



Social impact assessment of mode shift

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Abbreviations and acronyms

BRT	bus rapid transit
CBA	cost-benefit analysis
CCZ	congestion charging zone
DfT	Department for Transport (UK)
FCO	forced car ownership
GP	general practitioner
HTS	Household Travel Survey (Ministry of Transport)
IMD	Indices of Multiple Deprivation
MaaS	mobility as a service
NZRS	New Zealand Health Survey
SDG	sustainable development goal
SES	socio-economic status
Stats NZ	Statistics New Zealand
TOD	transit-oriented development
Waka Kotahi	Waka Kotahi NZ Transport Agency

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Executive summary

This report considers the social and distributional impacts of mode shift policies. The report reviews international literature with a particular focus on the existing situation and evidence in Aotearoa New Zealand and presents a rapid evidence review of evidence relating to three mode-shift policy levers and potential social and distributional impacts.

In line with the Government Policy Statement on Transport (Ministry of Transport 2018b) Waka Kotahi NZ Transport Agency, in conjunction with urban authorities, is proposing a series of measures aimed at achieving transport mode shift in six high-growth urban areas.

New Zealand is car dependent. The rate of car ownership is amongst the highest in the world with 93.5% of households owning cars. People in many urban areas rely on car use to access essential goods and services, because of low-density urban form and large distances involved in reaching destinations, meaning it is difficult to travel by other modes. Despite high levels of household car ownership, car availability for individuals within households means this mode is not available to everyone. Previous studies have suggested that up to 30% of New Zealanders do not have access to a car, due to disability, age, income or inclination (Rose et al 2009). High levels of societal car dependence result in relative disadvantage for those without a car (Rose et al 2009) but reducing societal level dependence on car through policies aimed at mode shift can help to reduce the need for a car to participate fully in society.

As the policy focus moves from strategic objectives to specific measures and interventions to achieve mode shift it is important to consider how to ensure that mode shift policies have positive social outcomes. It is also important to consider how all impacts are distributed across society for the transport outcomes to support the wellbeing and quality of life of all New Zealanders. Considering the fairness of transport policies is important for public acceptability. Transport policies tend to be considered fairer and more acceptable when people believe the policy will protect future generations, nature and the environment, and when they believe everyone is equally affected (Schuitema et al 2011).

Typically, those worst off in society tend to suffer the worst effects of the transport system while the most well off benefit most (Lucas and Jones 2012). Therefore, it is important to ensure that mode shift policies which focus on expanding mode choice do not restrict the opportunities of those who might already be facing transport deprivation. Similarly, if mode shift policies predominantly expand the choices of those who are already most mobile, existing inequities in accessibility and the choice of modes will widen (Groth 2019). Wiles and Kobayashi (2009) indicate that implementing equitable policy means implementing policies that improve the situation of the most disadvantaged first.

Equity has been studied extensively in a transport context. Most approaches to transport equity focus on socio-spatial distributional analyses of benefits and burdens. A consideration of the disaggregated impacts of a proposed transport policy or intervention is a basic approach to addressing equity concerns. It is also important to understand existing inequalities and the causes of these related to the social and cultural context in which travel 'choices' are made (Levy 2013; Sheller 2018).

Equity of participation in decision making and moving from top down technocratic approaches towards more participation and collective decision making is an important part of transport equity, in line with Te Tiriti obligations and a mobility justice approach that moves beyond disaggregated analyses.

Despite awareness of the significant social impacts of transport, the impacts have not been considered in transport appraisal to the same extent as environmental impacts (Lucas and Jones 2012; Anciaes and Jones 2020; Geurs et al 2009; Manaugh et al 2015). The range of interconnected social impacts, with

different timeframes and pathways can make it difficult to measure the social impacts of transport policies and to attribute outcomes to specific policies.

Defining equity goals, determining who gains and loses from transport policies and understanding the impacts of gentrification associated with improvements in transport and place (Anciaes and Jones 2020) are critical and challenging issues with assessing social and distributional impacts of transport mode shift.

At a broad level policies which reduce car dependence will benefit those who are the most transport disadvantaged (Rachele et al 2018). However, some mode shift policies are more suitable for addressing transport inequities than others. Therefore understanding the likely impacts of different mode shift levers is important for understanding the equity impacts of mode shift.

From an equity perspective, policies that shape urban form can do most to reduce car dependence, enhance access to opportunities and reduce exposure to risk in the transport system. Policies that make shared and active modes more attractive, including fare policies, should be targeted in transport disadvantaged areas whereas influencing travel demand and transport choices should focus on where people travel by car despite alternative options, or travel more than is necessary to fulfil basic needs, and therefore have capacity to reduce overall travel or change mode.

A greater understanding of existing inequities in transport resources and access to opportunities can help target mode shift policies so they contribute to achieving the Ministry of Transport's transport outcomes for all.

Abstract

This report considers the social and distributional impacts of mode shift policies. The research was undertaken from November 2019 – March 2020. The report reviews international literature with a particular focus on the existing situation and evidence in Aotearoa New Zealand and presents a rapid review of evidence relating to three mode-shift policy levers and potential social and distributional impacts.

The specified objectives for the research were to:

- consider and describe the potential impact of policy levers to encourage people to change modes from an equity perspective
- provide an assessment of the impact on people with different income levels and geographical/residential distribution
- outline what, if any, primary research is required for determining the social impact assessment of mode shift and the most appropriate method for this.

Mode shift policies may not be equitable if they prioritise the needs of those who already benefit most from the transport system rather than those who are excluded from access or exposed to harms. Social impacts have generally been less well considered than economic and environmental impacts of transport policies. This research helps to support assessment of mode shift policies from an equity perspective.

1 Introduction

1.1 Background

This report presents a review of the literature and existing evidence base on the social and distributional impacts of mode shift policies. The project was undertaken from November 2019 to March 2020. The report reviews international literature with a particular focus on the existing situation and evidence in Aotearoa New Zealand.

In line with the Government Policy Statement on Transport (Ministry of Transport 2018b), Waka Kotahi NZ Transport Agency, in conjunction with urban authorities in main urban areas is proposing a series of measures aimed at achieving transport mode shift. Mode shift is defined as an increase in the share of travel undertaken by people using active and shared modes of transport (Waka Kotahi NZ Transport Agency 2019). For the purposes of this report, the definition focuses on the movement of people rather than freight and considers land-based urban transport rather than air or sea travel.

A population level shift in transport mode contributes to all five outcomes in the Ministry of Transport's *Transport outcomes framework* (Ministry of Transport 2018a):

- healthy and safe people
- environmental sustainability
- resilience and security
- economic prosperity
- inclusive access.

These outcomes recognise the breadth of impacts that the transport system, in particular the car dependent transport system, has on social, environmental and economic outcomes. Social impacts are generally less well considered in transport appraisal than economic or environmental impacts (Anciaes and Jones 2020; Geurs et al 2009; Manaugh et al 2015). The Government's 2019 budget, referred to as the 'Wellbeing Budget' shifted the focus of government policy from economic growth towards a greater consideration of social and wellbeing outcomes and accordingly demands that greater attention be paid to social and distributional impacts of transport policies.

As the policy focus moves from strategic objectives to specific measures and interventions to achieve mode shift it is important to consider how to ensure that mode shift policies have positive social outcomes. It is also important to consider how all impacts are distributed across society for the transport outcomes to support the wellbeing and quality of life of all New Zealanders.

The transport system can create and exacerbate inequities. For example, lack of transport can reduce people's ability to access employment, reducing productivity and efficiency, and can impact negatively on economic prosperity, especially where urban form means that considerable travel is needed to access destinations. When transport is not designed to meet the needs of all population groups, people are excluded from full participation in society, including employment, healthcare, healthy food, education and social and recreational activities. A recent UK study found that unemployed people with a car were more than twice as likely to move into work over a one-year period than someone without a car (Chatterjee et al 2019).

Beyond differences in the ways in which the transport system meets the accessibility needs of the population there are differential impacts on other outcomes. The health, safety and environmental

outcomes of transport are experienced differently according to a range of dimensions, including socio-economic conditions and location. The ability of different groups to be resilient to major disruption and the benefits of economic prosperity all depend on an inclusive transport system.

Developing policies which are perceived as fair is important for public acceptability (Schuitema et al 2011; Bamberg and Rölle 2003; Eriksson et al 2006). People are generally in favour of individuals limiting car use for environmental reasons, but the issues of perceived fairness is important, especially for pricing policies (AEA Group 2011). Schuitema et al (2011) found that people thought transport policies were fairer and more acceptable when they believed a transport policy would protect future generations, nature and the environment, and when they believed everyone was equally affected by the policy.

This research brings an equity perspective to proposed mode shift policy levers in order to support policy implementation that ensures the transport system provides opportunities for all.

1.2 Objectives

The specified objectives for the research were to:

- consider and describe the potential impact of policy levers to encourage people to change modes from an equity perspective
- provide an assessment of the impact on people with different income levels and geographical/residential distribution
- outline what, if any, primary research is required for determining the social impact assessment of mode shift and the most appropriate method for this.

1.3 Structure of the report

The remainder of this report is structured as follows:

- Chapter 2 provides definitions of key concepts used in this report.
- Chapter 3 outlines the current state of the art in our understanding of transport, social and distributional impacts in Aotearoa New Zealand and internationally (stage 1). This section outlines the importance of equity in transport policy and summarises how social and distributional impacts might be assessed. This section also outlines groups who are often considered to be 'at risk' of transport inequity (stage 3).
- Chapter 4 outlines the mode-shift policy levers (stage 2) identified in *Keeping cities moving* (Waka Kotahi NZ Transport Agency 2019) and *Better travel choices* (Auckland Council et al 2019) and includes a rapid evidence review of existing evidence relating to equity impacts. This section assesses mode shift policy levers and how they may impact on different social groups, according to the evidence review.
- Chapter 5 provides recommendations for equitable mode shift policy including prioritising policies and changing decision-making processes. It also outlines some research needs to support equitable mode shift policy.
- Chapter 6 provides conclusions drawn from the research.

2 Key concepts

A number of terms are used in this report that relate to key concepts in the field of transport. Often these concepts are overlapping. We provide a brief outline of these concepts here:

Accessibility can be defined as ‘ease of access’. The Ministry of Transport’s (2018a) outcomes framework considers ‘inclusive access’ to enable all people to participate in society through access to social and economic opportunities, such as work, education and healthcare. Although accessibility is typically measured as the spatial separation of people from places, using a deterrence factor such as time, distance or cost, a broader range of factors are involved. Accessibility to important destinations is often considered the primary purpose of the transport system, which provides access through mobility.

Car dependency relates to the reliance of individuals or societies on the car in order to provide accessibility. Urban areas which have developed on the assumption of car-based mobility perpetuate this reliance as it can be difficult to get around by other modes of transport due to urban sprawl and the prioritisation of cars in urban centres and residential streets.

Distributional impacts relates to how the impacts of a policy or intervention vary across groups, depending on their circumstances, characteristics, capabilities and resources.

Equality describes the equal distribution of resources, exposures or outcomes among different groups. From a policy perspective, equality approaches aim to treat everyone the same.

Equity implies a moral judgement about whether a particular distribution of resources, exposures or outcomes is considered fair. Equitable policies allocate resources according to need rather than treating all groups in the same manner.

Excess travel occurs when people travel more than is necessary to meet basic needs.

Forced car ownership (FCO) describes the situation in which low-income households retain car ownership – despite the associated expenses – due to a lack of alternative transport options. The associated expense can be a large proportion of the household budget and have negative health and wellbeing consequences.

Mobility justice is an overarching theory that goes beyond distributive approaches to transport and spatial justice to bring into focus unjust power relations and uneven mobility. It focuses on unequal capabilities for movement as well as unequal rights to stay or dwell in a place. Mobility justice cuts across scales and connects the ‘triple crisis’ of climate, urbanisation and migration.

Social impact assessment refers to approaches used to assess the social impacts of policies.

Social impacts are any impacts of transport systems or policies that affect people.

Transport disadvantage relates to reduced availability of transport resources. Poor car access is often associated with transport disadvantage, which may lead to poor social outcomes and poor accessibility.

Transport justice similar to transport equity, relates to fairness in the transport system. As well as for socio-spatial distribution of benefits and burdens, transport justice considers the fairness of decision-making processes and seeks to outline basic minimum needs in transport.

Transport mode shift relates to increasing the share of travel undertaken by public transport, walking, cycling, or shared transport modes, while decreasing the share of travel undertaken by private car.

Transport poverty is a multidimensional concept combining **transport affordability** – ability to meet the costs of transport, **mobility poverty** – availability of transport resources, **accessibility poverty** – ability to reach key activities and destinations and, in broader definitions **exposure to transport externalities**.

Transport-related social exclusion is a theoretical concept for explaining the social consequences of transport disadvantage. Not everyone who experiences transport disadvantage will experience adverse consequences, but where they do, this is known as transport-related social exclusion.

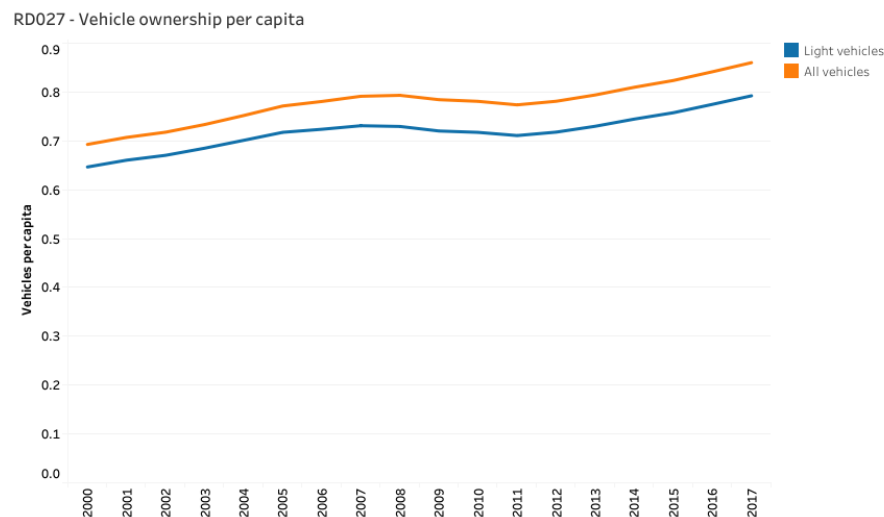
3 Transport equity, social and distributional impacts

3.1 Mode shift and equity

New Zealand is car dependent. The rate of car ownership is amongst the highest in the world with 93.5% of households owning cars. There are more cars than adults. Figure 3.1 shows around 0.8 light vehicles (cars and vans) per capita. When calculated for driving age adults only this equates to around 1.3 vehicles per person. The car provides unrivalled levels of mobility and so in some ways, this high level of car ownership means that most people benefit from the high levels of accessibility and mobility provided by the car.

Towns and cities that have been built around an assumption of car use tend to be lower density, with destinations far apart, and urban design that is not supportive of walking, cycling and public transport use. These types of urban form further perpetuate car use because it is harder or impossible to travel by other modes. Without land use planning that actively promotes density and housing built in proximity to important destinations, such patterns of car-based travel persist. Land that is close to urban centres and job opportunities is often expensive, leading to high housing costs in these areas (Mattingly and Morrissey 2014). These high housing costs result in the exclusion of lower income residents from the areas closest to job opportunities, and urban sprawl as residents seek cheaper housing further from the city centre. When high housing costs and urban sprawl are compounded by poor transport links, residents of peripheral areas find themselves with little alternative to car ownership despite the associated costs (Mattingly and Morrissey 2014; Currie et al 2018). In a sprawling, low-density city with poor peripheral transport linkages, mode shift is difficult to achieve.

Figure 3.1 Vehicle ownership in New Zealand



Source: NZ Transport Agency Motor Vehicle Register, Stats NZ (population)

The use of a lack of car ownership as a proxy for low income or deprivation demonstrates the increased opportunities offered by car ownership. However, car ownership and use is unevenly distributed across the population meaning that not all groups in society benefit equally. Even within households there are often stark gender differences in car access (Martens et al 2019) with men more likely to have consistent access to a vehicle. High levels of car dependence result in relative disadvantage for those without a car

(Rose et al 2009) but reducing societal level dependence on the car through policies aimed at mode shift can help to reduce the need for a car to participate fully in society.

The freedoms enjoyed by many to choose where to live and how they move can negatively impact on the rights of others to a good quality of life, a good living environment and freedom from road danger, noise and air pollution (Wood 2009). It is therefore important to recognise the difference between the right to movement and access, and the means by which this is achieved (Wood 2009). In other words, the perceived infringement of personal liberties associated with restricting car use confuses the right to access with the means by which that is achieved. Rights to transport need to be conceptualised as an entitlement to accessibility, rather than a right to a market-based service or product (Vanoutrive and Zijlstra 2018). Mode shift will not lead to equitable outcomes if it makes car use more expensive, without providing alternatives. Yet, the provision of such alternatives can make cities more attractive, and liveable, and therefore often more expensive places to live (Sheller 2018).

New Zealand experiences significant and enduring health inequities in relation to ethnicity and socio-economic deprivation, with persistent inequities between Māori and non-Māori (Baker et al 2019). There are inequities in the social determinants of health which contribute to persistent health inequities in Aotearoa NZ (Baker et al 2019; Blakely et al 2007; Howden-Chapman et al 2000; Robson and Harris 2007). Transport has a substantial role to play in the social determinants of health: access to education, resources, healthcare and employment and can have substantial impacts on household budgets. The current way in which we move around is inequitable. International studies suggest that as well as benefitting most from the current transport system in terms of accessibility and mobility, better off households contribute most to emissions (Brand and Preston 2010).

The accessibility and mobility benefits delivered by the transport system as a whole are not evenly distributed. Despite high levels of household car ownership, previous studies have suggested that up to 30% of New Zealanders do not have access to a car, due to disability, age, income or inclination (Rose et al 2009). Rates of car ownership and access vary by a number of factors, including gender, age, ethnicity, income, household structure and geographical location. Because cities and transport systems have often been designed around the assumption of high car ownership, widespread urban expansion means that destinations tend to be spread out, requiring considerable distances to be travelled to meet essential needs. As a result, those who do not have a car available often have poorer levels of accessibility to jobs, healthcare, education, food and social connections, unless they live in very well connected central urban areas. This can have adverse consequences such as unemployment, missed appointments, poor uptake of education, difficulties accessing healthy food and social isolation (Social Exclusion Unit 2003; Lucas 2012; Lucas and Jones 2012; Lucas 2004). A high level of societal reliance on the car means that, in the absence of other appropriate ways of getting around, some people can be 'forced' into car ownership which can be a financial burden, with negative wellbeing outcomes (Lucas et al 2016; Curl et al 2018).

High car dependency has negative impacts in terms of safety, physical and mental wellbeing, air pollution, noise and community severance. These negative impacts are also often unevenly distributed with air pollution and crashes being more prevalent in more deprived areas (Pearce and Kingham 2008; Factor et al 2010). The impacts of climate change, to which car use is a significant contributor, will also have a greater impact on more deprived populations, both globally and locally.

It is clear that the status quo needs to change:

Starting from a blank slate, one would be hard pressed to design a less efficient, less healthy and more socially and environmentally destructive system for moving people around (Jones 2008).

Societal mode shift away from a dependence on cars is essential to promote social inclusion amongst those who do not have car access, as well as to reduce the negative impacts of car use, which are unevenly distributed, leading Dennis and Urry (2009) to suggest that a truly equitable distribution of transport services is not possible in car-based societies. Moving away from car use is a positive step towards a more socially equitable transport system.

Reduced car use, better public transport and walking and cycling for short journeys have the potential to reduce health inequities. The greatest air quality benefits from policies that reduce transport emissions are likely to accrue to lower income households, which are more likely to be in areas affected by poor air quality (Markkanen and Anger-Kraavi 2019; Kingham et al 2007; Pearce and Kingham 2008; Hajat et al 2015; Pratt et al 2015). Hence transport policies that reduce CO₂ emissions have significant potential for positive social and distributional impacts, particularly on the affordability and accessibility of transport for lower income and rural residents (AEA Group 2011).

However, despite clear co-benefits of mode shift for environmental and health objectives there can be tensions with equity concerns (Mattioli 2016; Feitelson 2002), at least in the short term. Reducing emissions from transport is a pre-requisite for more equitable health outcomes, but it is not so straightforward to assume that all attempts to reduce emissions are therefore equitable. There are inherent difficulties in reconciling justice concerns from a transport/accessibility perspective and an energy consumption/climate change/emissions perspective (Mattioli 2016) because in many cases meeting accessibility needs leads to environmental impacts, and conversely attempts to reduce environmental impacts can reduce accessibility. Lower income groups will only benefit most from emission reductions associated with mode shift because of existing inequities, which mean they are the most affected by poor air quality at the moment.

Tensions between mode shift policies and equity concerns are particularly problematic when car ownership is necessary (Smith et al 2012; Mattioli and Colleoni 2016). In many places, particularly peri-urban and rural areas, the satisfaction of basic needs depends on carbon-intensive transport (Mattioli 2016). In New Zealand, one of the most car dependent countries globally, a car is considered essential in almost all circumstances, for example for accessing employment (which can be considered a basic need and a human right) (Mattioli 2016). Car dependency can lead to exclusion for those who do not have access to a vehicle, for example from employment opportunities (Hodgson et al 2020) and current solutions tend to reinforce this car dependency. Even if a car is not considered essential because of spatial separation, cultural reliance on a car is evident in many contexts: eg employers demand licences, even when driving is not a requirement of the job. As a result of such assumptions around the use and availability of cars, there can be a stigma for those who travel by public transport (Fitt 2018).

If a car is necessary, then attempts to reduce car use through restriction or increased cost lead to equity concerns (Mattioli 2016). Equity concerns in relation to mode shift are therefore prominent in relation to pricing policies (Levinson 2010; Rajé 2003) and fuel tax increases (Farrington and Farrington 2005).

On the other hand, policies which reduce the need to travel by car could support a transition to a fairer, lower carbon transport system. There are, however, concerns that mode shift policies which focus on public transport prioritise increased global patronage over coverage, removing services from areas of highest need (Mattioli 2016; Walker 2008) and targeting the needs of new users who are likely to be already more advantaged car drivers, rather than targeting those most in need. Large infrastructure investment in particular can have unevenly distributed social impacts, especially at the local scale because they are assessed based on high-level budget and time metrics, rather than considering impacts at the community level (Mottee et al 2020).

Typically, those worst off in society tend to suffer the worst effects of the transport system while the most well off benefit most (Lucas and Jones 2012). Therefore, it is important to ensure that mode shift policies which focus on expanding mode choice do not restrict the opportunities of those who might already be facing transport deprivation. Similarly, if mode shift policies expand the choices of those who are already most mobile, existing inequities will widen. Groth (2019) found that the most well off experienced benefits of shifts to multi-modality and smart mobility while those worst off were excluded due to affordability.

Prioritising mode shift towards public transport without consideration of equity issues might lead to prioritisation of new passengers rather than improving services for existing users (Walker, 2008) and prioritisation of rail over bus (Bae and Mayeres 2005; Manaugh et al 2015), both of which tend to prioritise the transport needs of already advantaged population groups according to international evidence. A study comparing Auckland with Vancouver, Brisbane and Perth found that Auckland's public transport system performed worst in terms of serving lower income communities (Nazari Adli et al 2019).

Manaugh et al (2015) suggest that while initiatives such as suburban rail might improve air quality universally and reduce emissions *if* they result in mode shift, they do not usually prioritise the accessibility needs of the most transport deprived. It is therefore important to consider how mode shift policies and infrastructure investment can prioritise the needs of disadvantaged groups. Similarly Manaugh et al. (2015) highlight the need to distinguish between walking and cycling as a matter of choice, where the urban environment supports active travel, and those who walk and cycle due to lack of alternatives, with potentially adverse consequences (Bostock 2001; Curl and Mason 2019).

Key points

- There are currently inequities in the transport system, consisting of uneven levels of accessibility and uneven exposure to harms.
- Many inequities occur because of societal car dependence.
- Societal mode shift is essential for an equitable transport system.
- Mode shift policies may focus on promoting transport choice among those already most advantaged, widening inequalities.

3.2 What is transport equity?

The objective of this research was to consider the potential impact of policy levers to encourage people to change modes from an equity perspective. This section explains how equity has been applied in transport studies.

Inequalities refer to differences among different social groups or places. Inequity arises when those differences are considered unfair, or have arisen from an unfair system or process (Reid and Robson 2007). Martens et al (2019) point out that differences in accessibility (inequalities) might not always be a problem (inequitable) providing people have good levels of accessibility to essential destinations. The same argument can be applied to inequalities in exposure to pollution or traffic injuries, within agreed acceptable boundaries. However, discussion about minimum needs and maximum harms have not been part of transport policy discourse. Equality in transport provision could be considered inequitable if it leads to inequitable outcomes because of different mobility and accessibility needs and capabilities.

Concerns regarding equity in social policy arise from a need to reduce systematic differences in outcomes or exposures between different groups (Wiles and Kobayashi 2009) or to reduce systematic marginalisation and discrimination (Guzman and Oviedo 2018). Such concerns are of particular importance given the context of health inequalities in Aotearoa New Zealand, in which systematic differences continue to arise due to persistent systematic marginalisation and discrimination. Given multiple connections between transport and health (Giles-Corti et al 2016; Rao et al 2007; Koohsari et al 2013; Curl and Clark 2019), transport policy has a clear role to play in addressing health inequities.

Equity has been studied extensively in a transport context. Beyazit (2011) suggests that social justice in transport refers to the fair distribution of transport goods, accessibility, affordability and the fair distribution of other gains such as increases in land and property prices. Adding to this Pereira et al (2017) outline three components of justice in transport:

- 1 How benefits and burdens are distributed in society
- 2 The fairness of processes and procedures in decision making
- 3 Rights and entitlements which are recognised and enforced.

The majority of the literature in transport equity is concerned with how benefits (eg accessibility/mobility) and burdens (pollution/injuries/noise/cost) are distributed in society. Less attention has been paid to the fairness of decision-making processes or what rights to mobility/accessibility might be appropriate.

As Pereira et al (2017) note, transport equity literature has engaged with a broad range of transport impacts, focused on:

- socio-spatial justice in terms of accessibility – which neighbourhoods and social groups benefit or lose out from transport infrastructure
- affordability of transport for different income groups
- differential exposure to transport externalities such as traffic injuries, noise and air pollution.

Literature focuses on three main types of transport-related inequalities: transport-related resources (car ownership/proximity to infrastructure), observed daily travel behaviour (trip frequency/distances/travel time) and transport accessibility levels (Pereira et al 2017). Inequities in outcomes, such as health outcomes as a result of transport inequities do not feature so strongly in the literature on transport inequality or inequity (Hosking et al 2019). See also the discussion of figure 3.4 in section 3.3. Studies also tend to outline differential impacts or distribution of transport resources among population groups or places, without clarifying whether such a distribution is fair.

Equity is defined according to different philosophical understandings of justice, fairness and equity – terms which are often used interchangeably especially in policy settings. Defining what is equitable is difficult, and often a political decision. Geurs et al (2009) suggest that while analysts can draw attention to social differences or inequalities, decision makers must decide what is just, depending on their understanding of equity. Equity implies a moral judgement (Pereira et al 2017) about what is fair in any given society.

Pereira et al (2017) outlined five theories of justice relevant to transport:

- **Utilitarianism** – maximises welfare to society as a whole. Prioritises aggregate wellbeing over individual rights. Is the basis of cost-benefit approaches in transport planning.
- **Libertarianism** – Free market is inherently just, results from free choices. Prioritises individual liberties over aggregate human welfare.

- **Intuitionism** – Moral problems in real life are complex. Different problems require different principles to be applied.
- **Rawls' egalitarianism** – Individuals should have as much freedom as possible, provided it does not infringe the freedom of others. Inequalities in society are unavoidable and are fair if they arise from fair equality of opportunity and work to the benefit of the least advantaged. Focuses on distribution of resources, rather than capabilities or implications of that distribution.
- **Capabilities approach** – Shifts the focus of Rawls' egalitarianism from distribution of resources to consideration of people's capabilities to translate resources into opportunities. Assessments should distinguish what people are able to do with resources, rather than distribution of resources per se.

Academic studies on transport equity tend to support pluralistic approaches to justice, meaning that differing ethical principles are drawn on depending on the situation (Pereira et al 2017). CBA is based on utilitarian principles (Thomopoulos et al 2009), in that it is only focused on aggregate welfare and not the gains or losses of different groups.

Wiles and Kobayashi (2009) indicate that implementing equitable policy means implementing policies that improve the situation of the most disadvantaged first. From a transport perspective, it is important to ascertain whether the situation to be improved relates to:

- availability of resources
- actual travel behaviour
- potential (eg accessibility)
- wellbeing impacts (eg transport mediated outcomes)
- affordability.

Pereira et al (2017) advocate for analyses of transport equity based on accessibility (what people can access given available resources), rather than considering resources or actual travel behaviour. They suggest focusing on distributive justice from an accessibility perspective is most consistent with a theory of justice based on Rawls' egalitarianism and the capabilities approach. This focus is also justified based on accessibility being a primary purpose of transport policy (Pereira et al 2017; Van Wee and Geurs 2011; Metz 2008).

However, such a focus on accessibility ignores the distribution of other impacts such as pollution, noise and transport costs, as well as the impacts of the mode of transport used to achieve accessibility, for example in terms of physical activity or affordability of transport. Additionally, it has been argued that existing approaches to measuring accessibility are inadequate for addressing equity concerns, because they are predominantly spatial measures of separation and do not consider the different perspectives, needs or capabilities of individuals (Smeds et al 2020; Curl et al 2011; Sheller 2018; Curl 2018). Spatial approaches to measuring accessibility ignore social differences among individuals in the same places and often assume heterogeneity of capacity for mobility, related only to geographical location and transport networks (Sheller 2018).

Martens et al (2019) note the importance of distinguishing between the fairness of a situation and the fairness of an intervention, with the latter ideally being guided by the former. The fairness of policy interventions should be assessed on whether they cause a move towards the desirable (fair) distribution. For example, Nunns et al (2019) suggest that equity concerns around a (hypothetical) cordon-based charge in Wellington are alleviated because existing commuters are more likely to have a higher income than the general population. However, before drawing such conclusions we suggest it is first important to

understand whether the current pattern of commuting into the central city by income is considered fair and desirable. Then, it is important to ask whether a cordon-based charge is likely to move closer or further away from the desirable situation. If low-income commuters are already excluded from accessing the city centre because of cost, increasing costs will widen inequities. While an intervention may be considered fair, because it affects everyone equally, this is not necessarily desirable unless the situation was fair in the first place.

A consideration of the disaggregated impacts of a proposed transport policy or intervention is a basic approach to addressing equity concerns, in line with concerns around distributive justice – how the benefits and burdens of any policy are distributed in society.

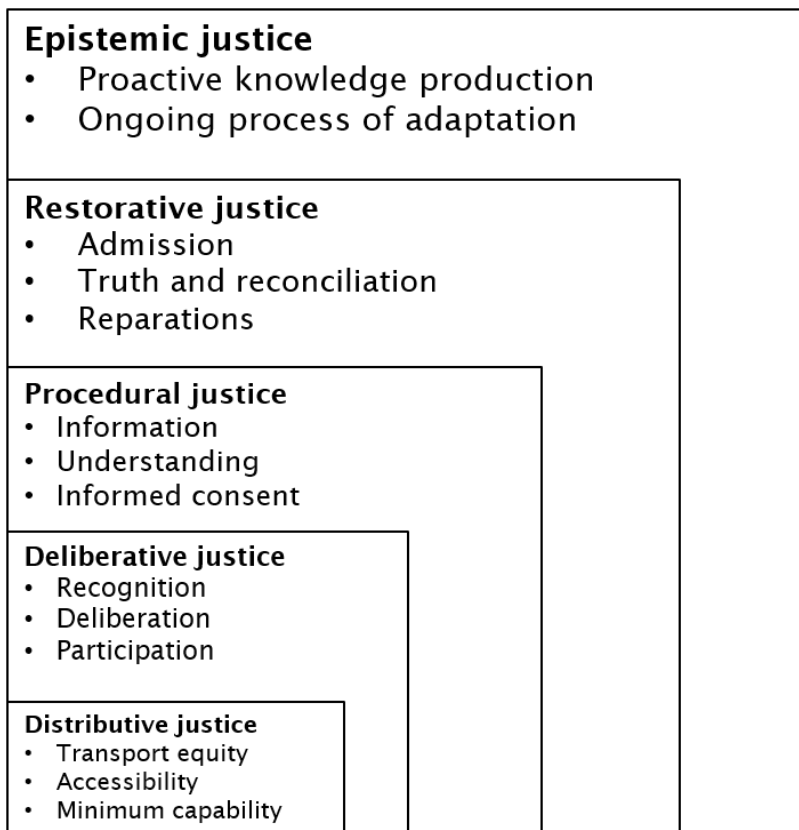
3.2.1 From transport equity to mobility justice

Sheller (2018) critiques current approaches to transport equity for their focus on distributional impact assessments and calls for a more overarching focus on mobility justice (figure 3.2). Such an approach recognises the need to move beyond simply disaggregating costs and benefits by different social groups to question the power structures and decision-making processes which have led to such inequities in the first place. Levy (2013) argues that impacts ‘go beyond the disaggregation of transport users by social relations such as class, gender, age and ethnicity’. Most approaches to understanding transport equity focus on distributive justice, indicated at the bottom left of figure 3.2. However, as the figure shows, this is only a small part of an overarching approach to mobility justice which also needs to consider broader justice issues.

As Smeds et al (2020) explain:

Decision-making and knowledge production is typically dominated by white men in technocratic professions, while it is clear ... that there are disadvantages suffered by women, non-white and lower-income people (p3)

Figure 3.2 Distributive justice approaches in transport as part of a wider framework of mobility justice – based on Sheller (2017, p35)



From this perspective, it is not sufficient to undertake, for example a distributional analysis of options improving peak commute times, without questioning that objective in the first place. For example, Jahanshahi et al (2015) discuss how transport services are targeted at full-time workers living in suburban areas, travelling at peak time which means they often do not service part time, or female workers well. It is important to understand existing inequalities and the causes of these related to the social and cultural context in which travel ‘choices’ are made (Levy 2013; Sheller 2018). A mobility justice approach would move from top down technocratic approaches to decision making towards more public participation and collective decision making.

Disaggregated assessments of transport policies *on* different groups do not account for the varying capabilities and aspirations of different (groups of) people for mobility and accessibility, or participation in society (Raerino et al 2013; Rose et al 2009). Considering the specific needs and aspirations of indigenous groups with regard to mobility, accessibility and social inclusion is particularly important (Raerino et al 2013) and has largely been missing from transport-related research in Aotearoa New Zealand. Processes of colonisation and disenfranchisement from land require attention to be paid to indigenous transport issues (Raerino et al 2013), beyond a disaggregated analysis by ethnicity and more in line with the mobility justice perspective offered by Sheller (2018).

Assessments of equity in transport often seek to mitigate adverse consequences of a proposed intervention, once a decision has already been made. Instead, equity concerns should feature at every stage of the decision-making process and consider the distribution of benefits.

Key points

- Transport inequities occur if the distribution of transport resources, exposures or outcomes is unfair.
- Most approaches to equity in transport focus on the distribution of benefits and burdens, often from an accessibility perspective.
- There is a need to consider the fairness of the situation and the fairness of the policy.
- A disaggregated analysis of benefits and burdens is the minimum approach to transport equity and justice.

3.3 Social impacts of transport

At the broadest level, social impacts relate to direct and indirect impacts of any policy or intervention on people. Geurs et al (2009) suggest that this definition is too broad to be practical, but also note most definitions of social impacts used in transport planning are too narrow. Given the breadth of social impacts, a large number of social impacts arising from transport interventions have been suggested in the literature. A non-exhaustive list is included in appendix A.

Jones and Lucas (2012) categorise social impacts into five broad categories:

- 1 Accessibility (potential)
- 2 Movement and activity (realised)
- 3 Health-related outcomes (road casualties and injuries, air quality, noise, physical activity, intrinsic value, mental health)
- 4 Finance related (affordability)
- 5 Community related (social interactions, personal safety and fear of crime, forced relocation).

There are connections between these categories. For example, a change in accessibility might impact on movement and activity, with health, community and financial implications. Social impacts might be immediate, arising directly from a result of a policy or intervention, or take longer to manifest (Jones and Lucas 2012).

