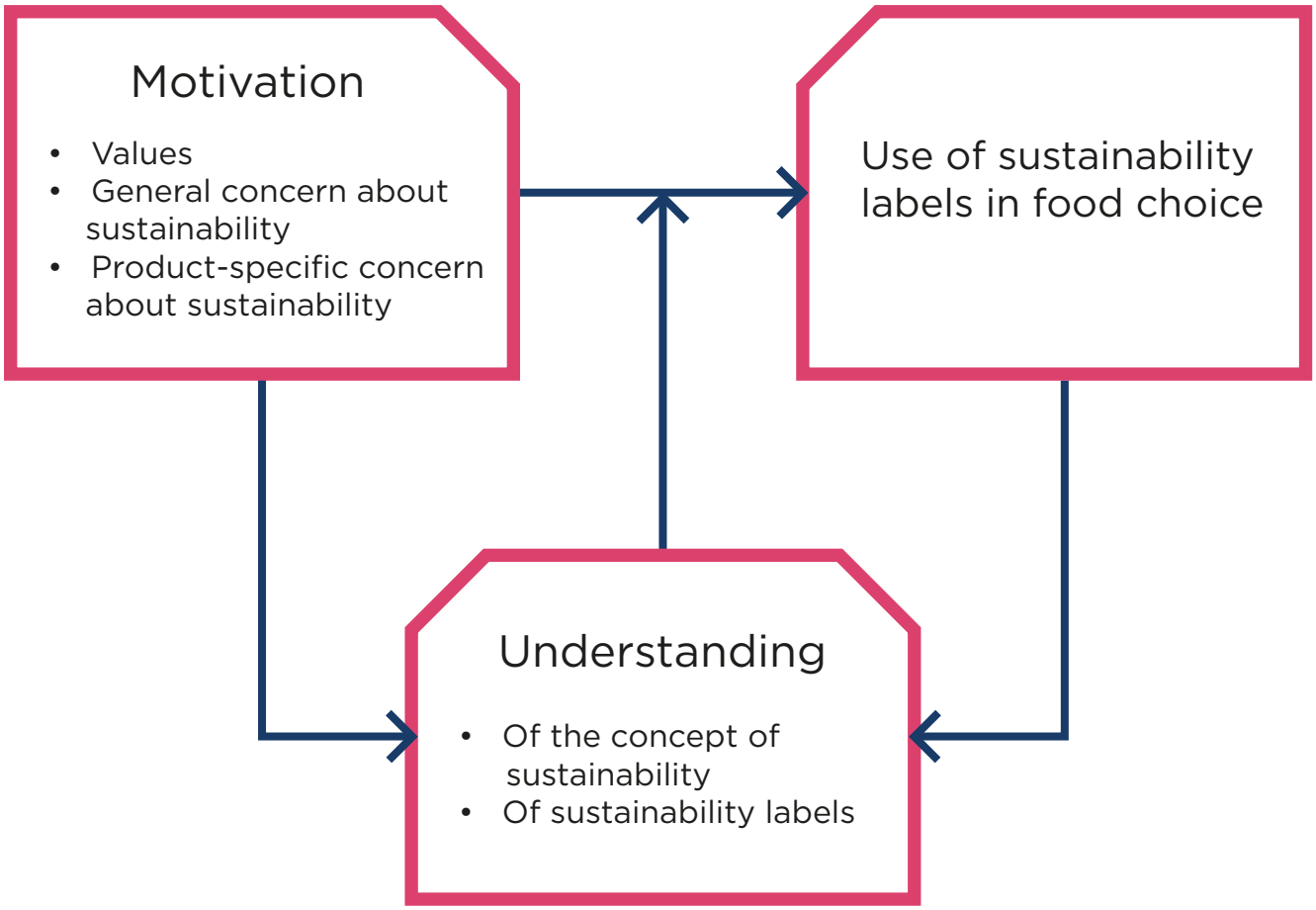


Figure 7.4 COM-B and sustainability labels (Source: Grunert et al. (331))

to obtain these products. It also facilitates eating and preparing local seasonal fruit and vegetables, improving capability and skills. In addition, community gardens or agriculture initiatives promote social cohesion within a community. However, most evidence comes from the grey literature, with more information about potential benefits than actual impact analysis information. Farmers' markets and community gardens also have the potential to increase access to fruit and vegetables, especially in low-income areas with low access to affordable, healthy foods. However, evidence for health benefits is limited. Interestingly, urban food growing projects can stimulate social cohesion and an interest in food (242). An example of urban agriculture in the Netherlands can be seen in Textbox 7.2. Especially organic (urban) farming may be promising, as it promotes biodiversity. Comparative biodiversity assessments on organic and conventional farms show that organic farms have 30% higher species diversity and 50% more flora and fauna fields and that in addition, less chemical fertilisers, herbicides and pesticides are used (263).

Mobile applications and internet-based strategies

As mentioned in Chapter 3, Bamberg (51) emphasises the importance of combining downstream measures (e.g. increasing individual awareness and skills to cook healthily) with context (upstream) measures (e.g. increasing the number of healthy food selling points in neighbourhoods). One type of innovative downstream measure is the use of mobile or web-based applications that can be used to stimulate or train people to eat more healthily or sustainably. Smartphones offer promising opportunities to stimulate health and sustainable behaviours, because more than half of adults own a smartphone and smartphones are frequently used (335). Lifestyle coaching applications exist that attempt to change determinants of behaviour such as self-efficacy, self-managing knowledge and motivation. They can provide cooperative feedback and motivational interviewing (313, 336). Internet-delivered, computer-tailored lifestyle interventions appear effective in changing dietary behaviours, and they can reach many people (337). These applications can change capability and

motivation, whereas parallel environmental change can provide opportunity. For example, by linking a lifestyle application to a local community garden or farming initiative, the changes in food consumption stimulated by the application are facilitated by changes in the environment, making actual behaviour change more likely (for example by increasing availability and accessibility of local fruit and vegetables).

