Evidence Review

on

Environmental Health Challenges

and

Risks in Urban Settings

Grant, M., Coghill, N., Barton, H. and Bird, C.

For

WHO European Centre for Environment and Health
Bonn

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WHO Collaborating Centre for Healthy Cities and Urban Policy

University of the West of England, Bristol

Part of the Institute for Sustainability, Health and Environment
Evidence Review on
Environmental Health Challenges and Risks in Urban Settings

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Section 1
Urban environments and health

Rapid, unplanned, unsustainable patterns of urban development and continuing urbanisation of the population have always made cities in the developing nations focal points for many emerging environmental and health hazards (WHO, 2002a). The public health issues of waste disposal, provision of safe water and sanitation and injury prevention are familiar issues at the interface between urban inequalities, environment and health.

Economic development has often been part of the package of solutions to these problems. However, a new agenda of largely non-communicable disease and seemingly intractable health risks is emerging from the urban settlements in developed nations. Obesity, asthma, health inequalities, mental illness and loss of social cohesion and support networks are becoming an increasing public health focus in urban areas.

Europe is one of the most urbanised continents. Approximately 75% of its population lives in urban areas; by 2020, this will be 80% (EEA, 2009a). Pressures for development in urban areas is becoming acute; urban sprawl is re-shaping landscapes and affecting people’s quality of life and the environment as never before. Urban planning is now high on the political agenda and the acknowledge by the European Environment Agency (2009a) as a critical challenge;

... today's trend of new, low-density approaches to urban development results in increased consumption of energy, resources, transport and land, thereby raising greenhouse gas emissions and air and noise pollution to levels that often exceed the legal or recommended human safety limits.

In the recently published report on the quality of life in European towns and cities (EEA, 2009b) they state that

... health, quality of life has deteriorated. For example, there have been marked increases in allergic reactions and lifestyle related diseases, such as cardiovascular disorders caused by obesity, physical inactivity or stress.

The challenges for health in European Cities have been a focus for the WHO Healthy Cities programme since its inception in 1998 and has recently been re-affirmed in the Zagreb Declaration for Healthy Cities (WHO, 2009), with the planning for healthy urban environments coming to the fore.

This review attempts to look at health risks from a spatial planning perspective. The risks to health are viewed as being woven into the very fabric of our towns and cities; the way we plan, design and manage the territory of places, spaces, facilities and buildings of our urban habitat impacts on health from both a positive and negative perspective (RCEP, 2007). The review provides an overview of the evidence. It reviews the effect of land use patterns, transport, greenspace and local environments as they impact on five specific health risks. These are basic components of the urban environment and are all subject to sectoral policies which spatial planning seeks to align and influence.

The health risks examined are air pollution, noise exposure, physical activity levels, social impacts and pathologies, and unintentional injuries. The way they are affected by
the urban components varies in absolute terms and in their relative contributions to
different sub-populations (CSDH, 2008). However, they all have a significant impact on
the general quality of life for those living and working in the urban environment through
influencing the potential for physical, mental, social and environmental well-being.

This review contributes to the agenda for frameworks and approaches as set out by the
International Public Health Symposium on Environment and Health Research (WHO,
2008a) in helping to close the science-policy gap. In particular, the objective is to
communicate the results of primary research and reviews of research with a high
degree of synthesis, so capturing the complexity and interdependence of environment
and public health issues in the urban realm. It is hoped that the form that this evidence
review takes will support researchers and policy makers in developing a better
understanding and developing new programmes to address the health risks examined.

The main questions for the review are:

• What evidence does exist on the environment-related or triggered health effects of
  urban settings?

• What urban features and risk factors are most dominant and what are their expected
trends?

• What urban planning solutions are being suggested in the literature?

Following this introduction, Section 2 ‘Approaching the evidence’, provides an outline of
how evidence has been identified and selected. Section 3: ‘Brief resume of the health
risks’ then briefly describes each of the five selected health risks and their effects on
health. Section 4, entitled ‘Main urban components and their risks to health’, addresses
in detail the evidence available to answer the first two questions above. Section 5 then
discusses the impacts on and relevance of climate change to the urban planning
agenda. The final question as to what urban planning solutions are being suggested in
the literature is dealt with in the concluding section entitled ‘Challenges for a healthy
urban environment’.
Section 2
Approaching the evidence

This review is based on selected recent published literature including peer review articles, scientific monographs and a selection of key national and international reports published by noted agencies in the field of health and the built environment. Due to the timeframe and resources for this report, it is not a systematic review of the literature, but seeks to provide a brief overview of the major health challenges and risks in an urban environment using a strategic search methodology.

Strategic Search Strategy

The strategic search used a ‘theoretical sampling’ technique. Early searches were used to suggest later searching decisions; the results from which were used to test emerging results. The point of saturation was reached when additional searches did not further enrich the literature already obtained.

The initial search strategy was limited by the following:
- Years, 2005-2009
- Humans only
- Published in English
- Reviews and meta-studies, reports, strategies
- Search terms; health, environment, transport, green space, urban design, urban servicing, air quality, air pollution water pollution, physical activity, social pathologies, mental health, air pollution, noise exposure, injuries and accidents, urban form and crime.

However, material lying outside these parameters has been included where it has been cited in items recovered using the initial search items and is relevant to the study.

Many existing studies shedding light on health risk in the urban environment do not meet the medical professions’ requirements for robust clinical and quantitative evidence. This can result in a tendency to discount a range of in-depth and rich qualitative studies. Such research is important for analysing and explaining the relationships illustrated through quantitative research methodologies and has been included where relevant.

Key websites were interrogated for relevant publications from both the UK and international statutory organisations. These including the Department of Health, National Institute of Clinical Excellence, Department for the Environment, Food and Rural Affairs, South West Public Health Observatory, Department for Transport and the World Health Organisation.

Other data sources included: CBA abstracts, Encyclopaedia of Life Sciences, Geobase, GreenFILE, Science Citation Index, Science Direct, Social Sciences, Citation Index and the Cochrane library.

Additionally, a bibliography resource, related to the effect of the built environment on health, which is currently under development by the WHO Collaborating Centre for Healthy Cities, commissioned by the Department of Health, was used to identify key literature.
Section 3
The health risks in outline

This section provides an overview of the five health risks associated with the built environment which are included in this report. These are:

- physical inactivity
- social impacts
- air pollution
- noise exposure
- unintentional injuries.

Each health risk is briefly described together with its associated health impacts.

3.1 Physical inactivity

Physical activity is defined as: 'Any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level' (CDC, 2008). In terms of urban living this is an all-emcompassing term that includes, in terms of increasing degrees of effort:

- every day activity such as walking, carrying and climbing stairs,
- health related physical activity such as gardening, cycling, dancing
- children’s active play such as chasing, skipping, hopscotch, frisbee
- exercise such as swimming, jogging, gym and exercise classes
- sport such as hockey, football and tennis.

This study focusses on everyday incidental activity. That is the energy expended by people going about their everyday work, shopping and leisure tasks. This would include cycling, as transport can be included as an everyday activity, as can children’s incidental play. The degree to which the built environment may support planned recreational activity is also noted where there is relevant evidence. Regular physical activity has multiple health benefits (Table 1).

<table>
<thead>
<tr>
<th>Health Benefits of Regular Physical Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces the risk of dying prematurely from cardiovascular diseases e.g. coronary heart disease and stroke</td>
</tr>
<tr>
<td>Reduces the risk of developing non-insulin dependant diabetes</td>
</tr>
<tr>
<td>Reduces the risk of developing high blood pressure</td>
</tr>
<tr>
<td>Reduces hypertension in those already with hypertension</td>
</tr>
<tr>
<td>Reduces the risk of developing colon cancer</td>
</tr>
<tr>
<td>Reduces the risk of developing breast cancer</td>
</tr>
<tr>
<td>Reduces the development of osteoarthritis and osteoporosis</td>
</tr>
<tr>
<td>Reduces fall-related injuries among older adults</td>
</tr>
<tr>
<td>Helps maintain a healthy weight and reduces overweight and obesity</td>
</tr>
<tr>
<td>Helps build and maintain healthy bones, muscles and joints</td>
</tr>
<tr>
<td>Reduces feelings of depression, anxiety and promotes physiological and psychological wellbeing</td>
</tr>
</tbody>
</table>

Table 1: Health benefits of regular physical activity. DHSS, 1996, DHSS, 2002.

Across Europe, levels of moderate-intensity physical activity are generally low and fail to comply with recommendations (WHO, 2004a). Over 40% of adults in the 15 European member countries reported no moderate level of physical activity in the past week, only 18% reported participating in daily moderate level physical activity, the frequency WHO suggests is required to reduce cardiovascular
disease, (BHF, 2005). Surveys that include both work-related and leisure time physical activity show that men in the lowest social class, including manual workers are more physically active than men in higher social classes, however, this difference does not persist in women. Physical activity levels decline with age. In developed countries females tend to be less active than males across all ages (DH, 2004).

A reduced all-cause and cardiovascular mortality has been observed in those who frequently cycle and/or use walking as a mode of active transport (Shephard, 2008). However, more information is needed regarding the weekly level of physical activity required through active commuting, to benefit health. Moreover, there is still a requirement to find better methods of encouraging a sedentary population to use active transport which should include changes to the built environment (Shephard, 2009).

Danish research (reported in KK, 2007) states that “Cycling has the same effect on health as other types of exercise and motion. Four hours of cycling per week or approx. 10 km of cycling a day is an adequate level [for recommended activity], which for many people is the equivalent of the daily cycle trip to and from work”.

3.2 Social impacts

Components in the urban environments can have both negative and positive social impacts. Negative social impacts can lead to a host of social, economic and psychological problems at the individual or community level which then can be detrimental to physical and psychological well-being.

Negative social impacts include what is often termed effects on social pathologies. These result from deviant social behaviours for including vandalism, crime, abuse, discriminatory behaviours, isolation and stigmatism. Whole communities can be affected by these pathologies and the associated fear and stress. These can also be direct social impacts from urban form such as community severance due to road building or heavy road traffic.

Positive impacts can also occur at both the individual and community level. For the individual the positive impacts are based on mental health, including reduced levels of stress and restorative and recuperative states of mind. They have all been associated with support for mental health and positive states of physiological well-being. A concept embodied in the concept of a salutogenic model of health as proposed by Antonovsky (1987; 1996). At the community level impacts are on social capital (De Silva, 2004) and social inclusion (SEU, 2004), often indicated by communities with more supportive social networks. There is a strong and well established link between mental illness and a lack of supportive social networks (Halpern, 1995).

Often it is an individual’s perception that these may occur or cause harm that impacts on health and well-being (Wilcox et al, 2003; Foster et al, 2008). Although risk perception of crime, for example, varies across neighbourhoods, the literature is consistent in showing that in developed nations, poverty, the proportion of a population that is non-white and residential instability are the most significant factors associated with risk perception (Wilcox et al, 2003; Whitley et al, 2005). Women, elderly people and those from ethnic minority groups report feeling more physically vulnerable compared to men, younger adults and white-caucasians (Foster et al, 2008).
3.3 Air pollution

Clean air is a basic requirement for health and well-being (WHO, 2005). However, the combination of outdoor, urban air pollution which is mainly from road transport, power stations and other industrial sources and indoor air pollution caused by the burning of solid fuels causes more than 2 million premature deaths each year (WHO, 2005). Over half of these deaths occur in developing countries. People with respiratory or cardiovascular disease, in particular coronary heart disease, are most at risk especially if they are elderly. The quality of our ambient air can also vary depending on the season and the relative altitude of the cities or towns in which we live in relation to the sources of air pollutants (Department of the Environment, 2002).

The European Union has established legislation which includes standards and objectives for the major air pollutants (Europa, 2008).

A number of different air-borne particulates are antagonistic to the sensitive lining of the airways and act as irritants, causing breathing difficulties and discomfort. Additionally, for those people with pre-existing respiratory disease(s) for example asthma and other chronic obstructive airways disease, these increase their risk of experiencing a respiratory exacerbation of their current condition.

Approximately 300 million people globally suffer from asthma and around 180,000 deaths per year are attributable to this chronic airway disease (Braman, 2006). It has been suggested that rates are increasing globally by 50% every decade. The prevalence is high in developed and developing countries, with the most striking increase being amongst children. Although the reasons for this increase are largely unknown, it has been suggested that an increase in environmental influences along with exposure to micro organisms and pollutants both indoor and outdoor, diet and exercise are strong influencing factors (Brahman, 2006). However, our current definition of asthma seems to be more inclusive, capturing more people than previously.

Coronary heart disease is the leading global, cause of death and ill health, accounting for around 17.5 million deaths per year (WHO, 2007). Coronary heart disease is one of the most common causes of death (BHF, 2008). In 2005, it was the cause of 7.6 million deaths. It has been predicted that by 2015, almost 20 million people will die from cardiovascular disease and of these the majority will die from heart disease and stroke. People in lower social economic groups are most at risk, and there is little difference in the incidence of coronary heart disease between men and women.

There is a clear association between long-term exposure to particulate air pollution (PM$_{2.5}$ and sulphate and sulphur dioxide) and a reduction in life-expectancy caused by cardiovascular disease (DH, 2006). Two accepted mechanisms exist to explain the associations between particles and their effect on the cardiovascular system. (i) Airborne particles set up an inflammatory response in the lining of the lungs, which in turn increases the likelihood of a clot or the rupture of an atheromatous plaque, (ii) a reflex reaction by the heart to the pollutants or secondary factors produced by the inflammatory response to the articles; which may in turn affect the autonomic control of the heart beat. Furthermore, outdoor pollution is known to represent 2% of cardiopulmonary disease mortality (WHO, 2007).
3.4 Noise exposure

Ambient or environmental noise is unwanted or harmful outdoor sound created by human activities. This includes noise created by road, air and rail transportation and industrial activities.

