Road space reallocation in Scotland: A health impact assessment

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ABSTRACT

Introduction: Road space reallocation involves re-distributing space away from motor vehicles, including car parking and carriageway space, towards other uses. This can promote a shift to more sustainable travel modes and is likely to affect health through multiple pathways.
Methods: We conducted a health impact assessment to identify and assess the potential impacts of road space reallocation on health and health inequalities in Scotland. This involved a facilitated scoping workshop to identify potential impacts, collation of routine data, interviews with 13 key informants and a rapid review of research literature.
Results: We found that road space reallocation could have positive impacts on health by reducing overall levels of private motorised traffic, encouraging walking, wheeling and cycling, realising benefits from alternative uses of space and supporting local businesses. There is potential for positive impact on public transport if space is reallocated to prioritise buses, but bus users can also be disadvantaged if bus routes are diverted or stops impeded. Reallocation can improve transport and health equity if it increases support for modes other than car use, but disabled people may be disadvantaged if the reallocated space, and alternative modes, are not accessible for them.
Conclusions: Road space reallocation can improve health and help reduce health inequalities. However, consideration is needed to ensure sufficient alternatives to car use are supported and the reallocated space is accessible for people with different needs. Reallocation schemes should be considered as part of a wider inclusive approach to road transport supporting active travel and public or community transport. Road space reallocation should contribute to wider place-making initiatives aiming to improve quality of local environments and meet community needs.

1. Introduction

The places people live affect health through multiple pathways and are influenced by the interaction between transport, spatial and community planning (Marmot et al., 2010). Places promoting good health should include sustainable transport options, good quality

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green and public spaces, equitable access to employment, goods and services, good maintenance, safety and opportunities for community influence (Improvement Service, 2022). Environments dominated by motor vehicles are unlikely to show these characteristics, instead being associated with severance, poor air quality, noise pollution, physical inactivity, road traffic casualties and carbon emissions (Teuton et al., 2020).

1.1. Road space reallocation

Road space reallocation involves re-distributing space away from motor vehicles, including car parking and carriageway space, towards other uses like active travel infrastructure, bus lanes, local retail, play space and greenspace (Victoria Transport Policy Institute, 2019). Reallocation measures may include removal of parking spaces, removal or narrowing of road lanes, replacing roads with pedestrian or cycling infrastructure, bus gates, modal filters that restrict through traffic, signage and restricting vehicle use (Victoria Transport Policy Institute, 2019). Space can be reallocated permanently, temporarily, or at specific times, for example creating play streets (Playing out, 2022) or safer access to school at the start and end of the day (School Streets Initiative, 2022). Changing road priority, reducing dominance of car traffic and a placemaking approach can support more sustainable modes and improve liveability (Curtis and Tiwari, 2008; McAndrews and Marshall, 2018; Tsigdinos et al., 2021) The stated aims of reallocation vary and may be unclear, inhibiting their evaluation. Reallocation may aim to discourage use of motor vehicles and/or encourage more sustainable travel modes, to improve public space, or have other aims (Victoria Transport Policy Institute, 2019).

1.2. Health impact assessment

Health impact assessment (HIA) is a recognised process to identify and assess the impacts of policies and actions across sectors on health and health inequalities, to inform decision making and improve health and equity (Douglas, 2019). Best practice principles (Winkler et al., 2021) state that HIAs should consider a comprehensive range of health determinants including impacts on equity and sustainability, involve stakeholders appropriately and use a range of evidence sources impartially. HIA follows the structured process shown in Table 1, but the assessment depth and evidence used are adapted to suit the circumstances. HIA can support a 'health in all policies' approach, characterised by holistic consideration of health determinants, partnership working and ensuring public policies enhance health benefits and minimise health harms (Green et al., 2021).

1.3. Context for the HIA

The Scottish National Transport Strategy has four priorities – equality, climate action, health and wellbeing, and economy (Transport Scotland, 2020a). It promotes the Sustainable Travel Hierarchy, prioritising walking and wheeling, followed by cycling, then public transport, then shared transport, with private cars lowest priority (Transport Scotland, 2020a). Scottish Government has set a target to reduce car kilometres travelled in Scotland by 20% by 2030 and consulted on policy measures to achieve that, which could include road space reallocation (Transport Scotland, 2022b). Understanding benefits and risks to health can help ensure these measures promote health and equity, meeting the National Transport Strategy priorities.

Public Health Scotland hosts the Public Health and Sustainable Transport Partnership group (including the current authors). This brings together transport and public health professionals and policy makers to identify health and equity implications of transport policies and influence responses to improve these impacts (Douglas, 2022).

During the Covid-19 pandemic in Scotland, road space was temporarily reallocated to provide space for people to safely distance while walking, wheeling or cycling under the 'Spaces for People' programme. Scottish local authorities can decide to make temporary 'Spaces for People' schemes permanent or introduce new schemes (Sustrans, 2021). The Partnership group identified road space reallocation as a policy response likely to have wider effects on health and wellbeing as well as the economy, emissions and equity. Despite potential benefits, it is often contentious (Anderson, 2021). Partners identified HIA as a useful way to understand the impacts and to inform future decisions across Scotland.

The HIA aimed to identify and assess both positive and negative impacts of road space reallocation on health and wellbeing in Scotland, including differential impacts on populations that experience poorer health. This paper will describe the methods and sources used in the HIA, present the findings, the impacts identified, set these in context of other literature and discuss the recommendations made to Scottish Government and local authorities.

Table 1
Health Impact Assessment steps (adapted from Green et al., 2021).

HIA steps	Tasks
Screening	Determine if a HIA would be useful.
Scoping	Identify relevant areas of impacts and set terms of reference for assessment.
Appraisal	Collate evidence to assess impacts. Evidence is commonly derived from a mix of routine data, stakeholder engagement and published research evidence.
Recommendations	Make recommendations to mitigate adverse impacts, enhance positive impacts and reduce health inequalities relating to the proposal.
Reporting	Report to decision makers and affected populations.
Monitoring	Monitor recommendations and impacts that arise after implementation.

2. Materials and methods

We used several sources of data and evidence to identify and assess affected populations and health impact pathways.

2.1. Scoping

To identify potential areas of impact, we held a facilitated scoping exercise using a health impact checklist (Douglas, 2019) prompting consideration of population groups and health determinants. This generated a set of hypothesised impacts. We then developed research questions to guide the collation of evidence to assess these impacts. Research questions and evidence sources for each are given in Supplementary Appendix 1.

2.2. Routine data

We collated routine data from National Records of Scotland and Scottish Public Health Observatory reports to provide a socio-demographic and health profile of Scotland. To describe patterns of transport use we used routine data from Transport Scotland, the Scottish Household Survey, Stats 19 road injury records, Cycling Scotland data from automated cycle counters and census data.

2.3. Rapid review of research evidence

We completed a scoping review of research evidence on the impact of reallocating road space to active travel infrastructure, on outcomes including active travel, air quality, safety, social interaction, access to goods and services, economic outcomes and equity. We searched Scopus and Medline for primary research or reviews of intervention studies, in high income countries, in English between 2000 to February 2021, using search terms agreed with experts in transport and health. We also hand searched for relevant articles in the last five years, in the Journal of Transport & Health and Health & Place. Finally, we contacted local and international academics and experts for ongoing or unpublished research. One author (JT) screened articles by title and abstract, and then reviewed full text of those meeting the inclusion criteria. Data were extracted on intervention and setting; methodology; outcome measures; key findings; outcomes. The full review and methodology are published separately (Teuton et al., 2022). We also completed a more limited database search for reviews of research in the last 10 years, on reallocation of road space to public transport, greenspace, recreational space and temporary interventions to promote active travel for children. In addition, we used a synthesis of umbrella reviews of links between transport and health, which we had completed in July 2020 and is published separately (Teuton et al., 2020).
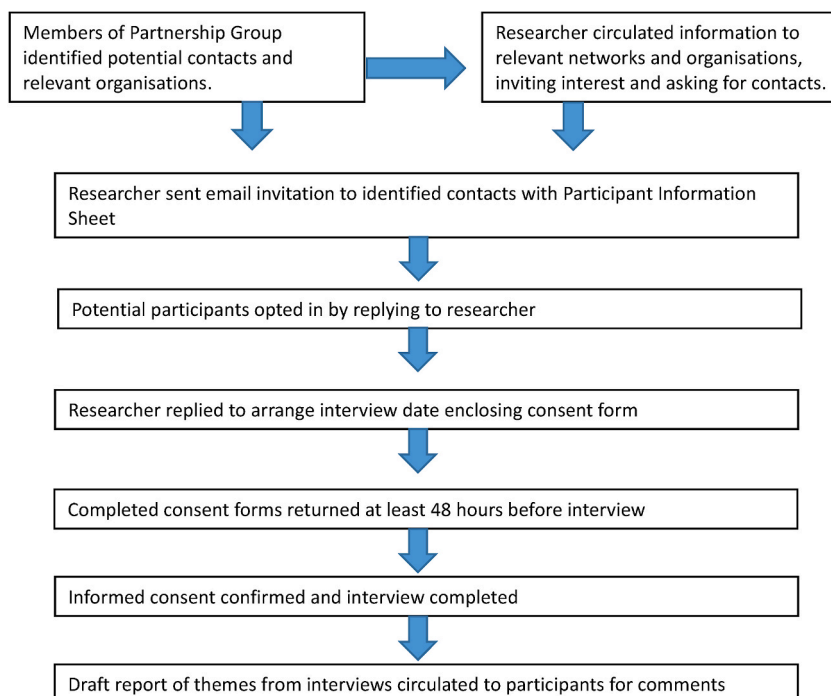

Fig. 1. Key informant recruitment process.