Reducing food waste

Eating healthily and reducing food waste appears to be related in people's mind, even though outcomes (nutrition-related diseases versus environmental impacts and money savings) are very different. Interventions that aim to change diets into more healthy and sustainable ones, should use this perceived relatedness between eating healthily and reducing food waste. Especially those food and food waste behaviours that have both health and environmental impacts should be targeted, such as increasing food planning skills and cooking the right amount of food, preventing both overconsumption and excessive food waste. In addition, the link between food waste and environmental impacts should be made more clear as well, because people currently appear to give little weight to environmental concerns that stem from food waste (247). It appears that campaigns to reduce food waste can be effective in making consumers more aware of the extent and consequences of food waste and how to reduce it (338). Similar to food label use, people make trade-offs about wasting food: they want to avoid it, but taste, convenience or health/safety concerns may be found more important (338). Furthermore, it appears that the concept of saving money and feelings of guilt can be powerful motivating factors in food waste prevention (247). This can be an especially effective strategy for low-income groups as they can be influenced effectively using pricing, emphasising and showing the monetary benefits of preventing food waste in the home.

The retail sector plays a significant role in European household food waste levels. In developed countries, food waste of households is, among other things, influenced by product and packaging characteristics and retail marketing strategies (338). As the retail sector is the link between consumers and earlier stages in the food supply chain, addressing supermarkets and food companies is a key focus of reducing food wastage (339). For example, the "buy 1 get 2" discounts should be changed or stopped, by making it more attractive to buy smaller portion and package sizes. Effective strategies may be to provide discounts on foods nearing expiration dates and to encourage buying of imperfect looking fruit and vegetables (338). Another potential solution to reduce food waste is by closing the loop: using food waste, such as fruit and vegetable and fish waste, as cattle feed. Esteban et al. (340) showed that using this biodegradable municipal waste could serve as alternative feedstuff in pig diets, reducing the amount of waste going to landfills.

TEXTBOX 7.2
DE VOEDSELTUIN / THE FOOD GARDEN NETHERLANDS

Voedseltuin Rotterdam stands for a healthy city, a pro-sustainable urban society, with healthy food for everybody, without poverty and social exclusion. Voedseltuin offers sustainably grown seasonal vegetables for the Food Bank Rotterdam. In addition, it is a place to meet and to be active (from producing food to being active in green space and developing skills).

www.voedseltuin.com

Table 7.1 Food behaviour change strategies

Determinants	How	Potential Impacts
Habits (COM)	**Ecological interventions:** Changes to environment, system level, upstream **Nudging:** Providing subtle guidance towards healthier, sustainable choices from environmental cues **Change choice architecture:** "Choice edit" to make the healthier, sustainable choice/behaviour the logical, easiest, most attractive option **Implementation intentions:** Help people formulate intentions: "If I am in situation A, I will perform behaviour B" **Exerting self-control** **Vigilant monitoring:** Actively watching for potential slip ups **Educate targeted groups:** New parents , schools **Reinforcement:** -Self-imposed penalties (" If I eat too many snacks, I will have to go for a run") -Negative economic incentives (taxes, fines) -Positive economic incentives (subsidies, monetary rewards) - Guilt as motivator **Introduction of new diet/food options:** E.g. increasing options for lactose free, gluten free, vegan etc.	Most likely effective when habits are tackled in times of change, as people develop new habits (e.g. new parents, recently moved, starting new school or job)
Affordability (COM)	**Financial measures:** Pricing, taxing or subsidizing (on food or food waste) **Home composting:** Closing food waste loops	Potential to reduce health inequities (affects low-income population more) Closed food waste loops may result in more food for disadvantaged groups. Wasting less food may lower food expenses for all groups, but low-income groups will relatively profit the most.
Knowledge/ Awareness (COM)	**Labelling/ Packaging:** - Guiding and informing consumers by providing nutrient or sustainability information - Reduce or simplify the amount of trade-off information on products (price versus calories versus sustainability labels) **Education:** - Campaigns or educational programs - Guidelines - Dietary recommendations Rebuilding the relationship between producer and consumer (local produce) Emphasise money saving benefits when reducing food waste	Health literacy (ability to read labels/packages) may be lower among low socioeconomic groups, widening differences between high and low socioeconomic groups Low-income groups often know what a healthy diet is, but due to unhealthy habits and lack of availability/affordability, they do not purchase them Social cohesion may increase, among both high and low socioeconomic groups May affect and support low-income groups the most

 Availability/ Accessibility (CM)	**Ecological interventions:** upstream changes in food environment Restrict/change marketing (information environment) **Urban gardening/ farming:** School vegetable gardens	Especially in low-income areas to reduce healthy food deserts and high marketing for unhealthy products.
 Social environment/ norms (COM)	**Home, School or Work programmes** **Parents as role models** **Peer-pressure:** (i.e. through social media and using apps) **Advocating for slow food**	

C = Capability, O = Opportunity, M = Motivation of the Behavioural Change Wheel, for an explanation, see Chapter 3.

7.7 DISCUSSION AND CONCLUSIONS

In general, current dietary patterns are both unhealthy and harmful to the environment. For example, our general overconsumption, excessive red meat consumption and low fruit and vegetable consumption result in health impacts such as diabetes, obesity and cardiovascular diseases, and meat and dairy consumption have the largest environmental impacts of all food groups. Common food behaviours such as consuming foods out of season and wasting food at high rates also present negative pressures for the environment. A diet low in meat and high in plant-based foods, fibres and low in sugar, fat and processed products would promote both health and sustainability. Importantly, promoting this type of diet would benefit disadvantaged groups more, as they currently have worse diets and are less healthy. However, not all food groups that are good for health are beneficial to the environment when consumed more: fish, meat and dairy have a relatively high environmental impact, while sugar-based sweets may have a relatively low environmental impact, presenting a challenge that should be carefully dealt with.