Excessive or persistent noise exposure from these sources can have a detrimental effect on health (WHO, 2007). The main impacts on health are on cardiovascular diseases, sleep disturbances, annoyance, which impacts on mental health, hearing impairment, tinnitus which can also affect mental health and disturb sleep and cognitive impairment (WHO, 2007). Based on a set of assumptions for Europe, which are described in the above report, the total burden of ischaemic heart disease related to noise exposure was estimated to be 88,000 DALY1’s, for noise-related sleep disturbance, from 2,798,594 to 559,719 depending on the disability weight assigned; and for annoyance estimates in DALYs ranging from 139,087-1,669,041. Different estimations are found depending on whether a survey based approach was taken, for example using the Eurostat survey (2000) or an exposure based approach.

Evidence supports the role of environmental and non-occupational noise exposure impairing hearing and can induce tinnitus (WHO, 2007). Temporary shifts in hearing threshold and the inducement of tinnitus can occur with excessive and prolonged noise exposure, however, although exposure response levels are available for hearing impairment these are yet to be established for tinnitus.

Health consequences associated with cognitive impairment resulting from environmental noise include problems with reading, recall, recognition and attention. The effect on learning for both children and adults can be negatively influenced by noise exposure, however estimates for DALYs have yet to be calculated. Noisy outdoor environments (commonly traffic noise) can also affect the social inclusion component of social pathology risk factors. For example, intrusive traffic noise can make streets less conducive for social interactions.

Furthermore, exposure to excessive, prolonged noise can also contribute towards exacerbating asthma. A report on the health effects of the built environment from Ireland found that city dwellers were unable to sleep with their windows open because of excessive noise (Lavin et al 2006).

3.5 Unintentional injuries

Unintentional injuries in this context refer to unintentional occurrences and include general hazards. The Manifesto for Safe Communities states that ‘all human beings have a right to health and safety (Spinks et al, 2005).

In children aged 5-19 years, unintentional injuries are the leading cause of death, the majority of these were as a result of road traffic collisions (Peden et al. 2008). In 2004, 42,000 children and young people aged 0-19 years died from unintentional injuries in the WHO, European region (Sethi et al, 2008).

For all types of accidents those in lower socio-economic groups are at greater risk of mortality and morbidity from non-intentional injury (Sethi et al, 2008; Peden et al, 2008). Older children are at greater risk of death from an injury compared to younger

1 DALY stands for ‘disability-adjusted life year’. It is a standard metric representing overall disease burden. It quantifies both the impact of premature death and disability in a population.
children, with almost half of all deaths in those aged 15-19 years, being caused by an injury (Peden et al, 2008).

Included also within this health risk category are specific risks of disease where the evidence has attributed this to a named urban disease from wildlife in greenspace.
Section 4
Main urban components and their risks to health

This section will discuss the environmental challenges and risks that impact on health and that are present in urban settings mediated through urban planning and design. The main components that will be discussed are:

- land use pattern
- transport
- greenspace
- local environment.

The urban environment is a complex system involving a web of connections (RCEP, 2007) and analysis of scale can provide an important orientation in terms of gaining a better understanding. As a group the elected components range in scale from the strategic to the local (Figure 1). Land use pattern is concerned only with the strategic scale, the scale of the city-region, city and towns. Transport and greenspace interact with health risk at all scales from the strategic to the local including the district and neighbourhood in the middle range. Local environments have some interactions with health risks at the scale of neighbourhood but the majority at estate, street and block level.

The review also sought to include two other components of the urban environment:

- Services and facilities provided by the municipal authorities
- Services and facilities provided by the commercial sector

Evidence associated with these is highly disparate and wide ranging, as hence within the scope of this study it was not possible to gather enough data to provide a worthwhile overview. Locational and siting impacts on health risk, except with specific potentially hazardous operations, are already covered in the
land use pattern and transport sections. Other material that has been found can be found in the Appendix 1.

Potentially these components can have negative and/or positive interactions with the main risk factors of air pollution, noise exposure, physical activity levels, social impacts and unintentional injuries.

The structure and ordering of Section 4 arises from the nature of the spatial urban environment, the relationships between components and inherent hierarchies in the urban system. To a large degree, these four components interact and influence each other.

Strategic planning, or the absence of it, will determine components at the largest scale, that is the form of the built environment across the whole settlement or urbanised region, what we are calling the urban form. Urban form has been split into three strategic components and one local level component. Land use pattern includes the density, disposition and nature of different land uses. These parameters of land use pattern lay the foundations the movement and activity needs across the settlement and hence strongly influence the transport systems required to meet those needs. Strategic greenspace is the location for major recreational open space. It comprises both strategic features that remain undeveloped due to their natural character or cultural resonance, for example escarpments, woods, watercourses or historic parkland, deer parks and estates. It also comprises habitats, not always publicly accessible, that have evolved taking advantage of larger scale features such as railway, canal, or road corridors.

4.1 The effect of land use pattern on the health risks

This section will address the large scale issue of land use pattern. In most settlements the land use pattern, which is dynamic and constantly changing, results from the decisions of a myriad of land owners, in a context of market forces, mediated or not and to varying degrees by a spatial planning system. Spatial planning policies especially zoning and large area masterplanning activities can have a profound effect on the developing urban form as expressed by the land use pattern.

This land use pattern comprises the nature, disposition and density of land use. Issues of layout, networks, connectivity, accessibility, distribution and availability of facilities and functions are influenced. In terms of impacts on health of the land use pattern we can discern relevant impacts at a series of distinct but nested scales. These are the region, city, town, district and neighbourhood scales. Several commentators discuss the general evidence of the impact of land use patterns on health (Lavin et al. 2006; Rao et al. 2007). Significant health dimensions at the smaller spatial scales of the street, the block, the individual dwelling or building are dealt with in the section on urban design/character.

Urban sprawl is the term used to describe land use practices that both physically separate and isolate different functions and services in a settlement and one that builds
residential (and often retail and commercial) accommodation at low densities. Modern urban systems can serve to discourage activity (RCEP, 2007).

### 4.1.1 The effects of land use pattern on physical activity

Urban land use pattern is one of the main influences on levels of physical activity. It influences physical activity as part of a complex system of interactions with pattern systems at larger and smaller scales.

**Figure 2:** Urban distance is dependent on density, land use mix and street network pattern.

Distance is the key to physical activity. The main parameters of the strategic land use pattern that determine distance are land use mix (Lavin et al. 2006) and density of development (Figure 2). These act in concert with the type of street network, to control a key factor in physical activity, namely the distance and availability of required facilities (Bauman and Ball, 2007). A planning review in the USA estimated that for active transport, short trips and every day tasks, walkable distances were those less than 800m and cyclable distances were those of less than 5km (Vojnovic, 2006). Current research (Barton et al., 2009) gives a more nuanced picture from the United Kingdom, with walking as the dominant mode at varying distances according to trip purpose; within 400m for trips to superstores, 1000m for trips to local shops and services, and over 2000m for trips to school and leisure activities.

A review of studies in the United States of America has shown that shops and services within a walkable distance result in significant increase in physical activity (Duncan, Spence and Mummery, 2005). This has also been confirmed by recent empirical work in the United Kingdom (Barton et al., 2009).

**Land use mix**

Mixed land use provides multiple destinations within close proximity. This has been found to be conducive to walking and cycling (TRB, 2005) with reasonable consistent associations for physical activity levels (Bauman and Bull, 2007). Conversely where urban development is unplanned or planned as segregated single use zones, often
spreading out into areas adjoining the edge of a city, car dependency is likely to be increased (Lavin et al., 2006).

Major trip generators, that is retail, office, leisure, educational and health will facilitate access though active travel modes (on foot and by cycle) if located within the built-up area of the settlement they are serving (Scwanen, Dijst and Dieleman, 2004; Cavil, 2007). They will also lead to better viability of public transport access, whose health impact is reviewed later in the report. A review by the Public Heath Institute of Ireland notes that land use practices that isolate employment locations, shopping and services and housing locations can encourage car use, particularly where public transport options are not available or attractive alternatives (Lavin et al., 2006).

There is evidence that building shopping malls at the fringes of cities may lead to a reduction in the number of shopping trips by foot made per month (to any location) and a tendency towards the use of motorised vehicles for the new pattern of trips (NICE, 2008).

**Density**

Higher residential densities can reduce distances to shops and increase shop availability, reasonable consistent associations have been found between physical activity levels and residential density (Bauman and Bull, 2007). Jones et al. (2007) concluded that several studies show a consistent positive association between density and walking. Higher residential densities increase the catchment population for services, shops and faculties, improving their viability and likely availability. An critical review of 65 studies, mainly in the USA but also including some European studies, stated that ‘accessible neighbourhood resources are strongly associated with levels of physical activity’ (Croucher et al., 2007,pvi).

**The type of local street network**

Active travel distances to the nearest shop are strongly influenced by street network design. This can facilitate short routes and a choice of routes (e.g. a grid based or reticulate pattern) or lead to long detours from the most direct path (e.g. cul-de-sac and dendritic patterns). A large review of cross-sectional research studies predominantly, but not exclusively, from the United States of America and Australia, concluded that there was a consistent correlation between active commuting and street connectivity (Wendel Vos et al, 2007). A separate review undertaken by Jones et al. (2007) also found consistent positive associations between street connectivity and walking. In the UK paying attention to the provision of safe routes to school was associated with short-term increases in level of walking and cycling (NICE, 2008), though the qualitative understanding of what comprises a safe route may need further research to widen applicability.

**4.1.2 The social impacts of land use pattern**

Where the land use pattern places work and home at a distance, with ease of commuting (this can be by car or public transport), long commuting times can have a negative impact at the individual and community level. They impact on mental health and family life and since they can also leave people with less time for civic engagement, they impact negatively on the supportive social networks which also underpin mental health (Dannenberg et al. 2003 in Lavin et al, 2007).
Land use mix will determine the presence or absence of physical community infrastructure such as churches, schools and other municipal support services. With a highly zoned and segregated land use policy these services and facilities will be in a different ‘estate’ to residential housing, average distances will be greater and resulting access poorer. Horowitz highlighted the importance of churches and youth programs to minimize exposure to violence and increase social support. Additionally access to local facilities such as doctors’ surgeries and counselling services were shown to have a positive effect though reducing fear of community violence (Horowitz et al, 2005).

Other evidence also shows a complicated situation dependent on the community’s perceptions of facilities and their reputation. For example, the presence of police or social services can be perceived with distrust; with the police seen as ‘intrusive and provocative’(Horowitz et al, 2005) in some studies in the United States. However, Wilcox et al (2003) found no such increase in fear from crime from the presence of schools in a large metropolitan city in the west of the United States, whether crime was controlled for or not.

Evidence from an inner urban area in North London found that residents experienced a ‘time-space inequality’ as a consequence of crime and other related factors (Whitley et al, 2005). This has been shown to result in poor mental health including feelings of social isolation, negative mood and low self-esteem. ‘Time-space inequality’ describes the variation in ability of community residents to access and use spaces both within their immediate and wider environment at different times during the day or night. This was less prevalent in mentally healthy men or middle-income women. Time-space inequalities seemed to be diminished by interventions that encouraged spatial and temporal movements and encourage connectivity to a wider geography, for example comprehensive local public transport systems and government-issued free travel passes for vulnerable populations. Mixed land use has also been shown to encourage connectivity, where networks for pedestrians and cyclists are provided within the closer and wider community (Lavin et al, 2006). Additionally, urban regeneration of inner city areas has been shown to reduce fear of crime if central spaces are more open. (Whitley et al, 2005).

Perceptions of increased community safety have been the main driver behind the development of ‘Gated Communities’ (Atkinson et al, 2004). However, it is not clear whether crime is actually reduced in such communities; as many are built in low-crime areas (Atkinson et al, 2004). Some community police offers report that gated communities may either displace or focus criminal activity on surrounding communities (Atkinson et al, 2004). This can cause tension in the surrounding communities along with tensions resulting from the elitism of such gated residences.

4.1.3 The effects of land use pattern on air pollution

Land use patterns determine levels of exposure to air pollution by determining where people live in relation to their daily activities and in relation to sources of air pollution. Transport is the leading source for many of the chemicals which contribute to air pollution (Kavanagh et al. 2005) although other sources such as industry and energy production are also important, the impact of transport on air quality is dealt with more fully below. Typical air quality analysis in urban areas addressed five pollutants: nitrogen dioxide (NO2), fine particulates (PM10), sulphur dioxide (SO2), carbon monoxide (CO), and benzene. Ground level ozone can also adversely impact on health.
In terms of land use pattern, the health impacts of air pollution are greater in urban areas with high density and tall buildings, these have higher levels of traffic and congestion, lower air dispersal characteristics and more people (RCEP 2007). There is a complicated balance of conflicting parameters, more compact urban centres will reduce the amount of per capita vehicle travel but at the same time the greater density can still result in increased numbers of vehicle trips in a given area (Frank et al. 2006) which together with higher congestion levels results in higher levels of air pollution.

