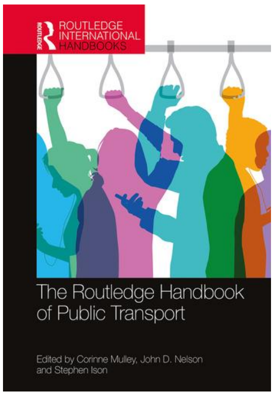

The Routledge Handbook of Public Transport

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The health impacts of public transport

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THE HEALTH IMPACTS OF PUBLIC TRANSPORT

Melanie Crane and Christopher Standen

Introduction

In 1953, a seminal paper was published which revealed an association between physical activity and coronary heart disease (CHD) (Morris et al., 1953). The study assessed the amount of physical activity done by London Transport workers during the course of their work, comparing the physical activity achieved by bus conductors during their work with the amount of activity achieved by the drivers. It was found that bus conductors, whose roles on the buses were more physically active, had lower early mortality rates than the drivers. Not only was there a clear difference in the incidence of CHD, but also in the severity of the disease, which was attributed to different levels of activity between the two roles. Since this landmark study, great strides have been made in learning how health and transport are related and how different modes of travel can influence health outcomes.

What are the health impacts of public transport?

Public transport can contribute to health in many positive ways. In this chapter, the most significant ones are discussed, including chronic disease prevention through physical activity and benefits to mental health and wellbeing. These impacts are summarised in Table 20.1. How public transport enables access to health services and the potential walkability of an area – and its associated benefits – is explored. The negative health impacts from air pollution and road trauma associated with public transport are considered, with comparisons to other modes of transport. Finally, the association between public transport use and the risk of contracting infectious diseases is discussed. The role of public transport in reducing social exclusion and associated health risks is covered in Chapter 26.

Physical activity

Physical inactivity is estimated to cost the global economy more than $67.5 billion in healthcare expenditure and lost productivity (Ding et al., 2016). Physical activity is important for normal growth and development, cardiorespiratory health, musculoskeletal and brain health (including cognitive function), sleep and quality of life (World Health Organization, 2010). Improving

Table 20.1 Summary of main health impacts of public transport provision

	Potential benefits	*Potential harms*
Physical activity	Promotes active travel (walking and cycling for transport) Provides opportunities for incidental physical activity in egress Reduces the risk of chronic diseases (cardiovascular diseases, diabetes, obesity) Supports walkable environments	
Air pollution	Reduced exposure to air pollution (if alternative clean fuel or electric vehicles are used) Reduced dependency on private vehicles	Pollution from vehicles using fossil fuels and non-exhaust sources (brake and tyre wear) Exposure to air pollution inside bus stops
Road injury and trauma	Lower risk of injury than other modes	Risk of injury falling within vehicle or in egress
Stress and wellbeing	Improves social connection through accessibility	Long-distance commuting produces stress and lower quality of life Noise pollution contributing to noise annoyance and sleep disturbance
Access to services	Improves access to health care and community services	Promotion of unhealthy foods and beverages at transport stations increases the risk of obesity
Risk of infectious diseases		Crowding increases the spread of infectious airborne diseases (e.g., influenza) Long trip durations increase the spread of some contagious infections

physical activity can reduce the risk of illness from chronic diseases (including heart diseases, type II diabetes and some cancers); improve cardio-respiratory and muscular fitness; lower the risk of anxiety, depression and dementia, and increase life expectancy (Kohl 3rd et al., 2012; Lee et al., 2012). New evidence also suggests certain population groups can receive specific benefits by engaging in adequate physical activity: a lower risk of fall-related injuries for older adults; reduced risk of excess weight gain, gestational diabetes and postpartum depression in pregnant women; improved bone health and weight status in young children; improved cognitive function in youth; and reduced risk of all-cause mortality in people with chronic medical conditions (Piercy et al., 2018).

What is a sufficient amount of physical activity?