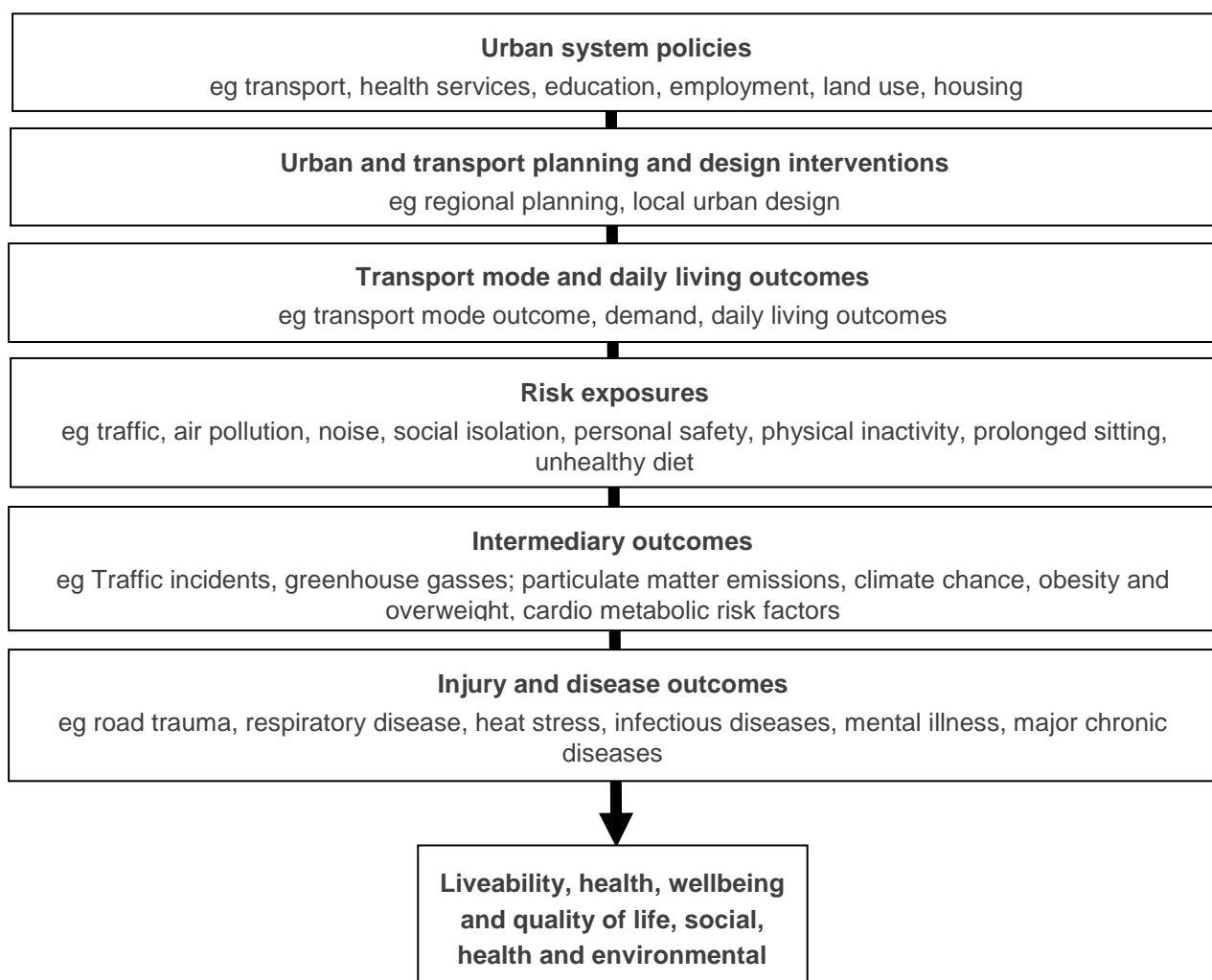
The range of interconnected social impacts, with different timeframes and pathways to impact can make it difficult to measure the social impacts of transport policies and to attribute outcomes to specific policies. Separating social impacts from environmental and economic impacts has been common in transport appraisal, which can cause conceptual difficulties when so-called environmental impacts (eg air pollution) have social impacts (Jones and Lucas 2012). Similarly, crashes are monetised and counted as economic impacts, when they might be better classified as social impacts.

Figure 3.3 shows a conceptualisation of direct and indirect pathways through which transport policies impact on health and wellbeing based on Giles-Corti et al (2016). Impacts from transport such as air pollution have environmental, social and economic impacts, but are often classified as environmental impacts. This conceptualisation helps to separate different types of impacts that transport policies can have and pathways to social impacts. There may be equity concerns at any stage of this pathway to an impact, leading to health inequalities. For example, if a transport policy impacts unfairly on people's ability to travel by differing modes that will filter through to health inequalities. Similarly, even if there are not

inequalities in travel behaviour differing needs and capabilities might mean there are inequalities in outcomes.

A consideration of social impacts in transport requires not just an assessment of the distribution of transport resources, but the social outcomes of this distribution (Lucas 2012). Another helpful categorisation is provided by Martens et al (2019) (figure 3.4). This shows how transport-related resources translate into opportunities or risks and ultimately social outcomes and wellbeing. Equity concerns can occur at any level in this diagram, but transport policy will mainly be concerned with equity of transport related resources, opportunities and risks. Lucas (2012) encourages policy makers to consider redistributing transport resources in order to address social outcomes. Understanding the links between distribution of transport resources, the opportunities and risks related to this and the impacts on population wellbeing are all important in examining the social impacts of transport policies.

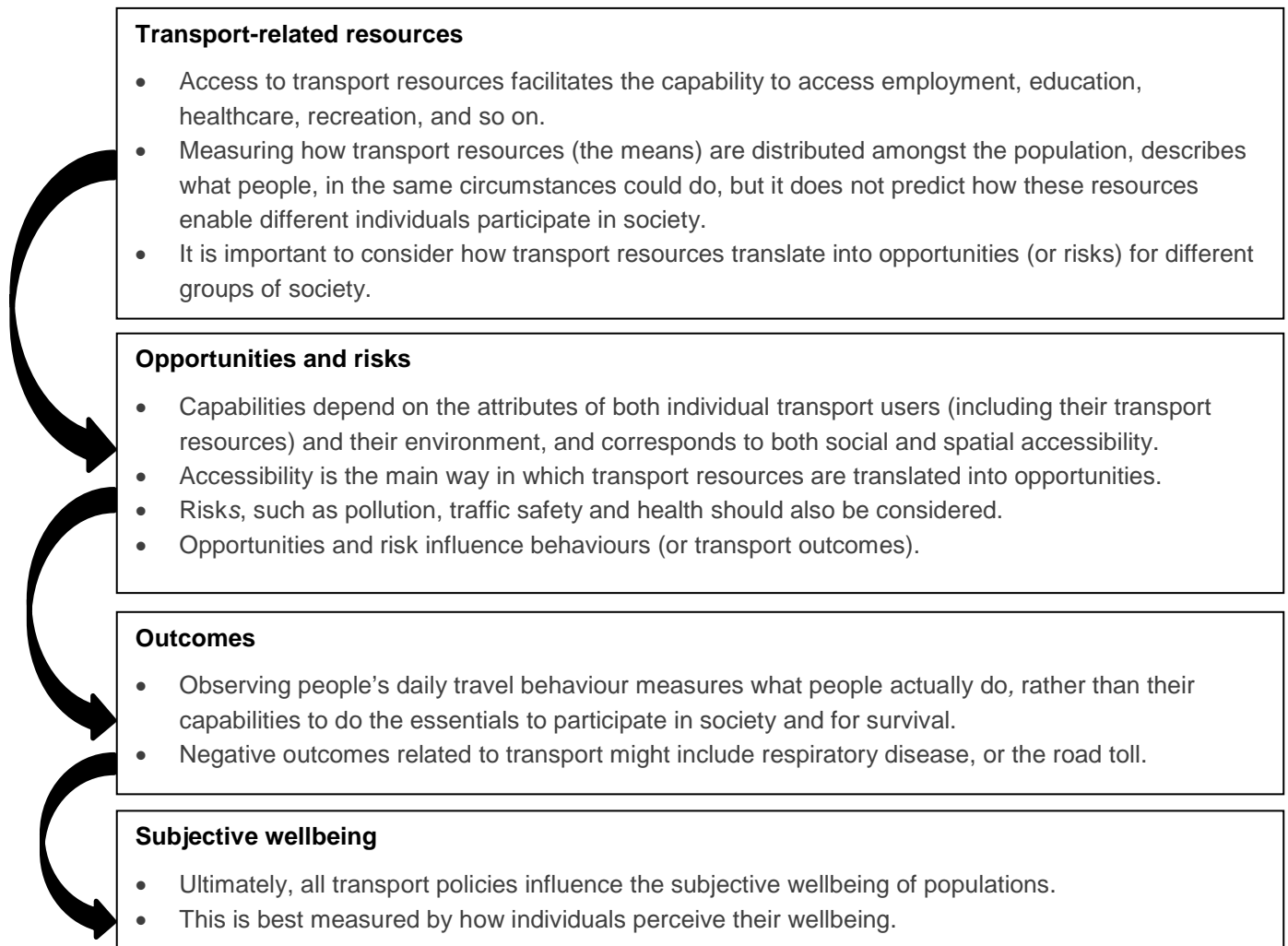
Figure 3.3 Direct and indirect pathways to health impacts



Concerns about social impacts and transport have a long history, but in a policy sense gained some momentum in the late 1990s and early 2000s, when increasing attention, particularly in the UK, was being paid to links between social exclusion, transport deprivation, poverty and (in)accessibility to key destinations (Lucas 2012; Beyazit 2011). A report by the UK Social Exclusion Unit (2003), which resulted in accessibility planning being integrated into English local transport plans can be seen as pivotal in highlighting links between transport and social policy in terms of unemployment, health inequalities,

educational attainment and neighbourhood deprivation (Lucas 2012; Beyazit 2011). Accessibility planning has encouraged cross-sector working on local accessibility issues but can be critiqued for its reliance on journey time-based measures of access, at the expense of considering other factors that impact on accessibility. Furthermore, a focus on accessibility means that other social impacts of transport have been given less consideration.

Figure 3.4 Transport related resources, opportunities and risks, outcomes and subjective wellbeing
(Source: Ministry of Transport unpublished)



Social impacts are often discussed in tandem with distributional impacts. Levy (2013) warns against conflation of social and distributional impacts, while Jones and Lucas (2012) clarify that social, environmental and economic impacts each have distributional impacts. They suggest that linking social and distributional impacts causes policy confusion. Instead, Jones and Lucas (2012) propose a conceptualisation of transport impacts that recognises all impacts might have environmental, social and economic consequences, and all of these will be distributed differently across society.

Key points

- A wide range of transport impacts can have social impacts.
- These can be overlapping, complex and occur over varying time periods, making assessment complicated.
- Transport planners and policy makers have most control over transport related resources, and opportunities and risks – but should understand the likely outcomes of their decisions.
- Studies of social impacts have often focused on accessibility.
- Social and distributional impacts should not be conflated.

3.4 Distributional impacts

As outlined in section 3.2, most approaches to transport equity focus on distributional analyses of benefits and burdens. Distributional assessments of transport impacts are usually undertaken by segmenting the population spatially and/or socially. However, consideration of temporal distribution is also important (Jones and Lucas 2012; Smeds et al 2020).

While much of the published research internationally focuses on differential levels of accessibility, particularly to employment and for lower income groups, there are a number of different groups identified as impacted by transport poverty. Other dimensions by which transport impacts have been assessed include: gender, age, ethnicity, geographic location, household structure (eg children/single parents), household tenure, deprivation, car ownership, disability, faith, economic activity, educational qualifications, being in receipt of state benefits and indices of multiple deprivation (Jones and Lucas 2012; Lucas 2012; Lucas and Jones 2012).

Until recently, most research into distributional impacts in New Zealand has apportioned the population according to an individual's ethnicity (Callister et al 2007; Grey et al 2018; Robson and Harris 2007) or by the level of area deprivation (Exeter et al 2017; Atkinson et al 2014) in their place of usual residence. The Integrated Data Infrastructure is a large research database holding microdata about people and households from government agencies, StatsNZ surveys and non-government organisations. The introduction of the Integrated Data Infrastructure has introduced new opportunities to explore person-level measures of socio-economic position such as levels of education, occupation, or income (either for individuals or their households); however, the number of studies using these measures is currently small (Zhao et al 2018).

Policy interest in distributional impacts is often around mitigating adverse impacts for particular groups. However, it is also important to consider how the benefits associated with any transport policy or intervention are distributed.

In this section we briefly outline the groups often identified in distributional analyses and explain how they are affected by the transport system, drawing on international literature. In section 3.5 we review the existing evidence on transport equity in Aotearoa New Zealand.

While there is no 'gold standard' measure of an individual's socio-economic position, in the context of the current research, we suggest that income (both personal and household) is relevant. Given a considerable amount of research uses NZDep¹, and that index also utilises the car ownership information

¹ The *NZDep* is an area-based measure of socio-economic deprivation in New Zealand.

from the census, we also consider the role of deprivation on distributional impacts. The Government's commitment to Te Tiriti and the reduction of wider health and social inequalities among all ethnic groups means that we also consider the role of ethnicity in the following review.

Although we summarise the evidence according to social groups often used in the literature it is important to note that transport disadvantage is usually intersectional and multi-dimensional. Many people fall into more than one of the groups outlined, compounding the disadvantage. This is not a comprehensive review, as we could write an entire book on each, but is designed to highlight the challenges faced by different social groups.

3.4.1 Income and deprivation

Income and social deprivation are among the more common equity factors considered in the literature. Rates of household car ownership tend to be strongly patterned by income and annual distances travelled by non-car owners is substantially lower than for car owners resulting in higher likelihood of social exclusion among these groups (Lucas 2012). In a study using longitudinal administrative datasets in the UK, Chatterjee et al (2019) found that an unemployed person with access to a car was more than twice as likely to move into work the following year than someone without a car. People with cars were almost four times as likely to be employed as those without a car. Lower levels of car ownership among low-income groups can therefore compound difficulties with finding employment.

Job seekers with poor access to public transport can find it difficult to attend interviews (Social Exclusion Unit 2003; Martens et al 2019). Poor public transport can constrain search horizons and make it difficult to maintain employment (Patacchini and Zenou 2005). Limited or expensive transport to facilitate access to employment can be associated with risk of poor mental health and wellbeing for lower income groups in particular.

People living in deprived urban areas rely more heavily on walking as a mode of transport, due to difficulties affording other modes of transport (Ogilvie et al 2008), often despite unpleasant built environments. However, in poor urban environments walking can have poor health outcomes, where it is the only option, rather than a matter of choice and where it is utilitarian rather than recreational (Ogilvie et al 2008; Curl and Mason 2019; Bostock 2001; Christiansen et al 2014). Similarly, some evidence suggests that built environment interventions, such as cycle infrastructure, are used more frequently by those in the least disadvantaged groups (Goodman et al 2013b).

In a study in Austin, Texas, the quality of the urban environment was poorer and crash and crime rates higher near schools in more deprived areas with higher numbers of Hispanic students, although they did have higher objectively measured walkability and shorter distances to school (Zhu and Lee 2008).

In car-dependent countries low-income households often struggle to afford the costs associated with car ownership, while depending on a car for accessibility (Mattioli et al 2018; Mullen and Marsden 2018; Currie and Delbosc 2011; Mattioli 2017; Curl et al 2018). In the UK, 9.4% of the population was classified as 'low income high costs', with a disproportionate amount of income being spent on transport (Mattioli et al 2018).

People from lower socio-economic backgrounds are also exposed to higher levels of risk. Those with lower socio-economic backgrounds and with lower levels of education are more likely to experience traffic casualties and injuries (Jones and Lucas 2012; Factor et al 2010). Several studies have found that exposure to ozone, particulate matter, or nitrogen dioxide is higher for lower income and/or more deprived communities (Mitchell 2005, Schweitzer and Zhou 2010; Pearce and Kingham 2008).

In considering shift towards smart mobility and multimodality, Groth (2019) highlights inequities according to socio-economic status, compounded by living in more peripheral urban areas. Those with lower incomes, no employment or part-time employment, females and those with no formal education were more likely to be restricted to one mode of transport. Younger and middle-aged adults, with higher education and income levels were more likely to live in central urban areas and have multiple transport options. He also found associations between availability of smartphones, use of multi-modal travel options and socio-economic status.

Lower income groups rely more heavily on public transport, which can be associated with boredom and depression for commute journeys (Gatersleben and Uzzell 2007). Commute stress is greatest for lower income commuters (Singleton 2019). Lower income commuters might also have less flexible routines, job insecurity and longer work hours making it more difficult to shift mode (Tranter 2010).

Bocarejo and Oviedo (2012) evaluated infrastructure and fare policies in Bogota using accessibility metrics accounting for the proportion of income spent on transport. They found that, subject to context, fare policies were more likely to benefit lower income groups than infrastructure.

3.4.2 Geographical location

Poor accessibility as a result of location has traditionally been seen as a rural concern (Farrington and Farrington 2005; Gray et al 2006; Fitzgerald 2012). However, pressure for increased housing and cheap(er) land has led to urban sprawl and poor accessibility even in urban areas (Power 2012). Lower income households living in peripheral urban locations will likely either be 'forced' into car ownership or have reduced accessibility to important destinations. In a study comparing 2001 with 2011, Cao and Hickman (2017) demonstrate an increasing number of suburban areas of London are subject to high housing and transport costs, whereas central London has become less car dependent. They note large spatial discrepancies between higher and lower income households in terms of their Car Dependency and Housing Affordability index.

Mullen et al (2020) find that increasing precarity of housing and employment challenges 'traditional' welfare economics approaches which explore the trade-offs that people make between housing and commute costs. In their study, residential uncertainty was managed in some cases through car ownership, despite considerable financial difficulties associated with car ownership. Given uncertainty and precarity, car ownership is often the difference between being able to find employment or not. Demands of multi-tasking, multiple responsibilities and tight scheduling which lead to car reliance are more likely in rural and peripheral urban areas (Lucas 2004; Lucas 2012).

Longer commutes can be detrimental to wellbeing and mood (Chatterjee et al 2020; Lancée et al 2017).

3.4.3 Age

Both younger and older people are more likely to be reliant on others for their transport (Martens et al 2019). Relationships between built environment interventions and physical activity differ according to age (Smith et al 2017) and different kinds of intervention are required to meet the needs of older (Annear et al 2012) or younger (McGrath et al 2015) people.

Young people, particularly those not in employment, education or training can find transport availability and costs challenging, resulting in difficulties accessing employment or education (Martens et al 2019). Children's independent mobility has declined dramatically in line with increased motorised traffic (Martens et al 2019). Transporting young children (with a buggy or pram) can make travel by certain modes more difficult (Martens et al 2019).

Younger people (aged 15–29), particularly men, are more likely to experience traffic casualties and injuries (Factor et al 2010; Jones and Lucas 2012), as are children, particularly from lower income groups (Edwards et al 2006; Desapriya et al 2011; Laflamme et al 2009; Noland and Quddus 2004; Jones and Lucas 2012).

Older adults can experience declines in personal mobility, making it more challenging to access destinations and social connections. Driving cessation, in particular is associated with increased risk of loneliness and social isolation. Older adults are less likely to leave the house on any given day, make fewer and shorter trips and are less car reliant (Schwanen and Páez 2010; Lucas 2019). Although in part these patterns can be attributed to a reduced need to travel, social isolation and loneliness result from inadequate transport resource (Lucas 2019).

Children, especially those in pushchairs are more exposed to air pollution from traffic than adults because the first 1 m above the surface level is most exposed (Sharma and Kumar 2018) although car drivers are most exposed to carbon monoxide (Kingham et al 2011).

Accessibility and walkability metrics based on average walk speeds are likely to overestimate the accessibility of older adults and therefore if policies are developed based on such metrics they will exclude the needs of older adults. Existing pedestrian infrastructure is often inadequately designed for the needs of older adults – for example, pedestrian crossing signals do not allow enough time to cross the road (Asher et al 2012). Older adults are at greater risk of pedestrian injuries, particularly from falls (Mindell et al 2012), and a fear of falls may result in avoidance of outdoor mobility.

3.4.4 Ethnicity

Due to small numbers involved in many studies it is rarer to see analyses disaggregated by ethnicity. In many countries, ethnic minorities often experience other forms of disadvantage, such as lower income. Fear for personal safety and racial harassment can mean some ethnic minority groups place great importance on car-based travel (Martens et al 2019). Immigrants may have shorter travel horizons, face language barriers with public transport information and feel uncomfortable travelling in certain places or using public transport for cultural reasons (Martens et al 2019). Minority groups are more likely to experience traffic casualties and injuries (Factor et al 2010, Jones and Lucas 2012).

3.4.5 Gender

Disaggregated analyses of transport patterns show that men and women travel very differently (Levy 2013). At a broad level, men travel more, take more and longer work trips and undertake more peak travel. Women do more trip-chaining, off-peak travel, use cheaper modes of travel, are less likely to use the family car and less likely to have a driving licence (Levy 2013). Women also do more trips over shorter distances for social or recreational purposes (Witten and Mavoa 2011). Blumenberg (2004) critiques ‘welfare to work’ policies in the US which are based on assumptions of male travel between central city areas and suburbs, which are not consistent with the travel patterns of low-income single mothers. They suggest such policies need to account for gender differences in patterns of travel.

The gender differences in travel patterns have implications for women’s mobility and wellbeing. In the UK, female-headed households were more likely to be ‘car-deprived’ than ‘forced car owners’ (Mattioli 2017). Women are far more likely to report personal safety concerns when travelling by public transport, thus restricting their use of this mode to some extent (Martens et al 2019). Single parents (who are far more likely to be female) are often identified as being at risk of transport-related social exclusion, due to lower incomes, more complicated trip patterns and more journeys overall – as responsibilities are not shared (Martens et al 2019; Middleton and Spinney 2019). Young female students are much more likely to have parental restrictions on travel (Emond and Handy 2012).

Middleton and Spinney (2019) describe the emotional ‘work’ and anxieties involved with using public transport for new mothers and explain that such experiential factors can have significant implications for travel patterns of different groups but are not accounted for in policy. Singh (2019) explains the implications of restricted travel choices in terms of access to services, cited a report that found girls in India chose to attend poorer quality colleges because they were safer to travel to.

The gendered patterns of travel also have negative implications for men, who are more likely to experience traffic casualties and injuries (Factor et al 2010; Jones and Lucas 2012). In a review of interventions to increase walking for transport, three studies found that men were more likely than women to increase their walking potentially suggesting that men are more able to change mode, though most studies either had primarily female participants or did not report this information (Ogilvie et al 2007).

3.4.6 Disability

Individuals with a mobility disability make fewer trips (Lucas et al 2018) suggesting that difficulties travelling can lead to trips not being made, with potential social impacts. Transport is one of the biggest challenges faced by many disabled people due to the design of urban environments, public transport vehicles and driver attitudes (Martens et al 2019). People with vision impairments can find travel more difficult, time-consuming and emotionally draining (Middleton and Spinney 2019). The negative experiences of disabled people using public transport are described in a recent book on public transport and disability hate crime (Wilkin 2020). Travel costs can also be a particular burden due to the need for specific vehicles such as those that can fit a wheelchair and increased use of taxis (Martens et al 2019). In some places, including Auckland, carers accompanying disabled people have to pay public transport fares, increasing the cost of travelling by public transport for disabled people – elsewhere this is not the case. Emerging modes of transport, such as e-scooters have presented challenges for those with vision impairments.

Obstacles such as vehicles parking on footpaths, lack of dropped crossings and advertising boards lead to inaccessibility for those with disabilities (Bonehill et al 2020) and can lead to falls risk or lack of ability to go outside among older adults (Curl et al 2016)

People with anxiety disorders can have particular difficulties using public transport because of concerns about safety, and feelings of lack of control and uncertainty (Mackett 2017; Mental Health Action Group and Anxiety UK 2016; International Transport Forum 2009).

3.4.7 Temporal considerations

Limited research has considered the uneven mobility offered by the public and active transport system at different times of day and the differentiated impacts based on gender, income and race (Smeds et al 2020; Chandra et al 2017; Rogalsky 2010) Gaps in transport provision at night are particularly likely to impact low-income shift workers for example (Chandra et al 2017).

In addition to differential service availability at night time, some groups are more likely to face fear-based exclusion (Smeds et al 2020). Low income groups (Oviedo Hernandez and Titheridge 2016) and women (Abenoza et al 2018; Yavuz and Welch 2010) have been identified in the literature as facing fear-based exclusion at night time.

Key points

- Distributional impacts assessments consider the impacts of transport on different social groups.
- This section highlighted some of the existing inequities and challenges faced by different social groups.
- Income, age, ethnicity, gender, geographic location, disability and car ownership are common groups considered 'at risk'.
- Transport policies should be developed based on an understanding of the differential transport needs and existing inequities.
- While often analysed separately, dimensions are overlapping and intersectional.

3.5 Transport equity in Aotearoa New Zealand

This section summarises existing and current research on transport equity in Aotearoa New Zealand. Previous research has found limited systematic research into the social impacts of transport (in)accessibility in New Zealand (Fitzgerald 2012; Rose et al., 2009), although this is a rapidly growing area of research, as we highlight by drawing attention to many ongoing studies (in boxes).

This section starts with an overview of Te Tiriti o Waitangi/Treaty of Waitangi obligations as a major consideration for transport equity in New Zealand, before reviewing the existing evidence according to different social groups, mirroring the review of international evidence in section 3.4.

We also present some basic analyses of the Household Travel Survey (HTS) (Ministry of Transport 2019); Census 2013; Indices of Multiple Deprivation (IMD) and the New Zealand Health Survey (NZHS) where breakdowns by socio-demographic groups are available for each dataset. HTS data for example is not available by ethnicity or disability and because census data on car ownership is reported for households it cannot be broken down by individual characteristics such as age, ethnicity and sex, without a bespoke data request.

3.5.1 Te Tiriti o Waitangi / Treaty of Waitangi obligations

The particular relationship between Māori and the Crown, arising from Te Tiriti o Waitangi/ Treaty of Waitangi should be considered beyond simply a comparative assessment of outcomes based on segmenting the population based on ethnicity. Māori are tangata whenua, the indigenous peoples of Aotearoa New Zealand (Anderson et al 2014). As indigenous peoples, Māori rights are recognised internationally through the United Nations Declaration on the Rights of Indigenous Peoples to which New Zealand is a signatory (United Nations 2007).

The Waitangi Tribunal is a permanent commission of inquiry established in 1975 to hear breaches of Te Tiriti o Waitangi/ Treaty of Waitangi. In relation to health outcomes for Māori, the Tribunal has determined a set of principles that are particularly relevant (Waitangi Tribunal 2019). They include the guarantee of tino rangatiratanga (sovereignty) and the principles of partnership, active protection, equity and options.

In the Land Transport Management Act (2003) there are specific requirements on local authorities to consult with Māori (Local Government New Zealand 2017). Likewise in the Local Government Act (2002), local authorities are required to have consultation processes in place with Māori, and under the Resource Management Act (1991) are required to consult with Māori, early in statutory planning processes.

While a range of processes for engagement exist, the Health Impact Assessment Tool (Ministry of Health 2019) gives useful guidance and recommends the following questions be worked through in policy development:

- How does the policy proposal provide for effective partnership with Māori?
- How does the policy proposal provide for opportunities for Māori to contribute to the policy process?
- How does the policy proposal contribute to improved outcomes for Māori?
- What is the potential effect of the policy proposal on mental and physical health and wellbeing of Māori whanau/ families /communities, and on spiritual and cultural values of Māori whanau/ families/ communities?

There is limited research considering the impacts of transport systems on indigenous wellbeing (Raerino et al 2013). In their research into Māori perspectives on transport and wellbeing Raerino et al (2013) identified four main themes:

- 1 The lived experience of being Māori (including identity, culture and access to the Māori world)
- 2 The relationship between transport behaviour and healthy daily lives
- 3 The relationship between transport behaviour and the built and natural environment
- 4 The ability to participate fully in society economically and in the wider family.

In addition to access to important destinations often highlighted in the transport and social exclusion literature, participants in the Raerino et al (2013) study talked about the importance of access to cultural sites and knowledge. Transport presented problems meeting cultural obligations and therefore had long-term effects on cultural identity. The participants also drew attention to issues of lack of safety as a barrier to active and public transport. A greater need for access to healthcare (due to existing health inequalities) was also noted.

The land use transport characteristics of Auckland are associated with equity issues for Māori, linked with health inequalities (Raerino et al 2013). For Māori in Raerino's study, employment was strongly connected to financial security and whānau ora (family wellbeing), and transport-related problems created difficulties accessing employment. The reliance on cars for access to employment presented financial challenges. The complexity of transport needs, balancing whānau and community commitments in part led to car reliance. Finally, participants discussed the lack of opportunity for participation in the planning process and the subsequent impacts on transport not meeting the needs of Māori (Raerino et al 2013).

Raerino et al. (2013) discussed the impacts of illegal driving and imprisonment for Māori men, alongside the challenges associated with the need for literacy and financial resources to gain a licence. McDowell et al. (2009) found high rates of unlicensed driving among rural (83%) and urban (65%) Māori.

In another study, Haerewa et al. (2018) studied shared mobility practices. They also found that lack of licensing and the costs of travel were key concerns of the community, in this case leading to shared journeys by car. They also highlighted positive aspects of sharing journeys, such as whānaungatanga (relationships) – spending time on the journey with family; māramatanga (understanding) – the opportunity to share information and knowledge while travelling; and mana motuhake (autonomy) – for example through a kaumātua (older person) van service provided by the rūnanga (tribal council).

Globally, indigenous populations are least responsible for emissions (and have not benefited from the mobility that has caused the emissions), yet indigenous populations are often most vulnerable to climate

change and in some cases least able to adapt due to ongoing inequities (Markkanen and Anger-Kraavi 2019).

Markkanen and Anger-Kraavi (2019) suggest that negative impacts on communities tends to focus on material wealth or environmental impacts, but less so on health impacts explicitly. They outline a need to consider the mental health impacts of involuntary relocation or loss of traditional livelihoods, which is also important in a transport context where major infrastructure projects had caused displacement or severance of communities (Ameratunga 2019).

3.5.2 Income and deprivation

Data from the HTS shows that those with lower income levels travel less overall and do a greater proportion of their travelling by more sustainable modes than do those on higher incomes (see figure 3.5). It is only those in the highest income category (over \$100,000) who do a noticeable amount of travel by air (assumption based on 'Other' modes in data) – the mode with the greatest impact through fuel-related emissions, while simultaneously doing large amounts of driving (see figure 3.6). However, looking at the scales on each graph, it is clear that for all income groups, the distance travelled by car is much greater than by shared or active modes. As a proportion of all car travel, lower income groups are less likely to be drivers and more likely to be passengers, suggesting a reliance on others or higher use of car-pooling. Those with household incomes above \$60,000 per year travel almost twice as far per year as the lowest income groups.

Figure 3.5 Household Travel Survey data on distance travelled per person per year for vehicle drivers and passengers by household income (Source: Ministry of Transport Household Travel Survey 2015–2018)

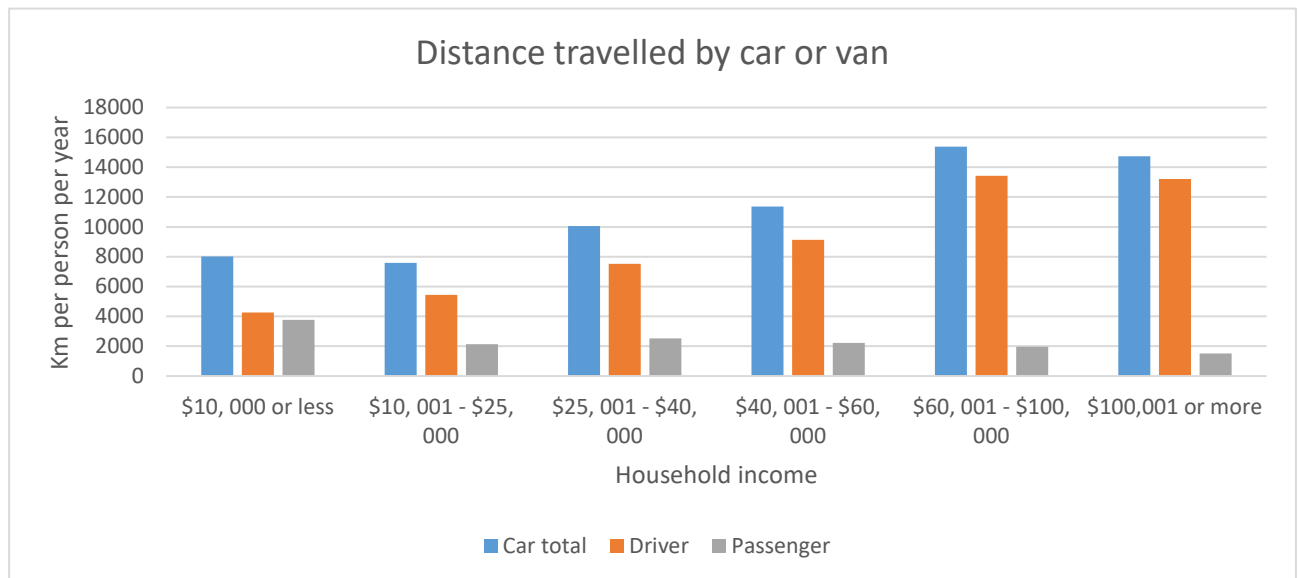
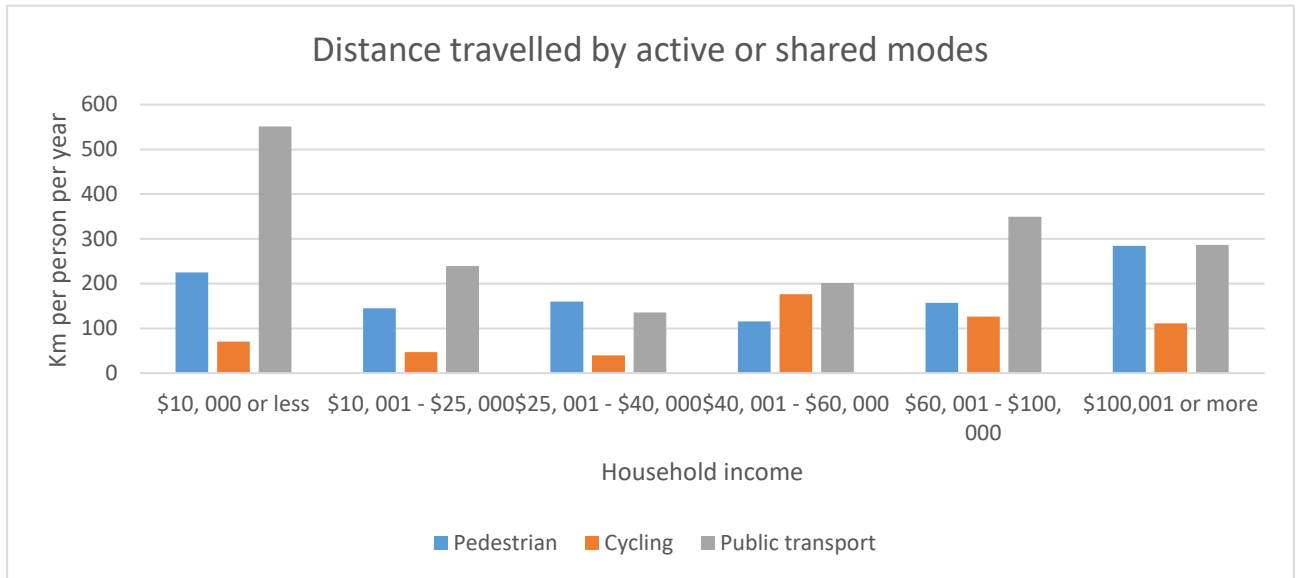


Figure 3.6 Household Travel Survey data on distance travelled per person per year for active and shared modes by household income (source: Ministry of Transport Household Travel Survey 2015–2018)



The IMD (Exeter et al 2017) clearly shows an increase in the proportion of households with no car as deprivation increases (figure 3.7). While these rates are low by international standards, the 15% of households in the most deprived decile of areas is twice the New Zealand average.

Census 2013 also offers information on the number of cars owned per household (figure 3.8). In total, 19% of low-income households (household income under \$30,000) in 2013 owned two or more vehicles. Currie et al (2018) described this group as being ‘forced car owners’. As household income increases, so does the number of vehicles owned per household. Among households earning \$100,000 or more, 83% own two or more vehicles.