With regards to health inequality a study reporting on England (Walker, 2003) found that the most deprived wards were clearly those with highest pollutant concentrations. The social distribution of NO2 was typical, showing that people in deprived wards are exposed to concentrations higher (by 41%) than those of wards of average deprivation. The report stated that:

The relationship between poor air quality and deprivation in England is particularly strong for peak pollutant values, including exceedences of standards. The number of people in wards above pollution thresholds increases progressively with increasing deprivation.

The reverse pattern was found in Wales, a country with a much more rural pattern of population. This was due to the least deprived households in Wales tending to be more urban than their English equivalents and mostly located in the more urbanized south, where most of the poorest air quality occurs.

The report also describes “clusters of wards that have poor aggregate air quality and high deprivation” or “hot-spots … [of] … pollution-poverty”, with large clusters in the parts of the main cities (Walker, 2003).

4.1.4 The effects of land use pattern on noise exposure

The pattern of land use is an important factor in determining the impacts of environmental noise on human health. Noise is seen as a key quality of life issue in the urban environment (Mayor of London, 2007) and it is generally accepted that transport is the biggest contributor to environmental noise (Kavanagh et al., 2005)) with industry being the other major contributor. Patterns of land use can have a significant impact on transport types, volume and proximity to areas of human activity. The extent to which noisy activities impact on health is determined particularly by their siting in relation to housing, schools and open spaces which should be “peaceful havens” (Mayor of London, 2007). In non-industrial urban environments, opinion poll research conducted in 2003 (cited in RCEP, 2007) found that environmental noise problems are worse in areas of high density housing, rented accommodation (both social and private sectors), areas of deprivation and areas which are highly urbanised. Other sources of noise irritation come from late night entertainment and other 24-hour activities where they affect residential areas and hence sleep (Mayor of London, 2007).

4.1.5 The effects of land use pattern on unintentional injuries

Flooding

Flooding is the most common natural disaster in Europe (WHO, 2002b). Land use of the floodplain is a strategic urban planning issue as spatial planning can be used to control development in the floodplain and ascribe uses compatible with different levels of flood risk (LiFE, 2009).
Urban flooding will present an increasing risk to health due to climate change (McMicheal et al., 2006). In addition to risk of inundation from the sea, as a result of sea level rise, development has occurred on fluvial floodplains in many cities. Climate change also brings more extreme weather events with higher risks of heavier and more prolonged periods of precipitation (Costello et al. 2009; RCEP, 2007). Direct health effects from flooding are mortality from drowning, heart attacks and injuries; and injuries that do not lead to loss of life. Indirect health effects are infectious diseases, poisoning and post-traumatic stress disorder. The latter should not be underestimated in impact. Data from the United States collected 36 months before a disaster and 48 months afterwards showed a statistically significant increase in suicide rates following floods, from 12.1 to 13.8 per 100 000 population (WHO, 2002b). Another significant health risk, often overlooked, is the secondary health risk of the loss of essential urban services which may be temporarily unavailable or severely disrupted by flooding. This includes utilities such as electricity, domestic water supplies, and services such as police and fire-fighters (LiFE, 2009).

In terms of health inequality, the effects of flooding can be particularly devastating to already vulnerable populations, such as children, older people and/or disabled people, ethnic minorities and those with low incomes (WHO, 2003b). A study in the United Kingdom (Walker et al., 2003) found that for England, the tidal floodplain analysis showed a clear relationship with deprivation. Of the population living within the tidal floodplain, there were eight times more people in the most deprived decile compared to the least deprived. In contrast, for the fluvial floodplain, there was an inverse relationship with deprivation, although of lesser strength, with a higher proportion of the floodplain population in the more affluent compared to the more deprived deciles. For Wales, the pattern of social distribution was less distinct but showed some similarities to England.

**Heat islands**

Heat islands are urban and suburban areas that capture and retain too much heat. This can make the ambient air temperature significantly warmer than areas in the surrounding countryside.

Exposure to heat is a cause of morbidity and mortality in the urban environment, and heat stress is a condition that can cause illness and death. Human exposure to excessively warm weather, especially in cities, is an increasingly important public health problem. Harlan (2006) examined heat-related health inequalities within one city in order to understand the relationships between the microclimates of eight diverse urban neighbourhoods, population characteristics, thermal environments that regulate microclimates, and the resources people possess to cope with climatic conditions. Statistically significant differences were found in temperatures between the neighbourhoods during the entire summer, which increased during a heat wave period. Lower socioeconomic and ethnic minority groups were more likely to live in warmer neighbourhoods with greater exposure to heat stress. High settlement density, sparse vegetation, and having no open space in the neighbourhood were significantly correlated with higher temperatures. People in warmer neighbourhoods were more vulnerable to heat exposure because they had fewer social and material resources to cope with extreme heat.
4.2 The effect of transport on the health risks

The transport infrastructure and the land use pattern are interdependent. The existence of transport networks affects the pattern of accessibility which helps determine where land use development occurs. The pattern of use determines movement patterns, which in turn triggers demand for extra transport provision.

The average person in the European Union cycles about 0.5 km, walks about 1.0 km and travels 28 km by car per day (Racioppi, 2004). Cycling and walking, as active modes, could be especially relevant in the urban environment where more than 50% of the total urban trips currently carried out by car in the European Union are shorter than 5 km (Racioppi, 2004).

4.2.1 The effect of transport on physical activity

The location of different land uses relative to one another for example, residential, retail and offices as well as the amount of development in a given location has an impact in how people travel. Together with the increase of labour saving devices at home and at work, the increase in personal motorised transport has reduced the level of physical activity involved in daily living (TRB, 2005).

Modal choice is the main factor that determines transport's impact on physical activity. Reflecting the causal web of interactions in the urban environment (RCEP, 2007), the key to modal choice is distance, and distance (as explained above) is a resultant outcome of land use mix, density and street pattern. It is the relative distance that people have to travel, to conduct general activities of daily living for example shopping and recreation that affects whether they choose to use active transport such as walking, cycling and roller blades or motorised transport (Cavil, 2007). If residential numbers are low, then facilities are likely to be sparse, which necessitates the increased use of motorised transport for commuting. In addition to distance, if access routes are poorly conceived, difficult to access, poorly maintained or perceived as unsafe these can also act as barriers to encouraging the use of active transport.

Trips can involve several modes of transport. In terms of physical activity, recent policy debate is paying attention to the synergistic effects that public transport can have in promoting walking and cycling to access public transport stops. This has not been reflected yet in systematic review evidence but some empirical papers and reports have been included below where they contain data relevant to the debate.

Car infrastructure

The construction of bypasses in and around urban areas increases total car use, however evidence now suggests that the construction triggers a greater switch to car use than previously forecast (Matson et al., 2006). Furthermore, this can then lead to a case for further road building in these areas (Matson et al., 2006). In general, insufficient action has been taken to improve accessibility to urban areas by foot, bike or public transport. In six town centres where improvements in pedestrian access were made at the same time as a bypass was constructed, a study found that people walked further and felt more relaxed, however it also reported that they were not walking more as a mode of travel into the town centre (Silcock, 1999).

Perceived physical danger posed by motorized traffic has been cited as one of the main barriers to engaging in walking and cycling (Davis, 2002). This has had a
disproportionate effect on activity levels in both children and older adults. However, these issues don’t seem to have been the focus of any recent systematic review studies. A recent meta-analysis in the United States of America showed that if individuals did not perceive traffic as a problem they were 20% more likely to be physically active (Duncan, Spence and Mummery, 2005). Further studies have also shown that busy traffic can reduce activity levels (Bauman and Bull, 2007).

Individuals from low-income groups, older people and those with disabilities are less likely to have access to personal transport (Lavin et al., 2006). These groups may find that access to services such as shops and health care is reduced. Consequently, they may spend a higher proportion of their income on transport (Lavin et al., 2006).

**Public transport infrastructure**

Settlement size, urban form and mix of uses all have an influence on public transport use, but it is difficult to establish the precise nature of these relationships (Balacombe, 2004). The higher the density of a city, the higher the demand for public transport. Contributing to this rise in demand is the association between high density areas and lower income groups with less car ownership. The more each new development is linked into the existing public transport infrastructure the more viable that infrastructure becomes (Balacombe, 2004).

The perceived quality of public transport services is related to several factors such as the safety and cleanliness of its operation. It is also strongly influenced by the built environment which includes the proximity to a transport pick-up point, frequency of the service, attraction of destinations served, reliability, and total trip time compared with other modes of transport (Balacombe, 2004). Investment in high-quality public transport infrastructure can prove a positive stimulus to people walking (Cavil, 2007). People will walk up to 1km to access good quality public transport, with the distance they are prepared to walk diminishing in line with a reduction in the quality of service offered (Balacombe, 2004; O'Sullivan, 1996).

**Cycling infrastructure**

Closing roads or reducing the capacity for motorised transport can lead to long-term increases in the levels of walking and cycling within the vicinity (Jones et al. 2007). In a similar manner, long term increases in cycling can result from introducing road charging schemes for motorised traffic such as in London (NICE, 2008). Additionally, infrastructures to support cycling can have positive, long-term effects on the prevalence of people using bicycles as a preferred mode of transport. (NICE, 2008). Infrastructures such as cycle lanes, preferably separated from other road users, and other measures to calm motorised traffic can be effective, in addition to off road cycle paths (Lavin et al., 2006).

Cycling can also be used to access good quality connected public transport, in particular the longer inter-urban journeys, with people prepared to not only travel a longer distance but also spend a longer time in accessing the public transport stop (Krygsman et al. 2004).
**Walking infrastructure**

In a review of European best practice for delivering integrated transport (CFIT, 2001) it was thought that levels of investment in pedestrian facilities contributed to the higher levels of walking found in wealthier countries.

Several reports have identified that the presence of pavements and other dedicated walking routes have a strong association with increased levels of walking (TRB, 2005; Lavin et al., 2009). These reviews go on to say that the poor maintenance and management of pavements can have a negative affect on walking. Littered streets, poorly maintained surfaces and ‘crime-ridden streets’ (p6) have been associated with low levels of physical activity.

A WHO report (Davis, 2002) reviewing walking found that populations who are most at risk from poorly maintained paved areas include older people, those with chronic diseases that restrict their ability to be mobile and independent, and parents with young children in prams and push chairs. It also stated that adaptations and thoughtful maintenance of the built environment are key to promote independence, active living and reduce falls where possible in this population. Reduction of uneven walking surfaces, ensuring walkways are clutter free, provision of public toilets (Greed, 2006) and seating can help contribute towards this (Davis, 2002; Bauman, 2007).

Walking to and from public transportation can help physically inactive populations, especially low-income and minority groups, attain the recommended level of daily physical activity (Besser and Danneberg, 2005). Therefore increased access to public transit may help promote and maintain active lifestyles.

### 4.2.2 The social impacts of transport

Access to transport that enables residents to move outside of their own community has been shown to positively correlate with a reduced fear of social isolation and positive mental health (Whitley et al, 2005). For those on higher incomes this is by car or taxi. However, for those on lower incomes access to public transport is important (Whitely et al, 2005). Fear of crime has been shown to be a barrier to the use of bicycles as transport for recreation (Stafford et al, 2007).

The density of motorised transport can negatively affect social cohesion within a community. Both though direct community severance due to road construction or through the impact of high levels of heavy motor traffic. The results of what has become a classic study in the United States of America were published by Appleyard (1981), his findings have since been replicated in the United Kingdom (Hart, [unpublished] 2008). Appleyard found increased in motor traffic on roads where they live, forced people to make major adjustments in their lives to shield against the nearly constant noise, pollution, dust and danger outside their front doors. Many residents reported sleep disturbances, no longer spending social time outside on their street and curtailing the independence of their children.

Increased risk of accidents from high traffic density can contribute towards the development of long-term mental health problems in drivers, passengers and victims (Racioppi, 2004). According to Mayou et al (1993), after an accident approximately 10% will develop mood disorders, 20% phobic traffic anxiety and 11% may develop post traumatic stress disorder. Moreover, nearly 20% of those injured in a road traffic collision develop and acute stress reaction and 25% display mental health problems within the first year after the accident.
4.2.3 The effect of transport on air pollution

Road transport is the major source of urban air pollution, emitting pollutants that damage human health and reduce life expectancy (RCEP, 2007). Douglas et al. (2007) suggest that long-term exposure to transport-related air pollution would reduce life expectancy by a few months, a similar effect to that estimated from passive smoking.

Emissions

The main transport related pollutants in the urban environment are particulate matter, ozone, carbon monoxide, nitrogen oxides and sulphur dioxide (RCEP, 2007) mainly due to emissions from the combustion of fuel. Particulates are also created from dust propelled into the air by tyres, ozone is a result of the reaction of emissions with the atmosphere (Kavanagh et al, 2005).

Road transport is expected to continue to contribute significantly to urban air pollution over the next few decades in most European cities whilst in some less developed cities it is still a growing problem (RCEP 2007; WHO 2005b). Whilst greater regulation and technological improvements have reduced individual vehicle emissions over the last decades, transport growth, more diesel vehicles and congestion have largely countered any improvements in air quality (RCEP 2007; WHO 2005b).

Continuing increases in the number of cars (RCEP, 2007), urbanization and expansion of urban areas and longer commutes (WHO 2005b) all point to transport related air pollution remaining a significant health issue for an increasing proportion of the population. Another issue in urban centres is that many trips are too short (<6km) for catalytic converters to be effective so average emissions per km are high (WHO 2005b) and congestion, involving more stopping and starting and changes in acceleration, means more fuel is used and even higher emissions result (Kavanagh et al, 2005).