2.4. Key informant interviews

We took a purposive sampling approach to allow in-depth discussion with a small number of individuals providing specific relevant perspectives, rather than gathering less in-depth responses from a larger number (Hammarberg et al., 2016). We interviewed 13 key informants, purposively selected to represent views of the following stakeholder groups: local authority officers involved in road space reallocation (3), disabled people's organizations (5), public transport (3), and businesses (2). Informants were individuals whose profession or role enabled them to represent the views of one of these groups. Potential participants were identified by the Partnership or through relevant networks. We contacted them with information about the study and participants opted in. Fig. 1 shows the recruitment process. One author (MD) conducted the interviews, online on Teams using a topic guide, in March or April 2021. Interviews were recorded, written up, and analysed thematically. We circulated a draft report of findings, inviting participants to check it accurately reflected their perspectives.

2.5. Synthesis of findings and recommendations

We collated evidence for each impact pathway in narrative text. We summarised impacts in an impacts table, which was discussed,
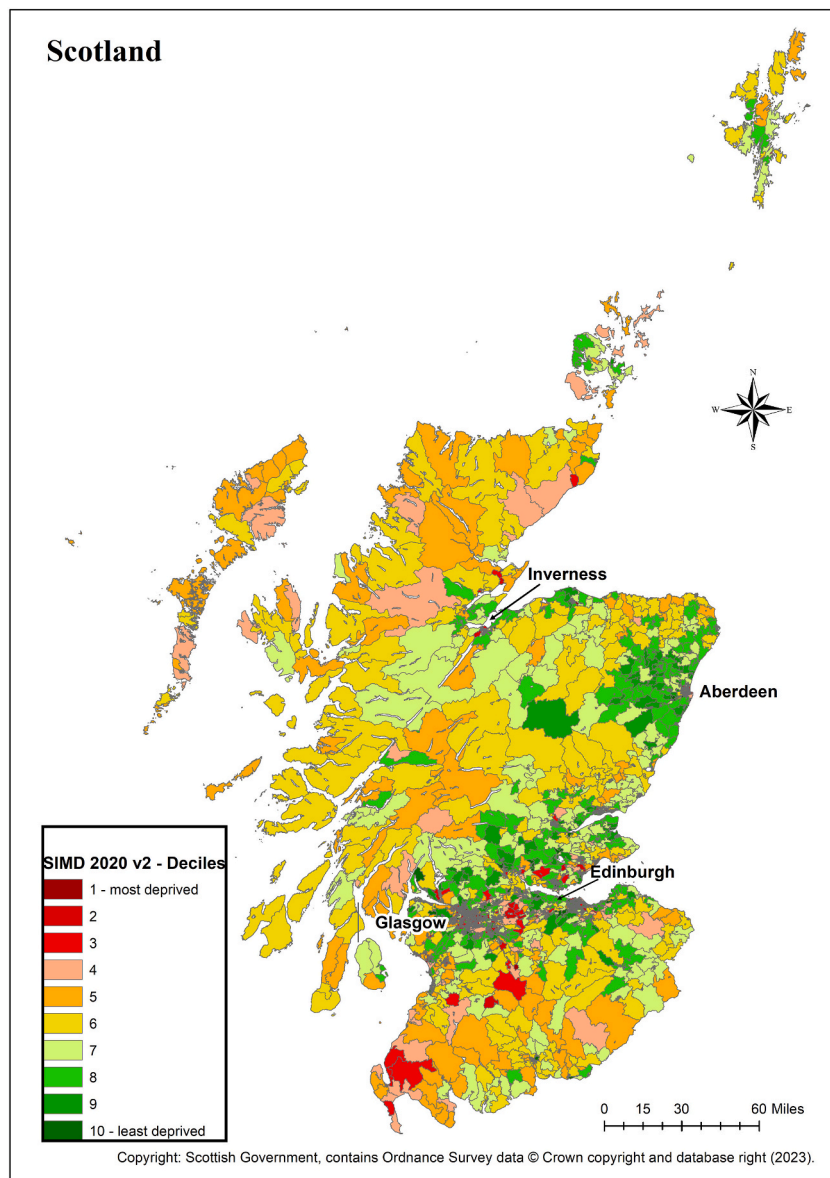

Fig. 2a. Map of Scotland showing datazones by deprivation decile.

amended and agreed by the Data and Evidence subgroup of the Partnership group. The full Partnership group reviewed the full report including all the evidence, debated the findings and agreed the HIA recommendations.

3. Results

3.1. Transport access and use in Scotland

Scotland has a population of 5.5 million people, 71% living in urban areas, 20% in accessible small towns and 9% in remote rural areas including islands (National Records of Scotland, 2021d). Life expectancy at birth is lower than other Western European countries, at 77 years for men and 81 years for women in 2020 (National Records of Scotland, 2021c). Healthy life expectancy in 2020 was 62 years for both men and women, so people spend many years in poor health (National Records of Scotland, 2021b). In 2019, 26% of adults reported a limiting long term physical or mental health condition, and 8% were unable to work due to illness or disability (Scottish Public Health Observatory, 2022). Fig. 2a and b shows the geographic distribution of multiple deprivation in Scotland, which is associated with significant health inequalities. Both men and women in the most deprived areas live 24 fewer years in good health compared with the least deprived areas (National Records of Scotland, 2021b).

Table 2 presents journeys by mode in 2019, pre-pandemic. In 2019, 74% of adults travelled every day with 65% of journeys as car driver or passenger (Transport Scotland, 2020b). Car travel had increased substantially over several decades while walking and public transport journeys reduced (Transport Scotland, 2022c). Transport is responsible for 37% of greenhouse gas emissions in Scotland, 40% of which are from cars (Transport Scotland, 2020a). The Covid-19 pandemic has affected travel behaviour and modes (Teuton et al., 2020). Fig. 3 shows that by summer 2021 the number of car journeys in Scotland approached 2019 levels while public transport journeys remained lower than 2019 levels. Table 3 shows household access to a car, for different populations. Seventy two percent of adults live in a household with access to at least one car, but this is lower among disabled people, people on low incomes and in urban areas (Transport Scotland, 2020b).

3.2. Key informant perspectives

Analysis of key informant interviews identified several themes: the role of road space reallocation in wider transport and place planning; public transport impacts; issues for disabled people; business impacts; public responses, communication and engagement; and implementation and monitoring. Table 4 presents illustrative quotes for each theme.

3.2.1. Role in wider transport and place planning

All informants recognised both benefits and adverse effects of road space reallocation. They highlighted the climate imperative, health and congestion as reasons to reduce car use, but also the need to retain access for populations without other transport options.

Informants stressed the need to complement reallocation with wider transport improvements, to ensure people had genuine alternatives to car use. Some suggested road space reallocation was more relevant in urban areas, which offer more alternatives to car use. Informants perceived that reallocation schemes often prioritised cyclists to the detriment of pedestrians, and that pedestrian
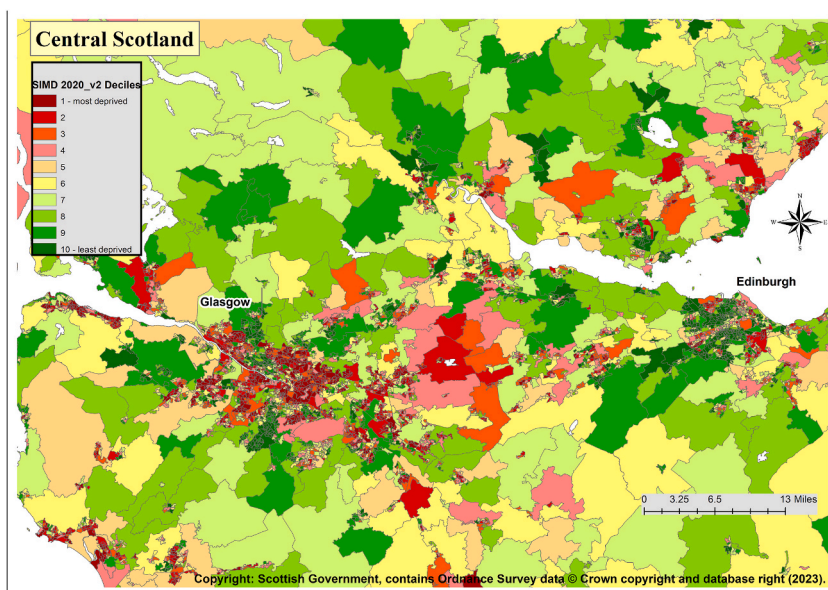

Fig. 2b. Enlarged map of central Scotland showing datazones by deprivation decile.