Figure 3.7 Households with no car by IMD (source: The University of Auckland. Index of Multiple Deprivation developed by Exeter et al 2017 and licensed by The University of Auckland for re-use under the Creative Commons Attribution 3.0 New Zealand licence and based on/includes Stats NZ’s data which are licensed by Stats NZ for reuse under the Creative Commons Attribution 4.0 International licence.)

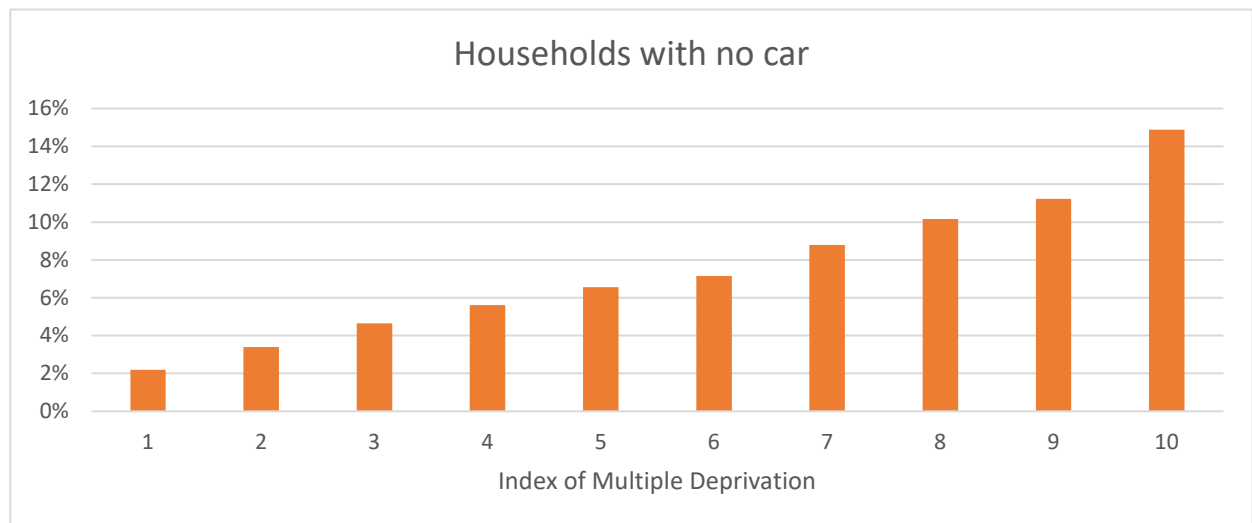
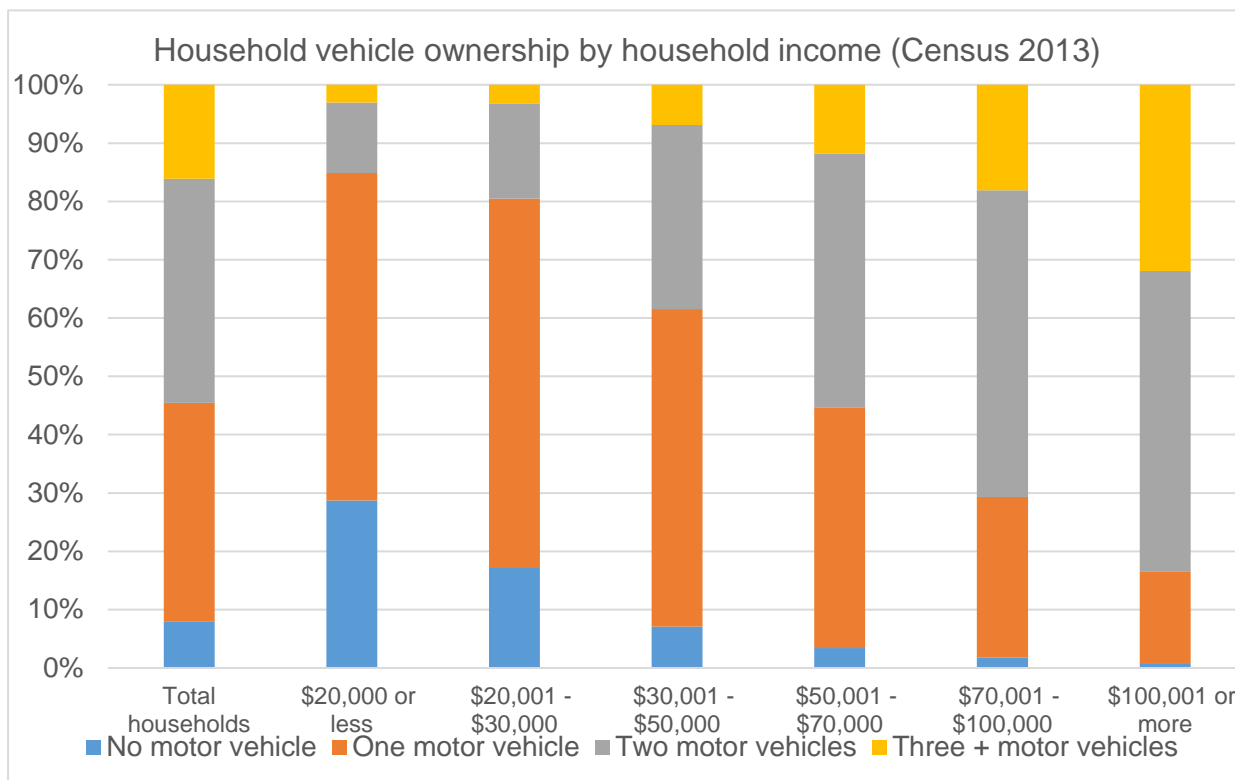
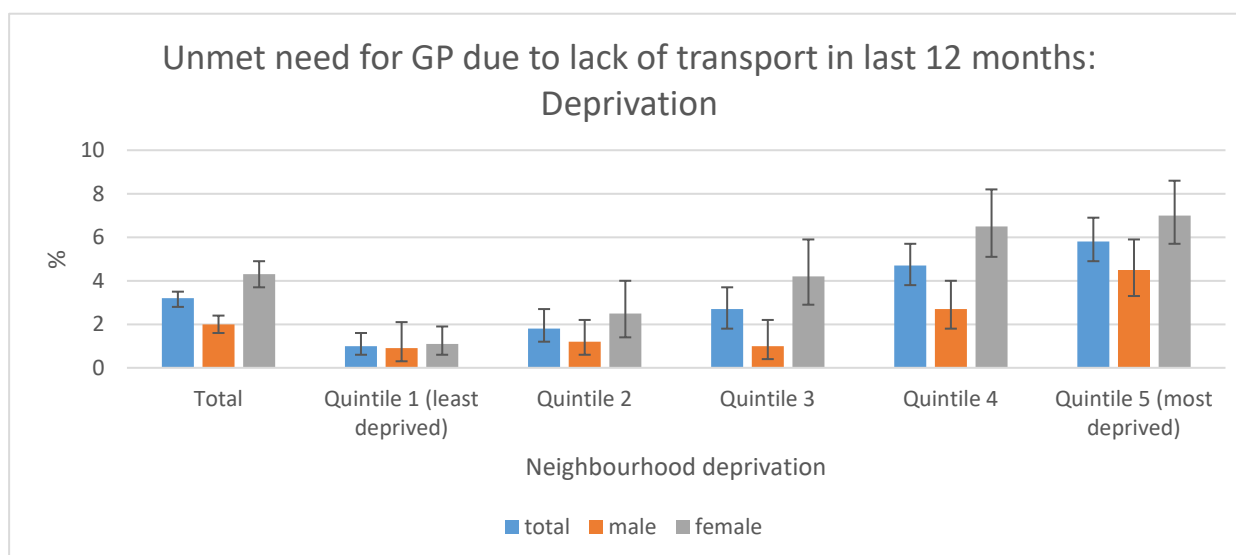


Figure 3.8 Vehicle ownership by household income (source: Stats NZ and licensed by Stats NZ for reuse under the Creative Commons Attribution 4.0 International licence.)



The unmet need for general practitioner (GP) data from the NZHS demonstrates that those living in the most deprived areas are most affected (figure 3.9). The effect is strongest amongst women, with particularly high results for those living in the two most deprived quintiles (40%) of areas. Rates for men were notably high in the most deprived quintile (20%) of areas. Research has found an association between increasing deprivation and shorter distance travelled to social and recreational destinations (Witten and Mavoa 2011).

Figure 3.9 Unmet need for GP due to lack of transport by deprivation (source: Ministry of Health, re-use licensed under Creative Commons Attribution 4.0 International Licence)



Rose et al (2009) found that car dependency in some low-income communities caused such financial difficulties that they often cut back on other essential spending. Car-related expenditure was a major reason for rent arrears, with many cases ending up in tenancy tribunals and convictions.

In a recent study comparing four cities worldwide (Auckland, Brisbane, Perth and Vancouver), Auckland was found to have the lowest public transport service spatial coverage (measured as kilometres per km²) but was second to Vancouver in terms of public transport temporal coverage (measured as service hours per km²). Auckland's public transport system provides better access to employment in more affluent neighbourhoods – a 1% increase in income increases the number of jobs accessible within 45 minutes using public transport by 0.57% (Nazari Adli et al 2019). In Auckland there are clusters of low-income, low-accessibility areas in the south, east and west, indicating areas for improvement of public transport services (Nazari Adli et al 2019).

A study from Christchurch demonstrated that while vehicle-linked air pollution was low compared with World Health Organization standards, areas with the highest deprivation scores had the highest levels of air pollution, a disproportionate exposure given this group is more likely to have one car or no cars in the household (Kingham et al 2007).

Those living in areas with the highest fifth of deprivation scores had much higher traffic injury hospitalisation rates for all modes except cycling (Centre for Public Health Research [CPHR] 2018). This was particularly marked among vehicle occupant injuries, where the hospitalisation rate is 2.6 times that of those living in the least deprived areas. Additionally, hospitalisation for vehicle occupants is much higher than for pedestrians.

Studies from Auckland have found that road traffic injury rates are higher in more deprived areas, particularly among children and Māori (Roberts et al 1992; Hosking et al 2013). Safety measures such as walking school buses (Collins and Kearns 2005) and traffic-calming modifications (Hopgood et al 2013) have been found to be implemented in least disadvantaged areas.

Smith et al (2017) conducted a systematic review of the impacts of built environment interventions on physical activity and active travel. They found that while interventions that focused on walkability, provision of parks and playgrounds, and improvements in active travel infrastructure had positive impacts overall the evidence indicated that such improvements predominantly benefited socio-economically advantaged groups. If such interventions predominantly benefit the most advantaged then the gap between the least and most well off widens.

Box 3.1

Te Ara Mua – Future Streets (Macmillan et al 2018)

- Te Ara Mua Future Streets programme modified urban streets in an area of higher deprivation (Mangere, Auckland), with the goal of making them more walkable and bikeable.
- A large follow-up wave for this project was scheduled for 2019.

Healthy Future Mobility (Mackie et al 2019)

- Large project covering four major topic areas: reshaping cities for youth, active school travel, future of the bike and growing niche innovations.

3.5.3 Geographical location

The impacts of poor accessibility are particularly pronounced in rural areas, with various studies identifying effects on material wellbeing; physical and mental health; family, community and networks; institutions, political structures and equity; cultural identity, life and expression; and on the quality of people's living environments (Fitzgerald 2012). Fitzgerald (2012) and Rose et al (2009) note the increasing dependence of rural populations on urban centres, due to depopulation and reduced viability of local services. As a result, increasing fuel prices will increase the fuel costs of rural populations with no transport alternatives, potentially leading to further rural depopulation. There have also been reductions in public and school transport services in rural areas (Fitzgerald 2012). In the 10-year period from 1996 to 2006 the proportion of the rural population travelling to work, rather than working and living at the same place, increased by 27%. Over the same period rural public bus use decreased by 29% to less than 1% (noting, this decrease was from a low baseline) (Fitzgerald 2012). Poor transport in rural areas is a particular concern for youth engagement (Rose et al 2009).

In another study from Auckland, Mavoa et al (2012) highlighted the importance of considering trip frequency in measures of access to public transit. As service frequency is one of the most important factors to users (Curtis and Scheurer 2010; Mavoa et al 2012), low frequencies can present a barrier to mode shift. The most recent figures from Auckland Transport suggest that around 30% of Auckland's population lives within 500 m of a frequent (at least four times per hour) bus service (Auckland Transport 2019).

In New Zealand, important destinations are most easily accessible by car, with a smaller proportion of people able to access schools, GPs and supermarkets within 15 minutes by other modes (NZ Transport Agency 2019). The differences between modes are particularly pronounced for education: 91% of the population can reach a secondary school by car within 15 minutes, compared to 34% by public transport and 19% walking. In terms of access to employment, on average across the country 45% of jobs can be accessed within 45 minutes by car, compared to 15% by public transport, 28% by bicycle and 7% by walking (NZ Transport Agency 2019). These statistics need to be available at a more spatially and socially disaggregated level in order to be meaningful from an equity analysis perspective.

Mattingly and Morrissey (2014) created a combined housing and transport costs model for Auckland which shows, after the inclusion of commuting costs the differentials in housing costs between suburban and inner-city areas are negligible. However, as previously mentioned, the idea that people make simplistic trade offs between housing location and transport costs can be challenged given increasing precarity of housing and employment situations (Mullen et al 2020).

In some cases spatial access is better in more deprived areas (Pearce et al 2006b). However, this analysis ignores the capabilities of different people to overcome distance, and the modes of transport available to do so. As already shown, people living in deprived areas are less likely to have access to a car, and journey time differences between car and other modes are stark.

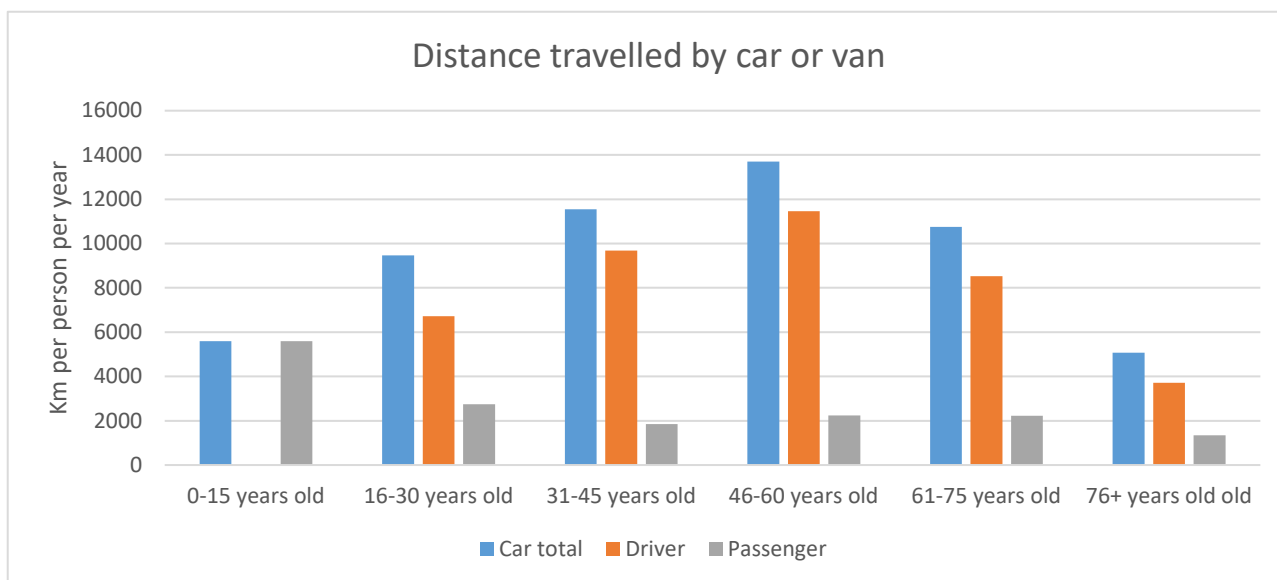
Road traffic injury hospitalisation rates are available for urban/rural classification (pre-2018 definitions) (Centre for Public Health Research [CPHR] 2018). This data shows that hospitalisation rates are highest for vehicle occupants in minor urban areas (small towns), for pedestrians in main urban areas (cities) and highest for cyclists in secondary urban areas (moderate-sized towns).

A high proportion of fatalities involving non-safety belt use is found in rural areas, with a higher prevalence of drug and alcohol use involved (Hirsch et al 2019).

3.5.4 Age

Distance travelled per person per year peaks among the 46–60 age bracket (see figure 3.10). Among all ages, travel is dominated by driving a car or van. The greatest distance per person travelling by bicycle is among those aged 46–60 (see figure 3.10).

Figure 3.10 Household travel survey data on distance travelled per person per year for vehicle drivers and passengers by age group (Source: Ministry of Transport Household Travel Survey 2015–2018)



The overall age group with the greatest unmet need is young adults (age 15–24, though age 25–34 is close behind). The highest levels of unmet need are among those aged 15–34, particularly adult women (age 15–34) had the highest unmet need due to lack of transport.

Older adults who can no longer drive report lower levels of life-satisfaction, reduced ability to get places, fewer trips out, more loneliness and poorer self-reported health than those still driving (Shope et al 2019).

Downward et al (2019) found that those aged over 40 are more likely to avoid transfers, even if the journey time is longer overall.

Hospitalisation rates for vehicle occupant injuries were highest among young adults (aged 15–25). For active travel, hospitalisation for pedestrian injuries were highest amongst youth (15–24) and older adults (65+), for cyclist injuries the highest rates were among those aged 45–64 (Centre for Public Health Research [CPHR] 2018). Younger adults, in particular men constitute a high proportion of fatalities involving non-seat belt use (Hirsch et al 2019).

Children in deprived areas experience higher rates of road traffic injuries (Hosking et al 2013). Children and young people are most likely to be affected by other people’s drink-driving (Connor and Casswell 2009).

Figure 3.11 Household travel survey data on distance travelled per person per year for active and shared modes by age group (source: Ministry of Transport Household Travel Survey 2015–2018)

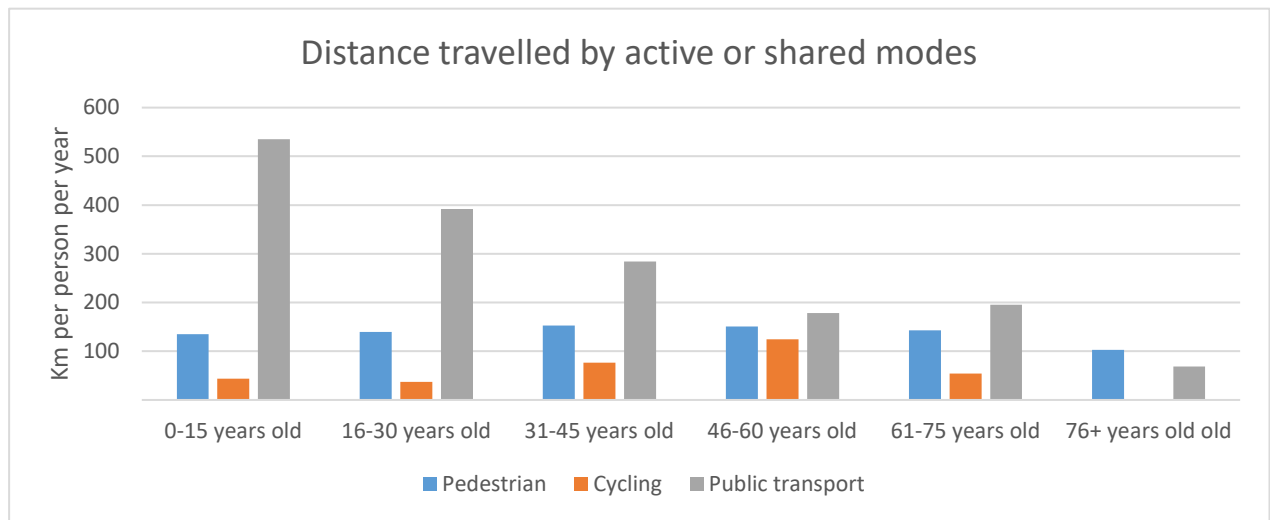
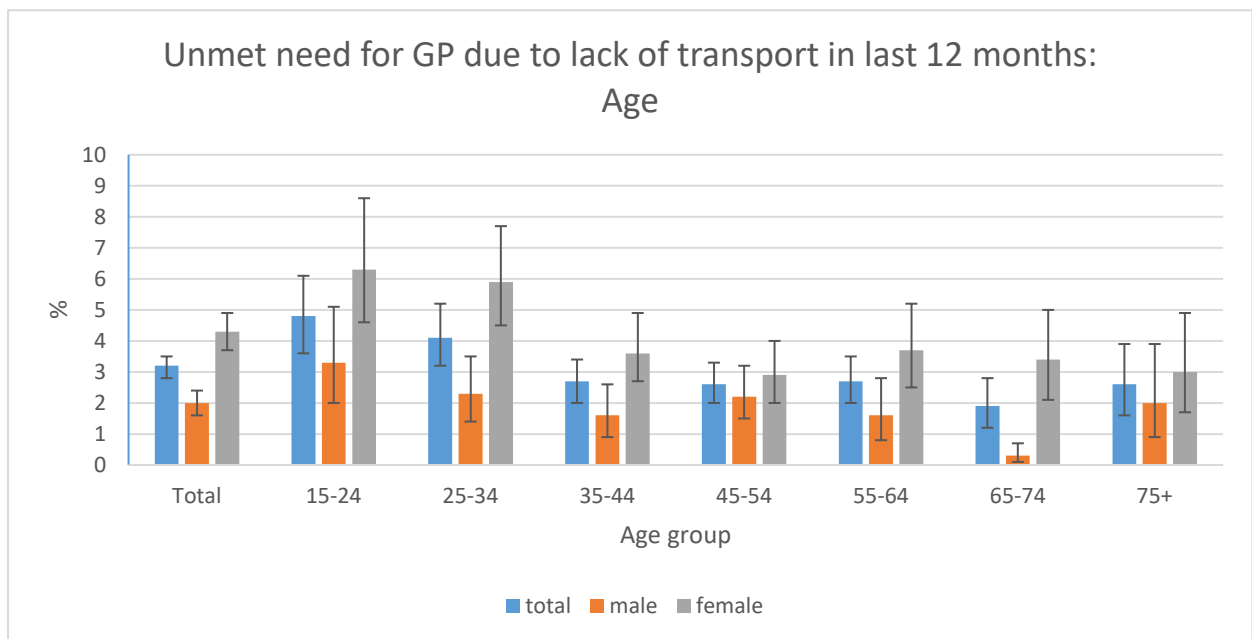


Figure 3.12 Unmet need for GP due to lack of transport by age group (source: Ministry of Health, re-use licensed under Creative Commons Attribution 4.0 International Licence)



Box 3.2: Transport for marginalised youth (Hodgson et al 2019) published conference abstract.

- Examines the experiences of marginalised youth in accessing transport.
- Notes negative perceptions of cycling as well as limitations of safety and distance for active travel.

3.5.5 Ethnicity

Raerino et al. (2013) cite a number of transport inequities for Māori:

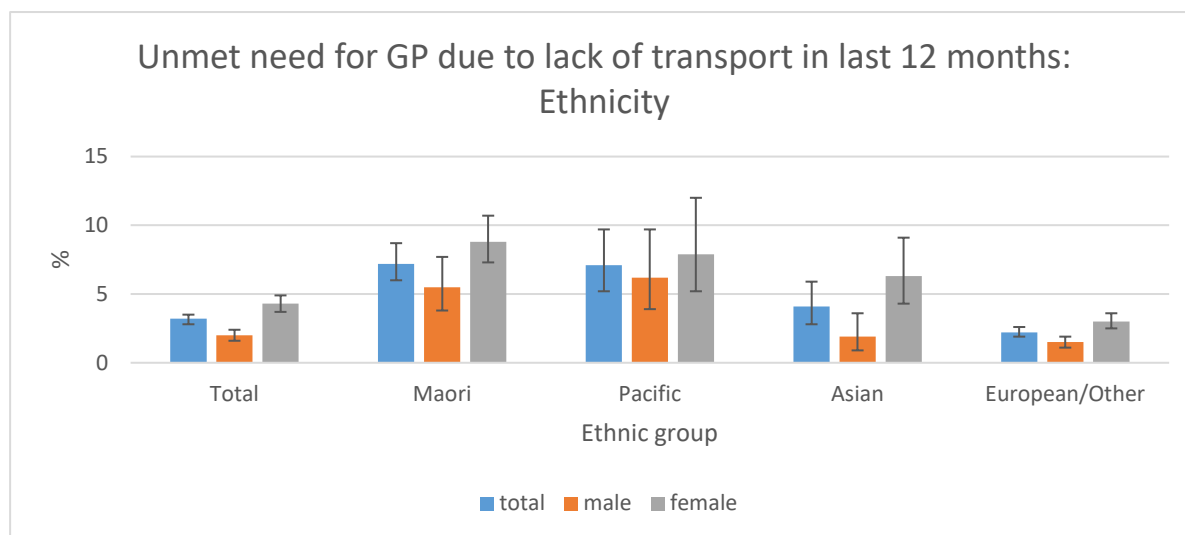
- Māori comprise 28% of road traffic fatalities (Ministry of Transport 2016) yet are 14–16% of the population (Statistics New Zealand 2013; 2020 [we have used most up to date information rather than that cited in the original research]).
- There are differences in road and pedestrian fatalities among Māori and non-Māori children, with Māori experiencing a higher rate of fatalities and injuries (Shaw et al 2005; Roberts et al 1992; Hosking et al 2013).
- There is evidence of higher exposure to air pollution and higher associated rates of mortality (Pearce et al 2006a; Hales et al 2012).

People of Asian ethnicities travel significantly longer distances for social and recreational trips (Witten and Mavoa 2011). Persons of Pacific ethnicities travel the shortest distances, but the effect was not significant.

In a study of adolescents’ perceptions of cycle helmets as a barrier to cycling to school, Māori youth were slightly more likely to report a helmet as a barrier to cycling (Molina-Garcia et al 2018).

Māori had noticeably high hospitalisation rates for vehicle occupant injuries, with the highest hospitalisation rates for pedestrian injuries found among Pacific peoples and Māori (Centre for Public Health Research [CPHR] 2018). The unmet need data from the HTS shows that the highest levels of unmet need were for both Māori and Pacific peoples where rates were high among both men and women (figure 3.13). Asian women also had high levels of unmet need. Rates of driver licensing are lower among Māori, and programmes are in place to improve this (Fatu and Elisaia-Hopa 2020).

Figure 3.13 Unmet need for GP due to lack of transport by ethnicity (source: Ministry of Health, re-use licensed under Creative Commons Attribution 4.0 International Licence)



Box 3.3: Inclusive streetscapes (Ameratunga 2019))

- Project focuses on experiences of older Māori and Pasifika in Auckland.
- Concerns raised include issues of mobility, community severance, urban design and transport justice.
- Challenges conventional thinking about accessibility and engaging with residents.

3.5.6 Gender

Women travel less distance by car overall, and a greater proportion of their car travel is as a passenger rather than a driver (figure 3.14). Women travel further than men by shared or active modes (figure 3.15), but their needs are not always taken into account when planning public transport services, or walking and cycling networks. Downward et al (2019) found that women prefer direct public transport routes with no transfers despite longer journey times. Their study was undertaken in Auckland in the context of bus service changes which are likely to result in more transfers and fewer direct routes. The impacts of service changes, which may be aimed at mode shift, need to be considered for different population groups.

On average, women make a larger number of shorter trips, and a higher proportion of these are to visit family and friends (Witten and Mavoa 2011). Conversely the same study showed a higher proportion of men’s trips are to recreational destinations.

The unmet need for GP data from the HTS demonstrated that women had the greatest unmet need for transport reasons, with young Māori and Pacific women most affected (see figures 3.9, 3.12 and 3.13).

Figure 3.14 Household travel survey data on distance travelled per person per year for vehicle drivers and passengers by gender (source: Ministry of Transport Household Travel Survey 2015–2018)

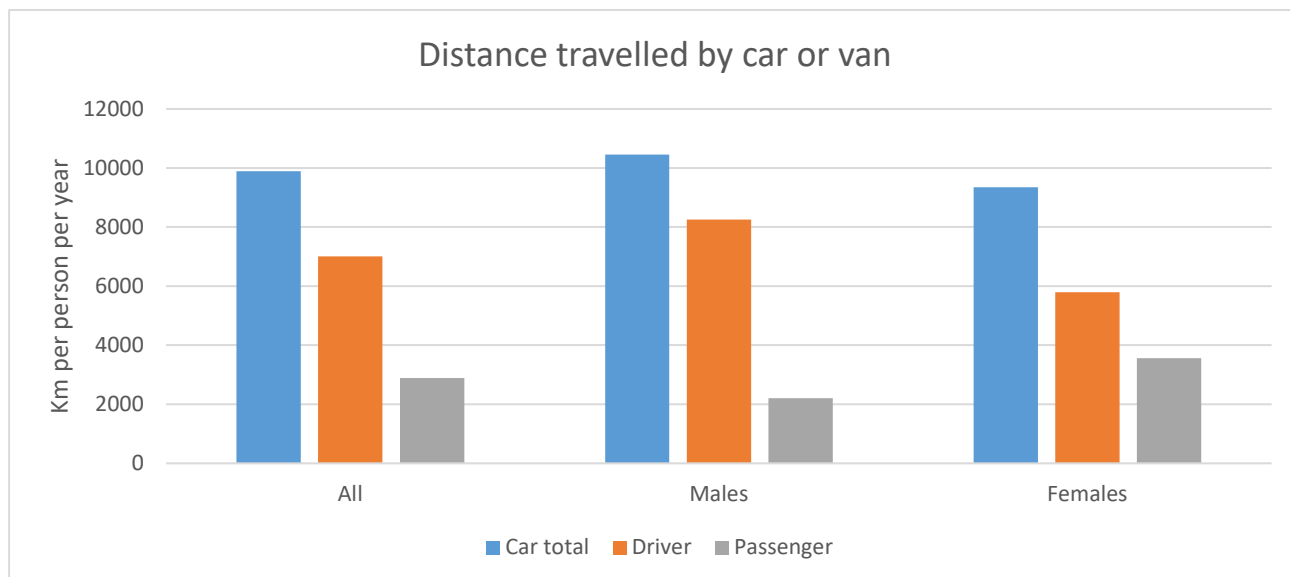
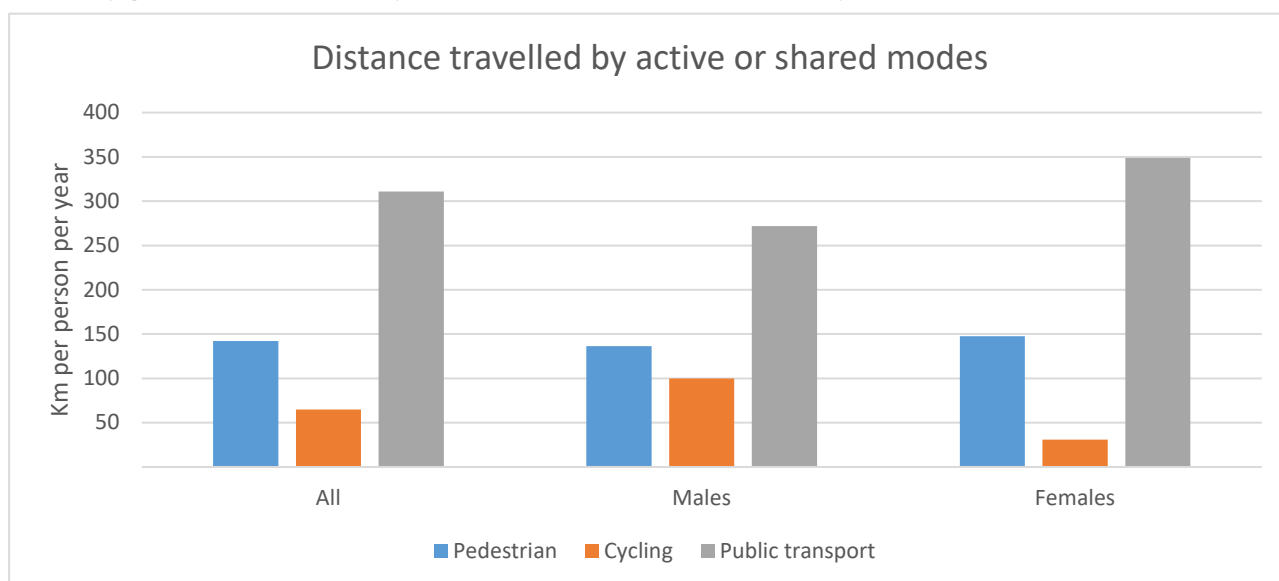


Figure 3.15 Household travel survey data on distance travelled per person per year for active and shared modes by gender (source: Ministry of Transport Household Travel Survey 2015–2018)



Girls are less likely to be allowed to travel independently to school (Bhosale et al 2017). At school age, girls are considerably less likely to cycle, often citing reasons of school uniform (Ward et al 2018; Frater and Kingham 2018).

Women report higher levels of driving anxiety than men, and in some cases this affects their usual activities (Taylor 2018). Males have a higher hospitalisation rate for traffic injuries, in some cases much higher, across all modes than females (Centre for Public Health Research [CPHR] 2018).

Box 3.4: Gender and active travel (Shaw et al 2019) published conference abstract.

- Using the Household Travel Survey, Shaw et al (2019) found that women take more trips by bicycle but travel slightly less distance than men.
- However, even among regular cyclists the majority of trips were still by car.
- Men travel further than women, regardless of whether they cycle, women walk and use public transport more than men.

3.5.7 Disability

Recent work (Carroll et al 2018) investigated the lived experiences of young people with disabilities. The extra time, planning and energy required before a journey even begins as well as the attitudes from the public and transport operators along the way were highlighted as particular challenges, which can prevent some disabled people from going out at all (Morris 2019). Transport systems can exclude and disable through design both of infrastructure as well as operational aspects such as timetabling, diversions and driver behaviour. Disabled people often face difficulties relating to bus driver attitudes, lack of awareness of their needs and the design of urban environments, footpaths and bus stops (Park and Chowdhury 2018).

Lack of awareness of needs or discrimination on public transport can cause concern for those with mental health problems (Human Rights Commission 2005).

Box 5: Enabling participation for disabled young people (Calder-Dawe et al 2019; Carroll et al 2018; Morris 2019).

- Issues raised around the extra time, planning and energy required to make travel possible.
- The attitudes of transport operators and the public can pose challenges.
- Some work from this study has been published.

Some of the work from box 4 also applies here.

Understanding barriers to better outcomes (Waka Kotahi NZ Transport Agency 2019)

- This is an ethnographic study centred around different street types examining the experiences of participants with a range of disabilities.
- The physical design (eg width), quality (eg maintenance) and use (eg café tables) can impact on the ability of users with disabilities to safely navigate the space.

Key points

- There is an increasing body of evidence on distributional impacts of transport in New Zealand.
- There is scope for more work, using existing datasets to build a greater understanding of the existing situation to support equity analyses of proposed policies.
- The needs and aspirations of Māori need to inform policy development by working with Māori at all stages of the policy process, in line with Te Tiriti o Waitangi/ Treaty of Waitangi obligations.

3.6 Social and distributional impacts: assessment, appraisal and evaluation

This section outlines how social and distributional impacts have been assessed in transport appraisal and how social and distributional impacts of transport policies have been evaluated. The section starts with an outline of the principles of social impact assessment before outlining how this has been applied in transport and some challenges in doing so.

3.6.1 Social impact assessment

The broad principles of social impact assessment (Vanclay 2003) are:

- 1 To ensure more sustainable and equitable development. Impact assessment should promote community development, capacity and social capital.
- 2 Social impact assessment should take a proactive approach to achieving better outcomes, rather than simply seeking to mitigate negative or unintended outcomes.
- 3 Social impact assessment should inform the design of the policy in an adaptive fashion.
- 4 Social, economic and environmental impacts are connected in a complex system. Impact pathways need to be articulated and second and higher order, wider impacts, considered.
- 5 Evaluation is a key component so that future analyses can learn from the results of past activities. The approach is therefore reflexive, evaluative and continually developing.

- 6 Social impact assessment can be prospective and retrospective. For example, the social impacts of unplanned events could be analysed retrospectively.
- 7 Participatory processes and local knowledge should be used to analyse concerns of those affected and use stakeholder knowledge in the assessment of impacts, appraisal of alternatives and monitoring and evaluation processes.

Although several studies have noted the importance of distinguishing between social and distributional impacts (Jones and Lucas 2012; Levy 2013), for Vanclay the two are linked:

Awareness of the differential distribution of impacts among different groups in society, and particularly the impact burden experienced by vulnerable groups in the community should always be of prime concern (Vanclay 2003).