The World Health Organization (WHO) recommends adults should do at least 150 minutes of moderate-intensity physical activity throughout the week, or at least 75 minutes of

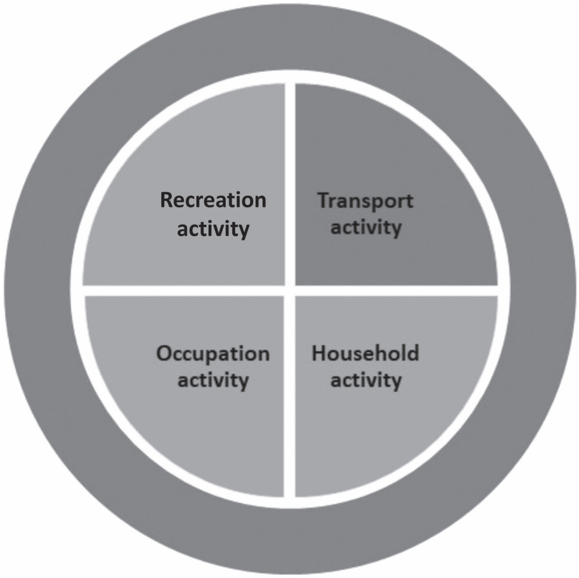

Figure 20.1 Physical activity domains

vigorous-intensity physical activity or an equivalent combination of both. Additional benefits are gained by increasing the intensity of physical activity and the time to 300 minutes per week and doing muscle-strengthening activities (such as climbing stairs) on two or more days per week. WHO recommends children and adolescents do at least 60 minutes of moderate- to vigorous-intensity physical activity daily, with muscle- and bone-strengthening activities done at least three times per week.

How does public transport improve physical activity?

There are four main domains through which physical activity is obtained: recreation, occupation, housework (including gardening) and transport (Figure 20.1). Global trends have seen a substantial decline in transport-related physical activity in the last 30–50 years (Kohl 3rd et al., 2012). "Active transport" is any form of transportation that incorporates physical activity and is generally inclusive of walking and cycling. Public transport is often also included because it generally incorporates some form of physical activity, such as walking/cycling to or from a public transport stop/station.

Guidelines in many countries consider public transport stops/stations within walking distance if they are less than 400 metres or ¼ mile from the trip origin or destination. Over a five-day working week, this distance – if walked – can provide a means of achieving sufficient amounts of physical activity. In a systematic review of public transport studies reporting on physical activity levels published before 2012, Rissel et al. (2012) established that a person who travels to work by public transport over a week will acquire 8–33 minutes of physical activity per day (on average 15 minutes). Over a week, this can equate to 150 minutes of light to moderate physical activity. The authors also note the physical activity benefits of public transport appear to mostly accrue to the least active people in the community. That means public transport provides an effective way of encouraging the least active in the community to participate in some form of physical activity.

It is now recognised that a small amount of incidental physical activity, if undertaken regularly (such as walking even short distances to and from public transport provision), is important for health – particularly for disrupting sedentary behaviour (too much sitting time), which independently contributes to poor health (Word Health Organization, 2010). Public transport use supports incidental activity, thus reducing the prolonged sitting time that is a feature of many office jobs. Standing while waiting at the bus or train station, standing up on the train or ferry, walking between the bus and train services or climbing stairs to a station platform all provide small opportunities for incidental physical activity.