Table 2
Journeys by mode, Scotland, 2019

Mode	% of all journeys
Car/van driver	52.9
Car/van passenger	12.3
Bus	7.0
Rail	2.3
Taxi/minicab	1.2
Bicycle	1.2
Walking	22.1
Other	1.0

Source: Transport Scotland (2020) Transport and Travel in Scotland, 2019): Results from the Scottish Household Survey. https://www.transport.gov.scot/publication/transport-and-travel-in-scotland-2019-results-from-the-scottish-household-survey/personal-travel/#sec2
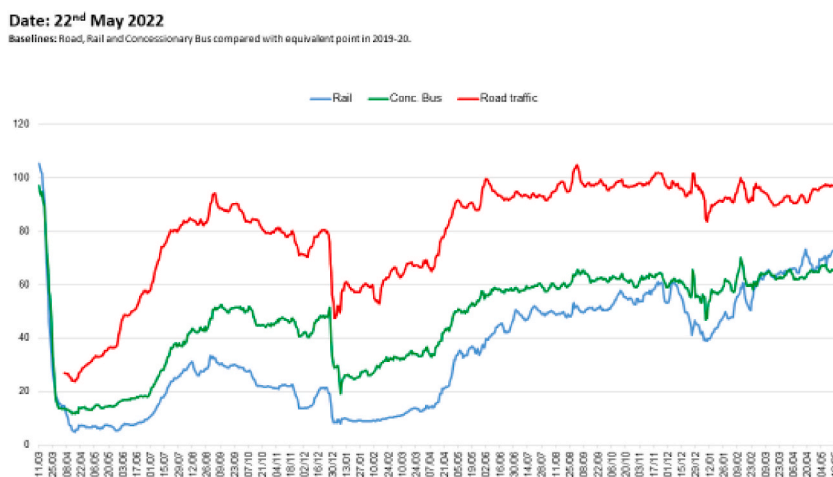
Fig. 3. Journeys by mode as a % of journeys by that mode in 2019/20, Scotland, March 2020 to May 2022. (Source: Transport Scotland).

Table 3
Access to a car in the household, Scotland, 2019

	% with access to one or more car in the household
All people	71
Disabled people	52
Most Deprived quintile	51
Least Deprived quintile	86
Large Urban area	61
Remote rural area	85
Household income up to £10,000 pa	41
Household income more than £50,000 pa	96

Sources: Transport Scotland (2020) Scottish Transport Statistics No. 38 2019 Edition. https://www.transport.gov.scot/publication/scottish-transport-statistics-no-38-2019-edition/.
Transport Scotland (2021) Disability and Transport: Findings from the Scottish Household Survey. https://www.transport.gov.scot/publication/disability-and-transport-findings-from-the-scottish-household-survey/.

infrastructure should be prioritised, following the sustainable travel hierarchy.

Informants reflected that reallocated spaces should create places where people want to spend time. Temporary Spaces for People schemes were completed rapidly without consultation and used unattractive plastic bollards and barriers, which were thought to colour public views on road space reallocation.

3.2.2. Public Transport impacts

Informants perceived that recent reallocation schemes favouring cycling and pedestrians had had negative impacts on bus users. Some had resulted in bus routes being diverted, increasing journey times. Others moved bus stops to places that were less accessible,

Table 4
Themes from key informant interviews with quotes.

Wider transport system	*There is now public acknowledgement that we cannot go on in the way that we have, that can be harnessed for the greater good, but we have to do it in a joined up way that doesn't leave the most vulnerable behind.* [PT3]
	If you remove private transport for large parts of Scotland there is nothing there. It's such an integral part of doing regular activities like shopping, visiting, travelling. Until we get an alternative system set up that allows people to do that, ease of access and convenience are impossible to resist. [B2]
	We are on different parts of the journey to sustainable travel. There are many views out there. A strong cycling lobby, a very strong car lobby – there is outrage if you remove parking. [LA1]
	[Temporary reallocation schemes] used materials similar to roadworks to allow flexibility and usability but they looked horrible. [LA1]
Public transport	*Bus is seen as a problem not a solution. [a pre-covid reallocation scheme] closed lanes into the bus station, and we only heard about this when it was 'leaked' from the council. In general communication is very poor.* [PT1]
	Bus carries far more passengers and for lot of people, especially older people and disabled people, is the main form of travel. Bus should be at the heart of these places. Full pedestrianisation not something we see as a solution because it is not accessible for less able bodied. [PT2]
Disabled people	*It's not just the physical space but rapid change and uncertainty. Disabled people have to plan more carefully and are more affected by disruption. More disabled people are dependent on private cars, which is often glossed over or dismissed when planning sustainable travel interventions. I'd like to see more thought about how to accommodate the accessibility needs of disabled motorists with the sustainability needs for active travel – how to accommodate both objectives. We don't want parked cars in cycle ways, we need another solution.* [DO3]
	The key thing is accessibility. Buses must be accessible for all but they are not just now. They only have to meet PSVR public service vehicle accessibility regulations which are 10 years old, and not fit for purpose, they only consider wheelchairs and even that is token. [PT2]
Business impacts	*Reallocation is good if for the right reasons and done to good quality. Businesses want to see increased dwell time, public realm is a very important part of that. The quality of seating, space, how safe people feel … [but] need to think about disruption during the work. If people may start going somewhere else, businesses need to survive.* [B1]
Public responses and communication	*A dual carriageway would be seen as 'need to do' because of traffic problems - but [road space reallocation] is seen as 'want to do'. There is a difference in perception of importance. Dominance of the car is still there.* [LA2]
	Would like genuine consultation when haven't made up your mind – we see lot of engagement but not much reflection on what people are saying or alteration. It changes only if people make a lot of noise publicly. [B02]
Implementation and monitoring	*Traffic management causes chaos for 2 weeks but then resolves – [temporary road space reallocation] is similar. We needed thick hides and to be strong – especially elected members and senior management need to sit out for 3 weeks before changing it.* [LA3]
	I don't know how to measure all the impacts. How to demonstrate improved physical and mental health and inclusion, behaviour change. [LA2]

particularly for disabled people. Public transport informants perceived that local authorities viewed buses as the 'poor relation' and devalued buses in transport and spatial plans, including (but not only) road space reallocation.

3.2.3. Issues for disabled people

Representatives from disability organizations expressed strongly negative views on the impacts of road space reallocation. They reported that some disabled people cannot travel any distance except by car and were disadvantaged if parking spaces were moved further from their destination. This was partly because buses, bus stops, trains and train stations were often inaccessible to disabled people. Also, public spaces were often inaccessible for people with mobility or sensory impairments. Consultation was needed to create accessible reallocated spaces for people with different mobility, sensory or other needs. The Spaces for People schemes had disadvantaged disabled people who found the reallocated spaces did not meet their accessibility needs, further exacerbated by their rapid speed of implementation. Informants reported that environmental change, especially sudden change, has a greater impact for disabled people who need to plan journeys carefully to find accessible routes.

3.2.4. Business impacts

Business informants reported a perception that road space reallocation, especially removal of parking spaces, could be detrimental to some businesses. This particularly applied to local retail in rural towns with large hinterlands with infrequent public transport. Other concerns included space for loading and deliveries, and effects on staff travel. However, they also identified benefits. Walkable, attractive environments could increase footfall and 'dwell time', attracting new customers, and providing space for hospitality or retail use would benefit relevant businesses. They reported that impacts varied by business even within one business sector. For example, tourist industries benefit from more attractive public realm but also want access for tour buses. Some informants reported that businesses often expect road space reallocation to bring negative business impacts, but then see positive impacts on footfall and turnover.

3.2.5. Public responses, communication and engagement

Local authority informants reported that most interventions (both permanent and temporary) received fairly equal numbers of positive and negative public responses. Informants recognised conflict between user groups and the often-polarised public debate about road space reallocation. They discussed reasons for opposition, including a car dominated mindset in both the public and politicians, politicised decision-making processes, perceived ease and convenience of private transport and individuals' emotional and financial investment in their cars. Informants perceived a lack of evidence of impacts, particularly for businesses. Evidence from other countries was felt to be irrelevant to Scotland, because of legal, cultural or historical differences.

Local authority informants described significant efforts to involve interest groups and the public. Other informants criticised these consultations, perceiving that decision makers' minds were set in advance, and that plans only changed if there was a lot of 'noise'. Rapid timescales for temporary schemes during the pandemic had reduced time for meaningful consultation.

3.2.6. Implementation and monitoring

Local authority informants reported on the long timescales needed for development and consultation on permanent schemes, which could be frustrating for stakeholders. They noted that it takes time for people to change travel patterns, so time should be allowed after implementation before altering schemes.

Informants suggested that interventions had different implicit aims, including: modal shift; creating safer, more attractive access and spaces; better subjective experience of a space; increased use of a space and footfall for businesses; improved air quality and improved health. They suggested the need to make the aims explicit and to monitor against them with appropriate indicators to increase the evidence base. Some reported that it was particularly difficult to monitor health impacts.

3.3. Impacts and pathways

The HIA considered the hypothesised pathways between road space reallocation and health identified in the scoping exercise. Evidence included routine data and key informant interviews discussed in sections 3.1 and 3.2, and the reviews of research evidence. For each pathway the HIA considered the evidence of likely impact on the intermediate outcome (such as reduced motor traffic) and the evidence of association between the intermediate outcome and health. Fig. 4 summarises the pathways between road space reallocation and health outcomes.