A distributional analysis might therefore be seen as forming part, but not all of a broader social impact assessment. The principles of social impact assessment outlined here also include components of a mobility justice approach, outlined by Sheller (2018) and go beyond just a disaggregated assessment of transport impacts.

3.6.2 Social and distributional impacts in transport appraisal

Traditional transport appraisal methods have prioritised mobility over accessibility. While easily monetised direct transport impacts are considered, broader social impacts (eg on population and planetary health and wellbeing) are not well accounted for in transport appraisal methods. This section outlines the approach to social impact assessment in transport in different countries and summarises the strengths and weaknesses of various approaches.

Despite awareness of the significant social impacts of transport, the impacts have not been considered in transport appraisal to the same extent as environmental impacts (Lucas and Jones 2012, Anciaes and Jones 2020; Geurs et al 2009; Manaugh et al 2015). Geurs et al (2009) analysed UK and Dutch transport appraisal guidance and a case study CBA from each and found many social impacts were excluded from appraisals. Searle and Legacy (2019) report a similar omission of social impacts from an analysis of three Australian business cases. Searle and Legacy (2019) suggest that this omission undermines the purpose of CBA and draws into question the decisions to invest in particular transport policies or interventions as a result of [flawed] CBA.

Part of the challenge is the monetisation of costs and benefits in transport appraisal, which means that when an impact cannot be quantified (or the tools to do so do not currently exist) then while impacts may be noted they are often disregarded (Anciaes and Jones 2020; Mackie and Worsley 2013). Searle and Legacy (2019) compare equity and social impacts to species extinction in that they are impossible to monetise in transport planning appraisal. Most attempts at measuring equity within traditional appraisal methods have focused on welfare analysis of monetised impacts, but based only on income distribution and excluding other dimensions of equity (Thomopoulos et al 2009).

Manaugh et al (2015) find that even when strategies and plans mention equity they have underdeveloped objectives and tools for addressing this. As a result, qualitative or quantitative assessments of social impacts might be mentioned, but it is not clear how they impact on the decision-making process (Geurs et al 2009). CBA is not considered suitable for assessing social exclusion issues (Van Wee and Geurs 2011) because of the focus on monetisation (Thomopoulos et al 2009). Thomopoulos et al (2009) suggest that multi-criteria analyses offer a more flexible approach for combining the competing technical, environmental, socio-economic and political interests in transport decision making. Jones and Lucas

(2012) recommend that 'minimum standards of transport provision, equity and fairness become a binding constraint in transport policy appraisal'.

Some transport appraisal methods rely on stated preference surveys and 'willingness to pay' in order to establish economic benefits. Such analyses value the travel time of the least deprived more, because they are more 'willing' or able to pay to reduce travel time. To address this, Anciaes and Jones (2020) report that equity has been assessed using 'equity values' or by weighting impacts relative to income. They also suggest that weights could be applied to analyses based on need or vulnerability in order to explicitly promote welfare of some groups.

Anciaes and Jones (2020) have recently reviewed the state of the art in transport appraisal methods for nine factors that they associated with liveability: trip quality, time use in transport, place quality, time use in places, personal security, visual blight, community severance, equity/social inclusion and health/wellbeing. They suggest that current appraisal frameworks only partially take into account the concerns of modern transport planning, which is (or should be) focused around developing a healthy, equitable and sustainable transport system, rather than car-based planning. In other words, they suggest that appraisal frameworks have not kept up with shifting policy paradigms and still predominantly focus on travel time savings and environmental externalities.

In reviewing the nine components, equity dimensions are noted separately but also in relation to many of the other dimensions, such as trip and place quality and personal security – all of which are experienced differently according to age, gender or ethnicity for example. Anciaes and Jones (2020) report that equity is usually assessed by disaggregating impacts by social group.

Some countries have attempted to incorporate social and/or equity impacts analyses into their transport appraisal methods. NZ Transport Agency (2016) *Social impact guide* for state highways recognises that highway interventions change access and accessibility, and that these changes are likely to have a range of social impacts. The guide identifies a number of possible social impacts including air quality, noise, vibration, water quality, (changes to) transport modes, social connectedness, community severance, changes to facilities, changes to local movement patterns, safety, economy or public health. These are framed as negative and unintended outcomes of highway schemes, rather than considering the possibility of positive social outcomes.

The social impacts included in NZ Transport Agency (2018) *Economic evaluation manual* include vehicle operating cost savings, crash cost savings, seal extension benefits, driver frustration reduction benefits, risk reduction benefits, vehicle emission reduction benefits, other external benefits, mode change benefits, walking and cycling health benefits, walking and cycling cost savings, transport service user benefits, parking user cost savings, journey time reliability benefits, wider economic benefits and national strategic factors.

The English transport appraisal guidance (WebTAG) includes a distributional impact appraisal where each impact is rated on a seven point scale for equity (Anciaes and Jones 2020; DfT 2015). England has separate guidance for social impact assessment which focuses on physical activity, security, severance, journey quality, option values and non-use values, accessibility impacts and affordability impacts – each of which are then subject to a distributional assessment (DfT 2019). French guidance suggests an equity index and mapping analyses (Anciaes and Jones 2020). Both Australia and the UK have guidance on qualitatively assessing impacts of transport projects on accessibility and affordability (Anciaes and Jones 2020).

Detailed assessments of accessibility for different social groups to a range of destinations were undertaken as part of accessibility planning by local authorities in the UK (Halden 2014; Halden 2010; Halden 2009; Halden 2008), but this is no longer a requirement. As part of this the UK Department for

Transport (DfT) produced journey time statistics (DfT 2017) at the zonal level to calculate journey time accessibility by cycling, driving and public transport/walking to a range of key destinations. Combining these statistics with census data allows inequities in journey time accessibility to be calculated and in previous years the DfT reported average journey times for vulnerable groups, compared with the general population. NZ Transport Agency (2019) reported accessibility statistics by mode for the first time in its 2019 annual report. If these statistics can be disaggregated and analysed in conjunction with census data this offers possibilities for detailed accessibility analyses for different social groups.

Anciaes and Jones (2020) report that Sweden has guidelines for measuring gender equality in transport at the local authority level. New Zealand's Ministry for Women recently introduced a gender analysis tool which could be applied to transport policy evaluation (Ministry for Women 2019).

Assessments of inequalities in accessibility to destinations account for a substantial body of literature related to transport equity and several authors have advocated for accessibility as the main measure of social equity in transport (Pereira et al 2017; Manaugh et al 2015). Manaugh et al (2015) advocate for accessibility as a measure of social equity although they also note the importance of affordability and safety from a distributional perspective. Arguably, affordability and safety are components of accessibility, but accessibility metrics have not accounted for aspects other than spatial separation measured using journey time or distance. A focus on journey time ignores other ways in which people can face exclusion from the transport system. Church et al (2000) identify seven ways in which the transport system can contribute to exclusion: physical exclusion, geographical exclusion, exclusion from facilities, economic exclusion, time-based exclusion, fear-based exclusion, space exclusion. Assessments focus on one or the other of these and do not account for the multi-dimensional nature.

There are some examples of incorporating travel cost or monetising accessibility impacts. Guzman and Oviedo (2018) incorporate travel costs into accessibility metrics and evaluate the potential impact of 'pro-poor' public transport subsidies. They demonstrate improved accessibility, through reduced travel costs in peripheral areas as a result of the proposed subsidy. Bills and Walker (2017) propose an approach to disaggregating and monetising accessibility impacts using log-sum approaches.

As noted earlier, accessibility metrics tend to focus on the distribution of accessibility, while assuming that everybody is affected and experiences transport in the same way and maintains an individual rational approach to transport decision making. For example, average walk speeds used to determine journey time are likely to underestimate the time taken by older adults, leading to incorrect assumptions regarding their levels of accessibility. A reliance on accessibility as the main indicator of equity ignores the distribution of other impacts.

Evidence can be a challenge in social impact assessment. The principles of social impact assessment outlined above note the importance of evaluation. A large amount of work goes into transport project appraisal or ex-ante assessment of costs and benefits, but ex-post evaluations are rarer. As such there is less causal evidence on the actual impacts, and even less on the equity impacts of transport policies and interventions on social outcomes.

There is a well established framework for health impact assessment, which assesses health outcomes of projects, including equity considerations (Nieuwenhuijsen et al 2020). There are many overlaps between health impact assessment and social impact assessment. There are some global and local examples of health impact assessments being undertaken for transport projects, but rarely for policies or strategies (Christofa et al 2020) and these tend to be limited to research and academic purposes (Nieuwenhuijsen et al 2020). Rather than being a core part of transport appraisal, health impact assessments have typically been commissioned by public health agencies, meaning that it is unclear how much impact these assessment have had on decision making (Christofa et al 2020). For example, Canterbury District Health

Board Community and Public Health undertook a health impact assessment of the Christchurch Urban Development Strategy (pre-quake) (Mathias 2008).

Health impact assessment tends to focus on the health impacts and outcomes associated with what would be considered the outcome, or end point from a transport perspective. For example, health impact assessments have been undertaken to consider the health impacts of mode shift, or reduced emissions – but not the health impacts of the specific measures which achieve those outcomes. This presents some potential for transport social impact assessments and health impact assessment to be used together. There are relatively few examples of what has been called ‘full chain’ health impact assessments, partly because this is data and labour intensive, requires multi-disciplinary expertise, and results in increased uncertainty and inaccuracies through complex chains of models (Nieuwenhuijsen et al 2020). Most health impact assessment modelling and social impact assessments do not consider feedback loops, although there are some examples of systems dynamics modelling of policies, accounting for such complexity (Macmillan et al 2014).

There is an increasing body of evidence utilising epidemiological methods to evaluate the impacts of place-based, built environment interventions, particularly on active travel. However, there is less research taking an equity perspective or includes sub-group analyses (Aldred 2019; Hosking et al 2019; Smith et al 2017) although some have focused on impacts for particular groups including low income (Macmillan et al 2018) and older adults (Ward Thompson et al 2014).

In summarising the main issues with assessing social and distributional impacts Anciaes and Jones (2020) conclude that challenges occur in defining equity goals (see section 3.1), determining who gains and who loses from transport policies and the challenge of gentrification associated with improvements in transport and place. They also suggest that wider impacts such as poverty, unemployment, tax contributions or social security payments associated with (lack of) transport could be one way to monetise broader social impacts.

Key points

- The broad principles of social impact assessment include a focus on community capacity and participatory processes; an adaptive, reflexive and responsive process, including evaluation; a proactive approach to achieve better outcomes, not just mitigation of unintended consequences.
- Social impacts have not been considered in transport planning appraisal to the same extent as economic and environmental impacts.
- There are opportunities and an increasing evidence base to support better appraisal and evaluation of social and distributional impacts.
- Existing studies have focused on the distribution of accessibility according to income – both social and distributional impacts need to be broader than this.

4 Social impacts of mode shift policy levers

The previous sections outlined the concepts of social and distributional impacts and equity and provided an overview of social impact assessment in transport policy more broadly. This section presents an evidence assessment of social and distributional impacts of mode shift policy levers based on a rapid review of evidence.

In most of the evidence reviewed, high-level analyses of transport policies from an equity perspective consider mode-shift to be one policy lever in a suite of climate change policies. There are few reviews of specific levers to achieve mode shift. We therefore use these high-level reviews of mode shift policy alongside evidence on the impacts of specific policy measures to draw conclusions on the social and distributional impacts of policy levers.

Situating mode shift as a climate change policy lever is linked to international commitments to sustainable development goals and carbon reduction provide opportunities for a 'just' transition to a low carbon economy (Markkanen and Anger-Kraavi 2019). The importance of considering social and equity impacts and providing support for negatively affected communities – a just transition to gain support for a low carbon transition was highlighted at COP24 in December 2018 (Markkanen and Anger-Kraavi 2019).

For climate change (and therefore mode shift) policies to be successful there is a need to understand where they do and do not support progress towards sustainable development goals (SDGs), in particular SDG-10 (reduced inequalities) (Markkanen and Anger-Kraavi 2019). Given transport's contribution to emissions, mode shift policies are one example of a climate change policy that can also support a fairer transition and help meet SDGs. Current climate change trajectories are concerning from an equity perspective because the mobility benefits associated with current emissions accrue to present generations, predominantly in developed countries, whereas the impacts will affect future generations in developing countries (Mattioli 2016). The Rockefeller Foundation–Lancet Commission on planetary health suggests: 'we have been mortgaging the health of future generations to realise economic and development gain in the present' cited in (Mattioli 2016).

Many mode shift policies have both positive and negative equity implications and the extent of these depends on context, policy design and implementation (Markkanen and Anger-Kraavi 2019). It is challenging to capture the full range of social impacts, or broader co-benefits associated with policy, which limits their incorporation in quantitative analyses (Markkanen and Anger-Kraavi 2019; Klinsky and Harald 2018; Stern 2016). While it can be challenging, impossible, or not even desirable to quantify the magnitude of impacts, it is important that policy making is guided by an awareness of the direction of impacts, and of any severely impacted groups (Markkanen and Anger-Kraavi 2019; Ürge-Vorsatz et al 2014). The purpose of this section is therefore to summarise the existing evidence on the social and distributional impacts of mode shift policy levers in order that policy makers can be guided by an awareness of the potential positive and negative impacts. In chapter 1 we provide recommendations for more equitable mode shift policies.

Keeping cities moving (Waka Kotahi NZ Transport Agency 2019) and *Better travel choices* (Auckland Council et al 2019) outline three high-level strategies for achieving mode shift:

- 1 Shaping urban form
- 2 Making shared and active modes more attractive
- 3 Influencing travel demand and transport choices.

Better travel choices identifies these three strategies as the key levers for mode shift, whereas *Keeping cities moving* calls these 'mechanisms' within which they identify levers.

Table 4.1 details the three high-level mechanisms, the levers and examples of specific interventions or policies. This research assesses the potential impacts of these different policy mechanisms or levers, and not specific policies, but we draw on evidence that has examined the impact of specific policies or interventions, as examples. Table 4.1 shows a number of policies or interventions beneath each of the three levers as described in *Keeping cities moving*, *Better travel choices* and from the wider literature. There is some overlap in the specific policies mentioned under each of the levers, so we have discussed evidence on specific policies under the lever where it is most relevant.

Table 4.1 Key interventions and policy levers

Mechanism	Lever	Key interventions		
		<i>Keeping cities moving</i>	<i>Better travel choices</i>	Other
Shape urban form	Spatial and place-based planning	<ul style="list-style-type: none"> • Cross sector working • Transit-oriented development • Place-making • Shared and active transport corridors 	<ul style="list-style-type: none"> • Transit-oriented development • Land use planning • Urban design • Safer streets 	
	Policy and regulatory settings	<ul style="list-style-type: none"> • Traffic control measures • 'Accessible streets' regulatory package • Vehicle classification and standards system • Road management legislation • Network optimisation • Active traffic management • Public transport corridors 		<ul style="list-style-type: none"> • Bicycle priority streets • Shared use paths • School zoning • Low-speed zones • Car-free zones • Minimum/maximum parking requirements
Make shared and active modes more attractive	Network design, management and optimisation	<ul style="list-style-type: none"> • Safety programmes • Speed management • Network optimisation • Network operating plans to reduce car dependency • Traffic reduction strategies • Innovating Streets programme 	<ul style="list-style-type: none"> • Public transport optimisation 	<ul style="list-style-type: none"> • Signage and accessibility • Signage and branding of bike routes • Traffic calming
	Investment in infrastructure, platforms and services	<ul style="list-style-type: none"> • Investment decision-making review • Rapid transit • Walking/cycling networks and projects • Close gaps in strategic networks 	<ul style="list-style-type: none"> • Public transport investment, eg bus lanes • Rapid transit • Cycle lanes 	

		Key interventions		
Mechanism	Lever	<i>Keeping cities moving</i>	<i>Better travel choices</i>	Other
Influence travel demand and transport choices	Economic tools (pricing and incentives)	<ul style="list-style-type: none"> • Parking management • Parking pricing • Review of revenue system • Subsidised public transport ('Greencard' initiative) • Fare policy • National ticketing programme 	<ul style="list-style-type: none"> • Subsidised public transport • Parking regulations • Road pricing • E-scooters/shared mobility 	<ul style="list-style-type: none"> • Personal/ household mobility budgets • Increase cost of car ownership and use
	Education, engagement and awareness	<ul style="list-style-type: none"> • Behaviour change • Seamless travel applications • Street 'activations' • Large scale street events • Travel demand management • Employer e-bike scheme • School travel • Travel planning 	<ul style="list-style-type: none"> • Behaviour change • Travel planning 	<ul style="list-style-type: none"> • Employer bike schemes
Other				<ul style="list-style-type: none"> • Low emission zones • Restriction on car use • Helmet legislation

4.1 Methods: rapid evidence assessment

The rapid evidence assessment reviewed literature identified through the following sources:

- Searching of research databases (detailed search processes in appendix C)
- The expertise of the research team and our wider networks
- Searching the reference lists of key review articles.

Where available we draw in existing systematic reviews as the most robust and appropriate evidence. We have included papers that either:

- 1 Outline the social impacts of transport for different social groups
- 2 Examine the social impacts of policy levers
- 3 Examine the impacts of policies on different social groups.

Most of the evidence reviewed falls into either 1) or 2) above, as few studies have examined the impacts of policies for different groups. Therefore, where the existing evidence does not mention equity outcomes we adopt the approaches taken by AEA Group (2011) and Markkanen and Anger-Kraavi (2019) to ascertain the potential impacts of policies on different groups, drawing on existing knowledge about transport disadvantage for certain groups. As such, we typically infer 3) based on 1) and 2) above.

In assessing policies we keep in mind that the current situation is unfair, as outlined in chapter 3. Therefore, we assess mode shift policies in terms of how they move towards a fairer transport system.

4.2 Overview of evidence

Evidence specific to equity impacts of mode shift policy levers is limited. Some studies have looked at the equity of climate change policies, which feature transport heavily but tend to be a high-level overview of mode shift, without a focus on how that is achieved, eg (Markkanen and Anger-Kraavi 2019; AEA Group 2011; Lucas and Pangbourne 2014).

Markkanen and Anger-Kraavi (2019) provide an assessment of energy consumption policies including improved public transport networks and financial penalties for private car use. They also assess renewable energy policies such as disincentives to own internal combustion engine vehicles. AEA Group (2011) focus on four types of transport policy – reducing trips, improving utilisation and mode shift, more fuel efficient vehicles and use of alternative fuels. Lucas and Pangbourne (2014) assess climate change policy packages proposed by the Scottish Government which consider fuel reduction/eco-driving, bus fare reductions and infrastructure investment. Most assessments at this level do not seek to quantify the impacts of policies, rather they provide a high-level evidence assessment and an indication of the direction of any likely impacts. In addition, they indicate where policies may have distributional impacts, similar to the approach we take in this report.

At a macro level mode shift has positive social impacts. Modelling studies have found that replacing individual trips by private car with active transport and/or reducing overall trip distances can have positive health and wellbeing benefits. These include increased physical activity, reduced healthcare costs and reductions in emissions (Shaw et al, 2017; Mizdrak et al 2019; Keall et al 2018; de Sá et al 2015). Nevertheless, there is a challenge in achieving such shifts, and the ways in which mode shift is realised can have differential social impacts.

Few studies have evaluated the social impacts of interventions, and even fewer consider equity impacts or distributional impacts (Aldred 2019; Hosking et al 2019; Smith et al 2017). Evidence that does exist can be methodologically limited, for example by not including control locations, or not considering longer term impacts.

The challenge of understanding social impacts is compounded by timeframes of impact (Braveman et al 2011). Some impacts can be short term and direct, but other impacts often occur over long time scales making it hard to assign causality to impacts.

4.3 Shape urban form

Urban form contributes to existing inequities in accessibility, exposures to risk, and health and wellbeing outcomes. The ‘four ‘D’s of urban environments (density, diversity, design and distances) have substantial implications for travel behaviour in different urban settings. Urban environments with low densities are characterised as those without diversity of land use mix, in which travel distances are greater, leading to car dependent communities. On the other hand, high-density urban environments, with a range of destinations in close proximity, reduce car reliance and support walking, cycling and public transport opportunities. The design of urban environments can exclude some populations from either travelling through, or using, certain spaces. Some of these challenges require long-term strategic interventions in spatial planning, whereas others are amenable to relatively easy policy or regulatory changes at the street or neighbourhood level. There are two levers for shaping urban form: 1) spatial and place-based planning, and 2) policy and regulatory settings.

Table 4.2 Abbreviated social and distributional impact of shaping urban form levers

	Social impacts			Distributional impacts		
	Transport resources	Risks and opportunities	Outcomes and wellbeing	Income	Location	Ethnicity
Spatial and place-based planning	Reduced need for transport resources	Improved access to opportunities Reduced exposure to risk	Reductions in overall travel Increased active travel and social connectedness	Can reduce housing and transport costs Can increase property values (gentrification)	Can impact on housing and transport costs Can reduce travel distances and need to travel	Can lead to displacement Opportunity for incorporating cultural values and identity in design
Policy and regulatory settings	Easier to walk and cycle, public transport More difficult to drive	Reduced exposure to risk (safety and severance)	Fewer road traffic injuries Improved social connectedness	Can reduce safety risk in deprived areas	Can reduce safety risk in deprived areas	Regulations may lead to discrimination

4.3.1 Spatial and place-based planning

This lever is primarily oriented around spatial planning at the national or regional level, and placemaking at the community level. The policies identified focus on ensuring developments occur in places with good public and active transport linkages (whether new or existing) in order to reduce car dependence.

Urban design and urban planning are among the most promising mechanisms for addressing health and health inequities associated with transport (Giles-Corti et al 2016; Giles-Corti 2016). The greatest benefits of reducing car dependence accrue to low income households (Rachele et al 2018).

Reversing patterns of low-density urban sprawl and designing places that support non-car travel are therefore fundamental to achieving mode shift. A report by the Sustainable Development Commission (2011) suggests structural changes that shape urban form and reduce the need to travel (rather than simply shifting mode) should be prioritised from an environmental and equity perspective. Good spatial planning can help reduce demand for powered and inequitable transport (Sustainable Development Commission 2011) by reducing the distances travelled to access destination and promoting inclusive urban design.

Improving the accessibility or attractiveness of neighbourhoods can lead to the displacement of lower income populations, a process known as gentrification. Improved accessibility or attractiveness (whether a result of road building, transit-oriented development, or place making) can be capitalised into land and housing prices (Dawkins and Moeckel 2016) and has been termed 'transit-induced gentrification'. Increased housing costs and changes in population structure can occur as a result of many kinds of public investment and the reverse is also true; lack of investment can cause residential displacement (Zuk et al 2017). Concerns about gentrification should therefore not lead to inaction and under-investment but rather, highlight that transport policies need to be coordinated with housing, land use and taxation policies for successful mode shift (Buehler et al 2017; Arnott et al 2014; Cervero 1998; Pucher et al 2010; van Wee et al 2013; Un-Habitat 2013).

Likewise, more localised placemaking strategies need to focus on communities most in need, rather than central city areas which may already be most advantaged, as has been found in an analysis of Australian planning documents (McGreevy et al 2019).

From an equity perspective there needs to be a particular focus on addressing the accessibility needs of the most transport disadvantaged. Achieving this requires cross-sector working and local council collaboration, particularly around land use and housing policy.

While positive changes such as improved social cohesion may occur as a result of transit-oriented development (Kamruzzaman et al 2014), understanding who benefits and who might not from such policies is important. Over time, if lower income residents are displaced because neighbourhoods are made more attractive through spatial and place-based planning then inequities in accessibility to employment, healthcare and social services will widen.

Dawkins and Moeckel (2016) suggest that setting housing affordability restrictions for new developments around transport hubs can help reduce the risk of gentrification. Without deliberate action to ensure that housing is affordable, transit-oriented development is more prone to displace those on lower incomes.

One study examining house prices and community composition near new rail transit facilities in 14 cities in the US between 1970 and 2000 found substantial variations in effects among the study cities (Kahn 2007). Commonly, 'walk and ride' facilities increased house prices relative to control areas (ie caused gentrification), whereas areas near new 'park and ride' facilities often experienced increases in poverty (Kahn 2007). Before implementation of the facilities areas were similar in terms of population density, household income and house prices, but those with park and ride had a higher black population and were further from the central business district. Active transport corridors such as cycle ways are also associated with concerns about gentrification, particularly when they are developed top-down by councils, rather than being built in consultation with the community (Hoffmann 2016; Wild et al 2017).

Many intervention studies do not consider neighbourhood self-selection (Smith et al 2017; McCormack and Shiell 2011) which is a particular concern when thinking about who benefits (Anciaes and Jones 2020) and the possibility of gentrification because of apparent improvements at the area level may be a result of changes in population structure rather than improved circumstances for existing communities.

In a case study in the Netherlands, Wiersma et al (2017) found that rural and suburban areas are becoming more car dependent while inner city areas reduce car dependency, widening inequities between urban centres and more peripheral areas. Spatial planning approaches need to consider not just urban centres but suburban car dependent areas too.

While there is an increasing body of evidence utilising epidemiological methods to evaluate the impacts of place-based interventions, particularly on active travel, few consider equity or include sub-group analyses (Aldred 2019). However, the Te Ara Mua Future Streets project in Māngere has focused on specific population groups including lower income Māori and Pasifika communities (Mackie et al 2018; Macmillan et al 2018).

There are positive examples of placemaking and urban design working with Māori to incorporate histories, stories and traditions into modern architecture. Hine-Pāka Bus Interchange in Ōtautahi Christchurch represents an example of partnership working between the government-led team and Ngāi Tahu, through the Matapopore Trust (Matapopore 2020). Te Ara Mua Future Streets is an example of an area level street re-design using co-design principles and incorporating the identity of the local community (Macmillan et al 2018).

Such examples of working with the local community to achieve urban change can help to address the risk of gentrification by ensuring changes reflect needs of the existing community.

4.3.2 Policy and regulatory settings

Changes to policy and regulatory settings can also be used to shape urban form by changing the ways in which space is used by different modes. Changes to legislative frameworks to prioritise active and shared modes, or remove measures that prioritise private car use, can help to promote mode shift (Khreis et al 2017). This might include changes to street design guidelines which shape urban form at the neighbourhood scale, compared with strategic spatial planning discussed in section 4.3.1.

The changing of policy and regulatory settings can be most effective from an equity perspective where accessibility for marginalised groups is improved and risks are reduced. At the broadest level regulatory changes that make it easier for non-car users to get around local streets can help reduce inequalities in accessibility between non-motorised users and motorised vehicles. Policy and regulatory settings can be used to remove barriers to accessibility for older and younger pedestrians, making it easier to get around and reducing the risk of injury.

There is limited evidence on the equity impacts of policy and regulatory settings in a transport context. One study examined changes in road traffic casualties according to socio-economic deprivation following the introduction of low-speed zones in London (Steinbach et al 2011).

Several reduced speed (20 mph/ 32 km/h) zones were introduced across London over a six-year period, targeting more deprived areas. Despite this targeting they found no clear evidence that the impacts of the 20 mph zones varied with deprivation. However, the underlying reduction in casualties on all roads declined fastest in the least deprived areas. The 20 mph zones targeted in deprived areas did not reduce existing socio-economic inequities in casualties but did mitigate against widening inequities. Steinbach et al (2011) posit that one reason for these findings may be differential changes in travel behaviour and therefore exposure to risk following traffic calming interventions. As noted in section 4.5.2, less deprived

populations have greater capacity to change behaviour and may be the first to benefit from behavioural interventions.

In a systematic review of speed reduction policies, Cleland et al (2019) found positive effects of speed reduction zones which include street re-design but not of speed limit reduction. They also note the lack of evidence of speed reduction on outcomes such as liveability, physical activity and pollution.

Aldred and Croft (2019) undertook an exploratory evaluation of a 'modal filter' in London. In which one residential street was closed to motorised traffic, as an example of filtered permeability. They found improved perceptions of the quality of the local environment, and an increase in walking and cycling, approximately two-thirds of which were attributed to mode shift. However, they did not undertake any sub-group analyses.

Evaluations of shared spaces can be positive in terms of creating more pleasant urban environments (Karndacharuk et al 2016; Curl et al 2015) but studies tend to focus on people who use a street, rather than those that are excluded (Karndacharuk et al 2016). Curl et al (2015) found that changes to residential streets as part of a UK programme called 'DIY Streets' led to more positive perceptions of the local area for walking, and a slower decline in physical activity compared with control sites, for older people. However, shared spaces can be problematic for visually impaired people and some older adults (Hammond and Musselwhite 2013). Changes to regulations that allow users to share space should therefore focus on removing motorised, or faster moving vehicles from a space, rather than adding them. For example, changes to existing footpaths to allow cyclists or e-scooters can make the space unsafe for pedestrians, whereas removing cars from streets is likely to improve conditions for all users.

Regulatory measures such as maximum parking standards and developer contributions can also be used to shape urban form in ways that support active and shared transport (Khreis et al 2017). However, Khreis et al (2017) note that regulatory restrictions and parking controls may increase inequities.

Regulatory measures also include changes to vehicle classification systems to support the use of 'micro-mobility' (Waka Kotahi NZ Transport Agency 2019). Such changes need to take into account emerging evidence on whether such technologies can support or restrict mobility and/or accessibility for those who are transport disadvantaged. Early evidence suggests that user of e-scooters, for example, are more likely to be privileged groups (Fitt and Curl 2019). There is also a possibility that e-scooters predominantly shift trips from active modes of transport (Fitt and Curl 2019), but further and more long-term evidence is needed. Shared micro-mobility is expensive and restricted to those who have a credit card, excluding a considerable proportion of the population. Current zones of operation mean that shared micro-mobility schemes do not operate in areas with the greatest transport need. Under current regulations, the mobility needs of pedestrians, particularly older and disabled pedestrians, are threatened by sharing of footpath space with e-scooters. There has been limited attention paid to the potential for new mobility services to address transport inequities from a gender or income perspective (Singh 2019). Increased reliance on technology though is unlikely to improve women's mobility because of more expensive services and new interfaces which are designed typically by and for men, meaning that even though some services have adapted (eg to include background checks for drivers) these have occurred in response to problems, rather than being designed into systems (Singh 2019).

Key points

- Shaping urban form to reduce the need for travel (particularly motorised travel) is the most important and most equitable approach to inducing mode shift.
- Changes to land use and associated transport investments need to be cross sectoral to avoid displacement of marginalised communities.

4.4 Make shared and active modes more attractive

Table 4.3 Abbreviated social and distributional impacts for making shared and active modes more attractive levers

	Social impacts			Distributional impacts		
	Transport resources	Risks and opportunities	Outcomes and wellbeing	Income	Location	Ethnicity
Network design, management and optimisation	May change access to PT. May change need to travel	Changes to network design impact on accessibility to opportunities. Street design can reduce pedestrian injury	Can lead to more active transport	Optimisation can remove coverage from low income areas. Safety improvement can benefit lower income areas	Optimisation may reduce rural services	May benefit from targeted safety programmes
Investment in infrastructure, platforms and services	Can improve access to transport networks. New infrastructure may increase cost	Can reduce injury for pedestrians and cyclists. Can increase access to opportunities	Walking and cycling infrastructure can increase physical activity. PT infrastructure can lead to shifts from active modes	May cause displacement (gentrification). AT infrastructure can increase walking and cycling and access to opportunities	Rural areas may not benefit from PT or AT investment	May cause displacement (gentrification)

Notes: PT = public transport; AT = active travel

4.4.1 Network design, management and optimisation

Optimising the design and management of transport networks can help to reduce car dependency by making shared and active modes more attractive. In terms of the evidence base there is considerable overlap between policies considered in section 4.3.2, particularly around the impacts of safety and speed management programmes.

Traffic signals can be optimised to prioritise the needs of pedestrians and cyclists and address existing inequities. For example, extending the green time for pedestrians would help to address the fact that at

present the network can prevent some older pedestrians from being able to cross the road (Asher et al 2012).

Safety programmes, speed management and programmes such as 'Innovating Streets' can be targeted towards the most transport-deprived areas, where accessibility is worst, and where risk of road traffic injury is greatest. However, as noted in section 4.3.2 even targeted programmes may widen inequities (Steinbach et al 2011). To resolve this, speed management and safety programmes need to focus not only on areas where it is 'easy' to implement, but where risks are greatest (Steinbach et al 2011).

Public transport network design and operation is generally governed by perceived economic efficiency (Jeekel and Martens 2017), rather than equity concerns. Optimising public transport to achieve mode shift (Waka Kotahi NZ Transport Agency 2019) without considering the needs of more marginalised groups may be at odds with equity concerns around accessibility and coverage of services. Farebox recovery requirements may mean that profitable high patronage routes are prioritised over those that meet the needs of transport disadvantaged groups. Rather than focusing only on peak travel and achieving maximum mode shift, addressing transport inequities requires the public transport network to facilitate cross city travel at any time of day to ensure accessibility for those without a car (Grengs 2005; McGreevy et al 2019; Mees 2009).

Network changes can impact on access to services (Blair et al 2013) and should be designed to ensure that low income peripheral areas have good levels of service (Jaramillo et al 2019; Currie 2010). Lower income areas are likely to benefit from new public transport routes, but only if the network services them well and the fare structure is appropriate (Currie 2004; AEA Group 2011). Prioritising global patronage over coverage risks having negative accessibility impacts, especially for those in peripheral areas who rely on public transport. Changes to public transport networks associated with the Rio de Janeiro Olympics resulted in poorer accessibility for the lowest income groups (Pereira et al 2019).

The Auckland bus network changes have balanced coverage with patronage to an extent and have connected some of the more remote communities (Hilson 2020), although this paper, reporting on improvements in two remote areas, does not clarify the network level impacts.

In one UK city, more trips of any variety were undertaken in two high deprivation neighbourhoods where there was good street connectivity, good level of bus services and where people felt safe (Lucas et al 2018).

4.4.2 Investment in infrastructure, platforms and services

Investment in public transport, walking and cycling infrastructure is essential to making these forms of travel safe and attractive so that populations are not either forced into car ownership due to lack of service, or relying on poor quality public transport services. AEA Group (2011) suggest that there is an implicit assumption that investment in new public transport, walking and cycling infrastructure will achieve modal shift but this is often not the case.

Existing evidence suggests that road and public transport infrastructure investments have tended to benefit the most advantaged (Smith et al 2017; AEA Group 2011; Goodman et al 2013b) often because they are focused on trips made by full-time employees living in suburban areas, travelling at peak times (Jahanshahi et al 2015). Forecasting based on extrapolation of current travel patterns can be a self-fulfilling prophecy in that infrastructure is built to cater for increased demand based on current trip patterns (Lyons and Marsden 2019), which can perpetuate the same trip patterns and not invest in areas where trip rates may be low due to poor quality infrastructure. This can especially be the case for road, rail and cycle infrastructure (AEA Group 2011) if benefits are assessed based on who currently uses those modes. However, improving infrastructure can lead to uptake by different groups of people – as we

explore below with cycle infrastructure and cycling. Focusing investments on trips made by part time, female, lower income and ethnic minority groups offers the opportunity to benefit disadvantaged groups.

4.4.2.1 Public transport

In previous research, improved public transport networks were found to be positive for health outcomes, lower income and ethnic groups, and have a low risk of conflict between environmental and equity objectives, but must involve meaningful community engagement at the planning stage to ensure the changes address the transport needs of the poor without additional cost barriers (Markkanen and Anger-Kraavi 2019).

Often new public transport leads existing passengers to make more or longer trips as people shift from walking to bus, or bus to train. AEA Group (2011) gives three UK examples: Manchester Metro, Sheffield Supertram and Jubilee Line Extension, where relatively little mode shift from private car occurred. Similar to road building, major public transport infrastructure can lead to induced demand – existing users make more trips or travel further, and people shift to public transport from walking and cycling. Therefore if major infrastructure addresses the accessibility needs of communities with poor accessibility and as a result creates new trips there are potential equity benefits, but there may not be mode shift from private cars in the short term.

Bus services tend to benefit those with lower incomes, women, younger and older people (AEA Group 2011).

In an appraisal of the accessibility impacts of bus rapid transit (BRT) in Lima, Oviedo et al (2019) found improvements in accessibility in higher income areas and decreases in lower income areas. Pereira et al (2019) found that public transport improvements associated with the Rio de Janeiro Olympics resulted in reduced accessibility to employment and education for lower income groups because of associated cuts in service levels, and that, even without those cuts, accessibility would have improved more for the least deprived groups because of service improvements. In contrast Pereira (2019) found that the TransBrasil BRT currently under construction in Rio de Janeiro will improve spatial accessibility most in more deprived areas.

