Department for Transport

Moments of change: Enhancing the effectiveness of travel behaviour interventions

A rapid evidence assessment

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Glossary

Before-and-after study (also called a pre-post study): An observational study that measures outcomes in a group of participants before and after an intervention. Any changes in outcomes are attributed to the intervention, although this study design cannot exclude factors other than the intervention causing the effect.

Critical appraisal: The process of systematically evaluating included studies to determine both their relevance to the review and the robustness of the study design and methodology. See also ‘risk of bias’ and ‘low risk of bias’.

Focalism: A behavioural intervention technique that encouraged participants making residential relocation choices to consider overlooked factors like accessibility, rather than focusing solely on more salient and tangible aspects like the physical features of the property. Focalism was used as a behavioural intervention in Bhattacharyya et al. (2019) along with “visualisation”.

Low risk of bias: A study is evaluated as having a low risk of bias if all or most of the methodological criteria appropriate for the study type have been fulfilled. The study is therefore considered unlikely to be affected by biases and the results can be considered as reliable.

Moments of change: Events that – by affecting capability, opportunity and motivation in any combination – make it more likely that people will change their behaviour.

Non-randomised controlled trial (NRCT): A study design in which participants are not randomly allocated to the intervention and control groups. The participant might choose a group, or the researcher may assign it. The lack of randomisation potentially introduces bias.

Randomised controlled trial (RCT): A study design in which participants are randomly allocated to intervention and control groups, ensuring that any pre-existing differences are minimised. The researcher delivers the intervention being tested, and this combined with randomisation allows RCTs to be used to draw causal claims about the effects of an intervention.

Risk of bias: The possibility that the design or methodology of a study is flawed and has introduced systematic errors that could distort the findings.

Soft interventions: Interventions that aim to encourage behaviour changes by modifying perceptions, attitudes, values or norms (Semenescu et al., 2020). Such interventions change behaviour using available infrastructure and without the use of regulations.

Hard interventions: Interventions that seek to alter behaviour by changing the physical environment (e.g., building bicycle lanes) or through regulations (e.g., congestion charges). Such interventions often require substantial capital investment. (Semenescu et al., 2020).

Statistical significance: A statistically significant effect is one that is unlikely to be due to random chance, as determined by a hypothesis test using a p-value (typically with a $p <$

0.05 threshold). However, statistical significance only indicates the likely presence of an effect, not whether its size has meaningful real-world implications.

Visualisation: A behavioural intervention technique involving mentally picturing or imagining a scenario. In this context, encouraging participants to mentally picture future opportunities for changes that they might experience as a result of moving. Visualisation was used as a behavioural intervention in Bhattacharyya et al. (2019) along with “focalism”.

Executive summary

Background and research questions

This publication (commissioned under the previous, Conservative, Government) reports on a rapid assessment of the research evidence for timing behavioural travel interventions to coincide with moments of change in society/people's lives.

A change in a person's life or environment often leads to them adopting new or different travel behaviours. For example, although this review did not set out to look at the impacts of moments of change themselves, it found evidence to suggest that domestic relocation can increase active travel and reduce car use.

At some moments of change, the immediate impact on travel behaviours is obvious and uncomplicated. When a railway line is blocked, people will be prevented from using that line and when someone's bicycle is stolen, they will no longer be able to ride it. Other impacts are harder to estimate: how people will behave when the rail line reopens, whether bike-theft affects the longer-term willingness to cycle; the impacts of events that change the whole repertoire of travel options (e.g. moving home or job), or the impacts of the introduction of a new transport option (such as a new bus route). It is this latter category of behaviour change that is of interest to this report.

Furthermore, the topic of this report is not the behavioural impact of moments of change themselves but, rather, whether it is advantageous to time behavioural interventions to coincide with these moments. In some circumstances, people who have recently moved house can be more receptive to a travel discount offer than those who have not moved (Kirkman, 2019). This report attempts to ask whether this relationship between travel discounts and domestic relocation can be generalised to other types of moment of change and other types of intervention.

The review aimed to address the following research questions:

- **RQ1:** At what moments of change have there been external interventions or policies that aimed at promoting travel behaviour change?
- **RQ2:** What interventions or policies have been deliberately introduced during moments of change with the intention of targeting travel behaviour change?

- **RQ3:** What is the impact of interventions implemented during moments of change on travel behaviour and other relevant outcomes?

- **RQ4:** Do travel interventions deliver additional impact when delivered during moments of change?

To answer these questions, the study team carried out a rapid evidence assessment of the available academic literature conducted in high-income countries since 2010.

Results

RQ1: At what moments of change have interventions or policies been implemented that aimed at travel behaviour change?

The review identified studies on the following moments of change:

- residential relocation (sometimes combined with starting a new job or starting university)

- workplace relocation

- transport-related events: holding a provisional driving license and driving cessation

- health-related events: COVID-19 and health problems

- having first child

RQ2: What interventions targeting travel behaviour change have been introduced during moments of change?

The studies captured by this review evaluated two hard interventions (both involving cycle lanes). The other interventions comprised combinations of soft interventions such as information provision, personalised travel planning and support, financial incentives, mobility services (e.g., car clubs) and behaviour change interventions.

RQ3: What is the impact of interventions implemented during moments of change on travel behaviour and other relevant outcomes?