Insights into consumers' food and food waste behaviours is of great importance to understand and change these behaviours. Literature shows that it is not enough to merely increase knowledge or awareness about the importance of health and sustainability: people choose certain foods based on taste preferences, price, attractiveness, convenience and norm fitting properties. In the trade-off with all the other options of a certain product, sustainability and health may currently be weak competitors. Therefore, changing the choice architecture and making the healthy, sustainable products the easiest and most attractive options is crucial to encouraging healthy, sustainable diets. Moreover, since food behaviours (including wasting food) are largely habitual, changing food habits into more healthy and sustainable ones requires changes to social, physical and information environments. Food choices take place in a context of factors, of which some are more upstream and not in an individual's sphere of influence (e.g. healthy food store availability) and factors that are more within an individual's sphere of influence (knowledge, food preferences, food storage skills, sociocultural food practices) (341). These environments are not the same for everyone, presenting unequal opportunities and pressures to health, resulting in (health) inequalities. Therefore, tackling the food environments in which people perform

their daily food behaviours is a promising way to reduce (health) inequalities, especially when special attention is paid to those who need it the most, the disadvantaged populations. For example, besides the important role of availability of healthy foods on healthy food consumption, affordability is important: pricing strategies appear to be especially effective in reducing health inequalities.

Evidently, in order to change individual and societal food behaviours, there is a need to change the whole food supply chain, from producer to consumer, combining upstream to downstream strategies. It is important to identify the leverage points where changes can be made in the food supply chain to create a healthier environment for consumers (e.g. food availability, pricing, marketing), and barriers, for example using supply chain analysis (342). Industries and retail must take responsibility and government should more actively stimulate the industry to change, as they play a key role in the availability and affordability of healthy and sustainable food for all. For example, the practice of large package discounts should be changed into stimulating the purchase of right size amounts, but also the common addition of sugar, salt and fats to processed products should be dealt with. When developing food and food waste policies and interventions, it is of great importance to take both health and sustainability into account. For example, food guidelines could be provided in an integrated way, which would give more powerful messages than the separate and sometimes conflicting messages that now come from the health and sustainability fields separately.

More implementation research is needed to understand which interventions and policies are the most effective to change food behaviours among disadvantaged populations. For example, how can integrated food labelling be best designed in order to promote its usage among low educated groups? In addition, future research on our food environments should provide insight into how industry and retail sectors could play a larger role in reducing food inequalities (e.g. supermarket availability and affordability of fruit and vegetables and package sizes).

TEXTBOX 7.3
LINK WITH INHERIT GOALS

Changing food consumption and related behaviours such as food waste are excellent examples of how changing behaviours and lifestyles can potentially lead to both health and environmental improvements and promote health equity. Since there are large differences in terms of food environments and impacts for different socioeconomic groups, and food behaviours are largely habitual and unconscious, changing food environments through upstream measures can increase opportunities to consume healthy and sustainable diets. Combined with innovative downstream interventions, such as food apps, capabilities and motivation can be increased. Thus, by integrating health and sustainability goals into food policies and interventions that take the determinants of food behaviour of populations across the social gradient into account, INHERIT's triple win can be reached.

CHAPTER 8
TOWARDS HEALTHIER, EQUITABLE AND SUSTAINABLE LIFESTYLES: BARRIERS AND OPPORTUNITIES

The research outcomes presented in this review have made clear that current production, transport and consumption patterns and lifestyles in Europe are unhealthy and unsustainable. Health and environmental issues related to how we live, move and consume are not only problems for Europe in the 'here and now'. Due to the interconnected nature of the world economy and our shared ecosystem, production, transport and consumption patterns in Europe and in other highly developed economies involve and affect all parts of the world. The global extraction of materials has tripled over the past four decades, resulting in the depletion of natural resources and huge waste production. Moreover, environmental impacts and their attendant health effects are rarely if ever distributed evenly across society and the poor and other vulnerable (e.g., the young, the old or those with pre-existing illness) are disproportionately affected. It is becoming increasingly clear that current production and consumption patterns in the consumer oriented-societies in which we live are unsustainable, and can no longer serve as a blueprint for economic and social development. The ways in which we live, move and consume are undermining the prospect of a healthy fulfilling life for future generations.

Changing this situation is far from straightforward. It means understanding and addressing the complex and interacting socio-economic and demographic, cultural, economic and political trends driving the current systems, and, implicitly, the hugely damaging 'take-make-consume-dispose' models of consumption and production. Change must come from adapting our lifestyles and behaviours and making choices that promote sustainability. This, in turn, requires public and private sector actors to take measures to facilitate change. Policies, products and services must be introduced that support and empower people to value and adopt more sustainable lifestyles and to change their lifestyles and behaviours accordingly.

For governments, this implies developing more conducive regulatory contexts in order to facilitate and inspire better decision making. It also implies stimulating market demand through sustainable public procurement, and nurturing an environment that stimulates and encourages healthy and sustainable behaviours. For the private sector, this implies integrating sustainability into core business strategies and developing innovative products and services to meet the needs of people in more sustainable ways. Public and private sector actors must, for example, collaborate to achieve more circular production processes. Public and private sector investors - particularly large corporations- must be encouraged to act coherently and sustainably wherever they operate in the world. These measures must be underpinned by an effective information and communication strategy, to support better decision making.

For individuals, it is vital to raise awareness and improve understanding of the impacts and implications of the choices and decisions they are making, and how these impact the environment, their health and equity (29).

This review identifies barriers and opportunities to encourage people to adopt lifestyles and behaviours that can contribute to better health and equity, as well as more environmental sustainability.