Mottee et al (2020) found that while the Sydney South West Rail Link was considered to be a success against budget and travel time objectives, there have been negative social impacts at the community level, largely resulting from a failure to effectively engage with the community prior to construction and rapid decision making which meant social and environmental impact assessments were ineffective in mitigating against adverse social impacts at the community level. .

Research evidence tends to show that new infrastructure has inequitable outcomes but there are positive examples such as the TransMilenio BRT system in Bogota, Colombia where land was acquired for affordable housing to support equitable transit-oriented development (Sheller 2018). It is important to establish that investment in infrastructure is designed to ensure that accessibility is improved for the people and places most in need. This might mean ensuring the improved infrastructure is not associated with service cuts or price increases.

4.4.2.2 Walking and cycling

In a UK-based study both improved safety and infrastructure to support active travel were key components of interventions that increased cycling rates relative to non-intervention towns (Goodman et al 2013a). Cycling rates for those living in the most deprived areas rose the least, but in comparison to a substantial decline for this group in other towns the ratio of change was most improved for this group. However, the result was not unambiguously positive with substantial variation between towns (Goodman et al 2013a).

Cycle infrastructure has been critiqued for: 1) prioritising the needs of existing users, who tend to be white, middle class and male, 2) for ignoring community needs (Hoffmann 2016) and 3) for being promoted as part of economic development strategies, which can lead to concerns around gentrification (Wild et al 2017). However as Wild et al (2017) explain, relationships are complex and cycle lanes may be a result of, rather than cause of gentrification. This suggests a need to ensure that lower income areas are not neglected and excluded from investment to meet their needs. It is important to consider the needs and aspirations of deprived communities, and not assume that building infrastructure will lead to uptake of cycling, in places where walking and cycling may take place out of necessity rather than a lifestyle choice. Wild et al (2017) conclude that engaging with communities at all stages of the process (of cycle planning) and building broader support for 'liveability' can help to address opposition and concerns around gentrification.

Hong et al (2019) found increases in cycling on new cycleways in Glasgow, but no indication of who was using them. Heesch et al (2016) found that new cycle infrastructure in Australia encouraged new users but did not greatly increase utilisation by groups less likely to cycle – although there was a small increase in the proportion of cyclists who were female. Gender inequalities in rates of cycling tend to be lower in cities with good cycle infrastructure, particularly the Netherlands and Denmark. Early evidence from Auckland and Christchurch suggests an increased proportion of female cyclists over recent years with the building of new segregated cycleways (Auckland Transport 2020; Christchurch City Council 2019).

In a systematic review, Smith et al (2017) found four studies that investigated the differential impacts of built environment interventions on physical activity or active travel according to sociodemographic status or ethnicity. Two of these relate to transport infrastructure. A UK study (Goodman et al 2014) found no difference in overall levels of walking and cycling according to socio-economic status (SES) after a package of interventions to support active travel but did find those with lower levels of education or income were less likely to use new infrastructure. In New Orleans, a new on-road bike lane led to an increase in both white and black riders, and a 133% increase in female riders, compared with 44% increase in male riders (Parker et al 2011).

Cycle infrastructure investments in English towns saw increases in walking and cycling to work and decreases in car travel to work (Goodman et al 2013a). Those living in more deprived areas in intervention towns benefited less than those living in the least deprived areas of the same towns; however, more deprived areas of comparison (non-intervention) towns experienced declines in rates of active travel. Although the intervention led to increased walking and cycling in more deprived areas relative to 'business as usual' policies in the comparison areas, inequalities widened (Goodman et al 2013a) meaning more could be done to target improvements in the more deprived areas.

4.4.2.3 Micro-mobility and new transport technologies

Similar trends can be seen with micro-mobility (Fitt and Curl 2019). It is important therefore to understand whether investment addresses unmet needs in transport. It is, however, also important to consider longer term impacts. While improved public transport may not result in mode shift from private car in the short term, it may reduce increased motorisation in the longer term, especially as new generations see a reduced need for car.

From an equity perspective investment should focus on improving access in those areas that are most transport deprived or who are currently disproportionately exposed to risk. Those at risk of FCO are those in more deprived areas with poor public transport, walking and cycling accessibility.

Key points

- The areas in which less advantaged groups often live tend to be poorly provided with public transport services and infrastructure. Designing and implementing networks which these groups can effectively use will help address transport inequities.

4.5 Influence travel demand and transport choices

Table 4.4 Abbreviated social and distributional impacts for influencing travel demand and transport choices levers

	Social impacts			Distributional impacts		
	Transport resources	Risks and opportunities	Outcomes and wellbeing	Income	Location	Ethnicity
Economic tools (pricing and incentives)	Impacts the cost of travel	May change access to opportunities	Public transport subsidies can increase trips, disincentives to car use can improve health	Can cause financial stress	Peripheral areas may lack car alternatives	Impacts depend on design
Education, awareness and engagement	Can support skills development	Can broaden access to opportunities through enhanced skills	Can help road safety and confidence with active travel May have limited impact	May benefit most advantaged	Peripheral areas may not be included	Targeted programmes can address inequities

4.5.1 Economic tools (pricing and incentives)

The economic tools lever is oriented around using the cost of transport (eg through taxes or subsidies) to incentivise or disincentivise certain transport behaviours. Using economic tools to achieve mode shift is predicated on assumptions of economic rationality in transport decision making which can ignore or underplay the role of culture and habits in travel practices. The policies identified focus on the regulation and pricing of facilities associated with car use or ownership, as well as public transport.

A substantial proportion of the costs associated with private motor vehicle travel are ‘external’ costs not paid by the user, despite existing taxes and charges (Jakob et al 2006). Jakob et al (2006) estimated that the external costs for private transport in New Zealand were 28 times higher in 2001 than for public transport; Khreis et al (2017) points out that these external costs are often underestimated by typical transport planning tools.

Pricing tools are considered a critical tool to improve the equity of the transport system, because higher income groups consume the greatest proportion of resources, yet shoulder the lowest proportion of the external costs (Collins and Kearns 2005; Jones et al 2005; Côté-Lussier et al 2020; Markkanen and Anger-Kraavi 2019; Sustainable Development Commission 2011; Currie 2010). Thus, pricing tools offer a way to increase the relative share of the costs borne by more advantaged groups and decrease the costs borne by the least advantaged groups. However, economic inequality arises when policies have regressive distributional impacts by increasing costs of essential goods such as mobility (Markkanen and Anger-Kraavi 2019). Thus, significant care must be taken to design these pricing tools so as not to further

disadvantage already disadvantaged groups, for example through exemptions or discounts for those living in rural areas (especially if lower income), excluding low-income areas from a congestion charging zone (CCZ), or providing discounts to residents.

Furthermore, by allowing those who can afford to do so to continue to travel and contribute to harms, road pricing policies can simply allow even greater mobility to the privileged and exclude others (Sheller 2018).

There are substantial equity concerns when it comes to the implementation of pricing policies. It can be difficult to meet basic transport needs without access to a car, or without the means to cover ongoing running and maintenance costs (Rose et al 2009). Rose et al (2009) found that public transport provided adequate access to employment, education, and basic goods and services only in a few city centre locations. Even in these 'ideal' locations, reliability, frequency, routes, cost and other key considerations were still not necessarily sufficient to ensure adequate access to essential services (Rose et al 2009; Currie 2004). Thus, there is a real risk that pricing policies may deepen inequities by making necessary transport more expensive for the least advantaged.

Long-term market fluctuations in fuel prices have been studied in attempts to simulate driver behaviour in response to a tax increase (eg Best and Burke 2019; Shaw et al 2018; Mattioli et al 2018). There are indications that increases in fuel prices can result in drivers choosing to travel by another mode, with positive benefits at the aggregate level. For example, Best and Burke (2019) demonstrate a decrease in road crashes, deaths and injuries, following a fuel price rise. In another example, fuel price increases reduced air pollution initially, but the benefits of this were not maintained long term (Shaw et al 2018). However, such studies have not considered the impacts on different population groups, and in particular the affordability implications for lower income groups of increased travel costs.

Not all drivers have the ability to change mode in response to pricing changes. FCO is a term developed in the UK to describe households with no alternative to car use, despite limited economic resources (Currie et al 2018; Mattioli 2017). Motor vehicle running costs are already highly regressive (Chatterton et al 2018) and FCO households exhibit inelastic fuel demand as they cannot switch modes in response to price rises (Mattioli et al 2018). FCO households thus experience increases in economic stress as fuel prices rise and may sacrifice other household expenditures in order to maintain a car (Mattioli et al 2018). Additionally, Markkanen and Anger-Kraavi (2019) caution that any policy increasing the price of basic consumer goods (eg food/mobility) will have regressive impacts. Increases in the cost of fuel or road user charges without provision for the transport of basic goods is also likely to cause this type of impact.

Current failures to provide adequate public transport results in transport-related social exclusion for those who do not or cannot own and run a car (eg Rose et al 2009; Jahanshahi et al 2015). Thus, increasing the cost of owning or running a vehicle without first providing an adequate alternative where practical, and making provision for those who struggle with car-related costs and cannot switch modes is likely to have a substantial negative effect on the most disadvantaged, regardless of the type of pricing tool selected and is likely to cause social exclusion in these groups (Lucas and Pangbourne 2014). Additionally, if adequate alternative transport is not available, the pricing tool selected is unlikely to achieve mode shift (Mattioli et al 2018), but may depress travel.

In the case of the London CCZ, Tonne et al (2008) demonstrated there were small but persistent improvements in air quality as a result of the CCZ, with the greatest benefit in more deprived areas. Conversely, a similar policy in Rome ('low emission zone') provided the greatest benefit to the most advantaged as a result of the social geography of the city (Cesaroni et al 2012). Thus the benefits of policies like these will depend on where and how they are implemented as well as the social geography of the city itself.

Although AEA Group (2011) suggests that congestion charging and parking charges could be considered progressive as they impact relatively more on higher income groups, low income drivers without alternatives will be negatively affected by charging policies (AEA Group 2011). Even though more advantaged populations may be the most affected proportionally, this is as a result of current inequities in access to transport resources which mean they travel more. Further marginalising those who are already excluded is problematic. Charging policies which only introduce charges once mobility exceeds what is needed to meet basic needs, or by guaranteeing rights to a minimum level of accessibility (Martens 2016) could be considered progressive. Levinson (2010) notes the importance of considering the type of charging scheme (eg high-occupancy lanes may be more equitable than distance or zone-based charging) and the recycling of revenue into supporting transport needs of more disadvantaged groups.

Pricing policies can also act as a disincentive to own private motorised transport, particularly vehicles with an internal combustion engine (Markkanen and Anger-Kraavi 2019). This can have positive benefits for health, with reduced air pollution and increased active travel, but can have negative impacts on wealth and there is a need to include exemptions for poor and rural households to prevent inequitable effects (Markkanen and Anger-Kraavi 2019).

Those on lower incomes are generally unable to afford fuel efficient or electric vehicles, and thus pay proportionately more for the travel they do despite travelling less in general (Mattioli et al 2017).

Conversely, pricing incentives to lower the cost of public transport can benefit vulnerable groups. In particular, Lucas and Pangbourne (2014) identify sole parents, young people, those living with disabilities and older adults as groups that could benefit. They also note that reducing the cost of public transport can help marginalised groups to access employment, opportunities and services. Bocarejo and Oviedo (2012) found that fare policies were more likely to benefit lower income groups than infrastructure and Guzman and Oviedo (2018) found that public transport subsidies could improve accessibility in peripheral areas.

Cats et al (2017) evaluated the free fare policy in Tallinn and found that free public transport improved the mobility of low-income residents, as well as increasing public transport usage by 14%. Serebrisky et al (2009) note that subsidies provided to users (demand side) are more effective in achieving positive social outcomes than supply side subsidies. Policies such as the proposed Greencard initiative therefore offer the potential of substantial equity benefits, although targeted policies can create stigma (Baum 2015) so universally free public transport may be a better approach.

Pricing policies and public transport subsidies are often time specific and seek to shift demand to time quieter times of day. However, applying such restrictions can be inequitable. Evidence suggests that women have less flexible schedules and are less able to change their time of travel even when incentivised to do so (Ben-Elia and Ettema 2011). The consequence of this is that time-varying charges may disproportionately affect women as they may be unable to modify their travel in response to the policy.

Changes to public transport ticketing such as the National Ticketing Programme can make public transport easier to use. However, shifts from cash fares to smartcard ticketing can be problematic for lower income groups and culturally difficult for people who rely heavily on cash transactions.

In a trial of free bus travel for school children, Bay of Plenty Regional Council has found reduced truancy levels, fewer late arrivals to school and an increase in bus patronage by 40% (Richards 2020). Parents reported feeling less stressed, and those whose children already used the bus had more money available for other expenditure. There were fewer vehicles at the school gate leading to improved perceptions of safety. However, it is important to note there was no decrease overall in the number of vehicles on the road, although peak traffic was more spread.

4.5.2 Education, engagement and awareness

The education, engagement and awareness lever focuses on public familiarity with and acceptance of shared and active transport modes. Many of the policies identified have a safety-related purpose (such as cycle training for children or school travel planning), but also encompass other behavioural change programmes. Evidence from the public health literature suggests education and behavioural change programmes have low effectiveness in achieving the desired change (Baum 2015). However, ensuring the public has the skills to safely use shared and active modes (primarily cycling, but also scootering) and is aware of new services and facilities are important functions of this lever.

Focusing on individuals' behaviour as problematic rather than upstream, structural determinants does not address the root cause of health inequities (Braveman et al 2011). In a study on intention to quit smoking, (Barbeau et al 2004) found no difference in intention to quit smoking according to socio-economic position, but those better off were more likely to quit – suggesting a greater capacity to change behaviour. This capacity to change behaviours has been linked to stress, associated with socio-economic position (Rod et al 2009; Umberson et al 2008; Dunn 2010), with those with higher stress levels less likely to quit smoking, more likely to become physically inactive and less likely to quit drinking (Rod et al 2009). Education and awareness campaigns are most likely to benefit those who have the capacity to change behaviour, given current structural conditions in terms of the social and built environment conditions. Policies which attempt to change behaviour without also changing the structures will benefit those who are most well-off (Baum 2015). Therefore, as noted in *Keeping cities moving* (Waka Kotahi NZ Transport Agency 2019) education, engagement and awareness campaigns must complement high-quality infrastructure and services.

Safety behaviours are one area in which educating the user can have a positive impact (eg O'Toole and Christie 2019). However, even in this case there are many structural improvements, particularly appropriate infrastructure which will have greater impact (Avineri and Goodwin 2010). In a review of the literature, O'Toole and Christie (2019) found that parent education impacted positively on use of child safety seats and children's bicycle helmets, however the impacts on pedestrian safety were mixed. Additionally, they identified a lack of work regarding how to engage with parents in "at risk" groups such as those from lower income backgrounds, from minority ethnic groups, or parents of children with disabilities (O'Toole and Christie 2019). Buttazzoni et al (2019) examined a school travel planning intervention and found that while the intervention had a positive impact on perceptions and reducing barriers, it did not have a noticeable effect on behaviour.

In an analysis of the impacts of the 'time discount' on graduated learner licences for attending a defensive driving course, Begg and Brookland (2015) found that those who participate in a defensive driving course are more likely to be younger drivers, non-Māori and live in less deprived areas, providing some evidence that those who participate in educational initiatives may be the most advantaged.

Walking school buses are another intervention that can increase children's active travel to school and increase safety. However, Collins and Kearns (2005) demonstrated that while walking school buses did have these positive impacts, they were established primarily in more advantaged areas where parents have more time, flexibility and resources to use on supporting their children to walk to school.

Digital applications may make travel easier for those with access to smartphones and data packages but relying on digital information can be exclusionary. Seamless travel applications, app-based travel and mobility as a service (MaaS) are emerging concepts that promise to deliver sustainable and equitable transport, but such approaches have been critiqued in terms of the potential for 'technological gentrification' (Pangbourne et al 2019). A Belgian pilot study has found that MaaS tends to complement rather than replace car use (Storme et al 2020) and a German study found that those who were multi-

modal tended to travel more overall (Groth 2019). New mobility applications based on MaaS, where provided by the market have an incentive to sell more mobility, not less (Docherty et al 2018) and therefore do not necessarily prioritise active transport in their subscriptions (Pangbourne et al 2019). More evidence is needed on the potential of ride-sourcing (eg uber/lyft), e-scooters, MaaS and bike-sharing schemes to promote mode-shift and transport equity – such claims should not be taken as given. There are concerns that smart mobility will exacerbate inequities (Sheller 2018).

A German study demonstrated that women may be more willing to change modes, partially due to a weaker habit of driving, and partially due to concerns about the environmental impacts (Matthies et al 2002). However, this is not necessarily a benefit from an equity perspective. Women already drive less than men and use public transport more, and thus may have less access to transport resources, reduced access to destinations given their modal use and public transport, which is often poorly designed to meet their needs (Matthies et al 2002; Rose et al 2009; Jahanshahi et al 2015). While targeting those most likely to change modes (such as women) could improve mode use statistics, from an equity perspective a more effective strategy would be to target efforts at groups where there is currently excess travel (ie the most transport advantaged).

Canterbury District Health Board piloted a programme called BuyCycles among clients of mental health services in Christchurch (Canterbury District Health Board 2018). Participants were offered cheap bicycles with interest free loans and most repaid the bike at \$5 a week. Most participants use the bike at least weekly and report being more active, improved access, saving money and improved wellbeing. Schemes such as this, which focus on the needs of disadvantaged groups should complement those focused on more expensive e-bikes for those in employment.

As identified above, education, engagement and awareness programmes and interventions often benefit those who are already transport advantaged, have more time and resources to engage with beneficial behaviours, and usually have greater access to transport. Relying on behavioural change without addressing underlying structural inequities in transport will only deepen the transport disadvantage of vulnerable groups.

Key points

- Road pricing is a useful tool to increase the share of transport costs borne by more advantaged groups who consume the most transport resources.
- Pricing policies raise equity considerations and must be designed to avoid reducing accessibility or increasing travel costs for the least advantaged.
- Pro-poor public transport fare policies are one of the most effective interventions in equity terms.
- Education interventions tend to have the most impact for those who have the resources to respond, but they can complement new infrastructure.

5 Recommendations for equitable mode shift policy

We have included specific equity considerations related to policy levers in sections 4.3 to 4.5. While there are some specific considerations for different types of interventions and it is clear that some interventions are more suited to addressing inequities than others, there are also some overarching considerations related to the processes by which decisions are made that are important from an equity perspective.

In this section, we first discuss a prioritisation of the mode shift policy levers, based on the review in chapter 4, before outlining general guidelines for policy decision-making processes that can address inequities.

5.1 Prioritising mode shift policy levers from an equity perspective

Long-term structural changes, such as changing land use, which reduce the need to travel should be given the highest priority (Sustainable Development Commission 2011). Lower priority should be given to modal shift, efficiency improvements and capacity measures (table 5.1). Policies which change focus on meeting accessibility needs in the least carbon intensive manner, by changing socio-spatial structures are most likely to resolve any tensions between environmental and equity goals (Mattioli 2016). At a broad level, any policy that has benefits for marginalised groups through improved welfare or opportunities can reduce inequities, whereas policies that reduce the opportunities or impose costs on marginalised groups are likely to perpetuate and widen inequities. There needs to be balance in terms of the time scales over which different interventions can be delivered.

Mode shift should be a lower priority than reducing the need to travel (Mattioli 2016; Sustainable Development Commission 2011). Mode shift in itself suggests that the same trips can be made using other modes, but to adequately address environmental and equity concerns, overall travel also needs to reduce. As noted in *Better travel choices* (Auckland Council et al 2019) despite a doubling of public transport patronage in the past 15 years, private vehicle travel has also grown. Mode shift can be achieved even if there is an overall growth in travel. If mode shift seeks to address environmental and equity goals then there also needs to be a reduction in the overall amount of travel, and this can only be achieved through structural changes in terms of the relationships between transport and land use. Reducing the overall need to travel is an essential part of mitigation of adverse impacts of transport policies (Mattioli 2016). Technological improvements have historically been offset by increased distance, increased mode share by car, larger and more powerful vehicles and lower occupancy rates (Mattioli 2016).

Achieving such structural changes requires intersectoral planning between transport and land use planning in terms of the locations of facilities. There can be tensions here between policies aimed at rationalisation and efficiency in other sectors and the subsequent impacts for transport. For example, school closure policies aimed at consolidating student numbers to fewer locations has led to increased distances travelled to school (McCone 2019) and suburban housing development without consideration of accessibility leads to car dependent neighbourhoods.

However, the hierarchy proposed by the Sustainable Development Commission (table 5.1) does not consider existing inequities in the system. Equity (differently from equality) is achieved through a process that accounts for existing conditions and actively improves the circumstances of the most vulnerable groups (Markkanen and Anger-Kraavi 2019). In transport terms, the circumstances include access to

transport resources, the risks and opportunities these afford and the travel, health and wellbeing outcomes associated with different modes of transport.

Table 5.1 Hierarchy of measures for a fair and sustainable transport system (Sustainable Development Commission 2011)

Policy lever (SDC 2011)	Policy levers from <i>Keeping cities moving</i> and <i>Better travel choices</i>
Demand reduction for powered travel	Spatial and place-based planning
Mode shift to more sustainable and space efficient modes	Policy and regulatory settings
Efficiency improvements	Network design, management and optimisation
	Economic tools (pricing and incentives)
	Education awareness and engagement
Capacity increases	Investment in infrastructure, platforms and services

While the Sustainable Development Commission (2011) highlights that policies should only move on to the next lever once all options for implementing previous levers have been exhausted, it is not clear how a decision about options being exhausted would be made and what pre-conditions must be in place before implementing a policy. For example, policies that impose charges must only take place once basic accessibility needs have been met, which may require investment in infrastructure which can take a long time. Based on our review we suggest a more socially, temporally and spatially nuanced approach is needed as policies implemented in a uniform manner are not best placed to address existing inequalities and transport interventions are inherently spatial. It is also worth recognising that the exact nature of the lever may differ at different spatial scales, as outlined in table 3.2, shaping urban form encompasses city or regional level land use planning as well as more localised measures such as shared and active transport corridors, urban design initiatives or safer streets.

While universal policies are potentially effective at the population level, as they can contribute to social solidarity, reduce stigmatisation, are efficient and may impact on some inequalities, they focus on aggregate improvement and so do not achieve redistributive justice (Baum 2015). Universal policies do not address persistent inequalities (Goodyear-Smith and Ashton 2019). Therefore specific design of policies is important for positive outcomes for all groups (AEA Group 2011).

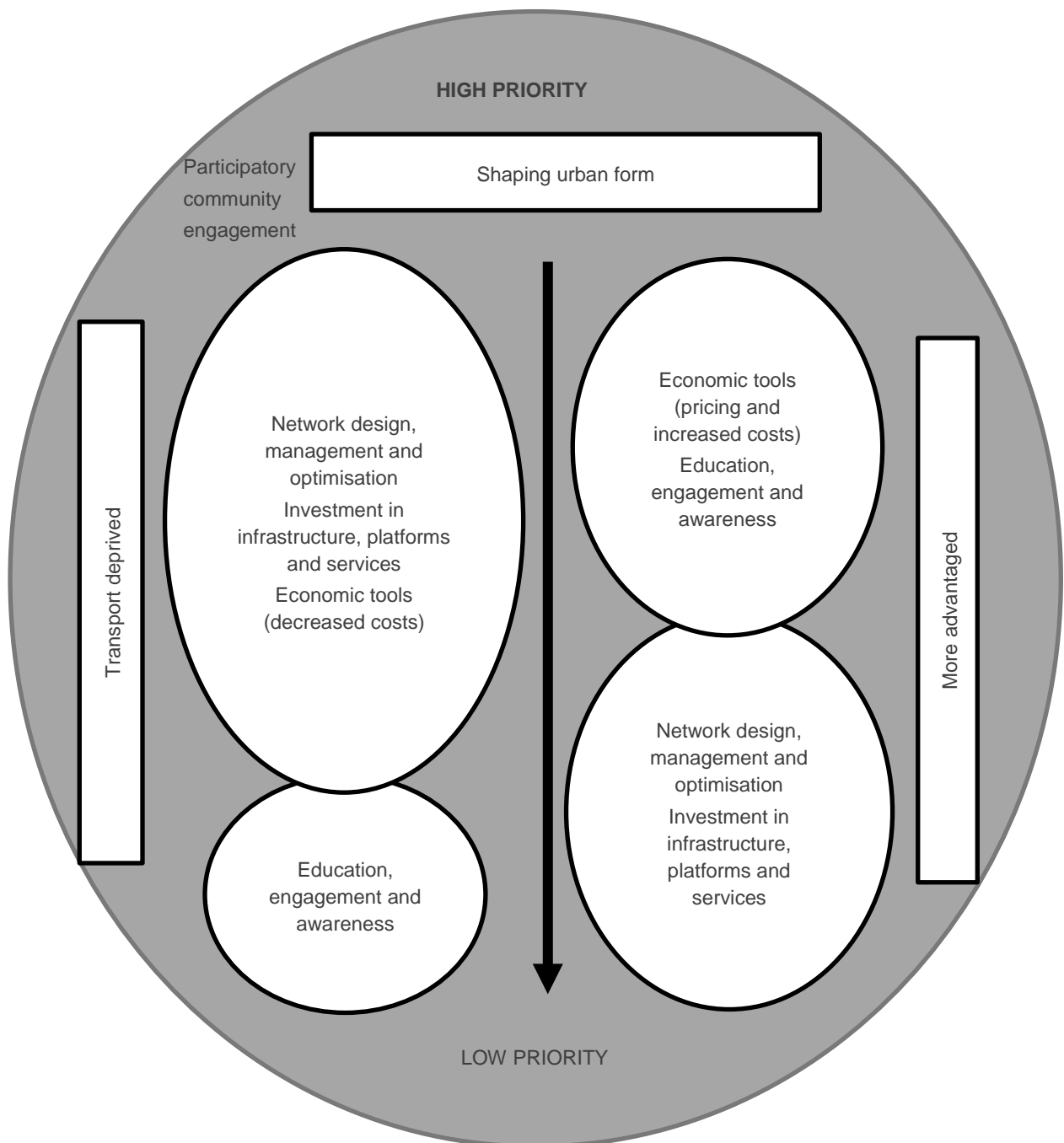
The hierarchy proposed by the Sustainable Development Commission is appropriate in terms of reducing overall travel at the population level, in the fairest way from an inter-generational perspective. However, different approaches are needed in different areas and over different timescales depending on the existing situation. For example, in areas where infrastructure is currently inadequate it might be more important from an equity perspective to invest in infrastructure before using economic tools, so that accessibility needs are not compromised. However, recognising that infrastructure investment can take time, economic tools such as fare policies can also be important to support accessibility.

Targeted policies, such as fare policy can best address the accessibility needs of disadvantaged groups. However, 'pro-poor' policies can be associated with stigma if they are not well communicated. Adopting the principles of proportionate universalism, whereby policies are implemented everywhere or available to everyone, but prioritising those most in need can help to reduce the risk of stigma associated with targeted policies and ensure that more resources are invested in areas that face current inequities.

Lucas (2004) advocated for policy that redistributes car ownership from privileged to disadvantaged households, potentially through taxation and charging for higher levels of car use – this means reducing car use among the most advantaged while not restricting use for the most disadvantaged at the same time as reducing overall travel.

Policies that reduce exposure to transport-related harms at the population level are most likely to reduce inequities given current patterns in exposure to risk. However, it is important that such policies are targeted in areas most exposed to harms, and not only in more affluent areas of cities.

Figure 5.1 Relative priority of mode shift levers



It is important that equity focused policies are implemented as a cohesive package. The policy packages assessed by Goodman et al (2013b) had positive impacts in lower income communities but it is hard to isolate the impacts of specific policies. Both infrastructure, and education and awareness can be important. Similarly, improving public transport networks will not benefit those on low incomes if fares are too expensive. In reality there is not a one size fits all and packages of measures are likely to be most effective. Infrastructure interventions based on a 'build it and they will come' approach may not be appropriate in marginalised communities (Wild et al 2017). Mode-shift policies are likely to be most effective (in achieving mode shift) and equitable when they are developed with rather than imposed on a community. This highlights the need for attention to be paid to decision making processes.

5.2 Decision-making processes

Current patterns of inequity in the transport system (as outlined in chapter 3) occur partly as a result of inequitable process and inequitable systems. Unjust processes have resulted in many of the existing inequities in the transport system, but the vast majority of the literature focuses on empirical analysis of the distribution costs and benefits rather than critiquing decision-making processes (Schweitzer and Valenzuela 2004). Rather than simply seeking to mitigate the effects of harmful policy (distributive justice) it is important to consider the decision-making processes and structures that have led to existing injustices and move towards restorative and epistemic justice approaches as outlined in figure 3.2 (Sheller 2018).

The groups that are most at risk from poorly designed or poorly implemented policies are typically those that are also least involved in decision-making processes (Markkanen and Anger-Kraavi 2019, Bhatta et al 2013; Brugnach et al 2017; Marino and Ribot 2012). Lower income and minority communities have less involvement in decision making processes (Schweitzer and Valenzuela 2004).

5.2.1 Treaty-based partnerships

Persistent health inequalities in Aotearoa arise as a result of mono-cultural policy, marginalising of non-dominant perspectives, deficiencies in cultural competency and the failure to uphold Treaty obligations (Came 2014). One of the recommendations from the primary health care claims to the Waitangi Tribunal is that the Crown should ensure more system wide accountability for equity. Similar to the opportunities in the health system, the transport system should operate on the basis of a partnership relationship with Māori for the design, governance and implementation of transport policy and interventions, that meets the needs of Māori (Baker et al 2019), to achieve equitable outcomes. Transport policy needs to engage with Māori as an equal partner, not one stakeholder among many and build capacity for Māori engagement in transport policy. This includes the diversity of the workforce. Government department diversity information reported in 2018 shows that the Ministry of Transport is among the departments with the lowest proportion of Māori staff, which is likely to have considerable implications for transport equity (State Services Commission 2018). Te Arawhiti is a new Crown agency responsible for Crown–Māori relations. It has developed a range of accessible tools based on consultation hui with Māori communities, designed to assist Crown agencies to improve responsiveness to Māori through a number of different settings, eg policy and service development, workforce capability.

The Te Ara Haepapa road safety programme delivered through Auckland Transport has focused on reducing high rates of deaths and serious injuries among Auckland's rangatahi (youth). The programme began with a shared vision and was developed with the community. Initially Auckland Transport recognised they did not have the staff with appropriate skills to deliver the programme. The programme is

delivered by six fluent Te Reo speakers and takes place within a holistic Māori framework (Fatu and Elisaia-Hopa 2020).

In urban planning, Stuart (2010) suggests three directions for integrating indigenous knowledge with (local) government knowledge, which are important for sustainable planning:

- 1 Supporting research on indigenous knowledge and its use in urban planning
- 2 Improving urban planning processes so that iwi and hapū are significant partners, and not just one stakeholder among many
- 3 Supporting local action place by place – recognising the role of Māori knowledge in connecting national/local government rhetoric to the neighbourhood and community level.

5.2.2 Participatory decision making

Mullen and Marsden (2016) suggest that a reflexive and participatory approach to decision making, involving deliberation on priorities at a community level (eg convenience for drivers' vs children's ability to play outside) might lead to more just outcomes. They suggest that this also requires re-framing narratives of individual choice, because individual choice implicitly has negative impacts on others. Others also emphasise the need for more participatory approaches to social impact assessment (Mottee and Howitt 2018).

Institutional practices and assessment procedures can also lead to a failure to achieve equity outcomes. Mottee and Howitt (2018) suggest that while projects are often justified on the basis of macro level social and environmental benefits, these may not occur and are rarely monitored post-opening. Therefore there needs to be consistency between how projects are justified and how they are appraised and evaluated. This requires thinking about measures of success from an equity perspective. Policies can often be deemed successful from budget and timescale of delivery perspective but have ongoing negative social impacts (Mottee et al 2020).

Mottee and Howitt (2018) note that teams leading transport appraisals are often led by physical scientists, project managers and decision makers, and conclude that social impact assessments require teams with social science expertise.

Existing processes for consultation and engagement with transport decisions makers and providers restrict engagement. Research undertaken in Auckland found much higher levels of complaints and engagement among better off communities who know how to engage with authorities and negotiate the system (Ameratunga 2019). This can lead to more action and investment in these areas because of greater levels of complaints, which are not necessarily a good indicator of the prevalence of issues that need to be addressed.

5.2.3 Data for decision making

Data that is used for decision-making is also open to biases that perpetuate inequities. The increased use of data from mobile phones or crowdsourced data applications like Strava in planning means that decisions are made based on the experiences and travel patterns of those who own a smartphone and opt-in to data reporting services (Le Dantec et al 2016; Barajas et al 2017). This means the perspectives of women, low income and minority ethnic communities are less likely to be used in decision making, and inequities, for example cycle safety, may be exacerbated as a result (Le Dantec et al 2016; Barajas et al 2017). Metrics typically used to measure walkability of urban areas have been shown to inaccurately represent women's walkability (Golan et al 2019). Developing measures of walkability based on women's experiences would lead to different interventions to improve the walkability (Golan et al 2019),

demonstrating the importance of considering the decision making processes and data sources in terms of achieving equitable outcomes.

An over reliance on data-driven and technical approaches can overlook equity concerns. There are gaps in the evidence base on social and equity impacts of transport policies as outlined in chapter 4. While in some respects this may limit appraisal of social and distributional impacts because of uncertainties, there are also many ways in which mode-shift policy can be more equitable without a reliance on technical appraisals, but through a focus on decision making processes and by following guidelines for equitable decision making outlined below. The skills gap in the transport workforce, which is largely technical has been noted as a reason for transport policies failing to meet social objectives (Ameratunga 2019).

Lyons and Marsden (2019) discuss the uncertainty and error in road traffic forecasting in the UK and propose that given rates of technological and population change uncertainties in forecasting outcomes will increase. They suggest that such uncertainties need to be accepted, and transport policy analysis needs to balance technical depth with analytical breadth to negotiate and understand uncertainties. Therefore, while it may not be possible to fully predict the impacts of policies from an equity perspective, a broadening of approaches, drawing on expert knowledge, and focusing on desired outcomes can aid decision making.

5.3 Recommendations for equitable mode-shift policy

In this section we outline some overarching recommendations for mode shift policies, based on the literature and evidence reviews.

5.3.1 Prioritisation of mode shift policies

- Mode shift policy should focus on improving access to opportunities and reducing exposure to harms for the most transport disadvantaged. This includes consideration of the current distribution of transport resources, opportunities and exposures and outcomes as well as an understanding of the needs and aspirations of different communities. Given current inequities in health outcomes associated with transport, focus should be on improving outcomes for Māori.
- In terms of the policy levers assessed this means prioritising spatial and place-based planning to reduce the need to travel while enhancing accessibility. Infrastructure investments should focus in areas with poorer levels of accessibility and highest needs. Economic and education levers should focus on areas where mobility is greater than needed to meet accessibility needs, to reduce unnecessary travel.
- Improving structural conditions requires cross sector engagement to improve living and working conditions.

5.3.2 Participation and partnership in decision making

- More attention needs to be paid to decision-making processes that lead to inequitable outcomes. There needs to be consideration of who is involved in decision making and the roles of iwi, key stakeholders, communities and corporations, in order to achieve procedural fairness.
- Design and implementation of policy should be culturally appropriate.
- Achieving procedural fairness in decision making requires capacity building so that those invited to participate in decision making have the skills and resources to do so. In particular there is a need to

build capacity for involvement of mana whenua (Māori with historical and territorial rights over the land) in decision-making processes.

- There needs to be careful consideration of who might be affected and involve those groups in the decision-making process and delivery (Markkanen and Anger-Kraavi 2019)

5.3.3 Rights and needs based approaches

- Mode shift policy needs to focus on ensuring that rights to accessibility are met, within environmental limits, rather than on widening choice.
- To address existing inequities, mode shift policies should focus on addressing the needs and reducing harms for the most disadvantaged populations. While there is clear potential to address inequities through transport infrastructure, it needs to be targeted so that the most disadvantaged populations benefit – most research indicates this is usually not the case.
- There should be a systematic consideration of how policy can benefit the most disadvantaged, followed by active measures to address any regressive outcomes (Markkanen and Anger-Kraavi 2019)

5.3.4 Reducing overall travel

- The system of hypermobility needs to be addressed at a societal level (Lucas 2012; Urry 2002), which means that transport policies need to reduce overall travel, not just shift modes. If overall travel is not restricted, then the gap between the most and least advantaged will deepen.
- Reducing travel that is related to ‘wants’ rather than needs is more equitable and contributes most to environmental objectives (Mattioli 2016). Long-distance travel and air travel are the most promising targets for mode shift in this respect (Mattioli 2016), and they are currently missing from the mode shift plans.