3.3.1. Reduction in motor traffic

There is consistent evidence of negative health impacts of car use through multiple determinants. These include air and noise pollution (Scottish Government, 2015), green house gas emissions (Transport Scotland, 2020a), road injuries (Transport Scotland, 2022a), community severance (Mindell et al., 2017), physical inactivity due to concern about traffic danger (Young and Whyte, 2020), and financial hardship from forced car ownership where car dominance limits viability of alternative options (Lucas et al., 2019). Many of these disproportionately affect vulnerable populations. For example, pedestrian casualty rates are higher in low income areas (Pirdavani et al., 2017); children are more likely to be pedestrian casualties and also to suffer more severe injury in collisions (Transport Scotland, 2022a); children, older people and disabled people are more susceptible to adverse effects of air pollution (Scottish Government, 2015); people on low incomes are more likely to face hardship from forced car ownership (Lucas et al., 2019).

The reviews found consistent evidence that road space reallocation could be effective in reducing overall motor traffic (Cairns et al., 2002). Interventions studied included: neighbourhood interventions using modal filters to restrict through traffic (often called Low Traffic Neighbourhoods) (Aldred et al., 2019; Aldred and Goodman, 2020; Goodman et al., 2020); road narrowing to provide cycling infrastructure (Arancibia et al., 2019; Toronto Transportation Services, 2017; Vasilev et al., 2018); and school street closures during
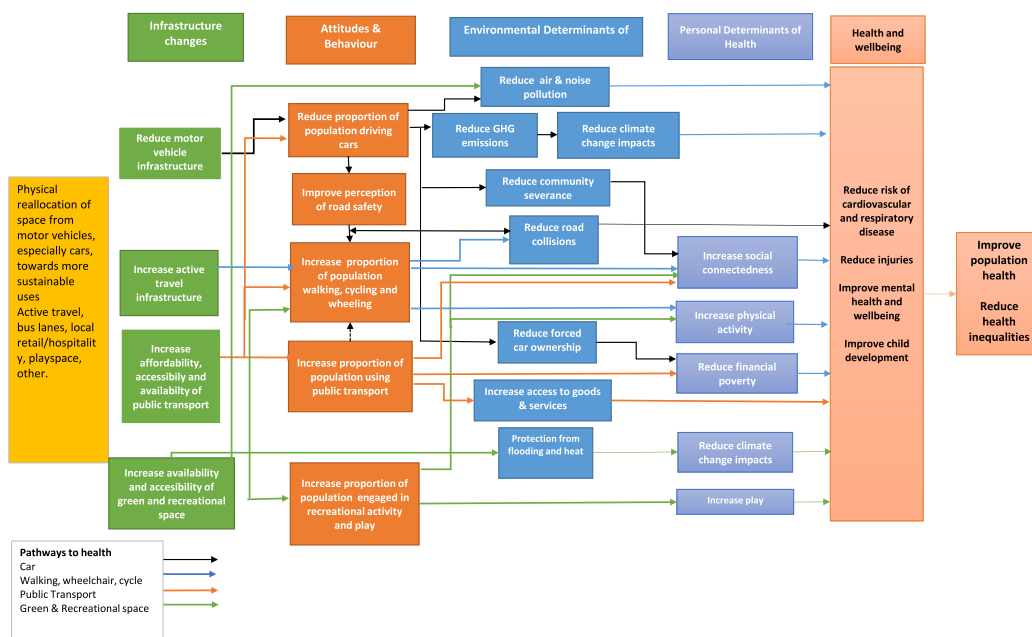

Fig. 4. Pathways from road space reallocation to health outcomes.

drop off and pick up times (Davis, 2020). There was some evidence of displacement to other routes, which was partially mitigated by lower overall traffic (Vasilev et al., 2018). Studies found that people responded in complex ways and the full effect on travel behaviour could take up to 3 years (Aldred and Goodman, 2020). Studies of the impact of road space reallocation on road safety found reductions in injuries and improvements in perceived safety on both affected and surrounding streets (Laverty et al., 2021; Toronto Transportation Services, 2017; Vasilev et al., 2018).

3.3.2. Modal shift to active travel modes
Physical activity through walking and cycling reduces the risk of cardiovascular and respiratory disease, obesity and mental health problems (UK CMO Guidelines Group, 2019; WHO Regional Office for Europe, 2022). Active travel can also promote social interaction (Cooper et al., 2019; Kelly et al., 2018). Pedestrians and cyclists are at risk from motor vehicle collisions but are far less likely to cause injury to others (Young and Whyte, 2020).

The review found consistent evidence that interventions reallocating road space towards active travel infrastructure were effective in increasing levels of walking and cycling (Aldred and Croft, 2019; Aldred et al., 2019; Aldred and Goodman, 2020; Brown et al., 2016; Cambra and Moura, 2020; Frank et al., 2021; Goodman et al., 2020; Kraus and Koch, 2021; Melia and Shergold, 2016). This is supported by other studies showing that providing cycling infrastructure can increase rates of cycling (Le Gouais et al., 2021).

3.3.3. Other benefits from alternative uses of space
Other uses of reallocated space include greenspace, recreation and play space. There is strong evidence that high quality accessible natural spaces can protect and promote health (Public Health England, 2020). Although some initiatives have reallocated road space to create parks (Gaete, 2016; Global Designing Cities Initiative, 2023; National Recreation and Park Association, ND; Salt, 2015), we found no review level evidence of their impacts.

There is evidence of the benefits of recreation and play, particularly for child development (Ginsburg et al., 2007). 'Play streets' are temporary road closures to allow safe space for children to play. There has been limited evaluation of these, but a systematic review suggested they can increase active play and social interaction (Umstattd Meyer et al., 2019).

3.3.4. Impact on public transport
Public transport, especially buses, are the primary mode of transport for people on low incomes, older people, young people and disabled people, so are essential for them to access services and facilities that support their health (Gates et al., 2019). Using public transport often involves some active travel contributing to physical activity (Cooper et al., 2019). The higher number of people per vehicle can reduce overall emissions and noise (Glasgow Connectivity Commission, 2019).

Evidence of initiatives reallocating space to prioritise buses is limited but case studies reported reductions in overall traffic, improved bus journey times, and increased bus use (Grimar, 2015; Urban Transport Group, 2014, 2015).

3.3.5. Impact on local businesses
An inclusive, thriving local economy can reduce social and economic deprivation, benefiting health (Improvement Service, 2020). Road space reallocation can support local businesses by: providing space for hospitality or retail use, creating more attractive public realm to encourage visitors or changing opportunities for people to travel to the businesses.

Case studies and evaluations have found that improvements to walking or cycling infrastructure, including those that remove carriageway or parking space, have significantly positive or non-significant effects on local businesses (Arancibia et al., 2019; Volker and Handy, 2021; Yu et al., 2018).

3.3.6. Equity of access
All transport modes provide access to employment, services and facilities that benefit health. Differences in the ability of different population groups to access these resources contributes to transport exclusion and health inequalities (Gates et al., 2019). Barriers vary for different populations. Women are less likely to drive, face barriers to walking and cycling including safety concerns, and are more likely to 'trip chain' – making daily multi-destination journeys for different purposes (Department for Transport, 2016). Older people and disabled people are less likely to drive or have access to a car and may find public transport and pedestrian infrastructure inaccessible (Martin et al., 2020). Low income groups are less likely to have access to a car or bicycle and rely more on public transport (Transport Scotland, 2020b). Rural populations often travel longer journeys and have lower access to public transport so are at risk of forced car ownership (Transport Scotland, 2020b). These populations could benefit from road space reallocation if it supports improved infrastructure for, or provision of, other modes.

There is limited empirical evidence on the differential impacts of road space reallocation. In a poll of disabled people in Scotland, mainly in Edinburgh, most reported that temporary road space reallocation during Covid-19 created inaccessible public spaces that were difficult for them to get around (Disability Equality Scotland, 2020). This was supported by the key informant interviews reported at 3.2.2. Studies of the socio-spatial distribution of temporary cycling infrastructure during Covid-19 found they were distributed equitably by deprivation and ethnicity (Aldred et al., 2021; Fischer and Winters, 2021).

3.3.7. Community engagement and perceptions
Community engagement activities giving people a say in decisions affecting them, especially people with less power and influence, can enhance community capacity, improve resilience and ensure proposals are tailored to local needs (Davies and Mackie, 2019). We found little evidence of health impacts arising from engagement on road space reallocation. However stakeholders have differing, often

Table 5
Impacts table.

Mechanism	Health Impact	Positive/Negative	Affected populations	Likelihood of impact	Size of health impact if it occurs	Equity issues
Reduction in motor vehicles	Reduced exposure to air and noise pollution, impacts of climate change, severance, injuries	Positive	Residents and others in communities with RSR schemes	Probable positive impact	Moderately positive impact	People with low-income, children, older people and disabled people most affected by adverse effects of traffic so likely to benefit most from reduction.
Shift from cars to active travel modes	Increased physical activity, social connectivity	Positive	People who change from car to active travel	Probable positive impact	Moderately positive impact	People in rural areas, some disabled people may not be able to shift to active modes Walking/wheeling accessible to all but access to bicycles lower in low-income groups.
Alternative uses of space	Depends on alternative use – potential to provide greenspace/local amenities/contribute to social cohesion	Positive	Residents and others in communities with RSR schemes	Possible positive impact	Depends on the alternative use	Equity impact depends on location and alternative use. People in deprived areas could benefit most from improved access to greenspace and amenities. Children and young people would benefit from greenspace and play facilities.
Impact on public transport	Access to services and amenities Could be improved if public transport prioritised in RSR schemes Could be reduced if public transport disrupted or not prioritised.	Positive or Negative	People who use public transport – particularly low-income, older people young people, women, disabled people	Possible positive or negative impact	Moderately positive or negative impact	People with low-income, young people, older people, disabled people most reliant on public transport so will be most affected.
Impact on local businesses	Income	Positive	Local business people and staff	Probable positive impact	Minor positive impact	Potential to contribute to community wealth building by supporting local economy. May be most beneficial in low-income communities.
Access inequalities	Access to services and amenities	Negative	Disabled or other people who are reliant on car transport or experience public transport disruption or inaccessible environment	Possible negative impact	Major impact for some disabled people if design of reallocated space is not accessible	Potential major adverse impact for some disabled people if not mitigated.
Access inequalities	Access to services and amenities	Positive	People who are unable to drive or cannot access a car	Possible positive impact	Impact for non-drivers depends on improving other modes	If RR supports/enhances other modes, potential to improve access for people who are unable to drive or cannot access a car – more likely to be disabled people, low-income people, older people, young people, women.
Local ownership and engagement	Psychosocial benefits of community engagement	Positive	Residents and others in communities with RSR schemes	Possible positive impact	Minor positive impact	People with less power may find it harder to engage and influence decisions if engagement does not include specific actions to reach them.

polarised, views about road space reallocation (Sustrans, 2022). Perceived lack of meaningful consultation can result in opposition and feelings of being disempowered (Dickie et al., 2015).