Transport hot spots with increased air pollution include street canyons which trap transport-related pollutants and belts along major urban highways which also clearly show higher levels of certain pollutants. Others are spread more evenly over the wider city area (WHO 2005b). Other transport hot spots include railway stations, airports and harbours which generate heavy road traffic as well suffering the bursts of high pollutant levels from diesel locomotives, airplanes and ships (WHO 2005b). Near ports and airports, although ships and planes do cause some raising of pollutant levels (10-20% from ships in coastal areas), the majority of the particulates come from the road transport serving the facility (WHO 2005b).

Exposure

Exposure is determined by daily activity patterns and the amount of time spent in highly polluted environments; living or working near busy roads and time spent in traffic are critical factors. Travellers can be exposed to levels three times the background levels and cyclists and walkers may experience higher levels as their physical activity means that they breathe in more air per minute, although generally motorists experience the highest levels of exposure (Douglas et al. 2007; Frank et al. 2006; WHO 2005b).

Research cited by the WHO (2005b) gave the example of Gare de l'Est in Paris which has 100 000 travellers on an average working day and is in a dense urban area. Within a 1000m radius of the station, the diesel locomotives (80 movements per day) emit
about 16% of total nitrogen oxides and 9% of primary particulates in the area; the rest is due to heavy road traffic. During peak operating periods when three locomotives operate simultaneously, they contribute about 50% of nitrogen oxides and 33% of particulates with the pollution lingering for up to 9 minutes.

4.2.4 The effect of transport on noise exposure

Transport is the main source of environmental noise in urban areas. Road traffic is the main cause with additional impacts from trains and airplanes being experienced by those people living close to railway lines or airports. (Kavanagh et al, 2005). Data on noise exposure in major agglomerations and at major infrastructures was reported to the European Commission in 2007 and cited by the EEA (2009c). This consisted of information on 162 settlements (with more than 250,000 inhabitants), some 82,000 km of major roads, approximately 12,000 km of major railways and 74 major civil airports (data from DG ENV 2008 cited EEA 2009c). The figures show that almost 67 million people living in towns and cities (i.e. 55% of the population) are exposed to daily averaged road noise levels exceeding 55 dB L_{den}, (the lower benchmark for the combined noise indicator), which is associated with significant annoyance (EEA, 2009b). Overall 80 million people (cities and rural areas) are exposed to continuous road traffic noise above 65 dB(A) which is associated with cardiovascular effects (EEA, 2009b).

Daily exposure to railway noise and airport noise in these settlements is lower but still significant, with 5.6 and 3.2 million people respectively exposed to levels above 55 dB L_{den}. With almost 48 million people exposed to levels exceeding 50 dB L_{night}, (the lower benchmark for night-time noise) road noise is also by far the largest source of exposure to night-time transport noise. In urban transport hot spots, almost 21 million people live in areas where night-time road noise levels are greater than the 55dB limit beyond which there will be detrimental effects on health. Night-time rail noise also impacts on around 2 million people in urban hot spots (EEA 2009c). In the UK around half the population may be exposed to daytime noise levels above 50-55dB (RCEP 2007).

Road noise comes mainly from three sources: engine systems, tyre/road interaction and air turbulence, which in turn are influenced by factors such as vehicle speed, traffic flow rate, vehicle type, tyre width, driving style, road surface and weather (Frank et al. 2006; Douglas et al. 2007; EEA 2009c). Vehicle horns and theft alarms are also sources of noise (Frank et al. 2006). Buses, trucks and motorcycles produce relatively high noise levels (Frank et al. 2006). Research has shown that “an holistic approach, combining measures on vehicles, tyres and road surfaces with speed moderation, would yield 5dB reduction in road noise at source in most situations with current technology” (Kropp et al 2007 cited EEA 2009c p24). Specific data on speed shows that “cars travelling at 30kph produce maximum sound pressure levels that are 7dB lower, and equivalent sound pressure levels that are 5dB lower, than cars driving at 50kph” (Kavanagh et al, 2005 p30). Surfacing impacts vary from the higher noise levels generated by concrete, stone and rough surfacing such as that with potholes caused by utility company works (Jha, 2007) to porous asphalt which can be used to reduce noise (Douglas et al. 2007). Traffic calming measures such as road humps may also increase traffic noise (Frank et al. 2006).

Rail noise can be the subject of significant public concern, especially from proposed high speed lines (EC 2008). In 2003, freight noise was ranked as the biggest railway noise problem (EC 2008; EEA 2009c) followed by high speed railways and inner urban railways (EEA 2009b). Freight is important because of the associated volumes of evening and night-time traffic (EC 2008; EEA 2009c). High speed rail impacts are from
the pass-by noise peaks occurring by day and more significantly at night. Railway stations also result in road traffic hotspots.

In relation to air travel, the number of people exposed to noise around major European airports has been increasing and this is likely to continue as airport capacity continues to expand (EEA 2009c). Impacts are both from greater numbers of aircraft and road traffic noise (Douglas et al 2007: EEA 2009c).

**4.2.5 The effect of transport on the risk of unintentional injuries**

The effect of transport on the incidence and prevalence of unintentional injuries includes the impact of both motorised and active transport across all ages. Globally, road traffic collisions are the single largest cause of accidents, despite preventative strategies being in place (WHO, 2008b).

Road traffic collisions in the Member States of the European Union annually claim about 43,000 lives and leave more than 1.8 million people injured (ERSO, 2008). In 2006, 67% of all road traffic collisions occurred in an urban environment (European Commission, 2007). Europe data reveals that in 2006 the majority (51%) of fatalities are car or taxi passengers, with 24% two-wheeled vehicle and 18% pedestrian deaths (7% others, tractor, coaches, vans and lorries etc.). Of the two wheeled vehicles 18% of people who on motorcycles or mopeds and 6% were cyclists (ERSO, 2008). The main determining factor relates to traffic speed. Evidence exists to support lower speed limits being associated with lower numbers of injuries and fatalities from both motorised and active transport road traffic collisions (Racioppi et al, 2004; Wilson et al, 2009). A 1km/h increase in speed is associated with a 3% increased risk of a crash involving and injury (Racioppi et al, 2004). This gives an exponential relationship with the probability of a pedestrian dying from car impact rising with car speed from about 4% at 20km/h to 10% at 30km/h, 30% at 40km/h and 70% at 50 km/h.

A number of different factors negatively impact on the rate of accidents and injuries associated with transport, for example, street lighting (Beyer et al, 2009). It has been shown that where there is adequate street lighting this may prevent road traffic collisions, injuries and fatalities (Beyer et al, 2009). Additionally, alcohol-related road traffic collisions, where drivers have exceeded a blood level of 0.05g/dl of alcohol account for between 5-40% of road traffic deaths in the European Union (Racioppi, 2004).

Pilot schemes have been shown that the introduction of a congestion charge for entering inner-city areas can reduce both the amount of congestion via reduced car traffic by an average of 19% in London and Sweden, and general congestion by up to 30% (KK, 2009a). There has also been a compensation increase in the use of public transport (KK, 2009a; TFL, 2009). In London where congestion charges were introduced in 2003, there has been a reduction in the rate of accidents by up to 5% (TFL, 2009).

**4.3 The effect of greenspace on the health risks**

In the urban realm, greenspace includes a huge variety of land from the strategic sale of country parks and river corridors running though cities, to the local, such as residential gardens and pocket parks. It includes land in public, commercial and individual ownerships. It includes a wide range of uses including public and private gardens and squares, amenity and sports open space (often associated with mown
swards), play space (often associated with shrubberies and mown grass), green
corridors, river and canal corridors and greenways, natural and semi-natural habitats
(including derelict and previously developed land) and other functional greenspace
such as allotments, churchyards and cemeteries. In some settlements this broad
category could also include remnant countryside now within urban boundary such as
woodlands, cliff ridges and coast-lines. For this review, greenspace is also taken to
include two important elements of urban nature, not necessarily connected with a
specific territory, street trees and green roofs.

A number of reviews have established that there are multiple connections between
urban greenspace and health (Brown and Grant 2005; Bird 2004, 2007; SDC 2008)
with conclusion broadly in line with Newton (2007, p.4) that 'the natural environment
provides synergistic physical, mental and social wellbeing benefits'. The idea that
engaging with nature has beneficial impacts on wellbeing is prevalent across many
cultures and societies. A range of different cultures identify sacred places, set in natural
landscapes, as having a role in the spiritual wellbeing of individuals (Burns 2006;
Smyth, 2005). A biophilia hypothesis (Wilson 1984) has been used to describe an
innate emotional affiliation of humans to nature that goes beyond nature's role in
providing basic needs to include what could be seen as a role in salutary health (Bird,
2007; Brown and Grant 2007).

Many studies indicate an association between living with greenspace and health and
well-being (Greenspace Scotland et al. 2008), but components such as physical health,
mental health and longevity are not always disaggregated. A large-scale
epidemiological study in Tokyo found that living in areas with greenspace had a
positive influence on longevity independent of several other socio-demographic
characteristics usually associated with health status such as income and education
(Takano 2002).

**4.3.1 The effect of greenspace on physical activity**

The natural environment plays a large part in facilitating physical activity. ‘Evidence
consistently shows that accessible and safe urban greenspaces have a positive
influence on levels of physical activity’ (Croucher et al. 2007). Accessible nature,
including trees, wooded areas and green open spaces can both encourage and
facilitate communities to become more active. A number of studies have found that
these effects are only valid where the greenspace is well-maintained and safe to use
(Greenspace Scotland et al. 2008).

The link between greenspace and activity can be separated into two domains The first
is the effect of background and everyday nature such as street trees, green verges,
pocket and local parks and front gardens and their associated flora and fauna. The
second is greenspace used for active and passive recreation, local and regional parks
and greenways. These two domains merge since the recreational greenspace will
provide background nature within its immediate environs and visually at a distance in
the urban fabric and equally background greenspace can provide the setting for some
recreational activities such as jogging or dog walking.

A number of reviews have attempted to explore whether greenspace in the
environment actually encourages people to exercise more, these are reported in below.
A review undertaken for the Institute of Public Health in Ireland concluded that
provision of attractive parks and open spaces can facilitate people taking the
opportunity for exercise (Lavin et al. 2006). Evaluations of programmes for encouraging
exercise indicate that an attractive, green environment close to home and work
provides the best opportunities to encourage daily exercise in the form of walking and cycling (HCN 2004, Bird 2004). In these studies it has also emerged that people keep exercising for longer in natural surroundings.

Evidence shows that children who have better access to safe green spaces, such as parks and playgrounds, are more likely to be physically active compared to those living in neighbourhoods with reduced access to such facilities (Croucher, et al. 2007). In the secondary analysis of an European cross sectional survey it was found that the likelihood of being physically active may be up to three times higher in residential environments that contain high levels of green space compared with areas with low levels of green space; the likelihood of being overweight or obese may be up to 40% less (Ellaway et al., 2005) Access to green space also has a positive effect on physical health, particularly on those from low income groups (Mitchell et al, 2008).

A recent study conducted in Sweden found that access to such recreational greenspace areas was associated with a positive assessment of neighbourhood satisfaction and time spent on physical activity, which they predicted could be expected to reduce obesity (Björk et al. 2008). A comprehensive literature review selecting 87 primary studies from 550 identified was undertaken by Greenspace Scotland (Croucher et al. 2008). Approximately one third of the studies were from the USA, a further third in the UK, and the remaining studies in Australia, Canada, the Netherlands, Japan, Sweden and Denmark. Physical activity was found to be influenced the following attributes of greenspace:

- distance of residence from a greenspace
- ease of access in terms of routes and entry points
- size of the greenspace in terms of levels of population use
- connectivity to residential and commercial areas
- attractiveness, including biodiverse habitats and absence of graffiti and litter
- range of amenity, the wider the range of informal and formal faculties the more likely the space is to be used by different kinds of people.

The study concluded that exercise was not however, the primary motivation for the majority of park users Moreover, many green space activities are sedentary or involve gentle exercise. Evidence from a number of reported in Croucher et al. (2008 p4) indicates that greenspace is most valued as an escape from the stress, dirt, and noise of urban environments' (Croucher et al. 2008, p4).

4.3.2 The social impacts of greenspace

According to several reviews access to green spaces and nature has been shown to positively effect mental health, possibly through reducing stress and through providing a distraction and distancing ourselves from the everyday activities (HCN, 2004; Pretty et al., 2005; Lavin et al, 2006). Additionally, green spaces have a positive effect on promoting social interaction and cohesion (Greenspace Scotland, 2008).

Conversely restricted access to green spaces has been associated with poorer mental health (Guite et al, 2006; Kuo 2001). Residents in urban social housing who had views of trees and open spaces demonstrated a greater capacity to cope with stress compared to those who did not have such access (Kuo, 2001). Older people in particular benefit from such access (Orsega-Smith et al, 2004).

However, in the UK, those who live in disadvantaged areas are less likely to benefit from green spaces and parks (Lavin et la, 2006). According to a UK report on urban green spaces (Department of Transport, 2002), in the 100 most deprived authorities,
40% of parks were in decline and 88% of parks that were already assessed as being in poor condition were in further decline.

A negative impact on health regarding the social impact of green space, is a community's perceived risk of crime, in particular fear from assault or violence (Croucher et al, 2007). This fear manifests itself in a reduced ability to accrue the positive benefits to mental health from accessing green spaces (Croucher et al, 2007). Closed or over landscaped designs that restrict the view of the immediate environment can reduce feelings of perceived safety. Also there is a potential for crime and anti-social behaviours in greenspace where areas are relatively isolated, lack people and lack supervision (Greenspace Scotland, 2008).