Recent systematic reviews provide further insight into the physical activity benefits of public transport. Collating the evidence from evaluation studies measuring the before-and-after effect of new public transport interventions (light rail and bus rapid transport systems) confirms the associations made by Rissel et al. (2012). The latest evidence suggests that proximity to new public transport does encourage walking and can lead to a significant increase in light to moderate physical activity among new public transport users (Hirsch et al., 2018; Xiao et al., 2019). The provision of public transport also increases energy expenditure, equivalent to about 30 minutes additional activity per week (Xiao et al., 2019). Cardio-metabolic health benefits (reductions in obesity prevalence, type II diabetes and cardiovascular risk) are also found, such that using public transport for commuting reduces body mass index [BMI: weight(kg)/height(m)^2], while shorter residential distance from new bus services may also contribute to obesity reduction (Patterson et al., 2019). These studies also reveal research and practice challenges: the ability to contribute to greater-intensity (moderate to vigorous) activity necessary to improve morbidity outcomes, such as through cycling to/from a station, remains dependent upon the availability of cycling infrastructure integrated with public transport systems (Xiao et al., 2019). Likewise, interventions in other domains need to help support an increase in total physical activity in the population so that population levels of sufficient physical activity increase overall (and do not decrease in another domain as a trade-off) (Hirsch et al., 2018).

WALKABILITY AND PUBLIC TRANSPORT PROVISION

One of the four key objectives of the Global Action Plan on physical activity 2018–2030 is to promote the integration of transport and urban planning policy to deliver walkable city neighbourhood designs and transport systems that will promote walking and cycling (World Health Organization, 2018a). Walkability reflects the ease of walking around a neighbourhood (Frank et al., 2010). The walkability of an area is determined by land use diversity (mix of residential, commercial, institutional, and public and green spaces for recreation), residential density, street connectivity, desirability (safe, attractive and accessible) and pedestrian/bicycle infrastructure separate from road traffic (Giles-Corti et al., 2016; Saelens & Handy, 2008; Sallis et al., 2012). Distance to frequent public transport services also contributes to walkability by connecting and promoting walkable areas. Neighbourhoods that are highly walkable provide physical activity and other health benefits, including psychological benefits for all ages, including older adults (Hajna et al., 2015). Various walkability indices have been developed at neighbourhood and district levels to identify neighbourhood-level built environment characteristics contributing to a neighbourhood's high or low level walkability. Several commercial walkability scores exist across countries, including the Walk Score that measures distance to amenities and how well an area is serviced by public transport (Hall & Ram, 2018).

Ambient air pollution

The World Health Organization estimates that ambient air pollution causes at least 4.2 million deaths every year, as well as the loss of 84 million years of life or productive life (disability-adjusted life years) (World Health Organization, 2016). Children and unborn babies, older adults and those with existing lung or heart diseases are most susceptible; for example, a recent systematic review by Khreis et al. (2017) revealed a significant association between asthma onset in children and ambient air pollution. Air toxins known to affect human health include particulate matter (PM), oxides of nitrogen, ozone, carbon monoxide and sulphur dioxide – major sources of which are motor vehicles and industry. Sources of PM include vehicle exhaust pipes and brake, clutch and tyre wear. PM causes cardiovascular and respiratory incidents, leading to worse symptoms and health care utilisation, and long-term exposure increases mortality; there is no safe level of PM exposure (Anderson et al., 2012). Proven measures for reducing the health effects of ambient air pollution include improving access to public transport (with its lower emissions per passenger-kilometre), fuel efficiency standards for buses and other vehicles and restricting private vehicle use (Landrigan, 2017). However, many towns and cities worldwide, in low- and high-income countries, continue to welcome and encourage motor vehicle traffic (Laurance & Arrea, 2017), resulting in a significant public health burden (Kheirbek et al., 2016; Mueller et al., 2017).

Impacts on public transport users

Air toxin concentrations decrease with distance from their source, meaning higher exposure for people living, working or attending childcare/school/college close to busy roads or travelling along them. When travelling, people sharing a lane with motor vehicle traffic generally have the highest exposure: a systematic review of commuters' exposure to ambient air pollution by mode of transport found that car and bus occupants have the highest exposure (Cepeda et al., 2017), followed by bicycle users and pedestrians, with rail commuters having the lowest exposure. Actual inhalation dose, however, was found to be highest for bicycle users and pedestrians – which includes people accessing and egressing public transport stations/stops – because physical activity increases ventilation rate. Cepeda et al. (2017) did not include travel by passenger ferry in their review; however, a separate study by Chan et al. (2002) found particulate levels inside Hong Kong's passenger ferries and non-air-conditioned buses and trams to be higher than those inside other types of public transport.