3.4. Impacts table

Table 5 summarises the health impacts of road space reallocation. It presents the HIA team's judgements, based on the evidence summarised in sections 3.1, 3.2 and 3.3 on: the affected populations, likelihood and size of impact and equity considerations for each pathway.

4. Discussion

4.1. Key findings

This HIA integrated a rapid review of existing research, routine data and new primary qualitative research with key informants. It found that road space reallocation in Scotland can affect health through several pathways: reduced motor traffic, modal shift to active travel, benefits from alternative uses of space including greenspace and play space, support for public transport and local businesses, improved equity of access to services, amenities and employment, and community engagement. Impacts may take 2–3 years to be fully realised as people take time to adjust and change travel behaviour. There was good evidence of potential health benefits. There was less evidence for potential health harms but displacement of private motorised traffic can occur, partially mitigated by the overall reduction in traffic. Qualitative findings from key informants also identified potential adverse effects for disabled people, and for public transport, if they are not considered during the development of reallocation schemes. Informants highlighted the potential for conflict and need for inclusive, iterative engagement with communities to enable the schemes to achieve the best overall outcomes.

In some areas, evidence seemed conflicting. For example, the finding that 48% of disabled people in Scotland have no access to a car conflicts with key informants' reports that disabled people are disproportionately disadvantaged by removal of car parking. Reasons for this include inaccessibility for disabled people of both reallocated public space and public transport. Similarly, several key informants perceived that Spaces for People schemes favoured cyclists and disadvantaged pedestrians, although the programme had funded more footpath widening schemes than cycle ways (Sustrans, 2022). Reasons for the perception that cyclists are prioritised may include a belief that the cycling lobby is strong, wider antagonism towards cycle users on social media and elsewhere (Field et al., 2018), and publicity about specific schemes that had obstructed pedestrians or required them to cross a new cycle way (Bol, 2021).

Both the routine data and key informant interviews demonstrated the dominance of car use in Scotland. The routine data showed that cars are the most common mode of travel and key informants reflected on the consequences of a car dominant mindset, in which restrictions on car use are strongly opposed but inconvenience to pedestrians is accepted. However, the informants presented a much more balanced perspective than the polarised views apparent in social and mass media. The adverse effects of car dominated environments are well recognised, including carbon emissions, pollution, poor health, inequalities and congestion (Teuton et al., 2020). The potential health, social and environmental benefits of road space reallocation should be more widely publicised. This includes the health inequalities benefit, as the populations least likely to use a car are often at highest risk of the adverse effects of motor traffic.

4.2. Comparison with current literature

HIAs bring together primary and secondary evidence sources to understand interactions between policy and health, in this case transport policy. Sharing methods and findings highlights the range of relevant impacts, including differential impacts, and can also inform future HIA practice but the literature contains few similar HIAs. A 2018 scoping review identified 158 health impact assessments of transportation plans and policies, mostly in grey literature (Waheed et al., 2018). Some of these considered road reallocation schemes, such as 'complete streets' which aim to create safe travel for all modes or 'road diets' which reduce road lanes to create walkways or cycle lanes. These HIAs were all from USA and considered reallocation projects in a specific location, whereas the current HIA considered impacts of reallocation schemes across Scotland. HIAs assessing specific projects can consider in more detail the local socio-economic and geographical context. They identified impacts resulting from reduced private motorised traffic such as improved safety and improved air quality, increased physical activity from modal shift to active travel, improved quality of space and 'eyes on the street' and better access for low income populations (Waheed et al., 2018). Their recommendations focused on improving the specific projects, whereas the current HIA aims to influence policy at both national and local government level in Scotland.

Other HIAs have considered transport policies. Several considered impacts of active travel policies, including some that quantified estimated health impacts of increased walking and/or cycling (Buekers et al., 2015; de Nazelle et al., 2011; Rojas-Rueda et al., 2012; Sommar et al., 2021). Most of these found the highest health gains from increasing physical activity, with further gains from improved air quality. Pedestrians and cyclists are more vulnerable to injuries than car occupants, but as active travel increases, the injury risk declines for each active journey (Jacobsen, 2003). Providing safe active travel infrastructure with physical separation from cars further improves safety (Cohen, 2013). Factors influencing injury severity vary between urban and rural settings (Fountas et al., 2022) so it is important to consider the context when developing infrastructure.

HIAs of comprehensive transport strategies from London (Mindell et al., 2004) and Edinburgh (Gorman et al., 2003) found that policies supporting active travel and public transport, and discouraging car use, could benefit health through several pathways. The HIA of the 2004 London Mayoral Transport strategy recommended road space reallocation, which was adopted in the final version of the strategy (Mindell et al., 2004). This shows that HIA can effectively influence policy, but more recent examples are sparse.

4.3. Implications for policy and practice: recommendations

Overall this HIA suggests that road space reallocation should be supported as it can bring multiple social, economic and environmental benefits, improve health and reduce transport and health inequalities.

Achieving these outcomes requires a 'whole system' approach, giving people genuine alternatives to car travel and ensuring reallocation creates places that people want to live, work and play. Road space reallocation should be part of broader transport planning, spatial planning and community planning. This includes investing in public and community transport, taking a place-making approach (Place Standard Partners, 2022) to reallocated space, and following the sustainable travel hierarchy, with pedestrians' needs given highest priority. Interventions should be adapted to the context and create higher quality environments that better meet community needs. The Partnership group recommended prioritising road space reallocation in communities with low levels of car ownership but high volumes of traffic, but also highlighted potential benefits for rural communities with through arterial traffic causing severance.

Road space reallocation can help to reduce transport exclusion and health inequalities, by providing more options for populations without car access (Lucas et al., 2019). It is important to consider different populations that may use the space, including people on low incomes, women, children, young people, older people and disabled people. To avoid the problems reported by disabled people, reallocated spaces should create an accessible environment for people with mobility, sensory or other impairments. They should avoid creating spaces that are shared between cyclists and pedestrians, particularly on busy routes.

Vocal public and media opposition is an important barrier to road space reallocation but the HIA found less polarised views than

Table 6
Recommendations to ensure road space reallocation initiatives maximise health and equity benefits.

Local planning	• Incorporate into place making approaches to create places where people want to live, work and play as part of an integrated transport, spatial and community planning approach • Combine with other measures as part of transport planning to ensure availability of alternatives to car journeys including public and community transport • Support should not be limited to urban areas. Consider rural context, particularly where through arterial routes with high levels of motorised traffic cause severance • Use to develop and maintain infrastructure consistent with sustainable travel hierarchy • Ensure new active travel routes connect with existing active travel networks and public transport stops • Link to and improve access to existing active travel infrastructure where relevant and ensure benefits are experienced equitably. • Assess and avoid or mitigate any potential negative impacts on public transport • Consider the need for management and maintenance and ensure implementation does not adversely affect existing community or active travel infrastructure or public transport access
Realising wider benefits	• Ensure reallocated space is a community resource and contributes to health, economic, climate and equity outcomes • Ensure new active travel routes contribute to green infrastructure and are integrated into existing green networks such as trails and parks • Ensure reallocated spaces contribute to safer environments through better lighting, slower road speeds, greater passive surveillance, and creating pedestrian routes where none exist
Accessibility	• Ensure spaces are accessible to populations of all ages and abilities • Consult at the outset with those who can advise on accessibility including those with lived experience • Avoid spaces shared by pedestrians and cyclists wherever possible • Prioritise bus users if requirement to cross cycle ways • Cycling infrastructure should follow best practice design guidance to ensure safety and accessibility for pedestrians as well as cyclists e.g. Cycling by Design • Retain vehicle and bike parking for disabled people and carers • Prioritise improving quality of space and increasing transport options for communities that have low levels of car ownership but high volumes of traffic and who experience transport exclusion
Supporting change	• Road space reallocation should be accompanied by other interventions to encourage behaviour change. • Provide training for transport and other partners on health behaviour change theory and practice
Community engagement	• Be broad and inclusive to ensure all voices are heard, including young people and populations with fewer transport options • Undertake early in the development of the scheme • Include communities living, working, trading and visiting the area • Use suitable tools such as the Place Standard Tool to identify characteristics of the place and how reallocation can improve it • Gather population-level evidence to inform change • Undertake health impact assessment
Monitoring & evaluation	• Before and after surveys should include acceptability, usage and unintended consequences of schemes • Include a range of potential impacts beyond modal share such as social interaction, contribution to green networks, local economy and traffic displacement • Ensure time lag sufficient long to allow for behaviour change – may be up to three years • Examine differential impacts across population groups

public discourse suggests. The Partnership group recommended broad engagement with all sectors of the community, focusing on the best use of public space for their needs, which could help to avoid being presented as just 'anti-car'. The Place Standard tool (Place Standard Partners, 2023), a framework commonly used in Scotland to prompt discussions about aspects of a place, can structure this engagement.