However, in spite of this, an England based survey found that 57% of respondents felt that safety in parks was good (Sport England, 2003). However, it also noted that people rarely visit parks alone unless walking a dog and that woman in particular are unlikely to visit green spaces unless accompanied by others.

4.3.3 The effect of greenspace on air pollution

Greenspace has a positive impact on health by improving air quality and removing pollutants. Both gases and particulate matter can be filtered by vegetation (Lavin et al 2006). Canopies of trees act as a physical filter for pollution by trapping particles on the leaf surfaces as well as absorbing harmful gases (LUC 2004). Greenspace also helps to cool urban areas and moderate the heat island effect which also helps to address air pollution by reducing the formation of photochemical ozone (RCEP 2007). Woodland areas especially are cooler although this varies with season and species. Research cited in Lavin et al. (2006) and LUC (2004) suggest that, for example, broad leaved woodland can reduce ambient air pollution by 17% and that streets with trees have around a quarter of the particles of those without. A possible adverse effect of dense planting may be that in some situations, the effects of pollution may be amplified by creating an enclosed space (Greenspace Scotland et al. 2008). Some species, such as pine, larch, and silver birch, have a more positive effect on air quality than others like oak, willow and poplar, since the latter emit higher levels of volatile organic compounds that contribute to the formation of other pollutants such as ozone and particulates (RCEP 2007 p70).

4.3.4 The effect of greenspace on noise exposure

Greenspace, particularly trees and large shrubs, can have a positive impact in reducing environmental noise by providing a barrier to screen out noise (Greenspace Scotland et al. 2008; RCEP, 2007). The ability of vegetation to attenuate noise is related to the size and density of planting (Greenspace Scotland et al. 2008; LUC 2004). Research suggests that dense planting reaching to the ground and with no gaps may achieve noise reductions of up to 15db. It is also suggested that sharp tones especially may be softened (LUC 2004). Street trees are the most commonly found trees in urban areas and these too may absorb some limited traffic noise (Mayor of London 2007).

People may also value greenspace for its restorative capacity in allowing an escape from the noise of the wider built environment (Greenspace Scotland et al. 2008). The perceived intrusion of noise from traffic can be reduced by vegetation obscuring the noise source and associated traffic movement although there is little research to establish the actual benefits of urban greenspace as a distance barrier or oasis (LUC 2004).
4.3.5 The effect of greenspace on the risk of unintentional injuries

This can include unintentional injuries from both water and land based open spaces. In 2005, there were 6,156 deaths from accidental drowning recorded from 26 European countries. This represents 3.4% of all deaths due to external causes. Many of these deaths occurred in naturally occurring water situated within greenspace. Other risks from open water include the possibility of contracting infections from protozoa, viruses, or bacteria, many of which are intestinal parasites. These are most likely to cause gastrointestinal disturbances.

Additionally, unsafe play areas in greenspace, account for a large proportion of accidents and injuries to children and young people. Poor equipment design, poor design and layout of play areas, unsuitable equipment, incorrect installation, lack of regular inspection and inadequate maintenance all contribute towards accidents and injuries. However, not all accidents and injuries are equipment related. An estimated 424,000 accidents and injuries occur as a result of falling where 66% of these involve falling from a height. Unsafe ground surfacing in children's play areas is a major source of accidents from falls in children.

Other risks from greenspace areas include contracting blood-borne disease through contamination from discarded syringes (Croucher 2008). Additionally, there is a small potential for catching diseases from resident wildlife. However, further research is be needed to properly explore these risks and associated risk-reduction strategies (Croucher et al, 2008).

4.4 The effect of the local urban environment on the health risks

The way we experience and use our immediate environments in towns and cities is determined at the smaller spatial scale of the street, the public square, the block and individual building (Rao et al, 2007). This is the realm of urban design. Impacts on health risks occur through these environments as modified by aesthetic perceptions, often unconscious, of containment and exposure, comfort and threat as much as by physical constraints (Croucher et al, 2007). Diversity and the presence or absence of nature and public realm activity are also important parameters.

Urban design can also have a health impact not mediated by our perceptions and use of space such as direct effects of impervious surfaces or green roofs on flood risk and aquifer recharge.

Urban design, at a slightly larger scale, can also determine the degree of social mixing or segregating through the locational control of social housing in new build and neighbourhood regeneration.

4.4.1 The effect of the local environment on physical activity

There have been several recent major reviews of evidence of the effect of urban design on physical activity (Jones et al., 2007; Bauman and Bull, 2007; Croucher et al., 2007). However, much of the original data is based on studies in the United States of America or Australia. The dominance of lower density development means that the findings may not necessarily be comparable with those from European cities. These reviews also attempt to pull together evidence from a disparate range of study methodologies with
little consistency in the way potential variables in the urban environment are identified. Nevertheless, some broad conclusions can be drawn which may be generalisable in Europe.

**Street Networks:** Evidence surrounding this element has been covered in earlier sections on land use patterns and transport. An example of the effect of street network form on physical activity is reported in Lavin et al. (2007, p17) in a study of Los Angeles residents where it was found that ‘those living in areas laid out in a ‘traditional grid system’ were up to 25% more likely to regularly walk to work compared with residents in socio-economically similar areas that were laid out specifically for cars’.

**Convivial spaces:** Urban environments that lack public gathering places can encourage sedentary living habits (Lavin et al., 2006). In the same review the attribute of ‘enjoyable scenery’ also positively impacts on physical activity levels within a community. Urban environments that are aesthetically pleasing and landscaped have been shown to encourage people to explore and access their local community by foot or bicycle when compared to the same urban space prior to renovations (Cavill, 2007, Duncan, 2005). There is also some evidence that observing people being active is positively associated with activity (Duncan, 2005) though further research is needed to examine this effect in a variety of situations with differing levels of background activity.

**Perceptions of the local urban environment**

Many studies have attempted to find correlations between people’s perceptions of the local environment such as convenience, safety, satisfaction and perceived distance with physical activity levels. Few consistent significant associations have been found. However, two categories of environmental perceptions have been found to have fairly consistent positive patterns of association with physical activity. The first is an association levels of physical activity (not including general walking) and perceived local safety and perceived leisure time. The second is an association between general walking and perceived convenience (Jones et al., 2007). Parent’s perceptions of neighbourhood safety were found to impact on the levels of physical activity in children (Croucher et al. 2007).

A meta analysis by Duncan et al. (2005) found that the perceived presence of pavements, shops and services and perception of ‘traffic as not being a problem’ were each separately positively associated with physical activity after adjusted for age, income and education.

**Management of the local environment**

Lavin et al. (2006) found that deteriorating physical features of urban environments such as dilapidated environments, vandalism, graffiti and litter can impact on physical health through reduction in physical activity. The findings from this study indicated that people are more likely to exercise if pavements are appropriately maintained. This points to a situation where health inequalities are exacerbated since graffiti and vandalism were also disproportionately found in disadvantaged areas. The impacts are confirmed by Ellaway et al. (2005) in the secondary analysis of a European cross sectional survey of 12 cities. They found that, compared to respondents from areas with low levels of litter and graffiti, those from areas with higher levels, were 50% less likely to be physically active and 50% more likely to be overweight.
The local urban environment as a system

In a systematic review, Jones (2007) notes that several studies have failed to find relationships between specific measurable attributes of the local environmental characteristics that might impact on physical activity. Attributes such as the presence of benches, trees, cleanliness, street width, traffic volumes have been investigated. However, Jones notes that some studies, both Australian, have demonstrated associations between combined composite variables.

Examples of composite variables

Pikora et al. (2006) uses a ‘walkability score’ based on the presence of features in the local neighbourhood, including safety, aesthetics (cleanliness, green space etc.), function (pavement quality, street width, traffic volume etc.) and density of destinations such as local amenities and parks.

Giles-Corti et al. (2003) uses a ‘physical environmental determinate score’ which includes living on a street that is aesthetically pleasing, with minor traffic, trees, pavements and a local shop.

Jones et al., (2007) note that “… using a combined variable might reflect the synergistic combination of a supportive environment, as hypothesised by theoretical ecological models of the environmental determinants of physical activity” (p26). The importance of treating the urban environment as a system, especially in rising to challenges of supporting public health is covered in more detail in the conclusions.

4.4.2 The social impacts of the local environment

At the larger scales of neighbourhood and estate layout, the local urban environment, as controlled through urban design also concerns itself with the placing of housing for different social groups. This is influenced though the nature of tenure, size and form of the residential units. Consequently the location and dispersal patterns of residence from different social classes and sub-cultures are strongly influenced by urban design both during new build and regeneration programmes. The nature of dispersal especially the size of similar residential units is critical. People feel more secure in areas where there are others from a similar social culture. It has been shown that the level of social inclusion in a society is just as important for health as income (Marmot, 2004). Yet without a degree of mixing ghettos are created.

Urban designs that facilitate neighbourhood bonds and encourage supportive social networks have been shown to be effective in reducing fear of crime (Lavin et al, 2006). Examples are urban designs that are mixed-use (including work and shops in predominantly residential areas) and those which include pedestrian and cycling oriented facilities. Such designs enable residents who do not own car to perform activities of daily living.

Lack of availability and accessibility of municipal services such as libraries, health facilities doctors surgeries, schools and social support can have a negative social impact on communities and affect both physical and mental health (Horowitz et al, 2005; Lavin et al, 2006). Places which lack facilities often become ghettoised fostering a risk of further criminal activities.

Lack of facilities such as public toilets (Greed, 2006), impacts on vulnerable groups for example young children, older people and those with illnesses or chronic diseases.
Lack of suitable areas for resting, for example benches and seating may also limit the ability for certain groups to explore or walk longer distances. With respect to the elderly this impacts negatively on social isolation.

The design of an urban environment can affect a community’s perception of safety (Wilcox et al, 2003). There is an inverse relationship between the fear of crime and lack of safety and subjective measures of good mental, physical and social health. Although many neighbourhood characteristics may not directly affect physical health, the perceived fear of crime can act as barrier to participating in social and health-promoting activities, leading to feelings of social isolation. This can impact directly on mental, physical and social health (Foster et al, 2008, Stafford et al, 2007). Women and older people are more concerned about safety in their neighbourhoods compared to men and younger women.

One of the main social impacts related to urban form, is residents perceived fear of violence or crime (Horowitz et al, 2005; Whitley et al, 2005). These aspects have been shown to negatively affect mental health. Groups who feel most vulnerable include women in particular mothers on a low-income and those with mental illness (Horowitz et al, 2005; Whitley et al, 2005). Perceptions of safety are influenced by fear of street crime but also injury from traffic (Croucher et al. 2007) and a reaction to the aesthetic impression, which includes the presence of graffiti, litter and state of disrepair of the surrounding community (Lavin et al, 2006). The latter is disproportionately high in low-income and disadvantaged areas (Lavin et al, 2006).

Poor building design for example those with small niches and blind spots, inadequate lighting and overgrown landscaping increase perceived feelings of fear from crime. Such areas provide opportunities for refuge of prospective criminals, in addition to restricting the opportunity of escape for potential victims Wilcox et al, 2003). However, according to Whitley, these fears are diminished if vulnerable areas are monitored by CCTV (Whitley et al, 2005).

Children who live in neighbourhoods that they perceived as unsafe are at greater risk of developing behavioural problems such as hyperactivity, aggression and becoming withdrawn (Lavin et la, 2006). According to recent research, up to 71% of children in a large metropolitan city in the west of the United States suffered from post traumatic stress disorder or partial post traumatic stress disorder (Horowitz et al, 2005).

4.4.3 The effect of the local environment on air pollution

Air pollution in the outdoor environment has been dealt with extensively in preceding sections in terms of land use pattern, transport (giving rise to the bulk of urban emissions) and greenspace. There is little to add from the local urban environment perspective. It should be noted however that indoor air pollution originates from both outdoor and indoor pollutants. As outdoor pollution also enters buildings, indoor pollution problems are worse in urban areas where the general air quality is low. Indoor sources of air pollution include household chemicals and airborne biological agents such as bacteria, fungi, allergens from dust mites and animals and viruses. These can all contribute towards respiratory diseases, including childhood asthma.

4.4.4 The effect of the local environment on noise exposure

Noise exposure has been dealt with extensively in preceding sections in terms of land use pattern, transport (giving rise to the bulk of noise emission) and greenspace. In the local environment the role of point sources related to urban planning come to the fore.
Traditional concerns are ‘noisy neighbour’ impacts, whereby many planning systems attempt to limit incompatible users, e.g. nightclubs and pubs, though a mixture of zoning and licensing. New issues are coming to the fore, namely increased noise exposures in higher densities, in mixed-use areas and in the central areas now being promoted in many cities for 24 hour living. These have not yet been the subject of study for long enough to provide the material for a systematic review of health risk.

4.4.5 The effect of the local environment on the risk of injuries

Road traffic collisions, which are the main cause of injury in the urban environment, have been discussed in an earlier section and are partially contributed to by poor urban design in the local environment. Falls are the next main cause of unintentional injuries related to the local environment. Causes of falls resulting are mainly due to extrinsic factors i.e. individual not medical conditions. Up to 20% of falls in all ages and 30-50% of falls among older people living in the community may be due to such factors (WHO, 2004b).

Unintentional injuries associated with urban design occur from several other sources. These can include poor street lighting (Beyer et al, 2009), choice of materials for footpaths and walkways or accidents resulting from poor maintenance of the built environment, poorly designed urban environments and poor maintenance of public open spaces, play areas, paths, rights of way, and canal towpaths (NICE, 2008).