Public transport users are also exposed to ambient air pollution during stop/station access and egress, waiting time and transfer. Air quality inside semi-enclosed bus shelters next to busy roads can be worse than outside the shelter – but it can be improved by orienting shelter openings away from the road, prohibiting smoking, and locating stops near open space (Hess et al., 2010). Levels of ambient air pollution inside semi-enclosed railway stations with diesel locomotives, and inside underground stations, can be higher than those along busy roads (Moreno et al., 2014).

Thus, it is difficult for public transport users in urban areas to avoid exposure to ambient air pollution. In highly polluted Asian cities, many public transport commuters wear face masks to protect themselves; however, most use simple surgical masks, which are not effective in filtering most air pollutants, as opposed to N95/P2-rated masks, which can be – if correctly fitted (Wong et al., 2017). According to the Hierarchy of Controls – a system promoted by numerous safety organisations to minimise or eliminate exposure to hazards (Centers for Disease Control and Prevention, 2018) – personal protective equipment, such as masks, should be the last resort. Addressing the source of the hazard is the most effective control. (In some cultures, e.g., Japanese, it is also common for people with respiratory infections to wear surgical face masks when in public or using public transport, as a courtesy to prevent infecting others (Burgess & Horii, 2012). In this case, a hazard source is being addressed through mask wearing. Infectious disease risks of public transport are discussed in more detail later in this chapter.)

Impacts on the general public

Air toxin emissions per passenger-kilometre are generally lower for buses and trains than for private motor vehicles. However, induced demand and the self-limiting nature of road congestion (Duranton & Turner, 2011) mean that increasing the use of public transport is unlikely to result in a significant and enduring reduction in private vehicle traffic in congested urban areas – unless private vehicle traffic is contemporaneously restricted through pricing or reductions in road or parking capacity. For example, converting general traffic lanes to exclusive bus lanes makes public transport more attractive while also reducing private motor vehicle traffic and associated air pollution.

Using cleaner fuels or electric propulsion in public transport vehicles can help. For example, buses running on compressed natural gas instead of petrol or diesel were introduced in Delhi, India, in 2001 – after which ambient levels of carbon monoxide, sulphur dioxide and aromatic hydrocarbons decreased, although levels of nitrogen dioxide increased (Ravindra et al., 2006). Transitioning bus fleets (and private vehicle fleets) from internal combustion to electric propulsion will help to reduce ambient air pollution. However, up to 90% of the particulate pollution generated by road traffic comes from non-exhaust sources, namely "brake wear, tyre wear, road surface abrasion and resuspension in the wake of passing traffic" (Thorpe & Harrison, 2008, p. 270).

Road injury and trauma

The World Health Organization reports that road traffic crashes kill an estimated 1.35 million people each year (World Health Organization, 2018b); millions more are seriously injured and/or permanently disabled, and road traffic crashes are the leading cause of death for people aged 5–29 years.

Risks for public transport users

Public transport passengers have a lower risk of being killed or injured in a crash than people walking, cycling or driving (Teschke et al., 2013). Most public transport trips do include walking and/or cycling for access, egress and transfer; however, the distances – and therefore exposure – are relatively low, meaning public transport users have a lower overall crash injury risk than users of other surface transport modes.

Public transport passengers can also be injured by falling inside a vehicle. Elvik (2019) estimates this risk to be 0.3–0.5 injuries per million passenger-kilometres and 0.8–1.7 injuries per million passenger trips. A further trauma risk is violence or harassment, which can occur during any stage of a public transport journey (in-vehicle, waiting, access, egress or transfer). The objective and perceived risks vary considerably across countries, regions and cultures; however, they tend to be greater for women than for men (Neupane & Chesney-Lind, 2014).