The HIA highlights the need for monitoring of road space reallocation schemes against indicators reflecting the range of anticipated outcomes including modal share, social interaction and business impacts. This should include monitoring the distribution of impacts across population groups. Monitoring can allow adaptations to be made, but it is also important to allow sufficient time for travel behaviours to change, which can take up to 3 years. Monitoring can also contribute to the evidence base and show whether, and how, local context influences impacts. This is important given key informants' scepticism about evidence from other contexts.

Finally, as noted in 4.2, there are few policy level HIAs of transport policies although transport affects health through multiple pathways. Health impact assessment should be used as part of a 'Health in All Policies' approach to enable transport policy and practice to contribute positively to health and health equity (Green et al., 2021). This HIA demonstrates the value of this approach, using different sources of evidence and engaging directly with policymakers and practitioners to influence future developments.

Table 6 summarises the HIA recommendations made by the Partnership group.

4.4. Strengths and limitations

A strength of this work is the use of a systematic HIA approach to ensure comprehensive consideration of potential impacts of road space reallocation in Scotland. It triangulated different sources of qualitative and quantitative evidence, reinforcing some impacts and highlighting areas where evidence appears conflicting. Understanding these factors can help create recommendations that account for differences within and between populations. A further strength is the involvement of transport policymakers and other stakeholders on the Partnership group in reviewing the evidence and agreeing recommendations. Their perspectives added depth to the understanding of findings and means that recommendations should be feasible and appropriate in the Scottish context. Members of the Partnership group are also able to support implementation of the recommendations directly and help dissemination to other relevant partners – co production with decision makers is a key strategy to get evidence into practice.

An important limitation is the detail and specificity of analysis that was possible given the geographical scope of the HIA. Scotland is a diverse country with 32 local authorities that vary widely in rurality, socio-economic context, and other factors (National Records of Scotland, 2021a). As the HIA highlights, the impacts will vary depending on the local context. The HIA sought to inform decisions across all 32 local authorities and so was necessarily high level. Consideration of needs and impacts across urban, rural, deprived and more affluent communities can inform decisions about prioritisation across the country.

The HIA was completed shortly after temporary Spaces for People schemes had been implemented to allow safe distancing during the Covid-19 pandemic. This influenced the key informant interviews. Although it meant informants all understood road space reallocation, their perspectives were coloured by experience of, and publicity about, temporary schemes that may differ from permanent schemes. A further limitation is that only a small number of key informants could be interviewed. Informants were selected to represent populations known to have specific needs relevant to road space reallocation but some other perspectives – such as parents of young children, and young people – were missing. However, many of the themes identified were consistent across informants representing different perspectives. Finally, the research evidence was limited in some important respects. Most of the available studies assess impacts of reallocation to provide active travel infrastructure, with much less evidence for reallocation to other uses such as greenspace or play space. Importantly, given the HIA focus on differential impacts, there is little research evidence of the distributional impacts of road space reallocation.

4.5. Implications for future research

High quality research on the impacts of road space reallocation is needed. This includes impacts on wider determinants such as social interaction, and the impacts of reallocating road space to uses other than active travel infrastructure, such as play streets, greenspace, and public transport infrastructure. Research should also study the differential effects on different population groups to assess whether reallocation schemes realise their potential to improve health inequalities. Evaluations in different settings could explore contextual factors that influence the effects. Both quantitative and qualitative research is needed to understand the pathways through which road space reallocation influences multiple outcomes and different populations. A further gap concerns influences on public perceptions of road space reallocation, including the respective roles of commercial interests and social media in shaping perceptions and decision making. Action research could study how consultation and engagement activities can be used to ensure schemes best meet – potentially conflicting - needs in a local community, and how that influences their response.

Finally, the HIA aimed to help inform Scottish local authorities making decisions about future road space reallocation schemes. Further research should study the effectiveness of HIAs in fulfilling this purpose, including the factors that affected this. This can strengthen future HIAs seeking to influence policy making.

5. Conclusions

This HIA highlighted that road space reallocation can benefit health and health equity through multiple pathways, with little evidence of harmful effects. Road space reallocation is often contentious and the HIA identified concerns raised by some stakeholders. The HIA recommendations include supporting alternative transport modes, using reallocated space to create quality environments that

benefit communities and ensuring good practice in community consultation and engagement. As well as enhancing the health benefits of reallocation, these actions may increase public support. However, given the car dominant culture and the lag time to fully realise the benefits, road space reallocation may remain contentious for some time. This suggests that strong political will and leadership from decision makers is needed to support these schemes to achieve their potential to improve health, wellbeing and equity.

Ethics

Key informant interviews were conducted in line with Public Health Scotland research governance procedures, including advance approval of the protocol and research materials by the research services officer. All participants opted in and gave signed informed consent before the interview.

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Margaret J Douglas: Conceptualization, Methodology, Investigation, Analysis, Writing - original draft.
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Declaration of Competing interest

A conflict of interest may exist when an author or the author's institution has a financial or other relationship with other people or organizations that may inappropriately influence the author's work. A conflict can be actual or potential. At the end of the text, under a subheading 'Disclosure Statement', all authors must disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three (3) years of beginning the work submitted that could inappropriately influence (bias) their work. Examples of potential conflicts of interest which should be disclosed include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

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Appendix A. Supplementary data

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References

Aldred, R., Croft, J., 2019. Evaluating active travel and health economic impacts of small streetscape schemes: an exploratory study in London. J. Transport Health 12, 86–96.

Aldred, R., Goodman, A., 2020. Low Traffic Neighbourhoods, Car Use, and Active Travel: Evidence from the People and Places Survey of Outer London Active Travel Interventions. Findings.

Aldred, R., Croft, J., Goodman, A., 2019. Impacts of an active travel intervention with a cycling focus in a suburban context: one-year findings from an evaluation of London's in-progress mini-Hollands programme. Transport. Res. Pol. Pract. 123, 147–169.

Aldred, R., Verlinghieri, E., Sharkey, M., Itova, I., Goodman, A., 2021. Equity in new active travel infrastructure: a spatial analysis of London's new Low Traffic Neighbourhoods. J. Transport Geogr. 96, 103194.

Anderson, J., 2021. War of Words over Edinburgh's Spaces for People Scheme. Edinburgh Evening News. Edinburgh, 1st February 2021 2021 [Online]. Available online: https://www.edinburghnews.scotsman.com/lifestyle/outdoors/war-words-over-edinburghs-spaces-people-scheme-3119438. (Accessed 19 April 2023).

Arancibia, D., Farber, S., Savan, B., Verlinden, Y., Smith Lea, N., Allen, J., Vernich, L., 2019. Measuring the local economic impacts of replacing on-street parking with bike lanes. J. Am. Plann. Assoc. 85 (4), 463–481.

Bol, D., 2021. Thousands of Edinburgh locals oppose controversial Spaces for People project. Herald. Glasgow2021 [Online]. Available online: https://www.heraldscotland.com/news/19345936.thousands-edinburgh-locals-oppose-controversial-spaces-people-project/. (Accessed 19 April 2023).

Brown, B.B., Smith, K.R., Tharp, D., Werner, C.M., Tribby, C.P., Miller, H.J., Jensen, W., 2016. A complete street intervention for walking to transit, nontransit walking, and bicycling: a quasi-experimental demonstration of increased use. J. Phys. Activ. Health 13 (11), 1210–1219.

Buekers, J., Dons, E., Elen, B., Int Panis, L., 2015. Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways. J. Transport Health 2 (4), 549–562.

Cairns, S., Atkins, S., Goodwin, P., 2002. Disappearing traffic: the story so far. Municip. Eng. 151 (1), 13–22.

Cambra, P., Moura, F., 2020. How does walkability change relate to walking behavior change? Effects of a street improvement in pedestrian volumes and walking experience. J. Transport Health 16, 100797.

Cohen, E., 2013. Segregated bike lanes are safest for cyclists. CMAJ (Can. Med. Assoc. J.) 185 (10), E443–E444.

Ginsburg, K.R., Committee on Communications & Committee on Psychosocial Aspects of Child and Family Health, 2007. The importance of play in promoting Healthy child development and maintaining strong parent-child bonds. Pediatrics 119 (1), 182–191.

Cooper, E., Gates, S., Grollman, C., Mayer, M., Davis, B., Bankiewicz, U., Khambhaita, P., 2019. *Transport, health and wellbeing , : An evidence review for the Department for Transport*, 2019. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/847884/Transport_health_and_wellbeing.pdf. (Accessed 19 April 2023).

Curtis, C., Tiwari, R., 2008. Transitioning urban arterial roads to activity corridors. Urban Des. Int. 13 (2), 105–120.