8.1 BARRIERS AND THREATS

A range of contextual factors and trends create the current unsustainable, unhealthy societal patterns and lifestyles:

• Current unsustainable lifestyles and behaviours are, in a very real sense, "locked in" current economic, political and social systems. Economies across the world have seen high levels of economic growth over the past four decades, accelerated in the context of the global economy and free trade. Economic growth based on the production and consumption of more goods, often transported across large distances, have led to the development of consumer societies. In highly development economies like those in the EU, this growth has taken place in the context of the transition from post-industrial to knowledge based, service economies, characterised by fast-paced technological development, automatisation processes and the rise of artificial intelligence. While these developments have led to many new opportunities, they have also come paired with increasing levels of inequality in EU societies and across the globe. The financial crisis also drew attention to the unsustainability of the financial systems underpinning global economic models. The predominant economic models that have driven high-levels of economic growth and that shape our lifestyles (e.g. our dependency on motorised vehicles) do not take into account the full impact of those activities on health, the environment and society at large. Global supply chains, for example, play an important role in exacerbating the depletion of natural resources, increasing greenhouse gases and promoting social inequalities. In addition, the economic gains that can be derived from built land often over-ride consideration of the (non-economic) benefits that urban green space can provide. Furthermore, in times of economic crisis budgets are often cut on services that provide more intangible benefits to the general public, like the maintenance of green space. The full costs of our actions, when also taking into account the environmental, health and social impacts still, go unconsidered.

• Urbanisation is a continuing trend, with 82% of the world population predicted to live in cities by 2050. Trends in Europe reflect this (20), creating multiple pressures on the cities and their surrounding environments. These include loss of biodiversity and green space, congestion, more use of non-renewable energy sources, more waste, and higher levels of air pollution, noise, CO_2 emissions and soil pollution, and consequent health impacts. Climate change may exacerbate these urban environmental impacts by promoting higher temperatures and heavy rainfall. Unless cities are well designed, the impacts on people's health are potentially very serious. Disadvantaged groups are often exposed to an accumulation of negative environmental conditions, contributing to the persistent health inequalities.

• Modern food production and consumption processes lead to more global transportation, generate pollution and greenhouse gases, deplete the soil of essential minerals and nutrients, and introduce hormones and antibiotics into the ecosystem. For example, our food production and consumption amounts to 20-30% of the European Union's total greenhouse gas emissions, with meat and dairy product production and consumption having the largest environmental impact. In addition, the current food supply is one third higher than required for a healthy diet, stimulating overconsumption (249). Whereas in many places access to food and food security are the communities' prime concern, food waste in Europe is also reaching alarming proportions. Although the EU-27 represents just 7% of the world's population, it accounts for 17% of food wasted in the world (262).

• People's tendency to prefer convenience and rapidity often leads to consumption of food that is low in nutrients but high in calories. Short car journeys are often defended on the grounds of time and convenience and the rates of active transport to school have declined dramatically over the past 30 years. As individuals spend more time in vehicles, there is likely to be less time available for physical exercise. It may also cause additional stress related to commuting and traffic jams. Growing levels of overweight and obesity and traffic related health effects are products of these trends. Furthermore, energy efficient housing offers comfort, but may have negative health effects if not well ventilated, due to bad indoor air, humidity and mould growth. There should be greater recognition that activities that involve movement, exposure to nature or that call on people to build or produce things themselves also promote wellbeing.

• There is an increasing disconnection between people and nature, creating detachment from food origins and natural environments, and a disregard e.g. for the environmental consequences of consumption choices and energy use. This situation leads to the development of more irresponsible behaviours, less use and awareness of green space, carelessness about impacts on environment and other societies.

A transition towards more sustainable transport, spatial planning which is consistent with health and sustainability (e.g. room for green space and active transport) as well as sustainable and healthy energy and food consumption, is urgently needed. Changing a system is hard and requires persistence. INHERIT believes meaningful and effective change is most likely to result from a combination of changes at a high (policy) level with bottom-up local initiatives with the commitment and involvement of private and public sectors alike.

Many of the daily behaviours are habitual and automatic and therefore resistant to change. The context and environment are powerful influencers of habit development and maintenance. Therefore, the best opportunity to change these habits is at moments in people's lives in which contexts and cues change (e.g. moving house, changing schools, getting married, having a baby, retiring). At such times, people are more amenable to change (51, 54). In addition, the automatic side of much behaviour implies that simply informing people is not enough, as people do not consciously reflect on the daily behaviours they perform. However, a combination of the two, described as "downstream + context measures" holds promise, since it changes both context and individual knowledge, attitudes and/or skills (for example, increasing availability of locally produced fruit and vegetables in stores, combined with raising awareness amongst consumers of sustainable food production and the importance of eating sufficient fruit and vegetables).

The findings from this review reinforce that people from lower socioeconomic groups, who often have to deal with an accumulation of health and environmental burdens, have fewer opportunities and capabilities to change their behaviour. They may also have lower motivation to change their lifestyles towards more sustainable or healthy ones, due to, for example, other worries and concerns (debt, unemployment, etc). In addition, they may have less knowledge of what constitutes an affordable and sustainable choice that benefits their health and overall lifestyle. This, together with the fact that these groups generally have poorer health and often deplorable living conditions, makes it important to explore what can be done to reach out and to empower them. There is a need to develop strategies, policies, services, products and infrastructure to help promote more sustainable lifestyles and behaviours.

8.2 OPPORTUNITIES FOR A TRANSITION TOWARDS MORE SUSTAINABLE AND HEALTHY SOCIETAL BEHAVIOURS

The INHERIT model depicts several entry points for actions, that offer opportunities to encourage people to adopt more sustainable lifestyles and behaviours. Influencing the drivers of behaviour and lifestyles is seen as the most effective one, since these drivers affect health and wellbeing and equity via the proximal (local environmental, "here and now") pathway as well as the distal pathway (involving changes to global ecosystems, "there and then") which impacts primarily on people in other parts of the world and future generations.
This means that policies, practices, products and services that change these drivers can have the largest impact in terms of the triple win that INHERIT aims for. As discussed above, governments, the private sector and individuals must act in partnership to address the forces that drive current trends of environmental degradation, ill health, unsustainable practices and inequity.