Many public transport authorities are taking steps to address this gender inequality; for example, Transport for London's 'Report it to stop it' campaign (BBC News, 2018) and women-only rail carriages in Iran, Japan, India, the UAE, Egypt and Brazil (Newton, 2016). Gekoski et al. (2015) have also found evidence that additional staffing, policing and security cameras can be effective. They warn, however, that many campaigns "are perceived to implicitly or explicitly blame or shame women for sexual harassment and assault, effectively re-victimising them" (p. 38), citing examples from Iran, Singapore, Canada and the United Kingdom.

Risks for the general public

Buses and street-running trams share space with pedestrians, bicycles and other vehicles, while many railways have at-grade crossings for pedestrian and/or vehicle traffic. Public transport vehicles are large and heavy, meaning the consequences of one crashing into another vehicle or a pedestrian can be severe. On the other hand, they are usually operated by highly trained drivers, while trams and guided buses move along predictable paths.

A 2005 analysis of pedestrian fatalities in the United States (Paulozzi, 2005) concluded that, per vehicle-kilometre, buses were about ten times more likely to kill a pedestrian than a car. However, only 1.5% of total pedestrian fatalities involved buses, owing to lower overall vehicle-kilometres. It should also be noted that average passenger occupancy of buses is higher than that of cars, so the risk per passenger-kilometre for buses is comparable to that of cars. That said, if the widely adopted aim of zero road fatalities is to be achieved, more must be done to reduce the risk of injury posed by all vehicles, including buses and other public transport vehicles, to vulnerable road users. For example, the practice of designing intersections to give a green walk signal to pedestrians concurrently with a green signal for buses (and other vehicles) turning across their path must be seriously reconsidered. For the aforementioned reasons, increasing the use of public transport is unlikely to result in significant and enduring reductions to injuries caused by private vehicles in congested urban areas – unless private vehicle traffic volumes and speeds are also further restricted.

Stress and wellbeing

Connections between mental health and wellbeing (quality of life) in relation to transportation are becoming an increasing concern, particularly as cities grow in population density and spatially, with implications for health associated with traffic congestion and travel times (Giles-Corti et al., 2016).

Wellbeing while travelling

The last decade has seen an emerging interest in valuing subjective wellbeing or quality of life, particularly with regard to the individual's experience of their trip or journey (Abou-Zeid & Ben-Akiva, 2011; Carse, 2011; De Vos et al., 2013; Ettema et al., 2010; St-Louis et al., 2014) and life satisfaction (Bergstad et al., 2011; De Vos et al., 2013; Delbosc, 2012). Travel satisfaction is often used by transport planners and researchers to measure transport-related wellbeing; yet, this does not adequately capture aspects of quality of life considered foundational to health – such as physical health, mental health and social interactions (Lee & Sener, 2016; Rissel et al., 2016). Life satisfaction may be directly influenced through physical mobility or indirectly through access to lifestyle choices.

In general, public transport has tended to be associated with poorer quality of life; however, the evidence is not so clear cut (Gottholmseder et al., 2009; Novaco & Gonzalez, 2009; St-Louis et al., 2014; Wheatley, 2014).

Most research attention has focused on mental distress (stress) associated with commuting to work. Commuting stress can have a profound impact on psychological adjustment (Novaco & Gonzalez, 2009). Long commuting times have been linked to depression and higher psychological distress among both car commuters and public transport users (Ding et al., 2014; Feng & Boyle, 2014; Gottholmseder et al., 2009). People moving to newly constructed greenfield developments on the outskirts of cities (where housing development usually precedes public transport infrastructure provision) have also reported unanticipated stress (Kent et al., 2019). Stress can also be a factor in short distances when the journey is out of the individual's control or the individual feels impeded, such as in conditions of increased traffic congestion (Gottholmseder et al., 2009). Wener and Evans (2011) suggest that car commuters experience higher levels of stress than public transport users because of the greater unpredictability of the trip (Wener & Evans, 2011). Gatersleben and Uzzell (2007) compared the experiences of drivers, cyclists, walkers and public transport users amongst university employees in a small study the United Kingdom. The findings from this study reveal that car users experience the most stress in their journey, while public transport users experience boredom as well as stress. Similar findings have been found by Morris and Guerra in the United States (Morris, 2015; Morris & Guerra, 2014).