Another cause of injury from the local urban environment includes adverse reactions caused by exposure to heat. Determinants of this heat island effect are found at the strategic scale with regards to land use pattern and strategic greenspace and these have been outlined previously. Contribution to heat islands are also found at a local level with local contributors being the hot ‘exhaust’ from summer air conditioning plant, lack of greenery (which provides cooling both through shade and evapo-transpiration) and the use of materials in paving, walls and roofs which captures a wide spectrum of the sun’s energy and then re-emits it in the heat spectrum (Gartland, 2007). Sparse vegetation, and having no open space in the neighbourhood were significantly correlated with higher temperatures (Harlan 2006). Local urban design detailing can lead to localised ambient air temperature differences with poorly designed areas being up to 6ºc warmer compared with other similar areas (Gartland, 2007).
Section 5
Climate change

This review does not attempt a comprehensive review of climate change and its associated health risks, it lies beyond the scope of the current work and the issue is being dealt with in depth in other quarters in the run-up to the Copenhagen 2009 meetings which are seeking to reach a post-2012 climate change agreement (Costello et al., 2009; McMichael et al. 2008). Neither can this review fail to mention climate change, as this would be an obvious omission. The purpose of this section is to provide an outline of climate change and spatial planning and in particular the basis on which climate change interacts with the urban components and risk factors dealt with in the preceding section.

At the World Health Assembly in May 2008, 193 member states adopted a resolution acknowledging the profound and adverse ways in which climate change will affect fundamental determinants of health (WHA, 2008). In doing so recognition is given to the strong global scientific consensus that warming of the climatic system is unequivocal (IPCC, 2007). Climate change has been stated as being the biggest global health threat for the 21st century (Costello et al., 2009; p1693)

The main threats are from regional weather changes and sea level rise. Regional weather changes affecting the urban environment will, in addition to rising average temperature, involve more frequent and more extreme weather events, such as heatwaves, droughts, storms and sudden and heavy precipitation (RCEP, 2007).

5.1 Direct Health risks

Climate change is predicted to have effects throughout the global politico-socio-economic system. The impact of sea level rise, weather events and heat could lead to health risk through adversely affecting inequities between rich and poor, territorial habitability and migration pressures (Costello et al, 2009). In terms of direct heath risk in the European urban environment the following are cited in the literature (Costello et al, 2009; DH/HPA, 2008; RCEP, 2007; Haines et al., 2006: NEF, 2009) which all contain details of predicted increases in morbidity and mortality:

- Heat stress; excess mortality and morbidity in the summer months
- Flooding; mental health and stress effect flood and potential flood situations, potential for water-borne disease outbreaks
- Vector-borne disease; changes in patterns of disease
- Drinking water; adverse effects on quality and availability
- Food poisoning; likely increases in incidents
- Air quality: higher ground level ozone concentrations in the lower atmosphere
- Ultraviolet exposure: Cases of skin cancer and cataracts are likely to increase.

In terms of population effects at a settlement level, older people, children and infants are more susceptible to prolonged exposure to heat (RCEP, 2007). There may also be
an uneven distribution in heat in relation to income, with more wealthy residents tending to live in area with more micro-climate moderation through being less low-lying and having a greater proportion of green space.

It should be noted that due to warmer winters, a reduction in excess winter deaths in the elderly through hypothermia has been predicted in the United Kingdom (RCEP, 2007). Contributing to excess winter deaths, in some European countries, is the combination of older building stock (poorly insulated and with inefficient heating systems) and relatively short periods of winter minimum temperatures, leading to a lack of incentive to upgrade insulation or heating systems.

5.2 Mitigation and adaptation

The breakdown of European greenhouse gas emissions (mainly carbon dioxide, methane and nitrous oxide) in 2006 was 59% from energy use. (EC, 2008), with the urban population in accounting for 69 % of all European energy use (EEA, 2009b). Transport accounts for 21% of the emissions; the amount of emission is determined by both mode of travel used and spatial land use distribution. Industry processes account for 8%, 9% is due to agriculture and 3% is from waste disposal (EC 2008).

The literature contains two basic responses to climate change, mitigation and adaptation.

Mitigation: reducing the likely extent of climate change through reducing the impact that human activity has as a cause of climate change. Typical actions are reductions in the emission of gasses which cause climate change and also proposals for CO2 absorption and sequestration.

Adaptation: adapting human development to minimize the impact of the results of climate change such as sea level rise and extreme weather, this can include relocation of activities and changing design and construction standards.

Land use pattern and transport

The quantity of carbon dioxide emission due to transport is determined by both mode of travel used and spatial land use distribution. These two components interact as described in earlier sections. For example, a combination of segregated land use and low densities can greatly reduce the relative attractiveness (and viability) of low carbon transport, both public transport and active travel. Mitigation requires tackling density and land use separation together.

Electric vehicles in towns may have a role in mitigation but only if the electricity is generated from low CO2 emitting technologies.

Greenspace and local environmental design

In terms of greenspace, increasing the number of street trees and the quantity of urban greenspace is an adaptive response, reducing heat island effects and also a mitigating response in areas where air conditioning is used. Climate change mitigation also occurs through urban tree planting in colder climates due to the increases in wind friction which can have the potential to reduce heat loss from residential areas in winter by up to 5%.
At a local environment level, buildings, tarmac and paving absorb and store heat, increasing air temperature as does human activity, in particular air-conditioning. The essential parameters being surface roughness, colour or porosity (all affecting albedo characteristics) and presence or absence of trees and vegetation which cool areas through shading and evapotranspiration (Gartland, 2008). This points towards a number of adaptive responses in terms of material choice and the use of greenery including green roofs.

Urban heat island reduction policies should specifically target vulnerable residential areas and take into account equitable distribution and preservation of environmental resources (RCEP 2007).

**Energy consumption and production**

One of the most prevalent greenhouse gasses is CO2, the role of urban energy consumption and production has in reducing CO2 emissions has become a focus. In urban areas decentralised energy distribution systems, involving more use of combined heat and power, district/community heating networks and local green energy sourcing would provide a contribution to climate change mitigation (NEF, 2008). Some of these measures (combined heat and power and district/community heating networks) become more viable in the mixed use areas which would also become more prevalent as a consequence of implementing some of the transport and land use mitigation measures.

Reducing the energy consumed through space heating and cooling has become a research focus in building design and construction. Low carbon emission forms of providing energy in the urban realm, such as solar space heating, solar electricity generation and solar water heating, and ever increasing levels of insulation are increasingly cited in literature as important mitigation measures to take in the built environment.
Section 6
Challenges for a healthy urban environment

6.1 Public health challenges

Effective planning for public health involves much more than planning for and responding to specific health conditions. It is about healthy human habitat, locally and globally, and supportive social structures (Barton and Grant, 2003). The public health challenge is related to our ability and commitment to creating a healthier built urban environment. The idea is expressed in Lavin et al. (2007 p23) as

Neighbourhoods are the localities in which people live and evidence shows they are vitally important for health and well-being. Combating heart disease, respiratory problems and mental illness means ensuring opportunities for healthy exercise, air quality and local social networks, all of which are influenced by the physical nature of localities.

To this should be added the public health challenges arising from inequalities in health and climate change.

Inequalities in health

Evidence shows that a disproportionate burden of ill-health associated with the built environment is borne by certain groups within the population. The least well-off people in society suffer poorer health (Marmot, 2004). Several of the reviews cited indicate that poor people are more likely to live in poor quality built environments and this contributes to poor health. Lavin et al. (2007) also identify children and the elderly as being particularly vulnerable not only because of a biological vulnerability but also because of the significant numbers of children and elderly who are poor.

6.2 The urban environment

This review demonstrates, within its relatively narrow focus, the huge impact that the urban environment has on public health. Whilst concentrating on specific urban spatial components it has not reviewed well known heath risks such as lack of access to good quality housing, lack of availability of employment and the basic environmental health concerns of good sanitation, food and water.

Instead, the attempt is to contribute to better understanding the impact of spatial policies on health through a review of evidence. The review demonstrates the importance of spatial planning at the macro-scale; specifically the way land use patterns, transportation infrastructure and greenspace affect health risk. At a more local scale, it provides evidence that the design of the urban realm, and the siting and location of some specific faculties and services also affect health risk (see Figure 3).
### Figure 3: Main interactions between the urban components and the health risks

The components of the urban environment both overlap in their extents and have a high level of interaction with each other in effect. The structure of the review has been designed to help avoid repetition; the higher-level components appear earlier in the review and the evidence reviewed captures most of the interaction. At the highest level, the physical, economic and demographic geography of a region will determine a settlement’s land use pattern. In its term, the land use pattern determines location, size and connectivity of strategic green space and also interacts with transport infrastructure to determine viable and effective transport modes.

In order to conduct research and add to knowledge, the empirical work on which this review is based breaks the real world down into more manageable subjects. In reviewing the science, this report has reflected this approach, focussing on naming and defining both urban components and health risks. This makes the complex task of understanding the urban system appear more manageable. Having laid bare some of the fragments, the important task now is to piece the system back together.

### 6.2.1 The urban environment as a system

The urban environment is a complex and open system. As with any such system, sitting at the interface of an intricate human economic socio-cultural phenomena and the natural environment, it is dynamic, with many sub-systems and displays emergent properties above and beyond those of its individual components.

Some of the recent studies reviewed come to this holistic viewpoint of a complex web of interactions (Lavin et al. 2006 p22; RCEP, 2007 p5-7). The evidence presented forms a picture whereby not only do the physical components have an impact but so can people’s perceptions. It presents examples where impacts can stimulate the inception of their own reinforcing feedback loops. This can intensify health risk, as in

<table>
<thead>
<tr>
<th>Health risks</th>
<th>Land use pattern</th>
<th>Transport</th>
<th>Green space</th>
<th>Local design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Social impacts</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Air pollution</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Noise exposure</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Injuries</td>
<td>X</td>
<td>X</td>
<td>X</td>
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\( X = \text{Major interaction} \quad O = \text{Very little interaction} \)

### Table: Urban form and Health risks

<table>
<thead>
<tr>
<th>Health risks</th>
<th>Land use pattern</th>
<th>Transport</th>
<th>Green space</th>
<th>Local design</th>
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<tbody>
<tr>
<td>Physical activity</td>
<td>X</td>
<td>X</td>
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<td>Social impacts</td>
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<td>Injuries</td>
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\( X = \text{Major interaction} \quad O = \text{Minor interaction} \quad O = \text{Very little interaction} \)
the case with increases in road space begetting cars which then increases pressure for more road space (RCEP, 2007). Alternatively this can reduce health risk, as in the case where a well-designed park attracts people, this in turn attracts others, encouraging them to stay longer and undertake more activity (Lavin et al., 2006).

In its report on the urban environment, the Royal Commission on Environment Pollution observes that many of the urban challenges and problems have been diagnosed repeatedly by specialists over the years with a broadly similar range of solutions being proposed (RCEP, 2007). Solutions that do not acknowledge the systemic nature of action required give rise to tomorrow’s problems. There is a need to encourage research based on the use of comprehensive ecological models that incorporate variables beyond basic demographic information (TRB, 2005); a need to use combined variables to better reflect the synergistic combination of a supportive environment, as hypothesised by theoretical ecological models of the environmental determinants of physical activity (Jones et al., 2007).

There have been a number of attempts to develop a systemic concept reflecting the wider determinants of health, from the work of Hancock though the 1980s (Hancock, 1993) in developing a ‘mandala of health’ to the wider determinants of health model of Whitehead and Dahlgren (1991). Building on this the work of Barton (Barton, 2005; Barton and Grant, 2006) has developed an ecosystem model of health determinants relating to the built environment (Figure 4).
The nature of human settlements is articulated by the Settlement Health Map. At the heart of the health map are people. People are the reason for settlements. People’s lifestyles, community networks, job opportunities and activities (represented by the inner spheres of the map) are all affected by the urban environment that they inhabit. Those lifestyles, activities and the urban environment all impact on the natural assets of air, earth, water and energy, and the global climate. In turn all of these spheres – the environmental, the social and the economic – affect the health and well-being of people. The health map has become widely accepted as a useful tool to help to understand the interactions between different facets of reality. It provides an holistic model of the relationship between people, their quality of life, and their local and global environment (Lavin et al., 2007; SDC p6, 2008; Williams and Fisher, 2007 p32).

6.3 Policy and planning responses

A key question underlying the literature is the extent to which it is reasonable to expect people to change their lifestyles in an environment that does not support such changes. Responses with regard to urban planning are needed.

However, the agenda is not just about new build communities, which will always only represent a small fraction of the built environment, nor is it about only including major regeneration schemes. It must also include the continuing modification to the built environment which provides opportunities, over time, to make significant changes to health risk (TRB, 2005). Such action is needed to make the changes that will affect “the multiple pathways within the obesity system in a sustainable way” (Foresight, 2007 p11). Reinforcing this message, with relation to physical activity, the Transportation Board Report (TRB, 2005 p15) recommends that:

Those responsible for modifications or additions to the built environment should facilitate access to, enhance the attractiveness of, and ensure the safety and security of places where people can be physically active.

It goes on to add (p15) that:

Even though causal connections between the built environment and physical activity levels have not been demonstrated in the literature to date, the available evidence suggests that the built environment can play a facilitating role by providing places and inducements for people to be physically active. Local zoning officials, as well as those responsible for the design and construction of residences, developments, and supporting transportation infrastructure, should be encouraged to provide more activity-friendly environments.