In the transition to sustainable societal lifestyle patterns, 'niche activities' or 'novel innovations' play an important role in catalysing necessary change in established systems. Recent times have seen a number of innovations with a potential to produce change e.g. measures which change travel behaviour in a fundamental way, while still meeting the need for mobility (186). These innovations are built not only on technological advances, e.g. in electric vehicles technology, but also on new business and ownership models (e.g. related to natural capital), fuelled by information technology (IT) developments (e.g. online brokerage of shared services, lifestyle coaching applications) and bottom up education and training initiatives (e.g. bikeability programmes in UK and Netherlands). Looking forward, public authorities have a key responsibility to ensure that different transport services are connected and interoperable, that the required (green) infrastructure is in place and that price signals are consistent. Through their regulatory and funding power, public authorities also have the possibility to shape consumption, production and mobility systems of the future (186). Authorities must also create the necessary regulatory and operating frameworks to ensure that innovative and sustainable technologies and business models can be fully exploited, and contribute to improved sustainability of the systems. In addition, they should ensure equal access for people from all socio-economic groups and generate engagement from citizens. This means helping them recognise the advantages of active transport, green space, healthy and sustainable food and ventilation behaviour in energy efficient housing for their health, the environment and even their personal economy.

Opportunities to change individual behaviour

Theories on behaviour highlight that motivation, capability, and opportunity are all entry points for interventions to change individual behaviour. For example, creating an accessible, well-maintained green space nearby offers opportunities to meet, relax, exercise, and enjoy 'nature'. This may be particularly interesting for people who do not use green space as yet, and are difficult to motivate to start or increase physical exercise.
To be effective, interventions targeting behavioural change need to take into consideration the characteristics of specific populations. For most people, especially low-income groups, economic measures (financial incentives, fiscal policies- e.g. taxing unhealthy foods and discounts on healthy foods) are attractive. This, for instance, implies that it is effective to lower the costs of healthy foods or to emphasise the money saved from being energy efficient and taking the bicycle instead of a car. In addition, awareness raising, education and training, by improving 'sustainability literacy' – educating people on sustainability and what they can do to improve it- in addition to improving health literacy may help. To be effective, one must know what is important to people in a specific target group, and adapt actions to their frames of reference.

Developments in policy

In practice, several of the current (inter)national policies appear to have a more integrated and systematic approach than traditional ones. Examples at the (inter)national level are the UN Sustainable Development Goals, the overarching Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth, the Paris Agreement on Climate Change, and the Parma Declaration on Environment and Health. Also, demonstrating greater integration and systems awareness are policies promoting Nature Based Solutions. For example in Norway, the Netherlands and Scotland, green space policies promote and create green space not only for nature conservation, but also to improve living conditions of disadvantaged groups, and offer places for outdoor

activities (sports, recreation, relaxation). In addition, sustainability aspects of foods have been integrated in national dietary guidelines, like in Sweden. Community involvement is becoming more and more common. Such policies offer the framework and create opportunities for improved lifestyles, and are important tools to affect the drivers of behaviour. Nevertheless, more policy action is needed to encourage people to adopt more sustainable lifestyles that also promote health and equity.

The private sector

The private sector can be involved in these actions by engaging in public-private partnerships. Since there is a big market for health and wellbeing, they can also develop innovative products and services that encourage people to improve their health in ways that also raise awareness about environmental conditions and sustainability. Promising examples are applications that provide tailored dietary advice on healthy and sustainable eating, or give rewarding feedback on active travel through local public parks. Applications may also give people insight in their energy use by providing feedback and setting energy use goals, or feedback on air pollution levels. Health insurance companies can also stimulate the use of green space by sponsoring health walks or contributing financially to the creation of attractive and accessible green space. Other strategies range from product placement in the supermarket to labels, certifications and even coupons and sales, to encourage people to adopt more sustainable behaviours. Enabling knowledge networks that facilitate the scaling up of strategies and programs, is another approach that allows the private sector to become more engaged in supporting consumers to improve their lifestyles.

Combining structural and behavioural measures for greater effect

The combination of structural and behavioural measures is often considered the most effective. Active transport (cycling and walking) rates are highest in countries and cities where biking and walking infrastructure is safe and attractive, where employers and schools promote active transport and where children have cycling lessons. Homes can be improved with insulation and smart meters, but people should also be taught to keep their

insulated indoor environment healthy through ventilation and the effective use of smart meters, to actually benefit from increased energy efficiency. In relation to consuming, increasing the availability or lowering the costs of healthy fruit and vegetables in local supermarkets should be combined with initiatives to educate people how best to cook and store them. Regarding green space, it is not sufficient to make attractive parks or more green spaces available. Activities should be organised to encourage people, particularly those that might not otherwise be aware or inclined to use such grounds, to do so.

Co-benefits in other domains

Some interventions may have a positive effect in several areas, offering co-benefits. For example, community gardens are interesting from the green space and the consumer choice perspective. They have the potential to deliver a potential triple win effect, by reducing the actual and perceived distance between food production and consumption and facilitating the choice to consume local seasonal fruits and vegetables. Community gardens may also promote social cohesion within a community, and have the potential to reduce inequalities. The same can be said of creating walking and cycling lanes in green spaces, stimulating active transport and thereby encouraging and supporting new, environmentally friendly behaviours (60). All green spaces can sequester CO_2 to a certain extent, thus contributing to environmental sustainability, with beneficial effects beyond the community and for future generations.