Davies, E., Mackie, P., 2019. The Community Empowerment (Scotland) Act 2015 Parts 3 and 5: what Is Public Health's Role?, 2019. Available online: www.scotphn.net/wp-content/uploads/2017/10/2019_08_13-CEA-Report-Final.pdf. (Accessed 23 April 2023).

Davis, A., 2020. School Street Closures and Traffic Displacement: A Literature Review and Semi-structured Interviews, 2020. Available online: https://www.napier.ac.uk/~/media/images/news/school-street-closures/school-streets-closure-traffic-displacement-literature-review-final2.pdf. (Accessed 19 April 2023).

de Nazelle, A., Nieuwenhuijsen, M.J., Antó, J.M., Brauer, M., Briggs, D., Braun-Fahrlander, C., Cavill, N., Cooper, A.R., Desqueyroux, H., Fruin, S., Hoek, G., Panis, L.I., Janssen, N., Jerrett, M., Joffe, M., Andersen, Z.J., van Kempen, E., Kingham, S., Kubesch, N., Leyden, K.M., Marshall, J.D., Matamala, J., Mellios, G., Mendez, M., Nassif, H., Ogilvie, D., Peiró, R., Pérez, K., Rabl, A., Ragettli, M., Rodríguez, D., Rojas, D., Ruiz, P., Sallis, J.F., Terwoert, J., Toussaint, J.F., Tuomisto, J., Zuurbier, M., Lebret, E., 2011. Improving health through policies that promote active travel: a review of evidence to support integrated health impact assessment. Environ. Int. 37 (4), 766–777.

Department for Transport, 2016. National Travel Survey Trip Chaining: 2002–2014. London. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/509447/nts-trip-chaining.pdf. (Accessed 19 April 2023).

Dickie, E., Hearty, W., Fraser, A., McCartney, G., Doyle, E., Myers, F., 2015. Power – a Health and Social Justice Issue, 2015. Available online: http://www.healthscotland.scot/publications/power-a-health-and-social-justice-issue. (Accessed 19 April 2023).

Disability Equality Scotland, 2020. Weekly Poll Results – COVID-19: Physical Distancing, 2020. Available online: https://disabilityequality.scot/weekly-poll-results-covid-19-physical-distancing-week-commencing-25-may-2020/. (Accessed 19 April 2023).

Douglas, M., 2019. Health Impact Assessment Guidance for Practitioners, 2019. Available online: https://www.scotphn.net/wp-content/uploads/2015/11/Health-Impact-Assessment-Guidance-for-Practitioners-SHIIAN-updated-2019.pdf. (Accessed 19 April 2023).

Douglas, M., 2022. Mitigating the Health Impacts of Transport Trends in the Pandemic. Available online: https://publichealthscotland.scot/our-blog/2022/april/mitigating-the-health-impacts-of-transport-trends-in-the-pandemic/. (Accessed 19 April 2023).

Field, A., Wild, K., Woodward, A., Macmillan, A., Mackie, H., 2018. Encountering bikelash: experiences and lessons from New Zealand communities. J. Transport Health 11, 130–140.

Fischer, J., Winters, M., 2021. COVID-19 street reallocation in mid-sized Canadian cities: socio-spatial equity patterns. Can. J. Public Health 112 (3), 376–390.

Fountas, G., Olowosegun, A., Basbas, S., 2022. Assessing school travel safety in Scotland: an empirical analysis of injury severities for accidents in the school commute. Saf. Now. 8 (2), 29.

Frank, L.D., Hong, A., Ngo, V.D., 2021. Build it and they will cycle: causal evidence from the downtown Vancouver Comox Greenway. Transport Pol. 105, 1–11.

Gaete, C.M., 2016. 6 cities that have transformed their highways into urban parks. Available online: https://www.archdaily.com/800155/6-cities-that-have-transformed-their-highways-into-urban-parks. (Accessed 19 April 2023).

Gates, S., Gogescu, F., Grollman, C., Cooper, E., Khambhaita, P., 2019. *Transport And Inequality: A N Evidence Review for the Department For Transport*, 2019. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/953951/Transport_and_inequality_report_document.pdf. (Accessed 19 April 2023).

Glasgow Connectivity Commission, 2019. Connecting Glasgow: creating an inclusive, thriving, liveable city. Glasgow. Available online: https://glasgow.gov.uk/CHttpHandler.ashx?id=45064&p=0. (Accessed 19 April 2023).

Global Designing Cities Initiative, 2023. Case study: pavement to parks; san francisco, USA, 2023. Available online: https://globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/parklets/case-study-pavement-to-parks-san-francisco-usa/. (Accessed 19 April 2023).

Goodman, A., Urban, S., Aldred, R., 2020. Impact of Low Traffic Neighbourhoods and Other Active Travel Interventions on Vehicle Ownership: Findings from the Outer London Mini-Holland Programme. Findings.

Gorman, D., Douglas, M.J., Conway, L., Noble, P., Hanlon, P., 2003. Transport policy and health inequalities: a health impact assessment of Edinburgh's transport policy. Publ. Health 117 (1), 15–24.

Green, L., Ashton, K., Bellis, M.A., Clemens, T., Douglas, M., 2021. 'Health in all policies'-A key driver for health and well-being in a post-COVID-19 pandemic world. Int. J. Environ. Res. Publ. Health 18 (18).

Grimar, K., 2015. Reviving One of Copenhagen's Most Important Thoroughfares, 2015. Available online: www.eltis.org/printpdf/discover/case-studies/reviving-one-copenhagens-most-important-thoroughfares-denmark. (Accessed 19 April 2023).

Hammarberg, K., Kirkman, M., de Lacey, S., 2016. Qualitative research methods: when to use them and how to judge them. Hum. Reprod. 31 (3), 498–501.

Improvement Service, 2020. Elected Member Briefing Note: Community Wealth Building, 2020. Available online: https://www.inclusivegrowth.scot/wp-content/uploads/2020/09/Community-Wealth-Building-A-briefing-note-for-elected-members.pdf. (Accessed 19 April 2023).

Improvement Service, 2022. *Place And Wellbeing Outcomes: Briefing*, 2022. Available online: https://www.improvementservice.org.uk/_data/assets/pdf_file/0020/30719/PWO-briefing-paper.pdf. (Accessed 19 April 2023).

Jacobsen, P.L., 2003. Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Inj. Prev. 9 (3), 205–209.

Kelly, P., Williamson, C., Niven, A.G., Hunter, R., Mutrie, N., Richards, J., 2018. Walking on sunshine: scoping review of the evidence for walking and mental health. Br. J. Sports Med. 52 (12), 800–806.

Kraus, S., Koch, N., 2021. Provisional COVID-19 infrastructure induces large, rapid increases in cycling. Proc. Natl. Acad. Sci. USA 118 (15), e2024399118.

Laverty, A., Aldred, R., Goodman, A., 2021. The Impact of Introducing Low Traffic Neighbourhoods on Road Traffic Injuries. Findings.

Le Gouais, A., Panter, J.R., Cope, A., Powell, J.E., Bird, E.L., Woodcock, J., Ogilvie, D., Foley, L., 2021. A natural experimental study of new walking and cycling infrastructure across the United Kingdom: the Connect2 programme. J. Transport Health 20, 100968.

Lucas, K., Stokes, G., Bastiaanssen, J., Burkinshaw, J., 2019. Inequalities in Mobility and Access in the UK Transport System, 2019. Available online. : https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784685/future_of_mobility_access.pdf. (Accessed 19 April 2023).

Marmot, M., Goldblatt, P., Allen, J., Boyce, T., McNeish, D., Grady, M., Geddes, I., 2010. Fair society, Healthy lives: strategic review of health inequalities in England post 2010. London. Available online: https://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review. (Accessed 19 April 2023).

Martin, A., Davidson, R., Pinto, C., Sawdon, E., Shipsey, F., Martin, I., Windle, K., 2020. *Motability: Disability and Transport Needs, Gaps and Innovation Rapid Evidence Assessment* London. Available online: www.motability.org.uk/media/0modpov4/rapid_evidence_assessment_rea_disability_and_transport_needs_gaps_and_innovation_natcen.pdf. (Accessed 19 April 2023).

McAndrews, C., Marshall, W., 2018. Livable streets, livable arterials? Characteristics of commercial arterial roads associated with neighborhood livability. J. Am. Plann. Assoc. 84 (1), 33–44.

Melia, S., Shergold, I., 2016. Pedestrianisation and Politics: Evidence Gaps and a Case Study of Brighton's Old Town. Available online: https://uwe-repository.worktribe.com/output/915477/pedestrianisation-and-politics-evidence-gaps-and-a-case-study-of-brightons-old-town. (Accessed 19 April 2023).

Mindell, J., Sheridan, L., Joffe, M., Samson-Barry, H., Atkinson, S., 2004. Health impact assessment as an agent of policy change: improving the health impacts of the mayor of London's draft transport strategy. J. Epidemiol. Community Health 58 (3), 169–174.

Mindell, J.S., Anciaes, P.R., Dhanani, A., Stockton, J., Jones, P., Haklay, M., Groce, N., Scholes, S., Vaughan, L., 2017. Using triangulation to assess a suite of tools to measure community severance. J. Transport Geogr. 60, 119–129.

National Records of Scotland, 2021a, 2021a. Available online:. Council Area Profiles https://www.nrscotland.gov.uk/statistics-and-data/statistics/stats-at-a-glance/council-area-profiles. (Accessed 19 April 2023).