Similarly the recommendations from the National Institute for Health and Clinical Excellence (NICE, 2008 p6) cover all urban development activity in recommending that action needs to be taken by:

Those responsible for all strategies, policies and plans involving changes to the physical environment. This includes the development, modification and maintenance of towns, urban extensions, major regeneration projects and the transport infrastructure.
### 6.3.1 Policy objectives

Policy objectives were set out in the *Healthy Urban Planning* book (Barton and Tsourou, 2000): twelve health objectives for planning and other professionals and decision-makers who determine the shape and design of the urban environment. The chart below elaborates that list and relates it explicitly to the settlement health map. The only significant innovation is to use the inner ‘people’ sphere 1 to relate to the principle of 'health for all', and therefore to the concerns about health inequalities. The two sphere 1 objectives are fundamental, and cut across all the other objectives.

<table>
<thead>
<tr>
<th>Spheres of the Health Map</th>
<th>Objectives for Healthy Urban Planning</th>
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</thead>
<tbody>
<tr>
<td>1. People</td>
<td>• providing for the needs of all groups in the population</td>
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<tr>
<td></td>
<td>• reducing health inequalities</td>
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<tr>
<td>2. Life-style</td>
<td>• promoting active travel</td>
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<td></td>
<td>• promoting physically active recreation</td>
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<td></td>
<td>• facilitating healthy food choices</td>
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<tr>
<td>3. Community</td>
<td>• facilitating social networks and social cohesion</td>
</tr>
<tr>
<td></td>
<td>• supporting a sense of local pride and cultural identity</td>
</tr>
<tr>
<td></td>
<td>• promoting a safe environment</td>
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<tr>
<td>4. Economy</td>
<td>• promoting accessible job opportunities for all sections of the population</td>
</tr>
<tr>
<td></td>
<td>• encouraging a resilient and buoyant local economy</td>
</tr>
<tr>
<td>5. Activities</td>
<td>• ensuring retail, educational, leisure, cultural and health facilities are accessible to all</td>
</tr>
<tr>
<td></td>
<td>• providing good quality facilities, responsive to local needs</td>
</tr>
<tr>
<td>6. Built environment</td>
<td>• ensuring good quality and supply of housing</td>
</tr>
<tr>
<td></td>
<td>• promoting a green urban environment supporting mental well-being</td>
</tr>
<tr>
<td></td>
<td>• planning an aesthetically stimulating environment, with acceptable noise levels</td>
</tr>
<tr>
<td>7. Natural environment</td>
<td>• promoting good air quality</td>
</tr>
<tr>
<td></td>
<td>• ensuring security and quality of water supply and sanitation</td>
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<tr>
<td></td>
<td>• ensuring soil conservation and quality</td>
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<td></td>
<td>• reducing risk of environmental disaster</td>
</tr>
<tr>
<td>8. Global ecosystems</td>
<td>• reducing transport-related greenhouse gas emissions</td>
</tr>
<tr>
<td></td>
<td>• reducing building-related greenhouse gas emissions</td>
</tr>
<tr>
<td></td>
<td>• promoting substitution of renewable energy for fossil fuel use</td>
</tr>
<tr>
<td></td>
<td>• adapting of the environment to climate change</td>
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</tbody>
</table>

*Table 2: Healthy Urban Planning objectives*
6.3.2 Effective urban policy

So what would effective urban policy look like? The Urban Environment report published by the Royal Commission on Environmental Pollution (2007 p8) warns that the “principle reason for the lack of satisfactory progress in many areas of urban environmental policy appears to have been the mismatch between complex problems and simplistic policy prescriptions”. The report suggests that focus should be given to more complex structure such as urban governance arrangements. Similarly Lavin et al. (2007 p23) talk of a need to guide “… physical development by outlining housing, transport and infrastructure demands and provide … the strategic direction for future needs.”

It is also important to avoid the trap of ‘physical determinism’. This was strongly represented in planning theory and application during in the latter half of the twentieth century; a set of rules or masterplan for a healthy urban environment, with universal applicability, cannot be developed.

Inherent in a systemic approach is the truth that, as part of an open system, even the correct solutions for a healthy environment will be necessary, but not sufficient.

Making decisions

Each of the urban components lie across several decision areas which ultimately affect the health risks. These decision areas may sometimes be the responsibility of a particular agency or department, though more often a number of agencies are involved. Without co-ordination this can lead to contradictory decisions, undermining the ability of any one agency to deliver positive health and sustainability outcomes.

For example taking the component ‘local urban environments’: the broad decision theoretically lies with the planning department, but many of the key decisions are likely to be taken by the economic development unit and the transport authority; similarly with transport, the strategic decisions may be taken by the national department of transport, or the national rail authority, rather than the municipal authority. The situation can be very confused – hence the need to establish collaborative working methods that draw together the relevant agencies and ensure a coherent approach.

Environmental health indicators

Decisions, and monitoring of subsequent implementation, need to be based on relevant and useful data. In the face of the ‘complexity and specificity of human settlements’ Lawrence (2008 p323) calls for the “radical reorientation of current uses of indicators” as a “worthy goal for identifying and counteracting the unintended consequences of persistent urban pathologies and problems. The spatial planning system itself may be a good place to look for indicators.

One process indicator which may herald future success is the focus that health risk is starting to command within urban planning policy. In the United Kingdom, for example, transport policy has always been about roads, yet in recent years it is becoming accepted to consider walking and cycling within a wider context of integrated transport planning (Cullingworth and Nadin, 2006).
6.4 The need for systemic research, policy and intervention

In approaching the urban health environment as a system, systemic approaches are required. Effective approaches should seek to identify key entry points within the system where interventions will affect multiple parts of the system. It is as if many of the issues and their solutions are tangled up at these nodes, hence we are calling them – nodes for systemic change (KNOTs).

One decision area usually relates to a whole series of objectives. Taking ‘the design of public spaces’ as an example. This is an important decision area which has the direct intention of creating an aesthetically stimulating environment, it has potential impacts across a range of health risks including active travel, supportive social networks, cultural identities, safety, economic buoyancy, accessibility, greenspace, air quality and greenhouse gas emissions. Equivalently each health risk will be influenced by action in many different decision areas. This too points to the need for all agencies to take off their traditional blinkers and, working with others, adopt a holistic view.

6.4.1 Examples of interventions for systemic change

Swedish’s vision of road safety: In 1997, Sweden, launched a road safety strategy known as ‘Vision Zero’, this progressive policy had the aim of reducing road accident fatalities to zero by 2020. The strategy has made a big difference. In 1995 there were a total of 572 road deaths in Sweden, or a fatality rate of 6.5 per 100,000. A decade later, in 2005, Sweden recorded some 440 road deaths or 4.9 per 100,000. (By way of comparison, in 1995 there were 2,995 road deaths in England or 6.1 per 100,000 and ten years later there were 2,735 deaths, equivalent to 5.4 per 100,000). Underpinning the governance, and critical to Vision Zero is the emphasis on shared responsibility, widening the responsibility for road safety from being that of the road user alone to includes that of the road system designer. Other parts of a chain of responsibility include making bicycle traffic safer; quality assurance in transport work; making better use of technology, public responses to traffic violations and examining supplementary ways of financing new roads and emphasising the role of voluntary organisations in road safety work.

Also important is its emphasis on best-possible scenarios. Using a holistic approach it therefore emphasises the optimal state of Sweden’s roads, rather than just tackling existing problems (SPG, 2008).

Health outside a ‘health setting’: Working with and making use of the natural environment has been shown to improve both physical and mental health, through reducing stress and strengthening communities (Department of health, 2009). Examples where this has been shown to be effective have been demonstrated by the Green Gyms set up by the British Trust for Conservation Volunteers. An evaluation by Oxford Brooks University demonstrated increased levels of fitness, better mental health and a strong retention rate of 70% in its participants after six-months.

Examining this concept Jones et al. (2007 p18) use the term the “Supportive neighbourhood”. There is notable tension between their positivistic finding that “… there is no strong evidence of consistent positive associations between summary
variables for a supportive neighbourhood and leisure-time physical activity” and their statement that:

a supportive neighbourhood environment for physical activity or walking is an obvious development from examining the relationships of different categories of environmental variables. Combinations of different components of the environment could make it more attractive to physical activity (because of the effect of the sum of its parts, rather than the parts alone). This view would be supported by ecological and social cognitive psychological theories of the environment interacting with and reinforcing physical activity behaviour.

In the United Kingdom there has been some development of the concept of a healthy living centre whereby ‘health’ can spill out from a local hub that has co-located medical, social support, amenity, community and educational faculties. Although more developed in concept than actuality, this facility would face outwards and could be a stimulus for cycle routes, allotment gardening and other health promoting activities in the surrounding neighbourhoods.

The approach is heavily influenced by the Peckham Experiment (PHF, 2007) a study into the nature of health.

The researchers decided to study the family unit in a community setting to study what contributes to human health. In a purpose built centre/laboratory, known as the Pioneer Health Centre they conducted that research by annual medical checks and observations of families interacting in social activities. Recognising the importance of sound nutrition, the rented a farm to provide fresh organic food. The Peckham Research Findings have influenced authorities across the world including the WHO.

Some of the features were: a study of health rather than disease; using a holistic approach; incorporating a social club and family membership; health checks and family consultations together with open discussions and non-directional help.

**Supporting cycling in Copenhagen**: In Copenhagen there are 350 kilometres of cycle tracks and 40 kilometres of green cycle (off-road) routes. One person out of three commutes by bicycle to work or school every day. (KK, 2009b). Cycling and increases in cycling in Copenhagen are supported through strategic policy ‘Cycle Policy 2002-2012’, with a biennial monitoring and progress report ‘Cycling Accounts’. The policy brings together the economic, health, environmental and quality of life divers together with decision areas including street design, street cleansing and maintenance, car parking provisions, public transport planning, parks and open space and neighbourhood renewal.

Great care and attention is given to the design of the street, using both vertical and horizontal cues and devices, to support active travel. Interventions are chosen from a palette of evaluated and constantly developing designs.

Cycle tracks, the preferred element in Copenhagen’s cycle infrastructure (KK, 2002), have developed a preferred design. They are found used alongside many main roads, and are tarmac paths segregated vertically by low kerbs from both the cars on the roadway and the pedestrians on the pavement. Vertical cues are successfully used at side road junctions, maintaining a continuity of level (and priority) for the cyclist with car traffic entering or leaving the side road having to drive over a raised platform. This junction design often also involves reducing road space for parked cars and increasing pedestrian quality with seating and trees or shrubs.
At more major intersections a well chosen and evaluated palette of other devices are used including forward stop lines for cyclists, marked routes (in blue) across the intersection and advanced green traffic signals for cyclists.

The value of this was demonstrated in a recent study concluding that construction of slightly raised cycle tracks alongside road resulted in an increase in cycle traffic of 18-20% and a decline in car traffic of 9-10%, whereas the construction on cycle lanes (at grade) on roads only led to an increase of cycling by 5-7% and no decrease in car traffic (Jensen at al., 2007). The report also found that cyclists felt safer on the raised tracks and that construction of cycle lanes led to a greater increase in accidents than separate cycle tracks, however the increase in accidents with either intervention was not found to be significant.

**Spatial mapping for health risk:** In a brief example of synergistic working the role of spatial mapping of health need and health risk needs to be noted. This is a developing field. In terms of need there is a trend to map population data, disaggregated at various spatial levels to better understand the links between territory and need. In the United Kingdom one outcome is the current Joint Strategic Needs Analysis reports being compiled though joint working between local authorities and health authorities.

On the risk side, city and district map covering subjects such as food accessibility, noise emissions and tranquil areas, air quality maps and walking accessibility are becoming increasingly common.

This spatial mapping can reveal hitherto hidden facts. For example noise maps can not only provide an overview of the ambient noise climate in urban areas but also provide details on the number of people affected by different levels of ambient noise, and the source of that noise, for example a road or industrial premises and the deprivation status of those people or other vulnerability factors (e.g. age).

**Joint planning and health policy:** The joining up of health and planning policy is the purest expression of what is often termed an ‘up-stream’ response. Such a response is common to all the case studies., It is more difficult to document the outcomes on the ground for up-stream interventions, partly since the results of joining-up at the level will be expressed differently in every local context. However there are many examples of this taking place. For example, each of the 90 cities in the phase IV of the WHO Health City Programme had a different but viable response to such an agenda, with many examples of health outcomes supported through healthy urban planning (Green and Tsourous, 2008).

Another recent example, from the United Kingdom, is the public health guidance covering urban planning published by the National Institute for Health and Clinical Excellence in the UK (NICE 2008). The recommendations are that:

- Strategies, policies and plans should ensure that applications for new developments always prioritise the need for people, including those with physical impairments to be physically active as a routine part of everyday living.
- Local facilities must be easily accessible by foot, bicycle and other modes of transport involving physical activity and they must ensure children can participate in physical activity.
• Planner and transport agencies should provide compressive networks of routes for walking, cycling and other modes of active transport. Reallocation of road space to support physical activity, respect vehicle access, use traffic calming measures to restrict speed and create safe routes to schools.

• Public open spaces need to be reached by foot, bicycle or other forms of active transport and public transport; and that these are safe and well maintained.

• Hospitals and university campuses must ensure that the different parts of their sites are linked by appropriate walking and cycling routes. New workplaces should be linked to waking and cycling networks where possible and be assessable by public transport.

• School playgrounds are designed to encourage varied, physical active play.