Intersectoral cooperation

Intersectoral cooperation is another lever for beneficial change. WHO (24) describes several approaches that may help reduce health problems linked to unhealthy environmental conditions, promote healthier and more sustainable lifestyles as well as more equitable societies. These approaches involve systematically considering health and health equity in all sectors, evaluating the costs and benefits of prevention through healthier environments, and promoting and supporting local governance to address environmental health planning (for example by providing them with the tools and support they need). Defining clear and common objectives, empowerment and building trust, agreeing on a common language, persistence and ensuring continuity, and ensuring long term funding opportunities are important to successful cooperation. Having the support of a governmental body often stimulates action. This support can come through the implementation of a policy or strategy, the provision of funding for health/social/nature initiatives or for sustainable business models, or through a political champion that plays an important role in awareness raising and putting it on the policy agenda. Effective dissemination of information and evidence to people working at the grass-root level as well as policy makers may help to increase the motivation and capability of people (63).

Consider the systemic implications

While recently more and more integrated policies are in place, most of the current policies and practices are still sectoral and fragmented, focusing on one topic at the time, with the inevitable risk that they may have an unintended negative consequence in another domain. A more coherent, integrated and systematic approach, placing a healthy environment at the center of such an effort, with common ambitions and goals is important for a transition to healthier, more sustainable and equitable lifestyles. This requires the creation of an enabling environment for intersectoral action, and new business models that support it. For example, when promoting energy efficient housing, it is important to take the health aspects of housing measures into account, to avoid the pitfalls of past efficiency measures that resulted in unintended health effects related to limited ventilation in the home. If green space is not well designed, air pollution levels or heat stress may increase, resulting in negative health effects. Regarding food consumption, most foods that are healthy are also those that can be

produced more sustainably. There are some foods however that may be good for health (fish) but less good for the environment (overfishing). Thus, it is important to be aware that there are situations where trade-offs must be made. There is an implicit need to provide balanced advice to consumers to avoid the confusion that arises from mixed messages. Electric cars may result in less air pollution but do not solve the problem of sedentary behaviours, jammed streets, road safety issues and severed neighbourhoods and communities, which can be a feature of urban car transport. Currently, guidelines and advice regarding food often come from the health or the environmental sector. When arguments from both sectors are combined, these guidelines could be much more powerful.

8.3 GAPS IN KNOWLEDGE

Although this baseline review highlights many examples of inspiring policies and interventions, only a few of them have been evaluated. Therefore, the effect of these policies and interventions and (economic) benefits are largely unknown. Such evaluation is needed in order to identify what is most effective, and which interventions are worthwhile to scale up. In particular, valuable knowledge on how to influence the behaviour of groups who need healthy lifestyles the most, and are at the same time often most difficult to reach, is largely absent. It is questionable whether the scientific quantitative methods often used for the evaluation of interventions can be applied effectively and are sufficient, for the triple win evaluations in our target areas. New mixed methods, that combine quantitative and qualitative approaches are needed. In addition, involving stakeholders in the development and evaluations of interventions, may also be an interesting way forward. Another issue is about the scalability of the outcomes of intervention studies presented in this review. For example, much of the knowledge on (differences in) use of green space comes from US studies, which may not be applicable to the European situation. In the case of active transport, it is uncertain to which extent, and in what way, active travel patterns such as those in the Netherlands or Switzerland could be adopted more widely in Europe. Although the Netherlands has a favourable topography for cycling, there are many flat areas in other European countries without much cycling. The high quality and safe infrastructure for cycling that exists in the Netherlands probably plays a bigger role in the prevalence of this form of active travel. In addition, good synergies with public transport are important, as in Switzerland where many trajectories are done on foot and there is generally a supportive culture towards active travel (212).

Moreover, often surprisingly little is known on the costs and benefits of many interventions. The cost-benefit analyses of interventions to stimulate more sustainable behaviours, such as those described in this review, can significantly inform strategies to improve health, environment and equity. Thus far, however, many studies are based on model calculations comparing different scenarios ex ante, rather than analyses of cost and benefits from implemented measures. This is the very information sought by decision makers, for whom the choice to engage may be optional and who are required to reconcile competing demands for resources. Knowing the benefits and best buys from an environmental, sustainability, equity and financial perspective can only benefit society. This information can also help us to develop new business models that deal with the fact that costs and benefits are often distributed unevenly among stakeholders. Costs must often be paid immediately, while the benefits may only become apparent later in time, and costs are often made by parties who do not receive the direct benefits. Interest in these new business models is growing though. This is evidenced by examples from some countries of health insurance companies who are recognising that they can potentially profit from the health benefits gained by people who exercise, relax and meet in green space, and are therefore investing in the development and maintenance of green space.

Potential for triple win

Most of the current measures discussed in this review, and currently implemented at different levels or in different sectors are not conceived or delivered with the explicit intention of delivering a 'triple win' for health and environmental sustainability and equity. Nonetheless some have clear potential, perhaps with expansion or modification, to achieve this goal. For example, a park can be developed to offer residents a place to relax, but can also buffer air pollution, noise, heavy rainfall and high temperatures. It can offer all people- including low-income segments- an attractive place for social interaction and exercise. In some cases however, the missing ingredient necessary to achieve triple win in relation to an urban park may be a social programme to promote engagement. The park may also be badly designed, and it may therefore have a negative effect on air pollution or high temperatures. Other interventions may have a positive effect in one dimension of the triple win, but a negative impact in another dimension. For example, biologically produced products are often more affordable to people in higher socio-economic groups.