There are a few things to note. First, these studies have mainly focused on individual transport modes and have largely ignored multi-modal trips involving public transport and active travel. A more recent study on commuting stress of hospital workers included uni-modal and multi-modal active travel (public transport, walking and cycling). Compared with car commuters, active and public transport commuters reported lower stress levels (Rissel et al., 2014). Second, the studies indicating public transport user boredom were conducted before the innovation and widespread diffusion of technologies such as smartphones and tablets. More recent evidence suggests these social and entertainment technologies help to counteract potential stress and boredom (Ettema et al., 2012). Third, several studies have shown that the fundamental ability to travel is associated with a greater degree of happiness, while inability to travel leads to a lower quality of life (Kolodinsky et al., 2013; Spinney et al., 2009). This has led to a focus on personal transport, particularly for people with disabilities or older adults participating in the community (Ravulaparthy et al., 2013; Spinney et al., 2009; van Roosmalen et al., 2010). With ageing populations in many countries, the ability to travel independently will largely depend on the provision of well-connected public transport services (see also Chapter 28).

Life satisfaction and community wellbeing

Community wellbeing is often understood in terms of the level of social capital and social cohesion (Phillips, 2012). Transport can contribute to the social capital and cohesiveness of society, such as through access to community services (discussed in the next section). Increasing evidence also suggests neighbourhood design, in relation to traffic conditions, also impacts community wellbeing. Busy road traffic creates community severance and contributes to poorer quality of life (Anciaes et al., 2019; Foley et al., 2017; Gundersen et al., 2013). Increasing public transport services can therefore help to reduce many of the health impacts of local road traffic, including wellbeing.

Public transport may, however, contribute to poorer wellbeing outcomes through noise pollution. Exposure to noise from road and rail transport contributes to noise annoyance and sleep disturbance, with negative impacts on quality of life, as well as cognitive development of children and risk of cardiovascular diseases (Clark & Stansfeld, 2007). Interventions to reduce the health impacts of rail and road transport noise include regulations to limit noise emissions, road buffers, increasing green space, urban planning controls and new or closed infrastructure (Brown & Van Kamp, 2017)

Access to health care, community services and healthy food choices

Poor access to health care facilities (e.g., general practices, hospitals and pharmacies) is associated with higher rates of avoidable hospital admissions (Ansari et al., 2006), while poor access to community facilities (e.g., libraries and community centres) is associated with poor mental health and vitality (Guite et al., 2006). Thus, improving access to community and health services is likely to improve these outcomes. Improving access to affordable healthy food is also important in reducing risk of overweight and obesity and associated health problems (Ghosh-Dastidar et al., 2014).

Food marketing in public transport stations and vehicles and in-station snack food vending machines are counteractive strategies for obesity prevention. One audit of train station advertisements across Sydney showed more than 80% of food advertisements to be for energy-dense discretionary foods (snack foods and sugar-sweetened beverages) (Sainsbury et al., 2017). A similar audit in New York showed subway station advertising of unhealthy foods and drinks targeted the most vulnerable population groups (Riley et al., 2018). Many cities have proposed or enacted bans on the advertising of unhealthy foods and beverages; however, the sale of unhealthy foods at stations remains a major challenge.

Good-quality, affordable public transport helps make access to health care, community facilities and healthy food more equitable, especially for people living in rural or car-dependent suburban areas and unable to drive – the number of which is set to increase significantly in countries with ageing populations. However, public transport serving such populations often does not attract enough ridership to make them financially viable, and they depend on large government subsidies (Walker, 2012). For this reason, there is growing interest among public transport authorities and providers in flexible public transport services, whereby bus routes adjust to passenger demand – with passengers requesting pick-up with a mobile phone app or phone call and smaller (lower-cost) vehicles typically used (Hensher, 2017). In some cases, public transport infrastructure might inhibit access to health care and community facilities. For example, an at-grade railway line with few crossings can act as a barrier between residents and facilities, significantly increasing network distances between them – even though the straight-line distance between them may be short.