These recommendations highlight the importance of urban design and spatial planning in facilitating a physically active population active within the urban setting. The important point here is the close joint working required between the medical and planning professions to create such guidance and to support it in implementation.

6.4.2 The nature of the evidence and the nature of the research

Several studies point out gaps in the evidence base. These usually relate to:

• Studies being unable to provide evidence of causal relationships. For example Bauman and Ball (2007) point out the need to distinguish between 'determinants' (antecedent causal variables) and correlates, which are parameters that are constantly associated together in the data. When stepping across disciplinary boundaries close attention needs paying to definitions.

• Evidence not being sufficient to identify which specific changes would have most impact on physical activity and health outcomes (TRB, 2005). Most systematic reviews, especially those undertaken within a medical paradigm, note the lack of an ability to ascribe causality in the published studies of interventions.

Studies arising from the urban design and transport fields have not been designed to attribute causality. Many studies arise from data collected when evaluating natural experiments, under these open system conditions, research methodologies required to examine causality are complicated and don’t yet have a long track record of research (MRC, 2008).

However, even though causal connections have not been demonstrated, the available evidence builds a strong case to suggest that attention to health risks in built environment policy, programmes and projects can facilitate better health outcomes across a range of public health objectives.

The systemic nature of the problem of health in the urban environment calls for interdisciplinary research approaches, such as that found in the Foresight Obesity report and its mapping of the obesogenic environment. These new approaches often highlight tensions between biomedical models and the holistic approaches which combine biological, cultural, economic, political, psychological and social factors (Lawrence, 2004).
6.4.3 A new public health for the urban environment

The twin pressures of rising levels of obesity and the increasing threats of climate change, against a background of ever larger, more populous and more sprawling urban settlements, loom large in the urban health agenda. Fuelled partly by this there has been a very high level of interest and research into how our health is affected by the human settlements in which we increasingly live and work.

Primary data is unearthed and written up and published in positivistic research papers, which are then collated into reviews and meta-studies, which in turn are synthesized into reviews of reviews. Through this process new understandings emerge, based sometimes on hundreds, if not thousands of primary papers. In terms of the risks and challenges to health in the urban environment. The emerging evidence points firmly in the direction:

- of legitimizing the validity of holistic approaches,
- of recognising the strength of the shift of focus from illness towards salutogenesis (Antonovsky, 1987; Antonovsky, 1996),
- of moving from an individual based approach to a population based approach, and
- of “shifting away from a mechanistic and reductionist focus on single health problems, risk factors and linear causality—towards a more holistic view, concerned to develop supportive contexts within the places that people live their lives”. (Kickbusch, 2003).

Knowledge needs to flow from holistic approaches to the evidence base into policy and practice. Reviews of research need to “bridge the gap” to be accessible to policy makers (WHO, 2008a) but to ensure effectiveness right though to implementation (as demonstrated in the examples given above) both policy development and decision making need to be undertaken in a systemic manner. The case studies demonstrate the power of making an ‘up-stream’ intervention as an essential step in systemic health interventions for healthier urban environments.
References


Barton H. et al. (2009) *Local Accessibility Results from the SOLUIONS Project*, unpublished. (Hugh.Barton@uwe.ac.uk).


Halpern, D., 1995, Mental health and the built environment, London; Taylor and Francis


Hart, J. (2007) MSc in Bristol; University of the West of England


Scottish Natural Heritage Commissioned Report No. 060 (ROAME No. F03AB01)


Appendix 1: Selected facilities and services

The review also sought to include two other components of the urban environment:
- Services and facilities provided by the municipal authorities
- Services and facilities provided by the commercial sector

The siting and location of these services and facilities can affect the health risks under review, options in terms of technical operation not part of this review but can also have health impacts.

There is potentially an exhaustive range of services and facilities which could be included, we found that the any research that was available was also very widely distributed in across different disciplines. As yet issues arising have not been systematically reviewed.

The material included in this appendix does not attempt to be comprehensive or even in its coverage. It serves as an outline of some of the issues, with detail included where it has been found.

The division between services and facilities provided by municipal authorities and by the commercial sectors is somewhat arbitrary. For example utility services may have been privatised in many but not all countries. Also in many countries there has been an increase in the use of public-private partnerships to deliver services traditionally delivered by the state.

**Services and facilities provided by municipal authorities**

In a more extensive trawl of the literature the following services of facilities should be included:
- public toilets
- allotments
- schools
- libraries
- waste facilities
- electricity facilities
- water facilities
- sports facilities.

The remit of this study did not enable these all to be dealt, the text below just represents some of the issues arising as evidence was gathered for sections of the main report.

**Schools**

In one study schools within the local community were a further environment that both parents and children perceived as unsafe (Horowitz et al, 2005). Reasons stated included poorly monitored hallways inadequate security both inside and outside the
school building. This also included lack of screening regarding who is permitted to enter the school.

However, Wilcox et al (2003) found no such increase in fear from crime from the presence of schools in a large metropolitan city in the west of the United States, whether crime was controlled for or not. In this study, the presence of neighbourhood level business parks and playgrounds increased individual perceptions of community danger, but once neighbourhood crime rates were controlled, these fears disappeared.

The community in investigated by Horowitz et al (2005) felt that their perception of stress related to potential crime could be reduced. They suggested that the provision of locally based services and a safe space for children to play together, but that was monitored by adults, would help to address these concerns.

**Waste and sewage management**

**Air quality:** The South West Public Health Observatory (2002) in the UK conducted a review of research into the health impacts of waste management. Whilst acknowledging that the evidence was not conclusive, they did find that some waste management activities would result in air pollution which is likely to have an impact on health. Specifically, the air pollution from landfill which comes from the anaerobic decomposition of organic matter produces methane, (which may be collected for energy), carbon dioxide, nitrogen, gases, sulphur and volatile organic compounds. Incineration of waste, produces combustion products which are discharged into the air as acidic gases, aerosols and particulates, although more modern processes are designed to minimise the amounts discharged. Incineration also produces CO₂ which contributes to climate change. Recycling produces dust and bio-aerosols (organic dust with bacteria and fungal spores) and composting emits volatile organic compounds and bio-aerosols. The process of collecting the waste also adds to air pollution from the transport used, (South West Public Health Observatory, 2002)

**Noise:** The noise produced during waste management including composting and landfill disposal methods has been identified as likely to effect health (South West Public Health Observatory, 2002). Transporting these of waste materials is also likely to add to traffic noise.

**Unintentional injuries:** The methods and mechanisms used to discharge sewage and other spoiled water can impact on the physical health of those who swim or bathe in open water that has the potential for contamination from these sources. The most common negative impact on health include gastrointestinal complaints particularly related to enterococci, that are not experienced among those who do not swim or bathe in these areas of open water (South West Public Health Observatory, 2002), in addition to eye and ear infections from water borne organisms.

**Energy production**

**Air quality:** Energy production will impact on air pollution levels. Electricity is produced primarily at major power stations fuelled by gas or coal or nuclear power although these are typically sited away from centres of population.

As increased emphasis is placed on renewable energy sources, these are generally smaller installations and sited closer to the end users. Production of heat too may often be sited near to the users. Production sources include local wind turbines, photovoltaic
panels and biomass generators and combined heat and power (CHP) installations. As yet there is little literature exploring the impact on risk to health in this area.

**Water treatment**

In 2002, 1.1 billion people lacked access to improved water sources, which represented 17% of the global population. Further more, 2.6 billion people lacked access to improved sanitation, which represented 42% of the world's population. The majority of these cases are found in low and middle income countries. It has been estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene, and is mostly concentrated in children in developing countries (WSH, 2004). Drinking unsafe water can increase the risk of exposure to protozoan, bacterial or viral disease, these mainly manifest themselves in humans as gastrointestinal upsets and disorders, the most common symptoms of which include diarrhea. Diarrheal diseases account for an estimated 4.1% of the total DALY global burden of disease and is responsible for the deaths of 1.8 million people every year (WHO, 2004a) global burden of disease.

**Services and facilities provided by the commercial sector**

In a more extensive trawl of the literature the following services of facilities might include:
- mobile phone masts
- fast food outlets
- 24 hr zones
- casinos
- supermarkets
- employer car parks

The remit of this study did not enable this list to be adequately addressed, the text below just represents some of the issues arising as evidence was gathered for sections of the main report.

**Cheap and fast food outlets**

The density of cheap, fast food outlets contributes towards health problems, particularly those associated with obesity for example type 2 diabetes, hypertension, and coronary heart disease. (Robinson, 2004). Globally, In the United States its been estimated that up to 10% of children's total energy intake comes from fast foods, compared to 2% in the late 1970's. This increase in fast food intake amongst children is significantly contributing to the rising childhood obesity statistics in the developed countries. In adults in the United States the odds of becoming obese over a 15 years period increased by 86% in white adults (Bowman, 2004). However, the issue of obesity is a multi faceted problem and no single risk factor for example inappropriate nutrition or lack of physical activity can be help accountable. Evidence shows that it is more likely to be an interaction and compounding of several risk factors including commercial activities that contribute (Tackling obesity, future choices, 2007)
Mobile phone base stations

Recent year have seen a very rapid deployment of mobile phone base stations in urban areas of dense population. There are potential direct and indirect risks associated with use of this technology such as the use of hand-held transmitting devices close to the body and the potential for injury due to their use while driving or walking. In terms of urban planning the relevant health risk reported on below is from base stations.

Potential health risk comes from both actual health risk and stress in some communities from perception of unknown health risk. The fifth annual report from the Swedish Radiation Protection Authority’s (SSI) Independent Expert Group (IEG) on Electromagnetic Fields (SRSA, 2008 p54) states;

The few studies that have been published on health risks among populations living near transmitters have had major methodological shortcomings. However, the exposure to the general population that results from transmitters is very weak and one would not expect such exposure to produce a health risk as discussed in the previous report. Indeed, one would assume that if RF exposure at low levels is associated with a health risk it would be considerably easier to detect it in studies of mobile phone users, or highly exposed occupational groups. The overall conclusion is that exposure from transmitters is unlikely to be a health risk.

A United Kingdom review, referred to as the Stewart Report (IEGMP, 2000 p1), concurs stating that “For base station emissions, exposures of the general population will be to the whole body but normally at levels of intensity many times less than those from handsets” However it goes on to say (p3):

We conclude therefore that it is not possible at present to say that exposure to RF radiation, even at levels below national guidelines, is totally without potential adverse health effects, and that the gaps in knowledge are sufficient to justify a precautionary approach.

and that (p6):

We recommend the establishment of clearly defined physical exclusion zones around base station antennas, which delineate areas within which exposure guidelines may be exceeded.

The report also identifies children as more vulnerable with evidence that at the frequencies used in mobile phone technology, children will absorb more energy (per kilogram of body weight) than adults. A one year old could absorb around double, and a five year old around 60%, more than an adult. Additionally, since children are being exposed to RF radiation from base stations (and from mobile phones) from a younger age than adults, they will have a longer time in which to accumulate exposure over the course of their lives, and a longer time for any delayed effects of exposure to develop. As a result, the Stewart Report says that “base stations sited within or near school grounds, should not have a beam of greatest intensity that falls on any part of the school grounds or buildings without agreement from the school and parents.”

A WHO factsheet (WHO, 2006) concludes that ‘Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.”
Appendix 2: Extracts from the initial terms of reference

Production of an evidence review
on environmental health challenges and risks in urban settings

The review is to be based on recent literature (peer-reviewed journal articles, scientific monographs as well as selected national reports by governments and international reports by EEA, WHO, UN agencies, etc.). The literature reviewed should in essence be no older than published in 2005. For key publications before that date, it is suggested that reference is made to one, maximum two milestone publications per topic that have “set the scene” and then focus on what the more recent publications have added.

The review should cover works from health, environment, and urban planning perspective. To make the review manageable in the expected time frame and with the available resources, WHO suggests focusing especially on meta-reviews and monographs that have already reviewed and structured the available evidence. However, these products should not be the exclusive source and need of course to be compensated with a good variety of selected journal articles that give more specific evidence and arguments (in summary, there is no need to do a systematic literature review but rather a strategic search for “key publications”).

Main questions for the review are:

1) What evidence does exist on the environment-related or –triggered health effects of urban settings?
2) What urban features and risk factors are most dominant and what are their expected trends?
3) What urban planning solutions are being suggested in the literature?

In doing so, the review should mostly focus on presenting the mechanisms that lead from urban conditions to the exposure to environmental risk factors, and only describe (rather short) the associated outcomes for which evidence is available (this can be done in a short paragraph concluding with a box in which the key health outcomes of respective risk factor are listed). The pathway from a certain exposure (e.g. noise or air pollutants) to specific health outcomes is not to be described in detail to save space for focusing on the link between urban form and the exposure.
### Suggested Table of Contents

A - Introduction of general field: urban environments and health  
   1-2 pages

B - Short review of methodology: what databases were searched, how was selected etc.

C – Several topical chapters on the main urban components  
   4-5 pages each
   - transport
   - built environment
   - energy, water and waste: supply and disposal
   - land use: sealed spaces versus open and green spaces
   - industrial activities
   - etc.

which are to be linked to the main health risks such as
   - climate change
   - air pollution
   - noise exposure
   - physical activity problems
   - social pathologies such as safety and crime
   - risks for injuries and accidents
   - etc.

D – Conclusion chapter summarizing the review, providing key messages, 2-3 pages  
   identifying weaknesses and major challenges, indicating potential solutions (using one or two charts/diagrams illustrating the main messages)