RECOMMENDATIONS

From this review, it should be evident that there is an urgent need for change, and huge potential in many of the policies, practices and innovations that are already in place. However, if such policies and interventions are to benefit societies across Europe and elsewhere, particularly those in most need, as well as future generations, more knowledge is needed on what works best for those who need it the most. We must understand the costs and benefits of existing interventions, their effectiveness in delivering a triple win, and extend the search for further effective interventions that can deliver greater sustainability, health and equity. There is a deficit in information, which INHERIT seeks to address at least in part. The current move towards more sustainable, integrated policies, as well as the various initiatives across Europe to encourage more sustainable ways of living, moving and consuming are promising. But more is needed to raise awareness and generate the big changes required to shift economic, political and social systems. The need for change is more pressing.

Despite decades, and indeed centuries, in which scientific understanding has accumulated and our capacity and influence as a species has multiplied, the importance of the environment for our health and our reliance on the natural world, its systems and processes have never been more evident. It is not an exaggeration to say that our fate as a species is inextricably linked to nature and the environment whether proximal or distal to our communities in Europe, demanding our most attentive stewardship if we are to deliver health, sustainability and equity. The current way we behave as individuals and as a society carry the seeds of our own destruction, if unmodified. Yet, understanding the role of behaviour and modifying it for sustainable living and better health and wellbeing opens up a brighter more equitable future for Europe and the world and simultaneously addresses many of the challenges which beset us today and help to create a better world for future generations.

APPENDIX 1 GLOSSARY

Attitude
The enduring positive or negative feeling about a person, object, or issue.

Cultural (ecosystem) Service
A nonmaterial benefit from an ecosystem that is experienced directly and personally by humans. Cultural ecosystem services include, for example, spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience.

Cultural Environment
The beliefs and customs of a human community or society to which an individual belongs. For example, an individual's cultural heritage and the religious practices of their family and friends would be part of their cultural environment.

DALY
Disability Adjusted Life Years: Measure of overall disease burden, expressed as the cumulative number of life years lost due to ill-health, disability or early death. DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequence.

Distal (Pathway)
The term distal pathway describes the pathway by which macro-level driving forces impact on health and wellbeing in other countries or regions (spatially distal) or later in time, perhaps after decades or even generations (temporally distal).
Distal impacts can involve quite dramatic environmental changes in countries and regions beyond their borders, yet little or no perceptible change to the originating environment is experienced. It is hard for the public and policymakers to appreciate the full impact of these events in the countries where they occur, still less how they might matter, for their own residents and their health and wellbeing. Obvious examples of spatially distal pathways arise when distant countries are damaged by extreme weather events leading to flooding and drought, or from more long term environment degradation and conflicts over scarce resources.
For INHERIT, the details of the Distal pathway are less important than the realisation that the way we behave when we live, move and consume in developed countries matters for others in lands beyond our borders and for future generations.

Downstream Measures
Individual-level intervention designed to change the behaviour of people who already suffer from a given risk factor (e.g., sedentary lifestyle, unhealthful diet). These interventions attempt to solve health and sustainability problems through the decision making of individual consumers. For example, providing training of self-regulation skills to promote healthy diets.

Driving Force
The Driving Forces comprise a spectrum of influences that, in combination, produce the Pressures that in turn, modify or sustain the Physical Environment in a location. The focus of INHERIT lies on behavioural and lifestyle driving forces, but behaviours take place alongside and are influenced by a broad range of other driving forces, for example societal, economic, political, cultural, technological, commercial driving forces.

Ecosystem
A community of plants, animals and smaller organisms that live, feed, reproduce and interact in the same area or environment. Ecosystems have no fixed boundaries; a single lake, a watershed, or an entire region could be considered an ecosystem.

Ecosystem Approach
A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use. It recognises that humans, with their cultural diversity, are an integral component of many ecosystems.

Ecosystem Service(s)
The benefits provided by ecosystems that contribute to making human life both possible and worth living. Examples of ecosystem services include products such as food and water, regulation of floods, soil erosion and disease outbreaks, and non-material benefits such as recreational and spiritual benefits in natural areas. Some authors make a distinction between ecosystem goods and ecosystem services, with the former being restricted to tangible benefits that have a market price. However, the term ecosystem services is used more commonly to encompass both the tangible and intangible benefits that humans obtain from ecosystems.

Environmental Awareness
Knowledge of the impact of human behaviour on the environment.

Environmental Health
The state of the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards

preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment and genetics.

Exposure & Experience (to/of Environment)
Whether an individual is actually exposed to, or experiences, health-relevant characteristics (e.g. space for relaxation or activities) of the environment where they live is determined by many factors. Whilst some Exposures/Experiences are largely unavoidable for anyone living in a location, others may depend on an individual's social or economic circumstances, the cultural environment, individual levels of mobility, or an individual's behaviour.

Health
A state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. Health is multifaceted (enjoying good health is not simply about being physically healthy) and is a positive state (it is more than 'not being unwell').

Health Behaviour
A behavioural pattern that affects health. The effects can be positive (e.g. protecting, promoting, maintaining and restoring health) or negative (e.g. damaging health). While the behaviour of organisations often have major consequences for people's health , research and policy have focused on individual behaviour, and on health-damaging behaviours in particular (e.g. smoking cigarettes and drinking large amounts of alcohol). Many health behaviours – for example, dietary habits, patterns of physical activity and alcohol consumption - may not consciously be seen as health behaviours; they may, instead, be undertaken for other reasons.

Health Inequalities
Differences in health status or in the distribution of health determinants between different population groups. For example, on average, children from poorer backgrounds will have poorer health across shorter lives than those from more advantaged circumstances, and people in richer countries will enjoy better health than those in resource-poor countries. The key difference between inequalities and inequities relates to the extent to which these inequalities are avoidable: whereas health inequalities may be attributable to biological variations or free choice, others may be attributable to the environment and conditions that are mainly outside of individual control, which may lead to uneven distributions that are unnecessary, avoidable, unjust and unfair. In this way, health inequalities can lead to inequity in health.