5.3.5 Funding, appraisal, evaluation and longer-term perspectives

- Attention should be paid to where funding for mode shift policies comes from so that it is not shifted from other social spending (Markkanen and Anger-Kraavi 2019). This might be of particular concern with public transport funding, if it targets patronage over needs.
- While many policies have the potential to improve social and equity outcomes, the extent to which they do in practice can be unclear (AEA Group 2011). Evaluation according to equity criteria is rare (Mottee and Howitt 2018). There is a need to evaluate mode shift policies from an equity perspective to inform future policy development (Mottee et al 2020).
- Social impact and health impact assessments need to be mainstream in transport policy appraisal so that social and health outcomes drive investment decisions, in line with the wellbeing budget. Achieving this also requires building capacity of the workforce.
- Measures of success from an equity perspective need to be stated and evaluated.
- Design and implementation of infrastructure should be future proofed and consider long-term trajectories. For example, while cycling may not be a community priority right now, allowing flexible use of space so that it could be accommodated in future is important.

5.4 Research needs

In this section we outline research needs to support the assessment of social and equity impacts of mode shift policies, including suggested methods for this.

5.4.1 Evaluation and impacts

- Although there are an increasing number of studies examining the impacts of transport interventions, there are still few that consider equity impacts (Smith et al 2017; Hosking et al 2019; Aldred 2019).
- Controlled intervention studies which evaluate mode-shift policies would help add to the evidence base and support social impact assessments. There are lots of good examples of policies and projects across the country that have the potential to address equity concerns (eg Te Ara Haepapa and free buses for school in Tauranga) but limited evaluation from an equity perspective makes it harder to learn from best practice.
- Understanding social impacts is complex, in part because of complicated causal pathways and time scales. More research is needed to understand the long-term impacts of transport on health and wellbeing, and in particular mental health (Jones and Lucas 2012).

5.4.2 Current situation

- Addressing inequities in the transport system requires an understanding of existing inequities. At the moment this understanding is patchy.
- There is a need for a greater understanding of the travel patterns of Māori and Pasifika. This could be addressed through over-sampling in the HTS and through participatory approaches to understand experiences of the transport system. Research in this area should use kaupapa Māori methodologies (methods based on Māori values and worldviews) in order to ensure effective and appropriate engagement with Māori communities.
- Analyses of existing datasets could help to improve understanding of existing inequities in transport resources, opportunities and risks, and outcomes. This should include an understanding of trips not made and the social implications.
- Levels of accessibility to opportunities using different modes of transport, based on GIS based metrics and census data would help understanding of current inequities in provision of public transport, cycle networks and the implications of this for access to opportunities. This work is already being undertaken by Waka Kotahi and if the data was available could feed into developing a Transport Poverty Index.
- There is a need for research to develop understanding of the needs and experiences of different groups, to inform measurement of accessibility as above. As noted by (Golan et al 2019) the assumptions in such models may not be representative of the experiences of marginalised groups.
- Exposures to risk such as safety, noise, pollution and costs of transport could be examined spatially using modelling approaches.
- Mode shift policy requires a greater understanding of car dependence. In areas where a car is required to meet basic needs, attempts to shift mode without offering alternatives will exacerbate inequities in accessibility and affordability. A Transport Poverty Index, as originally suggested in the project scope, could help to identify areas where car ownership is high because of poor levels of accessibility using alternative modes.

- The approach used by Mattioli et al (2018) to identify low-income, high-cost households is one approach to identifying households most at risk from increased costs of car ownership using existing datasets.
- A greater understanding of who disadvantaged groups are in New Zealand, in transport terms, can help to facilitate greater engagement with people in policy design (AEA Group 2011).

5.4.3 Basic needs in transport

- Using mode shift policies to address social and environmental outcomes requires approaches that reduce overall travel while ensuring needs are not compromised and exposure to risk is not increased.
- Doing this requires research into outlining basic needs in accessibility terms and setting minimum standards for access. In combination with an accessibility index (noted above) this could identify areas where basic needs are not met as priorities for public transport investment. Needs might vary according to socio-demographic characteristics and affordability. Approaches such as the Minimum Income Standard use participatory approaches to negotiate with communities around what is needed in different locations and societies for a decent minimum living standard, and this could be applied in transport to negotiate standards of accessibility, safety, air quality etc. Developing such standards demands a bicultural approach, and a focus on privilege rather than deficit (Fu et al 2015a; Fu et al 2015b).
- Mode shift policies can then be targeted in areas where there is most capacity to reduce travel (Mattioli 2016). Research is needed into understanding excess travel, but it has been suggested that reducing travel for 'wants' first will not result in serious harm, and so can reduce concerns around equity (Mattioli 2016). Mattioli suggests that long distance and air travel is most likely to fit into wants, not needs – more research into such travel could help prioritise more restrictive mode shift policies that take into account health and the environment, alongside economic considerations.
- In line with the suggestion above around trips not made it is important to understand where people face transport constraints that mean accessibility needs are not met.

5.4.4 Implications of new transport modes and delivery models for transport equity

- Emerging transport technologies offer some potential to reduce car dependence and support an equitable transition to low carbon transport. However more research is needed into the social and equity impacts of new transport technologies, including ride-sourcing (eg Uber); mobility as a service; e-scooters; smart ticketing.

6 Conclusions

This report has summarised the existing literature on social and distributional impacts in transport, provided a brief overview of the existing situation in Aotearoa New Zealand, and examined proposed mode-shift policy levers from an equity perspective.

Mode shift policies which consider economic, environmental and social impacts from an equity perspective will be best aligned with the *Transport outcomes framework* (Ministry of Transport 2018a).

Mode shift is crucial in order to break the cycle of car reliance and the negative health and social outcomes related to this dependence. The accessibility and mobility benefits offered by private vehicle use are unevenly distributed meaning that those who do not have access to a car are at risk of exclusion.

A transition towards a transport system that promotes mode shift should ensure that existing inequalities in transport resources and outcomes are addressed rather than perpetuated. This means more than just ensuring that policies impact on all population groups equally, but instead promotes a more inclusive and fair transport system so that all New Zealanders can benefit from the opportunities provided by the transport system.

There can be tensions between policies designed to address economic growth, environmental impacts and equity (Feitelson 2002). Current appraisal methods have tended to focus on economic growth and environmental impact, whereas social impacts and equity have been given less consideration.

Ensuring that people who are transport disadvantaged will benefit most from mode shift policies is important for achieving equitable mode shift. Groups of particular note are those on low incomes, Māori and Pasifika, women, youth, older adults, disabled people, members of ethnic minorities and those living in high deprivation rural or peripheral areas. These groups are often locked out of the benefits of transport interventions that are designed to meet the needs of more privileged social groups. Similarly, the greatest costs of mode shift should fall on those with most transport resources at present, as these groups take many more trips and utilise more problematic modes (private car, air).

Although policies focused on addressing equity may focus on those most in need first, Lucas (2012) notes that in addition to a focus on populations who are currently excluded or adversely impacted by the transport system, the system of hypermobility (Urry 2000) or over consumption of travel needs to be tackled at a societal level. In the current situation, those who travel long distances by car are subsidised because they do not pay the full social costs of such travel, often at the expense of investment in local transport networks. If the mobility patterns of the most advantaged are not also addressed, the gap between the most and least advantaged in terms of ability to access services will deepen. Mode shift policies can support reduced car reliance, but through spatial and place-based planning can also reduce travel overall.

The distributional impacts of mode shift are often assessed based on who uses modes more at the moment (AEA Group 2011). This can be problematic where the current situation is undesirable. For example, international evidence suggests that rail tends to be used more by higher income groups. Therefore raising rail fares could be seen to be fair because it has a disproportionate impact on those on higher incomes. However, if the reason that rail is predominantly used by higher income groups is because of already expensive fares, or the location of rail infrastructure, then increasing fares serves to widen rather than address inequities.

Transport policy has tended to see social impacts as a negative consequence of transport policies that can be mitigated. However, transport policies can have positive social impacts, and implementing policies that

are intended to address inequities or improve health outcomes should be a focus, rather than simply mitigating effects that occur in addressing environmental or economic objectives.

At a broad level, any policy that has benefits for marginalised groups through improved welfare or opportunities or reducing harm, can reduce inequities, whereas policies which reduce the opportunities, impose costs or expose marginalised groups to harms are likely to perpetuate and widen inequities.

In this report we have synthesised the evidence and encourage policy makers to use this as a resource to raise awareness and understanding of the range of equity outcomes that mode shift policies may have. This is a broad overview of policy levers and more detailed analyses of specific policies or packages of policies are possible. However, it is more important to consider the guidelines outlined in section 5.3 and have principles to adhere to when making policy decisions. Achieving equitable mode shift policy requires a change in approaches to policy appraisal, including more participatory decision making, which requires capacity building in the transport workforce. Policies which reduce the need to travel (by car) through spatial and place-based planning at the city and neighbourhood level are best able to address transport inequities. Mode shift policies need to be implemented in a way that pays attention to timescales and differing social and spatial conditions, rather than a one size fits all approach which tends to benefit the needs of the already advantaged.

7 References

- Abenoza, RF, V Ceccato, YO Susilo and O Cats (2018) Individual, travel, and bus stop characteristics influencing travelers' safety perceptions. *Transportation Research Record 2672*: 19–28.
- AEA Group (2011) *Knowledge review of the social and distributional impacts of department for transport climate change policy options*.
- Aldred, R (2019) Built environment interventions to increase active travel: a critical review and discussion. *Current Environmental Health Reports 6*: 309–315.
- Aldred, R and J Croft (2019) Evaluating active travel and health economic impacts of small streetscape schemes: an exploratory study in London. *Journal of Transport & Health 12*: 86–96.
- Aldred, R, R Johnson, C Jackson and J Woodcock (2020) How does mode of travel affect risks posed to other road users? An analysis of English road fatality data, incorporating gender and road type. *Injury Prevention*, injuryprev-2019-043534.
- Ameratunga, S (2019) Inclusive streetscapes: perspectives of disabled people and older adults challenge mainstream consultation process. *Transport Knowledge Conference*, Wellington, 2019.
- Anciaes, P and P Jones (2020) Transport policy for liveability – valuing the impacts on movement, place, and society. *Transportation Research Part A: Policy and Practice 132*: 157–173.
- Anderson, A, J Binney and A Harris (2014) *Tangata whenua: an illustrated history*. Bridget Williams Books.
- Annear, M, S Keeling, TIM Wilkinson, G Cushman, BOB Gidlow and H Hopkins (2012) Environmental influences on healthy and active ageing: a systematic review. *Ageing and Society 34*: 590–622.
- Arnott, B, L Rehackova, L Errington, FF Sniehotta, J Roberts and V Araujo-Soares (2014) Efficacy of behavioural interventions for transport behaviour change: systematic review, meta-analysis and intervention coding. *International journal of behavioral nutrition and physical activity 11*: 133.
- Asher, L, M Aresu, E Falaschetti and J Mindell (2012) Most older pedestrians are unable to cross the road in time: a cross-sectional study. *Age Ageing 41*: 690–694.
- Atkinson, J, C Salmond and P Crampton (2014) *NZDep2013 index of deprivation*. Wellington: Department of Public Health, University of Otago.
- Auckland Council, Auckland Transport, Waka Kotahi NZ Transport Agency, State Services Commission, The Treasury, Ministry of Transport and KiwiRail (2019) *Better travel choices: creating a more accessible, healthy, safe and sustainable Auckland by reducing our reliance on private vehicles*.
- Auckland Transport (2019) *Auckland Transport 2019 annual report: travel choices*. Accessed 16 June 2020. <https://at.govt.nz/media/1980960/at-annual-report-2019.pdf7>
- Auckland Transport (2020) *Monthly cycle monitoring*. Accessed 16 June 2020: <https://at.govt.nz/cycling-walking/research-monitoring/monthly-cycle-monitoring/> .
- Avineri, E and P Goodwin (2010) *Individual behaviour change: evidence in transport and public health*. Accessed 16 June 2020. <https://uwe-repository.worktribe.com/output/983014/individual-behaviour-change-evidence-in-transport-and-public-health>
- Bae, C and I Mayeres (2005) Transportation and equity. In: *Social dimensions of sustainable transport: Transatlantic perspectives*. K Donarghy, S Poppelreuter and S Rudinger (Eds) Aldershot, UK: Ashgate.

- Baker, G, J Baxter and P Crampton (2019) The primary healthcare claims to the Waitangi Tribunal. *The New Zealand Medical Journal* 132: 7–13.
- Bamberg, S and D Rölle (2003) Determinants of people's acceptability of pricing measures – replication and extension of a causal model. *Acceptability of transport pricing strategies*. Pergamon Press.
- Barajas, JM, K Beck and A Medury (2017) Assessing race and income disparities in crowdsourced bicycle safety data collection. *The 6th International Cycling Safety Conference*, 2017.
- Barbeau, EM, N Krieger and M-J Soobader (2004) Working class matters: socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. *American journal of public health* 94: 269–278.
- Baum, F (2015) *The new public health*. Melbourne: Oxford University Press.
- Begg, D and R Brookland (2015) Participation in driver education/training courses during graduated driver licensing, and the effect of a time-discount on subsequent traffic offenses: findings from the New Zealand Drivers Study. *Journal of Safety Research* 55: 13–20.
- Ben-Elia, E and D Ettema (2011) Rewarding rush-hour avoidance: a study of commuters' travel behavior. *Transportation Research Part A: Policy and Practice* 45: 567–582.
- Best, R and PJ Burke (2019) Fuel prices and road accident outcomes in New Zealand. *New Zealand Economic Papers* 53: 109–124.
- Beyazit, E (2011) Evaluating social justice in transport: lessons to be learned from the capability approach. *Transport Reviews* 31: 117–134.
- Bhatta, B, AL Karna, OP Dev and O Springate-Baginski (2013) Participatory forest management in the Nepalese Tarai: policy, practice and impacts. *Forests People and Power*. Routledge.
- Bhosale, J, S Duncan and G Schofield (2017) Intergenerational change in children's independent mobility and active transport in New Zealand children and parents. *Journal of Transport & Health* 7: 247–255.
- Bills, TS and JL Walker (2017) Looking beyond the mean for equity analysis: examining distributional impacts of transportation improvements. *Transport Policy* 54: 61–69.
- Blair, N, J Hine and SMA Bukhari (2013) Analysing the impact of network change on transport disadvantage: a GIS-based case study of Belfast. *Journal of Transport Geography* 31: 192–200.
- Blakely, T, M Tobias and J Atkinson (2007) *Tracking disparity: trends in ethnic and socioeconomic inequalities in mortality, 1981–2004*. Wellington: Ministry of Health.
- Blumenberg, E (2004) En-gendering effective planning: spatial mismatch, low-income women, and transportation policy. *Journal of the American Planning Association* 70: 269–281.
- Bocarejo, JP and D Oviedo (2012) Transport accessibility and social inequities: a tool for identification of mobility needs and evaluation of transport investments. *Journal of Transport Geography* 24: 142–154.
- Bonehill, J, N Von Benzon and J Shaw (2020) The shops were only made for people who could walk': impairment, barriers and autonomy in the mobility of adults with cerebral palsy in urban England. *Mobilities*: 1–21.
- Bostock, L (2001) Pathways of disadvantage? Walking as a mode of transport among low-income mothers. *Health and Social Care in the Community* 9: 11–18.
- Brand, C and JM Preston (2010) '60–20 emission' – the unequal distribution of greenhouse gas emissions from personal, non-business travel in the UK. *Transport Policy* 17: 9–19.

- Braveman, P, S Egerter and DR Williams (2011) The social determinants of health: coming of age. *Annual Review of Public Health* 32: 381–398.
- Brugnach, M, M Craps and A Dewulf (2017) Including indigenous peoples in climate change mitigation: addressing issues of scale, knowledge and power. *Climatic change* 140: 19–32.
- Buehler, R, J Pucher, R Gerike and T Götschi (2017) Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland. *Transport Review* 37: 4–28.
- Buttazzoni, AN, AF Clark, JA Seabrookj and J Gilliland (2019) Promoting active school travel in elementary schools: a regional case study of the school travel planning intervention. *Journal of Transport & Health* 12: 206–219.
- Calder-Dawe, O, K Witten and P Carroll (2019) Being the body in question: young people’s accounts of everyday ableism, visibility and disability. *Disability & Society*: 1–24.
- Callister, P, R Didham, D Potter and T Blakely (2007) Measuring ethnicity in New Zealand: developing tools for health outcomes analysis. *Ethnicity & Health* 12: 299–320.
- Came, H (2014) Sites of institutional racism in public health policy making in New Zealand. *Social Science & Medicine* 106: 214–220.
- Canterbury District Health Board (2018) *BuyCycles: evaluation of a novel approach towards alleviating transport disadvantage*. Accessed 16 June 2020. www.cph.co.nz/wp-content/uploads/BuyCyclesEvaluation.pdf
- Cao, M and R Hickman (2017) Car dependence and housing affordability: an emerging social deprivation issue in London? *Urban Studies* 55: 2088–2105.
- Carroll, P, K Witten, O Calder-Dawe, M Smith, R Kearns, L Asiasiga, J Lin, N Kayes and S Mavoia (2018) Enabling participation for disabled young people: study protocol. *BMC Public Health* 18: 712.
- Cats, O, YO Susilo and T Reimal (2017) The prospects of fare-free public transport: evidence from Tallinn. *Transportation* 44: 1083–1104.
- Centre for Public Health Research (2018) Road traffic injury hospitalisations in New Zealand, 2001–2016. *Environmental Health Indicators [EHINZ]*: Wellington.
- Cervero, R (1998) *The transit metropolis: a global inquiry*. Island Press.
- Cesaroni, G, H Boogaard, S Jonkers, D Porta, C Badaloni, G Cattani, F Forastiere and G Hoek (2012) Health benefits of traffic-related air pollution reduction in different socioeconomic groups: the effect of low-emission zoning in Rome. *Occupational and environmental medicine* 69: 133–139.
- Chandra, S, J Jimenez and R Radhakrishnan (2017) Accessibility evaluations for nighttime walking and bicycling for low-income shift workers. *Journal of Transport Geography* 64: 97–108.
- Chatterjee, K, B Clark, A Nguyen, R Wishart, K Gallop, N Smith and S Tipping (2019) *Access to transport and life opportunities*. Report prepared for Department for Transport, UK. London: NatCen Social Research.
- Chatterjee, K, S Chng, B Clark, A Davis, J De Vos, D Ettema, S Handy, A Martin and L Reardon (2020) Commuting and wellbeing: a critical overview of the literature with implications for policy and future research. *Transport Reviews* 40: 5–34.

- Chatterton, T, J Anable, S Cairns and R Wilson (2018) Financial implications of car ownership and use: a distributional analysis based on observed spatial variance considering income and domestic energy costs. *Transport Policy* 65: 30–39.
- Christchurch City Council (2019) *More women in Christchurch opting to go by bike*. Accessed 16 June 2020. <https://newsline.ccc.govt.nz/news/story/more-women-in-christchurch-opting-to-go-by-bike>
- Christiansen, LB, T Madsen, J Schipperijn, AK Ersboll and J Troelsen (2014) Variations in active transport behavior among different neighborhoods and across adult lifestages. *Journal of Transport and Health* 1: no.4: 316–325.
- Christofa, E, SE Esenther and KJG Pollitt (2020) Chapter sixteen – Incorporating health impacts in transportation project decision-making in the United States. In: *Advances in transportation and health*. MJ Nieuwenhuijsen and H Khreis (Eds.) Elsevier.
- Church, A, M Frost and K Sullivan (2000) Transport and social exclusion in London. *Transport Policy* 7: 195–205.
- Cleland, CL, K McComb, F Kee, R Jepson, MP Kelly, K Milton, G Nightingale, P Kelly, G Baker, N Craig, AJ Williams and RF Hunter (2019) Effects of 20 mph interventions on a range of public health outcomes: a meta-narrative evidence synthesis. *Journal of Transport & Health* 100633.
- Collins, DC and RA Kearns (2005) Geographies of inequality: child pedestrian injury and walking school buses in Auckland, New Zealand. *Social Science & Medicine* 60: 61–69.
- Connor, J and S Casswell (2009) The burden of road trauma due to other people's drinking. *Accident Analysis and Prevention* 41: 1099–1103.
- Côté-Lussier, C, A Knudby and TA Barnett (2020) A novel low-cost method for assessing intra-urban variation in night time light and applications to public health. *Social Science & Medicine* 248: 112820.
- Curl, A (2018) The importance of understanding perceptions of accessibility when addressing transport equity: a case study in Greater Nottingham, UK. *Journal of Transport and Land Use* 11, no.1.
- Curl, A and J Clark (2019) Health, wellbeing and quality of life. In *Transport matters*. I Docherty and J Shaw (Eds) Bristol, UK.: Policy Press.
- Curl, A and P Mason (2019) Neighbourhood perceptions and older adults' wellbeing: Does walking explain the relationship in deprived urban communities? *Transportation Research Part a-Policy and Practice* 123: 119–129.
- Curl, A, J Nelson and J Anable (2011) Does accessibility planning address what matters? A review of current practice and practitioner perspectives. *Research in Transportation Business & Management* 2: 3–11.
- Curl, A, CW Thompson and P Aspinall (2015) The effectiveness of 'shared space' residential street interventions on self-reported activity levels and quality of life for older people. *Landscape and Urban Planning* 139: 117–125.
- Curl, A, J Clark and A Kearns (2018) Household car adoption and financial distress in deprived urban communities: a case of forced car ownership? *Transport Policy* 65: 61–71.
- Curl, A, CW Thompson, P Aspinall and M Ormerod (2016) Developing an audit checklist to assess outdoor falls risk. *Proceedings of the Institution of Civil Engineers: Urban Design and Planning* 169, no. 3: 138–153.

- Currie, G (2004) Gap analysis of public transport needs: measuring spatial distribution of public transport needs and identifying gaps in the quality of public transport provision. *Transportation Research Record 1895*: 137–146.
- Currie, G (2010) Quantifying spatial gaps in public transport supply based on social needs. *Journal of Transport Geography 18*: 31–41.
- Currie, G and A Delbosc (2011) Mobility vs. affordability as motivations for car-ownership choice in urban fringe, low-income Australia. Pp 193–208 in *Auto motives: understanding car use behaviours*. K Lucas, E Blumenberg, R Weinberger (Eds). Emerald Group Publishing Limited.
- Currie, G, A Delbosc and K Pavkova (2018) Alarming trends in the growth of forced car ownership in Melbourne. *40th Australasian Transport Research Forum*, Darwin, Northern Territory, Australia, 2018.
- Curtis, C and J Scheurer (2010) Planning for sustainable accessibility: developing tools to aid discussion and decision-making. *Progress in Planning 74*: 53–106.
- Dawkins, C and R Moeckel (2016) Transit-induced gentrification: Who will stay, and who will go? *Housing Policy Debate 2*: 801–818.
- de Sá, TH, DC Parra and CA Monteiro (2015) Impact of travel mode shift and trip distance on active and non-active transportation in the São Paulo Metropolitan Area in Brazil. *Preventive medicine reports 2*: 183–188.
- Dennis, K and J Urry (2009) *After the car*. Cambridge, Polity.
- Department for Transport (DFT) (2015) *TAG unit A4-2 distributional impact appraisal*. London.
- Department for Transport (DFT) (2017) *Journey time statistics 2017*. Accessed 16 June 2020. www.gov.uk/government/statistics/journey-time-statistics-2017
- Department for Transport (DFT) (2019) *TAG unit A4-1 social impact appraisal*. London.
- Desapriya, E, M Sones, T Ramanzin, S Weinstein, G Scime and I Pike (2011) Injury prevention in child death review: child pedestrian fatalities. *Injury Prevention 17*: i4.
- Docherty, I, G Marsden and J Anable (2018) The governance of smart mobility. *Transportation Research Part A: Policy and Practice 115*: 114–125.
- Downward, A, S Chowdhury and C Jayalath (2019) An investigation of route-choice in integrated public transport networks by risk-averse users. *Public Transport 11*: 89–110.
- Dunn, JR (2010) Health behavior vs the stress of low socioeconomic status and health outcomes. *JAMA 303*, no.12: 1199–1200.
- Edwards, P, I Roberts, J Green and S Lutchmun (2006) Deaths from injury in children and employment status in family: analysis of trends in class specific death rates. *British Medical Journal 333*: 119.
- Emond, CR and SL Handy (2012) Factors associated with bicycling to high school: insights from Davis, CA. *Journal of Transport Geography 20*, no.1: 71–79.
- Eriksson, L, J Garvill and AM Nordlund (2006) Acceptability of travel demand management measures: the importance of problem awareness, personal norm, freedom, and fairness. *Journal of environmental psychology 26*: 15–26.
- Exeter, DJ, J Zhao, S Crengle, A Lee and M Browne (2017) The New Zealand Indices of Multiple Deprivation (IMD): a new suite of indicators for social and health research in Aotearoa, New Zealand. *PLOS ONE 12*: e0181260.

- Factor, R, G Yair and D Mahalel (2010) Who by accident? The social morphology of car accidents. *Risk Analysis* 30: 1411–1423.
- Farrington, J and C Farrington (2005) Rural accessibility, social inclusion and social justice: towards conceptualisation. *Journal of Transport Geography* 13: 1–12.
- Fatu, B and R Elisaia-Hopa (2020) Te Ara Haepapa road safety programme. *Transportation Conference*. Christchurch, New Zealand.
- Feitelson, E (2002) Introducing environmental equity dimensions into the sustainable transport discourse: issues and pitfalls. *Transportation Research Part D: Transport and Environment* 7: 99–118.
- Fitt, H (2018) Habitus and the loser cruiser: how low status deters bus use in a geographically limited field. *Journal of Transport Geography* 70: 228–233.
- Fitt, H and A Curl (2019) *E-scooter use in New Zealand: insights around some frequently asked questions*. Christchurch: University of Canterbury.
- Fitzgerald, G (2012) The social impacts of poor access to transport in rural New Zealand. *NZ Transport Agency research report 484*.
- Frater, J and S Kingham (2018) Gender equity in health and the influence of intrapersonal factors on adolescent girls' decisions to bicycle to school. *Journal of Transport Geography* 71: 130–138.
- Fu, M, DJ Exeter and A Anderson (2015a) The politics of relative deprivation: a transdisciplinary social justice perspective. *Social Science & Medicine* 133: 223–232.
- Fu, M, DJ Exeter and A Anderson (2015b) So, is that your 'relative' or mine? A political-ecological critique of census-based area deprivation indices. *Social Science & Medicine* 142: 27–36.
- Gatersleben, B and D Uzzell (2007) Affective appraisals of the daily commute: comparing perceptions of drivers, cyclists, walkers, and users of public transport. *Environment and Behavior* 39: 416–431.
- Geurs, K, W Boon and B Van Wee (2009) Social impacts of transport: literature review and the state of the practice of transport appraisal in the Netherlands and the United Kingdom. *Transport Reviews* 29: 69–90.
- Giles-Corti, B (2016) The influence of the built environment on transport and health. *Journal of Transport & Health* 3: 423–425.
- Giles-Corti, B, A Vernez-Moudon, R Reis, G Turrell, AL Dannenberg, H Badland, S Foster, M Lowe, JF Sallis, M Stevenson and N Owen (2016) City planning and population health: a global challenge. *Lancet* 388: 2912–2924.
- Golan, Y, N Wilkinson, JM Henderson and A Weverka (2019) Gendered walkability: building a daytime walkability index for women. *Journal of Transport and Land Use* 12.
- Goodman, A, J Panter, SJ Sharp and D Ogilvie (2013a) Effectiveness and equity impacts of town-wide cycling initiatives in England: a longitudinal, controlled natural experimental study. *Social Science & Medicine* 97: 228–237.
- Goodman, A, S Sahlqvist and D Ogilvie (2013b). Who uses new walking and cycling infrastructure and how? Longitudinal results from the UK iConnect study. *Preventive Medicine* 57: 518–524.
- Goodman, A, S Sahlqvist and D Ogilvie (2014) New walking and cycling routes and increased physical activity: one- and 2-year findings from the UK iConnect Study. *American Journal of Public Health* 104: e38-46.

- Goodyear-Smith, F and T Ashton (2019) New Zealand health system: universalism struggles with persisting inequities. *The Lancet* 394: 432–442.
- Gray, D, J Shaw and J Farrington (2006) Community transport, social capital and social exclusion in rural areas. *Area* 38: 89–98.
- Grengs, J (2005) The abandoned social goals of public transit in the neoliberal city of the USA. *City* 9: 51–66.
- Grey, C, R Jackson, S Wells, B Wu, K Poppe, M Harwood, G Sundborn and AJ Kerr (2018) Trends in ischaemic heart disease: patterns of hospitalisation and mortality rates differ by ethnicity (ANZACS-QI 21). *The New Zealand Medical Journal (online)* 131: 21–31.
- Groth, S (2019) Multimodal divide: reproduction of transport poverty in smart mobility trends. *Transportation Research Part A: Policy and Practice* 125: 56–71.
- Guzman, LA and D Oviedo (2018) Accessibility, affordability and equity: assessing 'pro-poor' public transport subsidies in Bogotá. *Transport Policy* 68: 37–51.
- Haerewa, N, J Stephenson and D Hopkins (2018) Shared mobility in a Māori community. *Kotuitui-New Zealand Journal of Social Sciences Online* 13: 233–245.
- Hajat, A, C Hsia and MS O'Neill (2015) Socioeconomic disparities and air pollution exposure: a global review. *Current environmental health reports* 2: 440–450.
- Halden, D (2008) Making connections in the UK with accessibility planning. *International Conference on Mobility and Transport*.
- Halden, D (2009) 10 years of accessibility planning in the UK – What has been achieved? *European Transport Conference*. Association of European Transport.
- Halden, D (2010) Accessibility planning – social impacts and social equity. *UKTRC Social Impacts Equity in Transport Policy: Workshop 1*.
- Halden, D (2014) Shaping the future: case studies in UK accessibility planning. *Transportation Research Procedia* 1: 284–292.
- Hales, S, T Blakely and A Woodward (2012) Air pollution and mortality in New Zealand: cohort study. *Journal of Epidemiology and Community Health* 66: 468.
- Hammond, V and C Musselwhite (2013) The attitudes, perceptions and concerns of pedestrians and vulnerable road users to shared space: a case study from the UK. *Journal of Urban Design* 18: 78–97.
- Heesch, KC, B James, TL Washington, K Zuniga and M Burke (2016) Evaluation of the Veloway 1: a natural experiment of new bicycle infrastructure in Brisbane, Australia. *Journal of Transport & Health* 3: 366–376.
- Hilson, D (2020) Auckland's bus network, connecting remote communities. *Transportation Conference*. Christchurch New Zealand.
- Hirsch, L, H Mackie, R Scott, J De Pont, S Douglas and D Thomsen (2019) For whom didn't it click? A study of the non-use of seat belts in motor vehicle fatalities in New Zealand. *Journal of the Australasian College of Road Safety* 30: 18–26.
- Hodgson, R, G Hawley, A Macmillan, J Connor, A Moore, A Field, K Witten, C McKerchar and R Kearns (2019) Shaping cities for youth – exploring the transport, place, and wellbeing needs of marginalised youth in New Zealand. *Journal of Transport & Health* 14: 100737.

- Hodgson, R, G Hawley, F Macmillan, A Field, K Witten, R Kearns, J Connor, T Moore and C McKerchar (2020) *Shaping cities for youth: key findings and recommendations: volume 1*. Healthy Future Mobility Research Programme. Wellington: Ministry of Business, Innovation, and Employment.
- Hoffmann, ML (2016) *Bike lanes are white lanes bicycle advocacy and urban planning*. University of Nebraska Press.
- Hong, J, DP McArthur and M Livingston (2019) The evaluation of large cycling infrastructure investments in Glasgow using crowdsourced cycle data. *Transportation*.
- Hopgood, T, T Percival, J Stewart and S Ameratunga (2013) A tale of two cities: paradoxical intensity of traffic calming around Auckland schools. *The New Zealand Medical Journal* 126.
- Hosking, J, S Ameratunga, D Exeter, J Stewart and A Bell (2013) Ethnic, socioeconomic and geographical inequalities in road traffic injury rates in the Auckland region. *Australian and New Zealand Journal of Public Health* 37: 162–167.
- Hosking, J, A Macmillan, R Jones, S Ameratunga and A Woodward (2019) Searching for health equity: validation of a search filter for ethnic and socioeconomic inequalities in transport. *Systematic Reviews* 8: 94.
- Howden-Chapman, PC, P O'Dea, D Salmond, C Wilson and T Nick Blakely (2000) *Social inequalities in health: New Zealand 1999*.
- Human Rights Commission (2005) *The accessible journey: report of the inquiry into accessible public land transport*.
- International Transport Forum (2009) *Cognitive impairment, mental health and transport: design with everyone in mind*. OECD.
- Jahanshahi, K, Y Jin and I Williams (2015) Direct and indirect influences on employed adults' travel in the UK: New insights from the National Travel Survey data 2002–2010. *Transportation Research Part A: Policy and Practice* 80: 288–306.
- Jakob, A, JL Craig and G Fisher (2006) Transport cost analysis: a case study of the total costs of private and public transport in Auckland. *Environmental Science & Policy* 9: 55–66.
- Jaramillo, AG, I Philips and K LUCAS (2019) *Social impact assessment: the case of bus rapid transit in the City of Quito, Ecuador*. *Measuring Transport Equity*. Elsevier.
- Jeekel, J and C Martens (2017) Equity in transport: learning from the policy domains of housing, health care and education. *European Transport Research Review* 9: 53.
- Jones, P and K Lucas (2012) The social consequences of transport decision-making: clarifying concepts, synthesising knowledge and assessing implications. *Journal of Transport Geography* 21: 4–16.
- Jones, R (2008) Postscript II: decolonising cities. In *Re-thinking urban environments and health*. Public Health Advisory Committee (Ed).
- Jones, SJ, RA Lyons, A John and S Palmer (2005) Traffic calming policy can reduce inequalities in child pedestrian injuries: database study. *Injury Prevention* 11: 152–156.
- Kahn, ME (2007) Gentrification trends in new transit-oriented communities: evidence from 14 cities that expanded and built rail transit systems. *Real Estate Economics* 35: 155–182.
- Kamruzzaman, M, L Wood, J Hine, G Currie, B Giles-Corti and G Turrell (2014) Patterns of social capital associated with transit oriented development. *Journal of Transport Geography* 35: 144–155.

- Karndacharuk, A, DJ Wilson and RCM Dunn (2016) Qualitative evaluation study of urban shared spaces in New Zealand. *Transportation Research Part D-Transport and Environment* 42: 119–134.
- Keall, M, C Shaw, R Chapman and P Howden-Chapman (2018) Reductions in carbon dioxide emissions from an intervention to promote cycling and walking: a case study from New Zealand. *Transportation Research Part D-Transport and Environment* 65: 687–696.
- Khreis, H, AD May and MJ Nieuwenhuijsen (2017) Health impacts of urban transport policy measures: a guidance note for practice. *Journal of Transport & Health* 6: 209–227.
- Kingham, S, W Pattinson, I Longley and J Salmond (2011) Determination of personal exposure to traffic pollution while travelling by different modes. *NZ Transport Agency research report 457*.
- Kingham, S, J Pearce and P Zawar-Reza (2007) Driven to injustice? Environmental justice and vehicle pollution in Christchurch, New Zealand. *Transportation Research Part D-Transport and Environment* 12: 254–263.
- Klinsky, S and W Harald (2018) Building equity in: strategies for integrating equity into modelling for a 1.5 C world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*: 376 20160461.
- Koohsari, MJ, H Badland and B Giles-Corti (2013) (Re)designing the built environment to support physical activity: bringing public health back into urban design and planning. *Cities* 35: 294–298.
- LaFlamme, L, M Hasselberg, A-M Reimers, LT Cavalini, and A Ponce de Leon (2009) Social determinants of child and adolescent traffic-related and intentional injuries: a multilevel study in Stockholm County. *Social Science & Medicine* 68: 1826–1834.
- Lancée, S, R Veenhoven and M Burger (2017) Mood during commute in the Netherlands: What way of travel feels best for what kind of people? *Transportation Research Part A: Policy and Practice* 104: 195–208.
- Le Dantec, CA, C Appleton, M Asad, R Rosenberger and K Watkins (2016) Advocating through data: community visibilities in crowdsourced cycling data. In *Bicycle justice and urban transformation*. A Golub, ML Hoffmann, AE Lugo and GF Sandoval (Eds). Routledge.
- Levinson, D (2010) Equity effects of road pricing: a review. *Transport Reviews* 30: 33–57.
- Levy, C (2013) Travel choice reframed: 'deep distribution' and gender in urban transport. *Environment and Urbanization* 25: 47–63.
- Local Government New Zealand (2017) *Council-Maori participation arrangements* [online]. Wellington. Accessed 16 June 2020. www.lgnz.co.nz/equip/training/on-demand-webinars/council-maori-participation-arrangements/.
- Lucas, K (2004) *Locating transport as a social policy problem*. Bristol, Policy Press.
- Lucas, K (2012) Transport and social exclusion: Where are we now? *Transport Policy* 20: 105–113.
- Lucas, K (2019) A new evolution for transport-related social exclusion research? *Journal of Transport Geography* 81: 102529.
- Lucas, K and P Jones (2012) Social impacts and equity issues in transport: an introduction. *Journal of Transport Geography* 21: 1–3.
- Lucas, K, G Mattioli, E Verlinghieri and A Guzman (2016) Transport poverty and its adverse social consequences. *Proceedings of the Institution of Civil Engineers – Transport* 2016. 353–365.

