

Building Health

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Masterclass Briefing

Evidence Review Spatial Determinants of Health in Urban Settings

Part 2b

Transport

WHO Collaborating Centre for Healthy Urban Environments

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Text based extracts from:

Evidence Review on the Spatial Determinants of Health in Urban Settings

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The basis of the material

Evidence was reviewed in terms of reports from 2005 onwards. The search for evidence was based in the main on meta-studies, systematic reviews and reviews of reviews. Other evidence, either from before this date or findings from single studies, has been included where significant. The four components of the urban situation looked at are:

- Land use pattern (Part 2a)
- Transport (Part 2b)
- Green space (Part 2c)
- Urban design (Part 2d)

This section of the evidence review (Part 2) takes one urban component and reviews its significance in terms of five health factors. The health factors are:

- physical activity
- social and psychological impacts
- air quality
- noise exposure
- unintentional injury

This section should be read in conjunction with the overview paper (Part 1).

With special thanks for additional material supplied by the UWE Air Quality Management Resource Centre.

The evidence

Transport and its impact on the determinants of health

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).

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 (active as opposed to passive travel) is distance and route quality. The use of public transport – normally accessed by foot and therefore making a contribution to physical activity – is also heavily influenced by distance to stops, as well as service cost and quality and the ease or difficulty of using the car. 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 has been the focus for many reviews. 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 motorised 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).

With regard to 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).

In terms of 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 not only to travel a longer distance but also to spend a longer time in accessing the public transport stop (Krygsman et al., 2004).

Moving the discussion now to 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 effect 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.

The social and psychological 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 (Whitley 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 through direct community severance due to road construction and 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 an increase 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 road traffic collisions 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% will develop phobic traffic anxiety and 11% may develop post traumatic stress disorder. Moreover, nearly 20% of those injured in a road traffic collision develop an acute stress reaction and 25% display mental health problems within the first year of the accident.

The effect of transport on air quality

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. The impact of transport on this determinant of health is best understood by looking separately at issues of emissions and then issues of exposure.

In terms of 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 2005). 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 2005).

Continuing increases in the number of cars (RCEP, 2007), urbanisation and expansion of urban areas, and longer commutes (WHO 2005), 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 2005) 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). Importantly, studies of the impact of congestion charging in London, implemented for traffic flow reasons and not air quality, have not detected air quality benefits (TfL 2008).

Trends in measured ambient outdoor air quality across central and inner London continue to primarily reflect factors external to the scheme, such as the weather and vehicle technology changes, not all of which have been beneficial. No clear scheme impacts from either the original central or western extension zones can therefore be discerned. (p6)

Although in absolute terms improvements were outweighed by external factors, the report goes on to add:

Although congestion charging and other changes originally led to reductions in emissions, this did not feed through to observable improvements to measured air quality. This was to be expected, for reasons explained in previous reports. However, all other things being equal, reduced emissions will feed through to **relative** improvements in outdoor air quality, against conditions in the hypothetical absence of the scheme. (p107)

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 2005). 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 2005). 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 2005).

Emissions are only one side of the equation. 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 2005).

Research cited by the WHO (2005) 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.

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 2008a). In 2003, freight noise was ranked as the biggest railway noise problem (EC 2008a; 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).

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 unintentional injury, 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 (EC, 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 were 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.

Children aged 0-19 years and older adults aged 60 plus are particularly vulnerable to injury through road traffic accidents (DfT 2005a; DfT 2004).

A number of different factors negatively impact on the rate of collisions 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 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 Stockholm, 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 road traffic collisions by up to 5% (TfL, 2009).

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