Health Inequity
Health inequalities that are considered both unfair and avoidable. Health inequities are differences in health status or in the distribution of health resources between different population groups, arising from the social conditions in which people are born, grow, live, work and age. Health inequalities between richer and poorer groups in society, and between wealthier countries of North American and Europe and the resource poor countries of Africa are examples of health inequities; they are widely regarded as unfair and avoidable.

Health in All Policies (HiAP)
Health in All Policies (HiAP) is an approach to public policies across sectors that systematically takes into account the health and health systems implications of decisions, seeks synergies and avoids harmful health impacts, in order to improve population health and health equity. A HiAP approach is founded on health-related rights and obligations. It emphasizes the consequences of public policies on health determinants, and aims to improve the accountability of policymakers for health impacts at all levels of policymaking.

Intersectoral
Working with more than one sector of society to take action on an area of shared interest to achieve better results than those obtained working in isolation. Sectors may include government departments such as health, education, environment, justice, etc.; ordinary citizens; non-profit societies or organizations; and business.

Interventions
Human actions, including policies and strategies, to address specific issues, needs, opportunities, or problems. Interventions may be of legal, technical, institutional, economic, and behavioural nature and may operate at various spatial and time scales.

Lifestyle
An identifiable pattern of behaviours woven into our everyday life. The behaviours that make up our lifestyle are often routine and habitual, undertaken without much conscious thought. They include behaviours that influence our health, for example, travel habits (car vs walking), eating habits (take-out pizzas vs homemade meals) etc. Lifestyles also have environmental effects; modern urban lifestyles are much more environmentally damaging than those associated with traditional agrarian communities.

Natural Environment
All of the biotic (living) and naturally occurring abi-

otic (non-living) factors that act on a human or non-human organism, population, or community and influence its survival and development. Biotic factors include the organisms themselves, their food, and their interactions. Abiotic factors include sunlight, soil, air, water and climate.

Physical Environment
All of the abiotic (non-living) and human-created factors that act on a human or non-human organism, population or community, and influence its survival and development. Abiotic factors include sunlight, soil, air, water and climate; human-created factors include buildings, infrastructure such as roads, and pollution.

Population Health
The overall health of a population or society (e.g. life expectancy of the population) and its social patterning (e.g. life expectancy of men compared to women, of low-income versus high-come groups). The term therefore refers to the health of groups of individuals, including the distribution of health within the group.

Pressure
These are the pressures that are created by Driving Forces, which act directly to modify or sustain the Physical State of the environment in a location. For example, the introduction of CO2 and particulate matter caused by our high levels of car use.

Provisioning (ecosystem) service
An ecosystem process that is utilised by humans to provide marketable products or goods, including, for example, the production of food and fibre, and the provision of clean water.

Proximal (Pathway)
The Proximal Pathway from Macro-Level Driving Forces to human health, wellbeing and equity deals with the relationships traditionally addressed in environmental health where the concern is with the environment, near in time and space and it's health, wellbeing and equity implications for those who live there.

Psychosocial
Referring to the mind's ability to consciously or unconsciously adjust and relate the body to its physical and social environment.

Public Health
The term is used in two ways. Firstly, it is shorthand for the health of the public. Alternative terms, like population health, similarly refer to people as a group. Secondly, public health refers to 'what we, as a society, do collectively to assure the conditions in which people can be healthy'.

Regulating Ecosystem Service
An ecosystem process that is utilised by humans indirectly to support human activities, for example, the regulation of climate, the regulation of natural hazards.

Salutogenic
Able to produce human health and wellbeing.

Social Environment
The social environment encompasses people's everyday social relationships and the wider cultural environment. It also includes the built environment, at home and in the workplace, as well as transport and communication networks. Looking beyond people's immediate surroundings, the social environment includes labour markets and the wider social structure (e.g. inequalities related to social class, gender, and ethnicity) together with human services (e.g. education, healthcare, welfare).

Social determinants of health
The circumstances in which people are born, grow up, live, work and age, and the systems put in place to deal with illness. The World Health Organisation (WHO) notes that these circumstances are in turn shaped by a wider set of forces: economics, social policies, and politics.

Sustainability
A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs. Sustainability is about both inter-generational equity (captured by 'environmental sustainability') and intra-generational equity (captured by 'social sustainability'). Sustainable development is about balancing both demands and not about sacrificing one entirely for the other.

Sustainable behaviour
Behaviour that minimises the negative impact of one's actions on the physical, social and economic environment.

Susceptibility
How individuals or groups of individuals or organisms respond to and recover from stressors inadequately or not as well as the average

Social gradient
The poorest of the poor, around the world, have the worst health. Within countries, the evidence shows

that in general the lower an individual's socioeconomic position the worse their health. There is a social gradient in health that runs from top to bottom of the socioeconomic spectrum. This is a global phenomenon, seen in low-, middle- and high-income countries. The social gradient in health means that health inequities affect everyone.

Upstream Measures
Upstream policy and environmental interventions that do not treat problems after they occur but rather are designed to prevent undesired outcomes and maintain optimal lifestyles. Example include changes to the environment, such as the development of cycle path infrastructure or attractive public parks which through new environmental cues facilitate the development of new behaviours and habits.

Wellbeing
A multidimensional concept covering physical, psychological, and social aspects of wellness. It includes the presence of positive emotions and moods (e.g. contentment, happiness), and the absence of negative emotions (e.g. depression, anxiety), satisfaction with life, fulfilment, resilience and positive functioning.

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INHERIT is about stimulating effective policies, practices and innovations that address key environmental factors and promote health and wellbeing.

This report is the first product of INHERIT and explores ways to stimulate sustainable lifestyles and behaviours in the areas of living, moving and consuming which protect the environment, health and promote health equity.

Working methods include development of a conceptual framework and a review of the scientific literature and grey literature collected by the INHERIT partners.

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