- Lucas, K and K Pangbourne (2014) Assessing the equity of carbon mitigation policies for transport in Scotland. *Case Studies on Transport Policy* 2: 70–80.
- Lucas, K, I Philips, C Mulley and L Ma (2018) Is transport poverty socially or environmentally driven? Comparing the travel behaviours of two low-income populations living in central and peripheral locations in the same city. *Transportation Research Part A: Policy and Practice* 116: 622–634.
- Lyons, G and G Marsden (2019) Opening out and closing down: the treatment of uncertainty in transport planning's forecasting paradigm. *Transportation*.
- Mackett, R (2017) *Building confidence – improving travel for people with mental impairments*. London: Centre for Transport Studies.
- Mackie, H, A Macmillan, K Witten, P Baas, A Field, M Smith, J Hosking, K King, L Sosene and A Woodward (2018) Te Ara Mua – Future Streets suburban street retrofit: a researcher-community-government co-design process and intervention outcomes. *Journal of Transport & Health* 11: 209–220.
- Mackie, H, A Woodward, K Witten, M Smith (nee Oliver), A Field, A Macmillan, J Hosking, P Baas, G Hawley, K Wild, R Hodgson, L Hirsch, R Thorne and C Mc Kerchar (2019) Healthy future mobility: synthesis report.
- Mackie, P and T Worsley (2013) *International comparisons of transport appraisal practice*. Institute for Transport Studies, University of Leeds.
- Macmillan, A, J Connor, K Witten, R Kearns, D Rees and A Woodward (2014) The societal costs and benefits of commuter bicycling: simulating the effects of specific policies using system dynamics modeling. *Environmental health perspectives* 122: 335–344.
- Macmillan, AK, H Mackie, JE Hosking, K Witten, M Smith, A Field, A Woodward, R Hoskins, J Stewart, B Van der Werf and P Baas (2018) Controlled before-after intervention study of suburb-wide street changes to increase walking and cycling: Te Ara Mua-Future Streets study design. *BMC Public Health* 1: 850.
- Manaugh, K, MG Badami and AM El-Geneidy (2015) Integrating social equity into urban transportation planning: a critical evaluation of equity objectives and measures in transportation plans in North America. *Transport Policy* 37: 167–176.
- Marino, E and J Ribot (2012) Special issue introduction: adding insult to injury: climate change and the inequities of climate intervention. Elsevier.
- Markkanen, S and A Anger-Kraavi (2019) Social impacts of climate change mitigation policies and their implications for inequality. *Climate Policy* 19: 827–844.
- Martens, K (2016) *Transport justice: designing fair transportation systems*. Routledge.
- Martens, K., J Bastiaanssen and K Lucas (2019) Measuring transport equity: key components, framings and metrics. In *Measuring transport equity*. S Lucas, K Martens, Di Ciommo and A Dupont-KIEFFER (Eds) Amsterdam: Elsevier.
- Matapopore (2020) Hine-Pāka Bus Interchange. Accessed 26 February 2020.
http://t5i.813.mwp.accessdomain.com/wp-content/uploads/2019/09/1047_CRCL_MP_BusInterchange.pdf
- Mathias, K (2008) *An impact evaluation of the Christchurch Urban Development Strategy Health Impact Assessment*. Christchurch, New Zealand: Canterbury District Health Board.
- Matthies, E, S Kuhn and CA Klöckner (2002) Travel mode choice of women: the result of limitation, ecological norm, or weak habit? *Environment and Behavior* 34: 163–177.

- Mattingly, K and J Morrissey (2014) Housing and transport expenditure: socio-spatial indicators of affordability in Auckland. *Cities* 38: 69–83.
- Mattioli, G (2016) Transport needs in a climate-constrained world. A novel framework to reconcile social and environmental sustainability in transport. *Energy Research & Social Science* 18: 118–128.
- Mattioli, G (2017) 'Forced car ownership' in the UK and Germany: socio-spatial patterns and potential economic stress impacts. *Social Inclusion* 5: 147–160.
- Mattioli, G and M Colleoni (2016) Transport disadvantage, car dependence and urban form. *Understanding mobilities for designing contemporary cities*. Springer.
- Mattioli, G, K Lucas and G Marsden (2017) Transport poverty and fuel poverty in the UK: from analogy to comparison. *Transport Policy* 59: 93–105.
- Mattioli, G, Z Wadud and K Lucas (2018) Vulnerability to fuel price increases in the UK: a household level analysis. *Transportation Research Part A: Policy and Practice* 113: 227–242.
- Mavoa, S, K Witten, T McCreanor and D O'Sullivan (2012) GIS based destination accessibility via public transit and walking in Auckland, New Zealand. *Journal of Transport Geography* 20: 15–22.
- McCone, ER (2019) *The importance of the local school environment in encouraging active school travel*. Master's thesis. Accessed 16 June 2020. <https://ir.canterbury.ac.nz/handle/10092/16691>.
- McCormack, GR and A Shiell (2011) In search of causality: a systematic review of the relationship between the built environment and physical activity among adults. *International Journal of Behavioral Nutrition and Physical Activity* 8: 125.
- McDowell, A, D Begg, J Connor and J Broughton (2009) Unlicensed driving among urban and rural Maori drivers: New Zealand drivers study. *Traffic Injury Prevention* 10: 538–545.
- McGrath, LJ, WG Hopkins and EA Hinckson (2015) Associations of objectively measured built-environment attributes with youth moderate – vigorous physical activity: a systematic review and meta-analysis. *Sports Medicine* 45: 841–865.
- McGreevy, M, P Harris, T Delany-Crowe, M Fisher, P Sainsbury and F Baum (2019) Can health and health equity be advanced by urban planning strategies designed to advance global competitiveness? Lessons from two Australian case studies. *Social Science & Medicine* 242: 112594.
- Mees, P (2009) *Transport for suburbia: beyond the automobile age*. Earthscan.
- Mental Health Action Group & Anxiety UK (2016) *Mental health and transport summit report*.
- Metz, D (2008) The myth of travel time saving. *Transport Reviews* 28: 321–336.
- Middleton, J and J Spinney (2019) Social inclusion, accessibility and emotional work. *Transport Matters: Why transport matters and how we can make it better*. 83.
- Mindell, JS, D Leslie and M Wardlaw (2012) Exposure-based, 'like-for-like' assessment of road safety by travel mode using routine health data. *PLoS One* 7: e50606.
- Ministry for Women (2019) *Bringing gender in* [online]. Ministry for Women. Accessed 17 December 2019. <https://women.govt.nz/gender-tool> [
- Ministry of Health (2019) *Health impact assessment* [online]. Accessed 16 June 2020. www.health.govt.nz/our-work/health-impact-assessment.

- Ministry of Transport (2018a) *A framework for shaping our transport system: transport outcomes and mode neutrality*. Wellington, New Zealand: Ministry of Transport.
- Ministry of Transport (2018b) *Government policy statement on land transport 2018/19 – 2027/28*. Wellington: Ministry of Transport.
- Ministry of Transport (2019) *Household travel survey*. Wellington: Ministry of Transport..
- Mitchell, G (2005) Forecasting environmental equity: air quality responses to road user charging in Leeds, UK. *Journal of Environmental Management* 77: 212–226.
- Mizdrak, A, T Blakely, CL Cleghorn and LJ Cobiac (2019) Potential of active transport to improve health, reduce healthcare costs, and reduce greenhouse gas emissions: a modelling study. *PloS one*: 14.
- Molina-Garcia, J, A Queralt, EG Bengoechea, A Moore and S Mandic (2018) Would New Zealand adolescents cycle to school more if allowed to cycle without a helmet? *Journal of Transport & Health* 11: 64–72.
- Morris, T (2019) Enabling participation: research with young people on ableism. Accessed 16 June 2020. <https://shoreandwhariki.ac.nz/news/2019/7/8/enabling-participation-of-disabled-children-and-young-people>
- Mottee, LK and R Howitt (2018) Follow-up and social impact assessment (SIA) in urban transport-infrastructure projects: insights from the parramatta rail link. *Australian Planner* 55: 46–56.
- Mottee, LK, J Arts, F Vanclay, F Miller and R Howitt (2020) Reflecting on how social impacts are considered in transport infrastructure project planning: looking beyond the claimed success of Sydney's South West Rail Link. *Urban Policy and Research*: 1–4.
- Mullen, C and G Marsden (2016) Mobility justice in low carbon energy transitions. *Energy Research & Social Science* 18: 109–117.
- Mullen, C and G Marsden (2018) The car as a safety-net: narrative accounts of the role of energy intensive transport in conditions of housing and employment uncertainty. Pp145–164 in *Demanding energy*. A Hui, R Day and G Walker (Eds) Palgrave Macmillan.
- Mullen, C, G Marsden and I Philips (2020) Seeking protection from precarity? Relationships between transport needs and insecurity in housing and employment. *Geoforum* 10: 4–13.
- Nazari Adli, S, S Chowdhury and Y Shiftan (2019) Justice in public transport systems: a comparative study of Auckland, Brisbane, Perth and Vancouver. *Cities* 90: 88–99.
- Nieuwenhuijsen, MJ, H Khreis, N Mueller and D Rojas-Rueda (2020) Health impact assessment of transport planning and policy. Chapter 14 in *Advances in transportation and health*. MJ Nieuwenhuijsen and H Khreis (Eds). Elsevier.
- Noland, RB and MA Quddus (2004) A spatially disaggregate analysis of road casualties in England. *Accident Analysis & Prevention* 36: 973–984.
- Nunns, P, E Whitaker and S Donovan (2019) Social and distributional impacts of time and space-based road pricing. *NZ Transport Agency research report 654*.
- NZ Transport Agency (2016) *Social impact guide. People place and environment series*. Wellington.
- NZ Transport Agency (2018) *Economic evaluation manual*. Wellington.
- NZ Transport Agency (2019) *NZ Transport Agency annual report*. Accessed 16 June 2020. www.nzta.govt.nz/resources/annual-report-nzta/

- O'Toole, SE and N Christie (2019) Educating parents to support children's road safety: a review of the literature. *Transport reviews* 39: 392–406.
- Ogilvie, D, CE Foster, H Rothnie, N Cavill, V Hamilton, CF Fitzsimons, N Mutrie and Scottish Physical Activity Research (2007) Interventions to promote walking: systematic review. *BMJ* 334: 1204.
- Ogilvie, D, R Mitchell, N Mutrie, M Petticrew and S Platt (2008) Personal and environmental correlates of active travel and physical activity in a deprived urban population. *International Journal of Behavioral Nutrition and Physical Activity* 5: 43.
- Oviedo, D, L Scholl, M Innao and L Pedraza (2019) Do bus rapid transit systems improve accessibility to job opportunities for the poor? The case of Lima, Peru. *Sustainability* 11.
- Oviedo Hernandez, D and H Titheridge (2016) Mobilities of the periphery: informality, access and social exclusion in the urban fringe in Colombia. *Journal of Transport Geography* 55: 152–164.
- Pangbourne, K, MN Mladenović, D Stead and D Milakis (2019) Questioning mobility as a service: unanticipated implications for society and governance. *Transportation Research Part A: Policy and Practice*.
- Park, J and S Chowdhury (2018) Investigating the barriers in a typical journey by public transport users with disabilities. *Journal of Transport & Health* 10: 361–368.
- Parker, KM, J Gustat and JC Rice (2011) Installation of bicycle lanes and increased ridership in an urban, mixed-income setting in New Orleans, Louisiana. *Journal of Physical Activity and Health* 8, Suppl 1: S98–s102.
- Patacchini, E and Y Zenou (2005) Spatial mismatch, transport mode and search decisions in England. *Journal of Urban Economics* 58: 62–90.
- Pearce, J and S Kingham (2008) Environmental inequalities in New Zealand: a national study of air pollution and environmental justice. *Geoforum* 39: 980–993.
- Pearce, J, S Kingham and P Zawar-Reza (2006a) Every breath you take? environmental justice and air pollution in Christchurch, New Zealand. *Environment and Planning A: Economy and Space* 38: 919–938.
- Pearce, J, K Witten, R Hiscock and T Blakely (2006b) Are socially disadvantaged neighbourhoods deprived of health-related community resources? *International Journal of Epidemiology* 36: 348–355.
- Pereira, RHM (2019) Future accessibility impacts of transport policy scenarios: equity and sensitivity to travel time thresholds for bus rapid transit expansion in Rio de Janeiro. *Journal of Transport Geography* 74: 321–332.
- Pereira, RHM, T Schwanen and D Banister (2017) Distributive justice and equity in transportation. *Transport Reviews* 37: 170–191.
- Pereira, RHM, D Banister, T Schwanen and N Wessel (2019) Distributional effects of transport policies on inequalities in access to opportunities in Rio de Janeiro. *Journal of Transport and Land Use* 12.
- Power, A (2012) Social inequality, disadvantaged neighbourhoods and transport deprivation: an assessment of the historical influence of housing policies. *Journal of Transport Geography* 21: 39–48.
- Pratt, GC, ML Vadali, DL Kvale and KM Ellickson (2015) Traffic, air pollution, minority and socio-economic status: addressing inequities in exposure and risk. *International Journal of Environmental Research and Public Health* 12: 5355–5372.

- Pucher, J, J Dill and S Handy (2010) Infrastructure, programs, and policies to increase bicycling: an international review. *Preventive Medicine* 50: Suppl 1: S106–25.
- Rachele, JN, T Sugiyama, G Turrell, AM Healy and JF Sallis (2018) Automobile dependence: a contributing factor to poorer health among lower-income households. *Journal of Transport & Health* 8: 123–128.
- Raerino, K, AK Macmillan and RG Jones (2013) Indigenous Maori perspectives on urban transport patterns linked to health and wellbeing. *Health Place* 23: 54–62.
- Rajé, F (2003) The impact of transport on social exclusion processes with specific emphasis on road user charging. *Transport and Social Exclusion* 10: 321–338.
- Rao, M, S Prasad, F Adshead and H Tissera (2007) The built environment and health. *Lancet* 370: 1111–3.
- Reid, P and B Robson (2007) Understanding health inequities. In *Hauora: Māori standards of health IV. A study of the years 2000–2005*. B Robson and R Harris (Eds). Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare, School of Medicine and Health Sciences, University of Otago, Wellington.
- Richards, C (2020) Bus fare policies to improve equity in access to education. *Transportation Conference*. Christchurch, New Zealand.
- Roberts, I, R Marshall, R Norton and B Borman (1992) An area analysis of child injury morbidity in Auckland. *Journal of Paediatrics and Child Health* 28: 438–441.
- Robson, B and R Harris (2007) *Hauora: Māori standards of health IV. A study of the years 2000–2005*. Wellington: Te Ropu Rangahau Hauora a Eru Pomare.
- Rod, NH, M Grønbaek, P Schnohr, E Prescott and TS Kristensen (2009) Perceived stress as a risk factor for changes in health behaviour and cardiac risk profile: a longitudinal study. *Journal of Internal Medicine* 266: 467–475.
- Rogalsky, J (2010) The working poor and what GIS reveals about the possibilities of public transit. *Journal of Transport Geography* 18: 226–237.
- Rose, E, K Witten and T McCreanor (2009) Transport related social exclusion in New Zealand: Evidence and challenges. *Kōtuitui: New Zealand Journal of Social Sciences Online* 4:191–203.
- Schuitema, G, L Steg and M Van Kruining (2011). When are transport pricing policies fair and acceptable? *Social Justice Research* 24: 66–84.
- Schwanen, T and A Páez (2010) The mobility of older people – an introduction. *Special issue: The mobility of older people* 18: 591–595.
- Schweitzer, L and A Valenzuela (2004) Environmental injustice and transportation: the claims and the evidence. *Journal of Planning Literature* 18: 383–398.
- Schweitzer, L and J Zhou (2010) Neighborhood air quality, respiratory health, and vulnerable populations in compact and sprawled regions. *Journal of the American Planning Association* 76: 363–371.
- Searle, G and C Legacy (2019) Australian mega transport business cases: missing costs and benefits. *Urban Policy and Research* 37: 458–473.
- Serebrisky, T, A Gómez-Lobo, N Estupiñán and R Muñoz-Raskin (2009) Affordability and subsidies in public urban transport: What do we mean, What can be done? *Transport Reviews* 29: 715–739.
- Sharma, A and P Kumar (2018) A review of factors surrounding the air pollution exposure to in-pram babies and mitigation strategies. *Environment International* 120: 262–278.

- Shaw, C, T Blakeley, P Crampton and J Atkinson (2005) The contribution of causes of death to socioeconomic inequalities in child mortality: New Zealand 1981–1999. *The New Zealand Medical Journal* 118.
- Shaw, C, S Hales, R Edwards, P Howden-Chapman and J Stanley (2018) What can fuel price increases tell us about the air pollution health co-benefits of a carbon price? *Journal of Transport & Health* 8: 81–90.
- Shaw, C, M Keall and H Guiney (2017) What modes of transport are associated with higher levels of physical activity? Cross-sectional study of New Zealand adults. *Journal of Transport & Health* 7: 125–133.
- Shaw, C, M Russell, M Keall, K Wild, A Woodward and S Macbride-Stewart (2019) How do female patterns of utility cycling, and travel more generally, differ from men? Cross sectional survey in New Zealand. *Journal of Transport & Health* 14: 100692.
- Sheller, M (2018) *Mobility justice: the politics of movement in an age of extremes*. London, UK: Verso.
- Shope, JT, D Begg and R Brookland (2019) Older former drivers' health, activity, and transport in New Zealand. *Journal of Transport & Health* 14.
- Singh, YJ (2019) Is smart mobility also gender-smart? *Journal of Gender Studies*: 1–15.
- Singleton, PA (2019) Walking (and cycling) to well-being: modal and other determinants of subjective well-being during the commute. *Travel Behaviour and Society*, 16, 249-261.
- Smeds, E, E Robin and J McArthur (2020) Night-time mobilities and (in)justice in London: constructing mobile subjects and the politics of difference in policy-making. *Journal of Transport Geography* 82: 102569.
- Smith, M, J Hosking, A Woodward, K Witten, A Macmillan, A Field, P Baas and H Mackie (2017) Systematic literature review of built environment effects on physical activity and active transport – an update and new findings on health equity. *International Journal of Behavioral Nutrition and Physical Activity* 14: 158.
- Smith, N, D Hirsch and A Davis (2012) Accessibility and capability: the minimum transport needs and costs of rural households. *Journal of Transport Geography* 21: 93–101.
- Social Exclusion Unit (2003) *Making the connections: final report on transport and social exclusion*. London: Office of the Deputy Prime Minister.
- State Services Commission (2018) *Our people: public service workforce data 2018*.
- Statistics New Zealand (2020) *2018 Census – NZ.Stat tables*
- Statistics New Zealand (2013) *2013 Census – NZ.Stat tables*
- Steinbach, R, C Grundy, P Edwards, P Wilkinson and J Green (2011) The impact of 20 mph traffic speed zones on inequalities in road casualties in London. *Journal of Epidemiology Community Health* 65: 921–926.
- Stern, N (2016) Economics: current climate models are grossly misleading. *Nature* 530: 407–409.
- Storme, T, J De Vos, L de Paepe and F Witlox (2020) Limitations to the car-substitution effect of MaaS. Findings from a Belgian pilot study. *Transportation Research Part A: Policy and Practice* 131: 196–205.
- Stuart, K (2010) From a footprint to a (sustainable) place to stand: Where to from here? In *Tāone Tupu Ora: indigenous knowledge and sustainable urban design*. K Stuart and M Thompson-Fawcett (Eds). Wellington: Steele Roberts Aotearoa.
- Sustainable Development Commission (2011) *Fairness in a car-dependent society*. Author.

- Taylor, JE (2018) The extent and characteristics of driving anxiety. *Transportation Research Part F-Traffic Psychology and Behaviour* 58: 70–79.
- Thomopoulos, N, S Grant-Muller and MR Tight (2009) Incorporating equity considerations in transport infrastructure evaluation: current practice and a proposed methodology. *Evaluation and Program Planning* 32: 351–359.
- Tonne, C, S Beevers, B Armstrong, F Kelly and P Wilkinson (2008) Air pollution and mortality benefits of the London congestion charge: spatial and socioeconomic inequalities. *Occupational and Environmental Medicine* 65: 620–627.
- Tranter, PJ (2010) Speed kills: the complex links between transport, lack of time and urban health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine* 87: 155–166.
- Umberson, D, H Liu and C Reczek (2008) Stress and health behaviour over the life course. *Advances in Life Course Research* 13: 19–44.
- UN-Habitat (2013) *Planning and design for sustainable urban mobility: global report on human settlements 2013*. Taylor & Francis.
- United Nations (2007) *United Nations declaration on the rights of indigenous peoples (DRIP) UN GA resolution 61/295*.
- Ürge-Vorsatz, D, ST Herrero, NK Dubash and F Lecocq (2014) Measuring the co-benefits of climate change mitigation. *Annual Review of Environment and Resources* 39: 549–582.
- Urry, J (2000) *Sociologies beyond societies: mobilities for the twenty-first century*. New York, Routledge.
- Urry, J (2002) Mobility and proximity. *Sociology-the Journal of the British Sociological Association* 36: 255–274.
- van Wee, B, JA Annema and D Banister (2013) *The transport system and transport policy: an introduction*. Edward Elgar Publishing.
- van Wee, B and KT Geurs (2011) Discussing equity and social exclusion in accessibility evaluations. *European Journal of Transport and Infrastructure Research* 11.
- Vanclay, F (2003) International principles for social impact assessment. *Impact Assessment and Project Appraisal* 21: 5–12.
- Vanoutrive, T and T Zijlstra (2018) Who has the right to travel during peak hours? On congestion pricing and ‘desirable’ travellers. *Transport Policy* 63: 98–107.
- Waitangi Tribunal (2019) *Hauora: report on stage one of the health services and outcomes kaupapa inquiry*. Wellington: Waitangi Tribunal.
- Waka Kotahi NZ Transport Agency (2019) *Keeping cities moving: increasing the wellbeing of New Zealand's cities by growing the share of travel by public transport, walking and cycling*. Accessed 16 June 2020. www.nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf
- Walker, J (2008) Purpose-driven public transport: creating a clear conversation about public transport goals. *Journal of Transport Geography* 16: 436–442.
- Ward, AL, R McGee, C Freeman, PJ Gendall and C Cameron (2018) Transport behaviours among older teenagers from semi-rural New Zealand. *Australian and New Zealand Journal of Public Health* 42: 340–346.

- Ward Thompson, C, A Curl, P Aspinall, S Alves and A Zuin (2014) Do changes to the local street environment alter behaviour and quality of life of older adults? The 'DIY Streets' intervention. *British Journal of Sports Medicine* 48: 1059–1065.
- Wiersma, J, L Bertolini and T Straatemeier (2017) Adapting spatial conditions to reduce car dependency in mid-sized 'post growth' European city regions: the case of South Limburg, Netherlands. *Transport Policy* 55: 62–69.
- Wild, K, A Woodward, A Field and A Macmillan (2017) Beyond 'bikelash': engaging with community opposition to cycle lanes. *Mobilities* 13: 505–519.
- Wiles, J and A Kobayashi (2009) Equity. In *International encyclopedia of human geography*. R Kitchin and N Thrift (Eds). Oxford: Elsevier.
- Wilkin, D (2020) Introduction: exploring disability hate crime. In: *Disability hate crime: experiences of everyday hostility on public transport*. D Wilkin (Ed). Cham: Springer International Publishing.
- Witten, K and S Mavoia (2011) Social and recreational travel: the destinations, travel modes and CO₂ emissions of New Zealand households. *Social Policy Journal of New Zealand* 37: 1–13.
- Wood, C (2009) The 'right' to travel: seeing the world in a globalised, climate-vulnerable era. *Seventh Transport Practitioners' Meeting*, Reading, 13–15 July 2009.
- Yavuz, N and EW Welch (2010) Addressing fear of crime in public space: gender differences in reaction to safety measures in train transit. *Urban Studies* 47: 2491–2515.
- Zhao, J, S Gibb, R Jackson, S Mehta and DJ Exeter (2018) Constructing whole of population cohorts for health and social research using the New Zealand integrated data infrastructure. *Australian and New Zealand Journal of Public Health* 42: 382–388.
- Zhu, X and C Lee (2008) Walkability and safety around elementary schools economic and ethnic disparities. *American Journal of Preventive Medicine* 34: 282–90.
- Zuk, M, AH Bierbaum, K Chapple, K Gorska and A Loukaitou-Sideris (2017) Gentrification, displacement, and the role of public investment. *Journal of Planning Literature* 33: 31–44.

Appendix A: Transport impacts that have been identified as having social and/or distributional impacts

This list is not exhaustive but demonstrates the range of possible impacts from transport policies that could be assessed from a social and distributional impact perspective. It draws on the literature broadly but is based heavily on (Lucas and Pangbourne, 2014, Geurs et al., 2009, AEA Group, 2011)

Access to spatially distributed services and activities

Affordability

Availability and physical access

Averting behaviour

Barriers and diversions

Biodiversity

Connectivity

Crashes

Cultural diversity

Forced relocation

Historical/cultural resources

Housing and land use policy

Intrinsic value, journey quality

Journey ambience

Journey times

Landscape

Level of service provided

Local air quality

Noise nuisance

Physical fitness

Public safety (dangerous cargo)

Regeneration

Reliability

Resilience

Safety perceptions

Security

Severance

Social cohesion

Soil quality

Terrorism

Transport interchange

Transportation choice/option values

Uncertainty of construction

Use of space

Visual quality

Visual quality

Water environment

Appendix B: Transport indicators that could be used for social and distributional impact assessments

These are the Ministry of Transport’s transport indicators that could be used to support analysis of social and distributional impacts. In some instances, distributional assessments would depend on the level of disaggregated data

Transport indicator	Transport outcome
Regional connectivity	Economic prosperity
Greenhouse gases emitted from the New Zealand transport system	Environmental sustainability
Marine oil spills in New Zealand waters	
Mode share of short trips	
Transport-related water pollution	
Exposure to elevated concentrations of air pollution from the transport system	Healthy and safe people
Exposure to elevated levels of noise from the transport system	
Harmful emissions from fuel combustion	
Time spent travelling by active modes	
Transport-related deaths	
Transport-related serious injuries	
Household spending on transport (% of income)	Inclusive access
People unable to make a beneficial transport journey	
Rural households without access to a motor vehicle	
Population with access to frequent public transport services	
Access to jobs	
Perceived safety of walking and cycling	
Perception of public transport	
Unmet need for GP services due to a lack of transport	
Access for people with disabilities and/or limited mobility	
Integration of land use and transport planning	
Reliability of travel times for transport users	
Walkability in urban centres	
Availability of viable alternative routes	
Perceived personal safety while using the transport system	
Security incidents	
Susceptibility to coastal inundation with sea level rise	

Appendix C: Search strategy methodology

The search strategy included identification of key reviews, searching review reference lists, and database searches. The database search strategy for this search is based on that developed by Hosking et al (2019). We have modified the search to include a wider range of equity considerations, more transport modes, and more possible policies by incorporating policy levers from the Waka Kotahi NZ Transport Agency (2019) mode shift report *Keeping cities moving*. Additionally, we restricted results to transport-related subject headings to reduce the number of irrelevant results returned.

C.1 Inclusion criteria

We began by developing a set of eligibility criteria (see table C.1), on which the search strategy was based, and against which the results were evaluated. The equity, intervention and policy criteria outlined below were used in searches. The transport and utility criteria were additionally used in evaluating identified papers. Transport was addressed in searches by using the transportation subject heading.

In order to be included in the database of relevant literature, identified papers needed to fit within one of the three policy-focused tables. This resulted in excluding some potentially relevant studies that applied to equity in general, but not to a specific policy or policies. For example, papers examining equity assessment tools or principles. This literature has been included elsewhere throughout the report where appropriate.

Table C.1 Eligibility criteria

'Equity focused' criteria
<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Must assess whether impacts of transport interventions differ by at least one of: ethnicity, SES, age, gender or sex, employment status, urbanicity of home location, disability. • Income, education, employment, housing, tenure and area deprivation are all acceptable measures of SES. • Reported effects stratified by one of these variables are acceptable, as are interaction effects.
<p>Exclusion criteria</p> <ul style="list-style-type: none"> • Studies assessing only confounding by one or more of these measures • Reviews that did not discuss equity related factors in their analysis of the literature
'Intervention' criteria
<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Studies must include some type of policy, plan or programme where the effect is being tested, modelled, theorised, or highlighting inadequacies or effects of existing policy
<p>Exclusion criteria</p> <ul style="list-style-type: none"> • Studies that report on intervention induced behaviour change only within the population as a whole
'Policy' criteria
<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Has some kind of identifiable policy or policy relevant focus. • Addresses a policy identified within one of the two mode shift policy documents.
<p>Exclusion criteria</p> <ul style="list-style-type: none"> • Papers that discussed the benefits of mode shift in general without reference to a specific policy of mechanism for effecting that change

'Equity focused' criteria
<p>'Transport focused' criteria</p> <p>Inclusion criteria</p> <ul style="list-style-type: none"> • Studies of transport interventions covering any transport mode, including car, bicycle, walking, and public transport • Assessed impacts may include cost, time, noise, distance travelled, accessibility, air pollution, or FCO, quantitative measures of health and wellbeing • Studies may be either quantitative, including both empirical and modelling studies, or qualitative <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Studies describing (but not assessing) the implementation of a transport intervention are excluded • Studies examining walking or cycling for reasons other than transport, ie activities focused primarily on leisure, recreation, fitness or health.
<p>'Utility' criteria</p> <p>Inclusion criteria – at least one of:</p> <ul style="list-style-type: none"> • Discuss transport resources, risks and opportunities, or outcomes with reference to one or more affected population groups • Discuss transport resources, risks and opportunities, or outcomes with reference to a specific policy, intervention, or change (eg natural experiment) that fitted within one of the six policy levers • Discuss a specific policy, intervention, or change (eg natural experiment) that fitted within one of the six policy levers with respect to one or more of the affected population groups <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Papers that discussed equity in general, without reference to specific policies, social impacts (such as resources or risks) or sub-populations • Papers discussing tools for evaluating equity or related change, except where a relevant case study was included.

C.2 Key reviews and reference lists

Key reviews were identified by examining our existing database of relevant literature and checking reference lists of key review papers.

Additional literature was obtained from our existing database of relevant literature.

Additional papers were added when particularly relevant sources were encountered when evaluating literature for inclusion, as suggested by colleagues, from our existing library of literature, or during other tasks required for preparation of the report

C.2.1 Search strategy

We developed the search strategy in three parts: an 'equity' focused component (drawn from Hosking and expanded to fit our needs), a policy component combined with the transportation subject heading, and an optional 'intervention' component. Each policy component was split into a separate search so that it was clear which papers were identified by which search pattern. Each search has two outputs: the first output incorporates the equity (#10 in table C.2), policy (#13 in table C.3) and transportation (#11 in table C.1) searches (first output #14 in table C.3), and an output that added the intervention (#12 in table C.2) search (second output #15 in table C.3). The base structure for all searches can be seen in table C.2. The policy searches can be found in tables C.2 to C.7. Additionally, we used the same basic search

strategy with terms for New Zealand, which returned a small enough number of potential papers to be worth reviewing the results (table C.7).

We initially deployed the search strategy in MEDLINE, as this database has excellent and highly specific tools for searches. However, the MEDLINE search returned a high proportion of clearly irrelevant results (241/273, 88%), thus we repeated the search in the Web of Science using as similar a strategy as possible. The Web of Science search returned a much lower proportion of irrelevant results.

Table C.2 Base search strategy

#	Search terms	Results
1	TS=(equit* or inequit* or inequalit* or disparit* or equality)	454,351
2	TS= (ethnic* or race or racial* or racis*)	438,896
3	TS= ((social* or socio-economic or socioeconomic or economic or structural or material) NEAR (advantage* or disadvantage* or exclude* or exclusion or include* or inclusion or status or position or gradient* or hierarch* or class* or determinant*))	577,328
4	TS= (SES or SEP or sociodemographic* or socio-demographic* or income or wealth* or poverty or "educational level" or "level of education" or "educational attainment" or "well educated" or "better educated" or "home owner*" or tenure or affluen* or "well off" or "better off" or "worse off")	523,241
5	TS= (Age or young* or older or old or youth or elder*)	4,683,754
6	TS= (Gender or sex or woman or women or female or parent or mother or father)	3,330,657
7	TS= (unemploy* or employ* or "full time" or full-time or fulltime or "part time" or part-time or parttime or disability or disabled or "able-bodied" or "able bodied")	1,847,530
8	TS= (Urban or rural or city)	952,792
9	TS=("Vulnerable population*" or "socioeconomic factor*" or poverty or "social class*" or "Healthcare Disparit*" or "Health Status Disparit*" or depriv* or "depriv* areas" or "Urban population*")	242,260
10	#9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1	9,862,868
11	SU= Transportation	198,610
12	TS=(((pre or pre- or before) NEAR (test or measure or intervention or experiment or trial or implementation or implementing or evaluation)) AND ((post or post- or after) NEAR (test or measure or intervention or experiment or trial or implementation or implementing or evaluation)) or appraisal or ("ex ante" and "ex post"))	255,709

Table C.3 Policy search strategy for spatial and place-based planning

#	Search terms	Results
13	TS=("Transit-oriented development" OR TOD OR Densification OR "Walk* infrastructure" OR "walk* network" OR "walk* facilit*" or "bik* infrastructure" OR "bik* network" OR "bik* facilit*" OR "*Cycl* infrastructure" OR "*cycl* network" OR "*cycl* facilit*" OR "urban design" OR "street design" OR "built environment")	53,566
14	#13 AND #11 AND #10	1,801
15	#14 AND #12	24

Table C.4 Policy search strategy for education, engagement and awareness

#	Search terms	Results
13	TS=(“Mobility as a service” OR “Temporary traffic management” OR Roadworks OR “Street party” OR “Travel demand management polic*” OR “School travel plan*” OR “School travel” OR noise OR “Workplace travel plan*” OR “Residential travel plan*” OR “personal* travel plan”)	666,392
14	#13 AND #11 AND #10	1,855
15	#14 AND #12	10

Table C.5 Policy search strategy for economic tools

#	Search terms	Results
13	TS= (“Road pricing” or “Road user charg*” or “Congestion pricing” or “Workplace travel plan*” or “Residential travel plan*” or “Personalised travel plan*” or (Parking and (charg* or pric*)) or “Public transport subsidy” or “Public transit subsidy” or “Concessionary fare*” or “Integrated ticketing” or Tax or “Parking management” or “Congestion charge” or “Workplace parking levy”)	95,896
14	#12 AND #11 AND #10	1,285
15	#14 AND #12	27

Table C.6 Policy search strategy for safety

#	Search terms	Results
13	TS=(Safety AND (traffic OR pedestrian OR cyclist) OR accident*)	194,332
14	#13 AND #11 AND #10	134
15	#14 AND #12	2

Table C.7 Policy search strategy for New Zealand

#	Search terms	Results
13	TS=(“New Zealand” OR Aotearoa)	117,260
14	#13 AND #11 AND #10	294
15	#14 AND #12	5

C.2.2 Paper evaluation

In order to be added to the database of relevant literature, each paper needed to fit within one of the three policy-focused tables, as well as meeting the other inclusion criteria. In other words, each included paper addresses one of the following three combinations of material:

- transport resources, risks and opportunities, or outcomes with reference to one or more affected population groups
- transport resources, risks and opportunities, or outcomes with reference to a specific policy, intervention, or change (eg natural experiment) that fitted within one of the six policy levers
- examines a specific policy, intervention, or change (eg natural experiment) that fitted within one of the six policy levers with respect to one or more of the affected population groups.