Infectious diseases

"Infectious diseases" is an umbrella term for illnesses caused by bacteria, viruses and parasites – including tuberculosis, hepatitis, malaria, cholera, measles and influenza. Infectious diseases are spread by human-to-human contact, either directly or indirectly, or by animals to humans (zoonotic). Safe, effective and affordable vaccines and drug therapies have had an enormous impact on reducing or eliminating the spread of infectious diseases in high-income countries; however, many vaccine-preventable (e.g., typhoid, dengue, malaria) and drug-resistant (e.g., tuberculosis) diseases remain a major burden of disease in low-income countries (James et al., 2018). The threat of emerging disease outbreaks, particularly airborne diseases, has become of increasing global concern given increasing globalisation, urban population densities and the role of human movement (travel behaviour patterns and accessibility). This presents many challenges for public health, particularly with regard to controlling the global spread of diseases (Budd et al., 2009). Airborne respiratory virus outbreaks in recent years have spread quickly and widely, with high impacts on mortality – the most recent and largest scale being the COVID-19 coronavirus. Other recent airborne respiratory virus outbreaks include SARS (severe acute respiratory syndrome), the Middle East respiratory syndrome coronavirus (MERS-Cov), and H1N1 and H5N8 bird flu viruses.

Infectious disease transmission and public transport

Contagious airborne diseases, like influenza, tuberculosis or coronaviruses, are transmitted by droplets (primarily) when speaking, coughing or sneezing. Places where a large number of people congregate, like crowded buses and train carriages or stations, produce environments for spreading these diseases (Mohr et al., 2012). A recent study modelling the impact of influenza-like illnesses in relation to the London Underground showed a high correlation between the use of public transport and spread of disease (Goscé & Johansson, 2018). Travel patterns showed that passengers travelling from areas with high rates of infection (transport hubs) interact with a high number of people, likely increasing the spread of infection. Another study, also in the United Kingdom, looked at cases of disease based on general practitioner patient records and data on bus and tram patronage (Troko et al., 2011). The authors revealed a very high association between acute respiratory infection and having travelled by public transport in the days before symptoms appeared. However, they also found that the risk of infection was reduced in the more frequent public transport users, plausibly because they had developed a level of immunity from repeated exposure.

The majority of research investigating the role of transportation and infectious diseases has been in air transport, which appears to accelerate and escalate the spread of influenza-like diseases (Browne et al., 2016; Budd et al., 2009). Fewer case studies on ground public transport exist because of the challenges of contract tracing transmission from person to person, creating major gaps in our understanding of the role of public transport systems in transmitting and controlling the spread of these diseases (Browne et al., 2016; Mohr et al., 2012). Trip duration (length of time exposed), proximity to the infected person (face-to-face) and crowding likely increase the spread of contagious infectious diseases (Mohr et al., 2012); however, transmission rates (number of people infected) vary between diseases – for example, tuberculosis has more than twice the rate of infection as influenza yet it takes longer to incubate.

Some viruses, like the COVID-19-causing coronavirus, are very successful in spreading because they can survive for a period on surfaces between human-to-human contact. This means that someone who has the disease may pass it on after touching mouth or nose and then touching a public surface, like a bus handrail. Increasing transport efficiency, sanitary conditions and ventilation can help to decrease the spread of disease, alongside isolating cases of infection (Xu et al., 2013). Modelling studies (on airborne smallpox as an example) suggest that homes, offices and school environments create a higher risk for transmitting infections based on intimacy and contact time; closing schools and workplaces is therefore a key measure in controlling outbreaks (Zhang et al., 2016; Zhang et al., 2018). Suspending heavily used public transport depends on the contagiousness of the disease and if brief contact aids its propagation (Mohr et al., 2012; Zhang et al., 2016). Individual hygiene also plays an important role: not travelling when sick is the best way to help recovery and protect other people; covering one's mouth when coughing (not with the hand); and washing hands. For controlling the community transmission of COVID-19, WHO guidelines encourage physical distancing and the wearing of face masks. What researchers know about the risk of public transport and its role in the spread of COVID-19 more broadly is based on correlation studies and the evidence is still emerging.