National Records of Scotland, 2021b. Healthy Life Expectancy 2018-2020. Available online: https://www.nrscotland.gov.uk/files//statistics/healthy-life-expectancy/18-20/healthy-life-expectancy-18-20-report.pdf. (Accessed 19 April 2023).

National Records of Scotland, 2021c. Life Expectancy in Scotland 2018-2020. Available online: https://www.nrscotland.gov.uk/files//statistics/life-expectancy-in-scotland/18-20/life-expectancy-18-20-report.pdf. (Accessed 19 April 2023).

National Records of Scotland, 2021d. Mid-2020 population estimates, Scotland. Available online: www.nrscotland.gov.uk/files/statistics/population-estimates/mid-20/mid-year-pop-est-20-report.pdf. (Accessed 19 April 2023).

Pirdavani, A., Daniels, S., van Vlierden, K., Brijs, K., Kochan, B., 2017. Socioeconomic and sociodemographic inequalities and their association with road traffic injuries. J. Transport Health 4, 152–161.

Place Standard Partners, 2022. *Placemaking*. Scottish Government, Public Health Scotland, Architecture & Design Scotland, the Improvement Service and Glasgow City Council. Available online: https://www.ourplace.scot/about-place/placemaking. (Accessed 19 April 2023).

Place Standard Partners, 2023. *Place Standard: How Good Is Our Place?* Scottish Government, NHS Health Scotland and Architecture and Design Scotland. Available online: https://www.placestandard.scot/. (Accessed 19 April 2023).

Playing out, 2022. Play streets, 2022. Available online: https://playingout.net/play-streets/. (Accessed 19 April 2023).

Public Health England, 2020. Improving access to greenspace: a new review for 2020. London. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904439/Improving_access_to_greenspace_2020_review.pdf. (Accessed 19 April 2023).

National Recreation and Park Association (ND) creating mini-parks for increased physical activity, ND. Available online: www.nrpa.org/contentassets/f768428a39aa4035ae55b2aaff372617/pocket-parks.pdf. (Accessed 19 April 2023).

Rojas-Rueda, D., de Nazelle, A., Teixidó, O., Nieuwenhuijsen, M.J., 2012. Replacing car trips by increasing bike and public transport in the greater Barcelona metropolitan area: a health impact assessment study. Environ. Int. 49, 100–109.

Salt, L., 2015. Converting Roads to Parks, 19th April 2023. Available online: https://architectureau.com/articles/converting-roads-to-parks/. (Accessed 19 April 2023).

School Streets Initiative, 2022. What are school streets?, 2022. Available online: http://schoolstreets.org.uk/. (Accessed 19 April 2023).

Transport Scotland, 2020a. National Transport Strategy. Available online:. Scottish Government, Glasgow https://www.transport.gov.scot/media/47052/national-transport-strategy.pdf. (Accessed 19 April 2023).

Transport Scotland, 2020b. Transport and travel in Scotland 2019 results from the scottish household Survey. Glasgow. Available online: https://www.transport.gov.scot/media/48317/sct0920149008l.pdf. (Accessed 19 April 2023).

Transport Scotland, 2022a. Key Reported Road Casualties Scotland 2021. Available online: https://www.transport.gov.scot/publication/key-reported-road-casualties-scotland-2021/key-findings/. (Accessed 19 April 2023).

Transport Scotland, 2022b. A Route Map to Achieve a 20 Per Cent Reduction in Car Kilometres by 2030. Available online:. Scottish Government, Glasgow https://www.transport.gov.scot/publication/a-route-map-to-achieve-a-20-per-cent-reduction-in-car-kilometres-by-2030/. (Accessed 19 April 2023).

Transport Scotland, 2022c. Scottish transport Statistics 2021. Edinburgh. Available online: https://www.transport.gov.scot/publication/scottish-transport-statistics-2021/. (Accessed 19 April 2023).

Scottish Government, 2015. Cleaner air for Scotland: the road to a healthier future. Edinburgh. Available online: www.gov.scot/publications/cleaner-air-scotland-road-healthier-future. (Accessed 19 April 2023).

Scottish Public Health Observatory, 2022. Disability: key points, 2022. Available online: https://www.scotpho.org.uk/population-groups/disability/key-points/. (Accessed 19 April 2023).

Sommar, J.N., Schantz, P., Strömgren, M., Forsberg, B., 2021. Potential for reduced premature mortality by current and increased bicycle commuting: a health impact assessment using registry data on home and work addresses in Stockholm, Sweden. BMJ Open Sport Exerc Med 7 (1), e000980.

Sustrans, 2021. Spaces for People - Route Map to Permanence. Available online: https://www.showcase-sustrans.org.uk/wp-content/uploads/2021/02/Route-Map-to-Permanence.docx. (Accessed 19 April 2023).

Sustrans, 2022. Spaces for People Research Resources, 2022. Available online: https://www.showcase-sustrans.org.uk/news/news-opinion/spaces-for-people-research-resources/. (Accessed 19 April 2023).

Teuton, J., Sloan, P., Whyte, B., Cope, A., Macdonald, A., Cozzolino, N., Davis, A., Douglas, M., 2020. Transport use, health and health inequalities: the impaGyle SquareGyle Square. Available online: https://publichealthscotland.scot/media/2850/transport-use-health-and-health-inequalities-oct2020-english.pdf. (Accessed 19 April 2023).

Teuton, J., Douglas, M., Davis, A., Donaghy, G., 2022. *The Impact of Reallocating Road Space to Increase Provision for Walking, Wheeling and Cycling on Health-Related Outcomes A Rapid Review* Edinburgh. Available online. : https://publichealthscotland.scot/media/12262/the-impact-of-reallocating-road-space-to-increase-provision-for-walking-wheeling-and-cycling-on-health-related-outcomes-a-rapid-review.pdf. (Accessed 19 April 2023).

Transportation Services, Toronto, 2017. Bloor Street West Bike Lane Pilot Project Evaluation, 2017. Available online: www.thedanforth.ca/members/item/download/68_3181fc9564d4481ca2410230238c46dd. (Accessed 19 April 2023).

Tsigdinos, S., Nikitas, A., Bakogiannis, E., 2021. Multimodal corridor development as a way of supporting sustainable mobility in Athens. Case Studies on Transport Policy 9 (1), 137–148.

UK CMO Guidelines Group, 2019. UK chief medical officers' physical activity Guidelines. London. Available online: https://www.gov.uk/government/publications/physical-activity-guidelines-uk-chief-medical-officers-report. (Accessed 19 April 2023).

Umstattd Meyer, M.R., Bridges, C.N., Schmid, T.L., Hecht, A.A., Pollack Porter, K.M., 2019. Systematic review of how Play Streets impact opportunities for active play, physical activity, neighborhoods, and communities. BMC Publ. Health 19 (1), 335.

Urban Transport Group, 2014. Bus Priority Works for Business, Shops, Communities and Growth, 2014. Available online: www.urbantransportgroup.org/system/files/general-docs/pteg%20bus%20priority%20brochure%20June%202014_FINAL.pdf. (Accessed 19 April 2023).

Urban Transport Group, 2015. Small but mighty transport schemes: delivering big value for money, 2015. Available online: Case studies report www.urbantransportgroup.org/system/files/general-docs/PTEG%20Case%20studies%20report%20FINAL%20for%20WEB.pdf. (Accessed 19 April 2023).

Vasilev, M., Pritchard, R., Jonsson, T., 2018. Trialing a road lane to bicycle path redesign—changes in travel behavior with a focus on users' route and mode choice. Sustainability 10 (12), 4768.

Victoria Transport Policy Institute, 2019. Road Space Reallocation: Roadway Design and Management to Support Transportation Alternatives, 2019. Available online: https://www.vtpi.org/tdm/tdm56.htm#:~:text=Road%20Space%20Reallocation%20gives%20priority,others%20bear%20less%20congestion%20delay. (Accessed 19 April 2023).

Volker, J.M.B., Handy, S., 2021. Economic impacts on local businesses of investments in bicycle and pedestrian infrastructure: a review of the evidence. Transport Rev. 41 (4), 401–431.

Waheed, F., Ferguson, G.M., Ollson, C.A., MacLellan, J.I., McCallum, L.C., Cole, D.C., 2018. Health Impact Assessment of transportation projects, plans and policies: a scoping review. Environ. Impact Assess. Rev. 71, 17–25.

WHO Regional Office for Europe, 2022. Walking and cycling: latest evidence to support policy-making and practice. Available online: https://apps.who.int/iris/handle/10665/354589. (Accessed 19 April 2023).

Winkler, M.S., Viliani, F., Knoblauch, A.M., Cave, B., Divall, M., Ramesh, G.H.-R., Ben, Furu, P., 2021. Health Impact Assessment International Best Practice Principles. International Association for Impact Assessment, Fargo, USA.

Young, M., Whyte, B., 2020. Cycling in Scotland: a Review of Cycling Casualties, Near Misses and Under-reporting, 2020. Available online: www.gcph.co.uk/assets/0000/7810/Cycling_Casualties_in_Scotland.pdf. (Accessed 19 April 2023).

Yu, C.-Y., Xu, M., Towne, S.D., Iman, S., 2018. Assessing the economic benefits and resilience of complete streets in Orlando, FL: a natural experimental design approach. J. Transport Health 8, 169–178.