This means that some useful tools have been excluded. Examples include equity assessment tools or papers addressing how learnings from other disciplines can be applied to transport equity. This is because the purpose of this project is to address how the policy levers have the potential to impact on transport equity. Relevant papers that do not fit within this framework, such as the examples above, have been included elsewhere in this document.

Appendix D: Social impacts

The numbers in brackets throughout this appendix refer to the publications listed in appendix G.

Appendix D: Social impacts

Social impacts	Affected groups										
	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability
Transport resources (eg access to public transport (PT))	<p>Motoring costs highly regressive [45], low income associated with mobility poverty [20], cannot afford most efficient vehicles that would reduce costs [28], lack access to fast efficient travel [54]. TOD can improve access if designed for access [11], but PT cost can be high [21], and can be displaced by gentrification [13]. Cycle storage can be challenging [6], issues with bike storage and theft [3].</p>	<p>Often have more access to PT and other transport resources [2, 59]. Own more cars [6]. Likely to benefit from increased property values surrounding TOD [13]. Wealthier parents are more able to take time to support their child walking to school [7]</p>	<p>More resources required to travel long distances, may be negatively impacted by car reduction measures [3] or increases in costs [6], car ownership may be perceived as a necessity, young people in rural areas may be particularly disadvantaged [6], decline of rural PT (NZ?) [6], had high transport needs and limited or no service (Tasmania) [21], FCO can cause economic stress and limit travel [25], motoring costs highly regressive [45], PT in NZ meets mobility needs of those without a car only in a few city centre locations [51]. Cost of petrol tends to be higher and is a key risk [3,6]. May have limited PT access that is impractical to remedy [21]</p>	<p>Less likely to have access to high frequency public transport [1], may be negatively impacted by car reduction measures [3], addition of high transport costs for long commutes to housing costs negatively impacts affordability of peripheral areas [14]. Cost of petrol is a key risk [3]</p>	<p>Less likely to have access to high frequency public transit [1,2], addition of transport costs to housing costs negatively impacts affordability of peripheral areas [14], had high transport needs but high cost services [21], FCO can cause economic stress and limit travel [25], motoring costs highly regressive [45], high car ownership does not guarantee access [46], PT in NZ meets mobility needs of those without a car only in a few city centre locations [51].</p>	<p>Car ownership perceived as a necessary tool to access opportunities even with low income [27], but FCO can cause economic stress [25]. PT in NZ meets mobility needs of those without a car only in a few city centre locations [51].</p>	<p>More likely to use PT (NZ?) [6], may have a language or social barrier to PT use [29]</p>	<p>Young people in rural areas may be particularly disadvantaged [6]. Wealthier parents are more able to take time to support their child walking to school [7].</p>	<p>More reliant on public transport (NZ?), reliability issues [6]. Older women may struggle with access to transport (physical access, knowledge, safety), vulnerable to transport disadvantage [37], may have limited mobility depending on local policies & services [69]. Wealthier parents are more able to take time to support their child walking to school [7].</p>	<p>Older women may struggle with access to transport, vulnerable to transport disadvantage [37]. Transport options targeted at 'typical' commuter do not serve female or part time workers well [54]. Single parents may have limited mobility depending on local policies & services [69]. Women's walking patterns differ from men's [67]</p>	<p>Caregivers of someone with an illness or disability may struggle with access to transport, transport disadvantage [37], less likely to have a car & PT in NZ meets mobility needs of those without a car only in a few city centre locations [51]</p>
Risks & opportunities (eg noise, jobs)	<p>Access to services can be limited without a car [3, 6], but cost of car ownership and use [3, 6], and cost of public transport are also limiting [3,6, 21], access to employment can be limited [6]. Car ownership perceived as a necessary tool to access opportunities [27], Intl evidence shows lower access greenspace, recreation options in more deprived areas [65] but NZ evidence differs at least somewhat. More likely to live near busy roads (noise, air pollution, accidents) [3], and worse air pollution, noise & crime [5, 20, 29, 65], busy roads impact negatively on social cohesion [6]. Disproportionately affected by motor vehicle related injuries [4,6] and child pedestrian injury rates higher in more deprived areas [42]. Low income areas have highest concentrations of traffic related air pollution while emitting least [61]. More trips undertaken where there is good street connectivity, level of bus services & safe neighbourhoods [26], exposed to increases in price</p>	<p>Less affected by air pollution [5] but generate greatest amount of pollution and other negative effects [59, 61] and have greatest access to opportunities [59]</p>	<p>Traffic danger on busy rural roads (NZ?) [3,6]. Least exposed to transport related pollution [3]</p>	<p>Highest exposure to traffic pollution (in-car), least exposed to pedestrian accidents [3]</p>	<p>May have difficulty accessing activities due to a lack of transport [46]. More likely to be located near busy roads (noise, air pollution, crashes) [3]. Accessibility to goods and services may be poor [71]. Child pedestrian injury rates higher in more deprived areas [42].</p>	<p>More trips undertaken where there is good street connectivity, level of bus services, & safe neighbourhoods [26]. Accessibility may be comparable between high and low-income groups in dense central city locations [71] but needs may differ. May have limited mobility depending on location and local policies/services etc [69]</p>	<p>Personal safety issues (NZ?) [6], less access resources, eg services, greenspace (NZ?) [6]. Higher exposure to poor air quality and noise [65]. Over-represented in traffic injury statistics (NZ?) [6], Māori and Pacific children are more likely to be injured [7]. Discrimination [30]. May perceive walkability attributes differently and may value social cohesion [63]. Absence of data on how to engage with ethnic minority parents on child safety [64]. Māori and Pacific children are more likely to be injured [7]. Child pedestrian injury rates higher in more deprived areas [42]. International evidence suggests some groups may be more car dependent, but applicability to NZ is unclear [29], some groups may have a language or social barrier to using PT [29]</p>	<p>Independent mobility curtailed due to parental fear of traffic [6]. Hit by vehicle is a common cause of death for 5-14 [6]. Cost may be a barrier to access [9]. Lower air quality [61, 65]. Māori and Pacific children are more likely to be injured [7]. Child pedestrian injury rates higher in more deprived areas [42]. Adults supporting youth not in employment, education or training viewed driving as essential to access employment [73]</p>	<p>Fears of traffic, personal safety are a barrier [6, 37] Adversely impacted by motor vehicle crashes [65]. Higher risk of death in an accident [6] for all modes [60].</p>	<p>Women may have less flexibility in travel time and are less likely to alter their trip time even with incentives [40]. Fear of crime substantial factor in women's walking [67]</p>	<p>Lack of access restricts education and employment, risk of social exclusion [6]. Absence of data on how to engage and support parents of children with disabilities on child safety [64]</p>

Social impact assessment of mode shift

Social impacts	Affected groups										
	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability
	of consumer goods e.g. food [10]. Child pedestrian injury rates higher in more deprived areas [42]. Most exposed to and fearful of crime but may have no alternative to walking [4].										
Outcomes and wellbeing	Use buses & walking most [6]. FCO can cause economic stress and limit travel [25], high transport costs may be related to food insecurity [16], high transport costs can result in social exclusion and/or inability to purchase food or medicine [20,22], FCO can result in social exclusion [25]. Lack of a car can impair employment [28]. Lack of access can result in worse medical care [6]. Higher obesity rates (may benefit from active travel) [3], higher rates of illness deriving from air pollution, and other NCDs [6], lower access to greenspace (worse exercise & mental health outcomes) [6], higher levels of night time light [36], as the most exposed, air quality improvements should benefit this group [10], more deprived areas had higher fatality rates regardless of travel mode [60], adversely impacted by motor vehicle crashes [65]. Less likely to cycle [9]. People likely to experience both social exclusion and transport disadvantage belong to groups that are likely to be low income [39].	Travel much more than lower income groups [6, 59], thus receive a greater proportion of public spending [6], lower social exclusion [38]. Engage in more leisure time activity [65] and fewer pedestrian crashes [62]. Use car, rail, cycling most [6].	FCO can result in social exclusion [25]		Busy roads impact negatively on social cohesion [6], as can FCO [25]. Opportunities for access (measured by trips taken) are improved when there is good street connectivity, level of bus services & safe neighbourhoods [26]. Distance reduces physical activity opportunities [4].	FCO can limit travel and can result in social exclusion [25]. Higher levels of night-time light [36]. Wealthier parents are more able to take time to support their child walking to school [7]		Increasing rates of obesity, respiratory illness and issues relating to noise pollution [6]. Youth have higher fatality rates while driving [60], adversely impacted by vehicle crashes [65].	Lack of private vehicle is associated with social exclusion [6], older women vulnerable to social exclusion [37].	Women's walking needs differ from men's [67]. Women more likely to use PT, weaker car driving habits and more likely to change mode [33]. Older women vulnerable to social exclusion [37], people likely to experience both social exclusion and transport disadvantage belong to groups that are more likely to include women [39]. Males have higher fatality rates than females [60].	Those with illness or disability and their caregivers were vulnerable to transport disadvantage and social exclusion [37, 39]

Appendix E: Social impacts of policy levers

The numbers in brackets throughout this appendix refer to the list of publications reviewed in appendix G.

Policies	Social impacts		
	Transport resources (eg access to PT)	Risks & opportunities (eg noise, jobs)	Outcomes & wellbeing
Spatial and place-based planning	Planning for transport equity [2], reducing demand for powered or inequitable transport [6]. Transit-oriented development (TOD) can improve access to public transport [11,13], but issues of gentrification [13, 66]. Better access to bus routes may only support mode shift if combined with built environment that supports shared and active travel [55]. Commuting long distances can be just as unaffordable as inner-city housing [14]. Low density urban fringe presents logistical challenges for efficacy of PT [2]	Aesthetics and repair state of environment influence perceived safety and route selection [58], different social groups may perceive walkability attributes differently [63]	Good urban design can encourage social cohesion and walking for transport [4], TOD can increase property values and cause displacement - depending on design [11,13], TOD associated with higher level of social capital [32]. Street redesign improved walking particularly among lower income women [56].
Policy and regulatory settings (urban form)	Footpath cycling can present a hazard to vulnerable walkers (eg older adults), but roads are not always safe for cyclists (especially children) [72]		Policies that reduce automobile dependence will also reduce vehicle crashes [4]. Low emission zones can improve air quality but who benefits depends on where sited & social geography [47]. Low-speed zones (with traffic calming) reduced road casualties, low-speed limits (no traffic calming) had little effect [74].
Network design, management and optimisation	Assess PT access in low income peripheral areas when designing network [1,2]. Level of service can be a barrier to access for residents of deprived peripheral areas [21],	Changes to PT routes can impact on access to services [17]. Street design influences pedestrian crash frequency [62]	More trips undertaken where there is good street connectivity, level of bus services safe neighbourhoods [26].
Investment in infrastructure, platforms and services	Modelling suggests investment in infrastructure with separated cycleways and speed reductions most cost effective [44]. Investment may have best impact when combined with appropriate urban form to support non-car modes [55].	Gentrification [13, 66]. Mismatch between work and PT service provision inhibited this as a viable option for youth not in employment, education or training and adult supporters [73]	Improved infrastructure likely to increase active travel [15]. Physical fitness and wellbeing may improve health for new cyclists following new infrastructure [9], high-quality, safe walking and cycling routes can increase physical activity [6].

Policies	Social impacts		
	Transport resources (eg access to PT)	Risks & opportunities (eg noise, jobs)	Outcomes & wellbeing
Economic tools (pricing and incentives)	Reducing demand for powered or inequitable transport [6]. Fare structure can be a barrier to access for residents of deprived peripheral areas [21], variable pricing can reduce disparities between groups of motorists [29], road pricing could increase prices of non-transport related items, eg food [10]	Cost inhibited PT as a viable option for youth not in employment, education or training & adult supporters [73]	Increases in fuel prices result in fewer road crashes, deaths and injuries, but more serious injuries among cyclists [23], fuel price increase initially reduced air pollution but benefits not maintained long term [24], free buses targeted at youth caused slight increase in assaults but had little impact of active travel [49]
Education, engagement and awareness		School travel plan positively impacted attitudes but not behaviour [57].	Walking schoolbuses can decrease car use [7]. Parent education can improve child safety behaviours but lack of evidence on engaging and supporting 'at risk' groups [64]

Appendix F: Distributional impacts of policy levers

The numbers in brackets throughout this appendix refer to the list of publications reviewed in appendix G.

Policies	Affected groups										
	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability
Spatial and place-based planning	Derive greatest benefit from reducing dependence on cars [16]. Street redesign improved walking particularly among lower income women [56]. Accessibility to goods and services may be comparable to higher income groups in dense central city locations [71]. Depending on design, transit-oriented development (TOD) improve access to non-car transport or cause displacement [11,13]. Inability to afford centrally located housing can increase transport costs [14]. Can impact on uptake of new PT routes/infrastructure [55].	Depending on design, TOD can increase property values and improve access to non-car transport [11,13], likely to benefit from increased property values surrounding TOD [13]. Ability to afford centrally located housing reduces transport costs [14], more likely to benefit from AT improvements [15]	Widening gap in car dependency between urban and peripheral areas [75]	Policies that reduce urban sprawl could address high combined housing + transport costs that result in long commutes [14]	Policies that reduce urban sprawl could address high combined housing + transport costs that result in lower income residents moving further from city centres [14]			May benefit from improved safety and mobility of car-free development [6]	May benefit from improved safety of car-free development [6]	Street redesign improved walking particularly among lower income women [56]. May benefit from improved safety of car-free development [6]	
Policy and regulatory settings (urban form)	Traffic calming reduced child pedestrian injuries with greatest benefit in more deprived areas [42]	Benefited most from low emission zone in Rome [47], low speed zones reduced road casualties but greatest benefits to most advantaged [50]						Traffic calming reduced child pedestrian injuries with greatest benefit in more deprived areas [42]			
Network design, management and optimisation	Combination of improved safety and infrastructure increased cycling [18]. Changes to public transport (PT) routes can impact on access to services (+/-) [17]. Concentrating PT route development on main commuter routes & periods does not necessarily meet the needs of those experiencing transport exclusion [51]. Benefit only if provided [3]. Good street connectivity, level of bus services & safe neighbourhoods increased trips taken [26]		May not benefit from public transport improvements due to routing [3].	Could benefit from major new routes [3]	May not benefit from public transport improvements due to routing [3,21]. Exhibit transport disadvantage despite high car ownership, may benefit from careful provision of services [46]. Improvements in network design could result in more trips [1,2]	Better access with good street connectivity, level of bus services & safe neighbourhoods [26]			Concentrating PT route development on main commuter routes & periods does not necessarily meet the needs of those experiencing transport exclusion [51]	Concentrating PT route development on main commuter routes & periods does not necessarily meet the needs of those experiencing transport exclusion [51]	Concentrating PT route development on main commuter routes & periods does not necessarily meet the needs of those experiencing transport exclusion [51]
Investment in infrastructure, platforms and services	May have best impact when combined with appropriate urban form [55], street redesign increased walking particularly among lower income women [56], but can only benefit from AT infrastructure if constructed locally [15], high quality, safe walking and cycling routes can increase physical activity [6]. Derive greatest benefit from reducing dependence on cars [16]. Less likely to benefit from infrastructure investment [20], but combination of improved safety and infrastructure increased cycling [18] and may use new infrastructure to cycle [53].	Transport infrastructure investment tends to benefit those who are 'not poor' the most [20], may use new infrastructure to cycle [53], may be more likely to benefit from walkability improvements [15]	Unlikely to benefit from bike/walk projects due to journey distances [3]	Unlikely to benefit from bike/walk projects due to journey distances [3]	Low density urban fringe presents logistical challenges for efficacy of PT [2], high quality, safe walking and cycling routes can increase physical activity [6]	Proximity to new cycle infrastructure slightly increases odds of use [53]		Cycle infrastructure users mostly adults (Brisbane) [43]. Could benefit from services to non 'typical' destinations and times [73]	Investment in cycle infrastructure could resolve footpath use conflicts between cyclists and vulnerable pedestrians [72]	Cycle infrastructure investment increased women cycling (not significant) but users still mostly male [43], women preferred separated cycle infrastructure & "quiet streets" [48], differences in facility preferences between men and women [48], transport options targeted at 'typical' commuter do not serve female or part time workers well [54], street redesign improved walking particularly among lower income women [56]	Investment in cycle infrastructure could resolve footpath use conflicts between cyclists and vulnerable pedestrians [72]

Policies	Affected groups										
	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability
Economic tools (pricing and incentives)	<p>Already have low number of trips and journey distances. Further reductions can cause social exclusion [3], lower public transport fares would benefit those on lower incomes [9,21], FCO have high costs and few alternatives [19] and inelastic fuel demand [22], risk of increase in prices in other goods, eg food [10], low income people with no alternative transport vulnerable to road pricing [29], London CCZ air quality improvements greatest in more deprived areas [35], motoring costs already highly regressive [45], congestion pricing had small, insignificant negative overall effect, obscures larger negative for low income group [68], supply side subsidies are neutral or regressive, demand side subsidies mostly neutral, means-tested direct transfer had positive benefit, flat fare reduction regressive [70]. Vulnerable to road pricing [29], cost can be a barrier to access for those on low incomes despite need [21], at risk of (deeper) economic stress due to fuel price rises if FCO [22], modelling suggests most improved air quality after interventions [29]. demand from some users may be inelastic due to circumstance outside their control [29], inelastic demand among FCO means fuel price rises likely to increase economic stress, but may not increase incidence of stress [22], road user charging may be more effective than low emissions zones in reducing inequity [29]</p>	<p>In Rome higher income groups benefited most from air quality improvements from low emission zones [47]. Road pricing targeting peak periods usually targets those who are more affluent, but not exclusively [29]. High income individuals less sensitive to small monetary benefits [40]</p>	<p>Low income rural drivers may be vulnerable to cost increases [3], motoring costs already highly regressive [45]</p>	<p>Low income drivers with long journeys likely to be hardest hit by increased costs [3]</p>	<p>FCO have high costs and few alternatives [19], cost is a barrier to PT use [21], motoring costs already highly regressive [45]</p>		<p>Lower cost bus travel can have positive impacts on wellbeing [9]. Lower public transport fares would benefit minority ethnic groups who use PT regularly [9].</p>	<p>Reducing cost beneficial [9, 73], free bus travel for youth had little impact on active travel and shifted some trips from car to bus [49] but slightly increased the rate of assaults [49]. Likely to be responsive to road pricing [29].</p>	<p>Support to purchase an e-bike may help this to be a viable option when regular bike is not [6], likely to be responsive to road pricing, but lack of evidence on low income car-dependent older adults [29], older women are vulnerable to transport disadvantage and may benefit from subsidies [37].</p>	<p>Women are more likely to use a toll road for its journey time reliability in some circumstances and an alternate route for its lower cost in others [29], Lower cost bus travel can have positive impacts on wellbeing [9], older women and those looking after someone with an illness or disability are vulnerable to transport disadvantage and may benefit from subsidies [37],</p>	<p>Those looking after someone with an illness or disability are vulnerable to transport disadvantage and may benefit from subsidies [37],</p>
Education, engagement and awareness	<p>Cycling promotion & infrastructure increased active travel decreased car use with greater effects in more deprived areas [18], absence of data on how to engage with low SES parents on child safety [64], Walking schoolbuses can decrease car use but are inequitably distributed [7].</p>	<p>Walking schoolbuses can decrease car use but benefit most advantaged [7]</p>			<p>May not be included in behaviour change programmes [3]</p>		<p>Absence of data on how to engage minority ethnicity parents on child safety [64]</p>	<p>Cycle training can improve safety and knowledge [6], skills and likelihood of cycling to school increased with bicycle education [52]. School travel plan positively impacted attitudes but not behaviour [57], parent education can have positive impact on some child safety behaviours [64]</p>	<p>More likely to change mode [33]</p>	<p>Absence of data on how to engage and support parents of children with disabilities on child safety [64]</p>	

Appendix G: Reviewed evidence

Ref	Citation		Bibliographic			Evidence		Levers (names abbreviated)					Social impacts			Affected groups										Modes included								
	#	First author	Year	Title	Journal	Vol	Iss	Evaluation?	Type of evidence	Spatial planning	Policy and regulatory	Network design	Infrastructure investment	Economic tools	Education and	Resources	Risks & opportunities	Outcomes & wellbeing	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability	Car	Bus	Walk	Cycle	Other
1	Jaramillo, A	2019	Social impact assessment: the case of bus rapid transit in the city of Quito, Ecuador	Measuring transport equity (book)			N	Methodology, case study	N	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N	N
2	Currie, G	2010	Quantifying spatial gaps in public transport supply based on social needs	Journal of Transport Geography	18		N	Spatial analysis/ case study	N	N	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	N	N	Y
3	AEA Group	2011	Knowledge review of the social and distributional impacts of DfT climate change policy options	Report			N	Review	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
4	Giles-Corti, B	2016	City planning and population health: a global challenge	Lancet	388		N	Review	N	N	N	Y	N	N	Y	Y	Y	Y	N	N	N	Y	Y	N	N	N	Y	N	Y	Y	Y	Y	Y	N
5	Kingham, S	2007	Driven to injustice? Environmental justice and vehicle pollution in Christchurch, New Zealand	Transportation Research Part D Report	12		N	Cross sectional	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	~	
6	Sustainable Development Commission	2011	Fairness in a car-dependent society	Report			N	Review	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	~	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N
7	Collins, D	2005	Geographies of inequality: child pedestrian injury and walking school buses in Auckland, New Zealand	Social science and medicine	60		N	Cross sectional	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	N
8	Jagers, S	2017	How exposure to policy tools transforms the mechanisms behind public acceptability and acceptance – the case of the Gothenburg congestion tax	Inter-national Journal of Sustainable Transportation	11	2	N	Case study	N	N	N	N	Y	N	N	Y	N	N	N	N	~	N	Y	N	N	N	N	N	Y	N	N	N	N	
9	Lucas, K	2014	Assessing the equity of carbon mitigation policies for transport in Scotland	Case studies on transport policy	2	2	N	Methodology, review	N	N	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
10	Markkanen S	2019	Social impacts of climate change mitigation policies and their implications for inequality	Climate policy	19	7	N	Discussion	N	N	N	N	Y	N	N	Y	Y	Y	Y	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	
11	Dawkins, C	2016	Transit-induced gentrification: Who will stay, and who will go?	Housing policy debate	26	4-5	N	Modelled	Y	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
12	Calder-Dawe, O	2019	Being the body in question: young people's accounts of everyday ableism, visibility and disability	Disability and Society			N	Qualitative	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	Y	N	N	Y	N	Y	Y	N	Y	
13	Kahn, M	2007	Gentrification trends in new transit-oriented communities: evidence from 14 cities that expanded and built rail transit systems	Real estate economics	35	2	Y	Retrospective analysis	Y	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	
14	Mattingly, K	2014	Housing and transport expenditure: Socio-spatial indicators of affordability in Auckland	Cities	38		N	Spatial analysis/ cross sectional	Y	N	N	N	N	N	Y	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	
15	Smith, S	2017	Systematic literature review of built environment effects on physical activity and active transport – an update and new findings on health equity	International Journal of Behavioral Nutrition and Physical Activity	14		N	Review	Y	N	N	N	N	N	Y	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	
16	Rachele, J	2018	Automobile dependence: a contributing factor to poorer health among lower-income households	Journal of Transport and Health	8		N	Modelled	N	N	N	Y	N	N	N	Y	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	

Ref	Citation			Bibliographic			Evidence		Levers (names abbreviated)					Social impacts			Affected groups										Modes included							
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17	Blair, N	2013	Analysing the impact of network change on transport disadvantage: a GIS-based case study of Belfast	Journal of Transport Geography	31		N	Spatial analysis/ case study	Y	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N
18	Goodman, A	2013	Effectiveness and equity impacts of town-wide cycling initiatives in England: a longitudinal, controlled natural experimental study	Social Science and Medicine	97		Y	Natural experiment	N	N	Y	Y	N	N	N	N	Y	Y	~	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	
19	Currie, G	2018	Alarming trends in the growth of FCO in Melbourne	Australasian Transport Research Forum 2018 Proceedings			N	Longitudinal/ time series	N	N	N	N	Y	N	Y	N	N	Y	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	
20	Lucas, K	2016	Transport poverty and its adverse social consequences	Transport	169	6	N	Review	N	N	N	Y	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	
21	Currie, G	2004	Gap analysis of public transport needs: measuring spatial distribution of public transport needs and identifying gaps in the quality of public transport provision	Transportation Research Record	1895		N	Spatial analysis/ case study	N	N	Y	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	N	N	N	N	N	Y	N	N	N	N
22	Mattioli, G	2018	Vulnerability to fuel price increases in the UK: a household level analysis	Transportation Research Part A	113		N	Cross sectional	N	N	N	N	Y	N	N	Y	Y	Y	N	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	
23	Best, R	2019	Fuel prices and road accident outcomes in New Zealand	New Zealand Economic Papers	53	2	Y	Natural experiment	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	N		
24	Shaw, C	2018	What can fuel price increases tell us about the air pollution health co-benefits of a carbon price?	Journal of Transport and Health	8		Y	Natural experiment	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N		
25	Mattioli, G	2017	FCO in the UK and Germany: socio-spatial patterns and potential economic stress impacts	Social Inclusion	5	4	N	Cross sectional	N	N	N	N	N	N	Y	N	Y	Y	N	Y	N	Y	Y	N	N	N	N	Y	N	N	N	N		
26	Lucas, K	2018	Is transport poverty socially or environmentally driven? Comparing the travel behaviours of two low-income populations living in central and peripheral locations in the same city	Transportation Research Part A	116		N	Spatial analysis/ case study	N	N	Y	N	N	N	N	Y	N	Y	N	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y		
27	Curl, A	2018	Household car adoption and financial distress in deprived urban communities: A case of FCO?	Transport Policy	65		N	Longitudinal/ time series	N	N	N	N	N	N	Y	N	N	Y	N	N	N	~	Y	N	N	N	N	Y	N	N	N	N		
28	Mattioli, G	2017	Transport poverty and fuel poverty in the UK: from analogy to comparison	Transport Policy	59		N	Discussion	N	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	Y	N	N	N	N		
29	Parkhurst, G	2006	Understanding the social and distributional impacts of road pricing	Report (DfT)			N	Review	N	N	N	N	Y	N	Y	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N
30	Coughenour, C	2020	Estimated car cost as a predictor of driver yielding behaviours for pedestrians	Journal of Transport and Health	16		N	Cross sectional	N	Y	N	N	N	N	N	N	Y	N	Y	N	N	N	N	Y	N	N	N	Y	N	Y	N	N		
31	Kamruzzaman, M	2013	Residential dissonance and mode choice	Journal of Transport Geography	33		N	Cross sectional	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y		
32	Kamruzzaman, M	2014	Patterns of social capital associated with transit-oriented development	Journal of Transport Geography	35		N	Cross sectional	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
33	Matthies, E	2002	Travel mode choice of women: The result of limitation, ecological norm, or weak habit?	Environment and Behaviour	34	2	N	Cross sectional	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N		
34	Kelly, F	2011	The impact of the congestion charging scheme on air quality in London	Report			Y	Spatial analysis/ case study	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N		

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35	Tonne, C	2007	Air pollution and mortality benefits of the London congestion charge: spatial and socio-economic inequalities	Occupational and Environmental Medicine	65	9	Y	Spatial analysis/case study	N	N	N	N	Y	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	
36	Côté-Lussier, C	2020	A novel low-cost method for assessing intra-urban variation in night-time light and applications to public health	Social Science and Medicine			N	Cross sectional	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
37	Delbosc, A	2011	Transport problems that matter – social and psychological links to transport disadvantage	Journal of Transport Geography	19		N	Cross sectional	N	N	N	N	Y	N	Y	N	Y	N	N	N	N	Y	N	N	N	Y	Y	Y	N	Y	N	N	N	N	
38	Stanley, J	2011	Social exclusion and the value of mobility	Journal of Transport Economics and Policy	45	2	N	Cross sectional	N	N	N	N	N	N	Y	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	
39	Delbosc, A	2011	Exploring the relative influences of transport disadvantage and social exclusion on well-being	Transport Policy	18		N	Cross sectional	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
40	Ben-Elia	2011	Rewarding rush-hour avoidance: A study of commuters' travel behavior	Transportation Research Part A	45		N	Case study	N	N	N	N	Y	N	Y	N	N	Y	Y	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	N	
41	Zhao, P	2019	Travel satisfaction inequality and the role of the urban metro system	Transport Policy	79		N	Case study	N	N	Y	N	N	N	Y	N	N	Y	Y	N	N	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	
42	Jones, S	2005	Traffic calming policy can reduce inequalities in child pedestrian injuries: database study	Injury Prevention	11		N	Natural experiment	N	Y	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	
43	Heesch, K	2016	Evaluation of the veloway 1: a natural experiment of new bicycle infrastructure in Brisbane, Australia	Journal of Transport and Health	3		Y	Evaluation	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	Y	N	N		
44	Macmillan, A	2014	The societal costs and benefits of commuter bicycling: simulating the effects of specific policies using system dynamics modeling	Environmental Health Perspectives	122	4	N	Modelled	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N
45	Chatterton, T	2018	Financial implications of car ownership and use: a distributional analysis based on observed spatial variance considering income and domestic energy costs	Transport policy	65		N	Spatial analysis/cross sectional	N	N	N	N	Y	N	Y	N	N	Y	N	Y	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N
46	Delbosc, A	2011	The spatial context of transport disadvantage, social exclusion and well-being	Journal of Transport Geography	19		N	Cross sectional	N	N	Y	N	N	N	Y	N	N	Y	N	Y	N	Y	Y	N	N	N	N	N	Y	Y	N	N	N	Y	
47	Cesaroni, G	2012	Health benefits of traffic-related air pollution reduction in different socio-economic groups: the effect of low-emission zoning in Rome	Occupational and Environmental Medicine	69	2	Y	Natural experiment	N	Y	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N
48	Pucher, J	2010	Infrastructure, programs, and policies to increase bicycling: an international review	Preventive Medicine	50		N	Review	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	
49	Edwards, P	2013	Health impacts of free bus travel for young people: evaluation of a natural experiment in London	Journal of Epidemiology and Community Health	67	8	N	Natural experiment	N	N	N	N	Y	N	Y	N	Y	N	N	N	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	
50	Steinbach, R	2011	The impact of 20 mph traffic speed zones on inequalities in road casualties in London	Journal of Epidemiology and Community Health	65	10	N	Natural experiment	Y	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	
51	Rose, E	2010	Transport related social exclusion in New Zealand: evidence and challenges	Kōtuitui: New Zealand Journal of Social Sciences online	4	3	N	Qualitative	N	N	Y	Y	N	N	Y	N	N	Y	N	Y	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	

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52	van Lierop, D	2016	Bicycle education for children: evaluation of a program in Montreal, Quebec, Canada	Transportation Research Record	258	7	Y	Evaluation	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	Y	N	
53	Rodriguez-Valencia, A	2019	Impact of household proximity to the cycling network on bicycle ridership: the case of Bogotá	Journal of Transport Geography	79		N	Natural experiment	N	N	N	Y	N	N	N	N	N	Y	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	Y	N	
54	Jahanshahi, K	2015	Direct and indirect influences on employed adults' travel in the UK: new insights from the National Travel Survey data 2002–2010	Transportation Research Part A	80		N	Modelled	Y	N	N	Y	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	Y	N	Y	Y	Y	Y	Y	Y	
55	Combs, T	2014	Joint impacts of bus rapid transit and urban form on vehicle ownership: new evidence from a quasi-longitudinal analysis in Bogotá, Colombia	Transportation Research Part A	69		N	Natural experiment	Y	N	N	Y	N	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	
56	Chang, A	2017	The effect of BRT implementation and streetscape redesign on physical activity: a case study of Mexico City	Transportation Research Part A	100		N	Matched control	Y	N	N	Y	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	Y	N	N	Y	Y	Y	Y	N	
57	Buttazzoni, A	2019	Promoting active school travel in elementary schools: a regional case study of the school travel planning intervention	Journal of Transport and Health	12		Y	Evaluation	N	N	N	N	N	Y	N	N	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	N	Y	Y	Y	N	
58	Martínez, C	2019	Walking through deprived neighbourhoods: meanings and constructions behind the attributes of the built environment	Travel Behaviour and Society	16		N	Qualitative	Y	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N
59	Iglesias, V	2019	How uneven is the urban mobility playing field? Inequalities among socio-economic groups in Santiago de Chile	Transportation Research Record	267	1	N	Cross sectional	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	
60	Feleke, R	2018	Comparative fatality risk for different travel modes by age, sex, and deprivation	Journal of Transport and Health	8		N	Longitudinal/ time series	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	
61	Barnes, J	2019	Emissions vs exposure: Increasing injustice from road traffic related air pollution in the United Kingdom	Transportation research part D	73		N	Cross sectional	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	
62	Chimba, D	2018	Associating pedestrian crashes with demographic and socio-economic factors	Case studies on transport policy	6		N	Cross sectional	N	N	N	Y	N	N	N	N	Y	Y	Y	N	N	N	Y	N	N	N	N	N	Y	N	Y	N	N	N	
63	Adkins, A	2019	Differences in social and physical dimensions of perceived walkability in Mexican American and non-Hispanic white walking environments in Tucson, Arizona	Journal of Transport and Health	14		N	Cross sectional	Y	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	N	N	N	Y	N	N	N	
64	O'Toole, S	2019	Educating parents to support children's road safety: a review of the literature	Transport reviews	39	3	N	Review	N	N	N	N	N	Y	N	N	Y	Y	N	N	N	N	N	N	Y	Y	N	N	Y	N	Y	Y	Y	N	
65	Khreis, H	2016	The health impacts of traffic-related exposures in urban areas: understanding real effects, underlying driving forces and co-producing future directions	Journal of Transport and Health	3	3	N	Review	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	
66	Grimes, A	2013	Spatial effects of urban rail upgrades	Journal of Transport Geography	30		N	Natural experiment	Y	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	
67	Golan, Y	2019	Gendered walkability: Building a daytime walkability index for women	Journal of Transport and Land Use	12	1	N	Spatial analysis/ cross sectional	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N
68	Karlström, A	2009	Behavioral adjustments and equity effects of congestion pricing: analysis of morning commutes during the Stockholm Trial	Transportation Research Part A	43		N	Natural experiment	N	N	N	N	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	N	
69	Morency, C	2011	Distance traveled in three Canadian cities: spatial analysis from the perspective of vulnerable population segments	Journal of Transport Geography	19		N	Cross sectional	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y

Ref	Citation		Bibliographic			Evidence		Levers (names abbreviated)					Social impacts			Affected groups										Modes included								
	#	First author	Year	Title	Journal	Vol	Iss	Evaluation?	Type of evidence	Spatial planning	Policy and regulatory	Network design	Infrastructure investment	Economic tools	Education and	Resources	Risks & opportunities	Outcomes & wellbeing	Low income households	High income households	Rural areas	Long distance commuters	Deprived peripheral areas	Urban areas	Minority ethnic groups	Young people (<25)	Older people (>= 60)	Gender	Disability	Car	Bus	Walk	Cycle	Other
70	Serebrisky, T	2009	Affordability and subsidies in public urban transport: what do we mean, what can be done?	Transport reviews	29	6	N	Case study	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	Y
71	Pález, A	2010	Relative accessibility deprivation indicators for urban settings: definitions and application to food deserts in Montreal	Urban studies	47	7	N	Case study	Y	N	N	N	N	N	N	Y	N	Y	N	N	N	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	
72	Ward, J	2016	Footpath cycling rule options research	Report			N	Cross sectional	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	N	N	Y	N	Y	N
73	Hawley, G	Accepted	The normative influence of adults on youth access: challenges and opportunities in the context of shifts away from car-dependence	Journal of Transport and Health			N	Qualitative	N	N	Y	Y	N	N	Y	Y	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	
74	Cleland, C	In press	Effects of 20 mph interventions on a range of public health outcomes: a meta-narrative evidence synthesis	Journal of Transport and Health			N	Review	N	Y	N	N	N	N	N	Y	Y																	
75	Wiersma, J	2017	Adapting spatial conditions to reduce car dependency in mid-sized 'post growth' European city regions: the case of South Limburg, Netherlands	Transport Policy	55		N	Case study	Y	N	N	Y	N	N	Y	Y	N	N	N	Y	Y	Y	Y	N	N	N	N	Y	Y	N	N	Y		