Opportunities and barriers to health

The health impacts of public transport include direct and indirect impacts such as those mentioned previously. Calculating the health costs and benefits of new public transport infrastructure is important for minimising threats to vulnerable populations. Many studies have shown that a shift away from private vehicle transport to public transport, walking and cycling will result in population health gains, with the largest gain being a reduction of heart disease, stroke and type II diabetes due to an increase in travel-related physical activity (Mueller et al., 2017; Stevenson et al., 2016; Woodcock et al., 2009; Xia et al., 2015). Some initial increases in road injuries are likely in cities shifting from relatively high private vehicle mode share to walking and cycling. The benefits to respiratory health gained by shifting to higher public transport use are dependent on the change in transport-related particulate emissions, and that requires a change in fuel source and vehicle emissions.

The opportunity for public transport to contribute to improving health by reducing the risk of chronic non-communicable diseases relies on decreasing the distance to public transport options and integration with walking and cycling infrastructure. Lack of public transport options and poor integration with walking and cycling infrastructure and mobility options for people with disabilities continue to encourage private motor vehicle transport and perpetuate poor health outcome.

Health impact assessment

Health impact assessments (HIAs) are a tool for identifying potential health-related impacts of new project proposals, plans and policies. They can help in planning for public transport infrastructure provision by providing evidence about the potential health benefits or negative impacts that the infrastructure will have on health. What is reported varies widely, depending on how health is framed and if public health experts are engaged in transport planning decisions (Mindell et al., 2008; Riley et al., 2018). HIAs are sometimes voluntarily included as part of the environmental impact assessment process, and very few countries or their jurisdictions explicitly require HIAs to be conducted prior to construction. HIAs typically include five steps: screening, scoping, appraisal, reporting and monitoring of health impacts. Assessments of health impacts should generally include, but are not limited to, health impacts and outcomes explored in this chapter (primarily physical activity, air pollution and road injury), which have the largest direct impact on the burden of disease (Vos et al., 2017). HIAs should consider the population exposed, the health impact associated with the population exposed and equity impacts. Transport planners are unlikely to consider the full scope of health impacts and should look to involve public health authorities and researchers to help improve understanding of societal impacts.

Gaps in research evidence and practice

Evidence regarding the indirect costs of transport to health, variations in exposure and the potential benefits that an integrated public transport and active travel system can achieve remain limited. The impact of inequalities of public transport provision and accessibility challenges of the poorer households and older adults also require further investigation and consideration. The role of public transport and transport behaviour in controlling infectious disease transmission is a widening area of concern, now more than ever, and requires further research.

The majority of the research on public transport interventions (describing health impacts, mobility challenges and mechanisms and calculating health costs and benefits) comes from high-income countries. Translation of evidence to low-to-middle income countries (LMICs) is challenging. One issue is informal transport services' contribution to the health burden, including injury and air quality (Cervero, 2013). Research evidence and monitoring need to be improved to develop coordinated solutions for addressing rising health challenges associated with land use and urban transport in LMICs and in response to COVID-19 challenges.

Conclusion

Public transport can have positive and negative impacts on health – it can support and encourage physical activity, thereby helping to reduce the risk of many chronic diseases associated with poor physical activity in the population. Provision of public transport services contributes to improving accessibility to health and community services, thereby contributing to social health. It has a role to play in reducing air and noise pollution and traffic-related injuries, and may provide some improvements to mental health and wellbeing. Efforts to improve public transport provision will lead to improvements in health and should be considered for the benefit of society.

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