Evidence from those studies with a low risk of bias showed:

- when introduced during a societal moment of change, new cycling infrastructure can increase cycling amongst existing cyclists; and, when combined with training and marketing, is even more impactful when it coincides with personal moments of change

- community-based education and support for people giving up driving for health reasons can prompt short-term increases in the use of public transport, trips out of the house and people's confidence in their ability to stay involved in their community

- travel information can reduce car use amongst people who are moving their place of residence to begin new study; and a combination of travel information and a free

travel card for people about to move home can reduce car use and increase use of public transport after their move

Some studies that had a risk of bias suggested that interventions during moments of change can impact on walking. These concluded that:

- personalised neighbourhood accessibility information reduces car use and increases walking to shops amongst people moving home and job; it can also increase bus use amongst those moving jobs

- focalism can increase walking to work and for visits to family and friends amongst people looking for a new rental home

- personalised mobility consultancy and activity tracking technology can increase walking amongst people who are either moving home or have been prescribed exercise

No statistically significant impact was reported by either of the studies that tested ways of improving driving safety.

RQ4: Do travel interventions deliver additional impact when delivered during moments of change?

Three of the studies captured in this review compared the travel impacts of interventions during a moment of change with their impacts at other times. This provides insufficient evidence for any conclusion to be drawn on RQ4.

One low risk of bias study (Schäfer et al., 2012) found no evidence to suggest that the effectiveness of phone-based marketing differed during the moments of change it looked at: life-events. In contrast, another low risk of bias study (Ralph & Brown, 2019) concluded that information provision was more effective during domestic relocation, and one risk of bias study (Chatterjee et al., 2013) found that cyclists themselves believe cycling interventions to be more effective during life events.

Background and methods

Background

Moments of change, such as moving home or the birth of a child, can lead to people adopting new or different travel behaviours. Moments of change comprise many different types of events. For example, a scoping review of research on the effects of major life events on travel behaviour found studies on residential relocation, parenthood, retirement, beginning of secondary school, entry into the labour market, beginning of post-secondary education and marriage (Larouche et al., 2020). In addition, moments of change can arise due to changes or disruptions in transport provision and infrastructure (e.g., London Tube strikes, Larcom et al., 2017).

Whilst moments of change alone can affect travel choices and behaviours, this review asks whether the effectiveness of travel interventions is enhanced when they are timed to coincide with such moments.

Aim and research questions

The aim of this study was to understand what existing research reveals about the effectiveness of travel behaviour interventions that are implemented at moments of change. The results can be used to inform intervention design and implementation, as well as to provide a direction for future primary research on moments of change.

The review aimed to address the following research questions (RQs):

- **RQ1:** At what moments of change have interventions or policies aimed at promoting travel behaviour change been implemented?
- **RQ2:** What interventions or policies targeting travel behaviour change have been introduced during moments of change?
- **RQ3:** What is the impact of interventions implemented during moments of change on travel behaviour and other relevant outcomes?
- **RQ4:** Do travel interventions deliver additional impact when delivered during moments of change?

For this review, moments of change were defined as events that – by affecting capability, opportunity and motivation in any combination – make it more likely that people will change their behaviour.

The term intervention refers to any policy or communication intervention that is implemented during or near a moment of change with the specific aim of influencing travel behaviours.

The main outcome of interest in this review was travel behaviour (e.g., choice of mode, purchase of a vehicle, distance travelled). Additionally, we also sought information about other relevant outcomes (e.g., predictors of behaviour and the environmental impacts of any changes in behaviour).

Methods

To identify relevant evidence, the research team conducted a rapid evidence assessment.

“A rapid evidence assessment provides a more structured and rigorous search and quality assessment of the evidence than a literature review but are not as exhaustive as a systematic review. They can be used to:

- gain an overview of the density and quality of evidence on a particular issue
- support decisions by providing evidence on key topics
- support the commissioning of further research by identifying evidence gaps” (Collins et al., 2015)

The research team identified academic literature using Scopus, Transport Research International Documentation (TRID), Web of Science and Google Scholar. This resulted in 6,981 unique records for screening. Further information on the methodology and literature search is available in Annex A and Annex B.

After screening by title and abstract, the remaining 94 records were screened by full text and 14 included. In addition, a further five articles were identified through searching reference lists of included articles and relevant literature reviews. A total of 19 articles representing 18 studies were included in this review. (One study was the focus of two articles.) An accessible description of the PRISMA flow diagram is in Annex C.

The research team then conducted a critical appraisal (sometimes known as a ‘risk of bias’ assessment) to evaluate the robustness of the included studies and their relevance to the research question. Twelve studies were classed as 1 – low risk of bias, and seven classed as 2 – risk of bias. Because none of the included studies were classed as high risk of bias, all studies were included in the synthesis of findings. For further details of the method see Annex A, and for the results see Annex D.

Limitations

Due to time constraints, at title and abstract sift each record was screened by one reviewer. However, during full text screening all excluded studies were double checked by

a second reviewer, and throughout the process a third reviewer resolved any conflicts via discussion.

It is possible that our search did not capture some existing studies:

- although we used broad search terms, there are many ways to refer to a moment of change, and it is possible that the search did not encompass all the relevant terminology
- it is possible that the reporting of some studies did not use terms related to moments of change
- we did not search for specific types of moments of change
- it is possible that some studies with null findings were not published

Resource constraints restricted our search to English-language sources. Most of the transport literature is written in English, but there could be literature in other languages that our search terms did not identify. Additionally, although we focused on literature from Europe and regions comparable to the UK, only three of the included studies were conducted in the UK. Therefore, we need to infer that the effectiveness of interventions in other contexts will be similar in the UK. This factor was considered as part of the critical appraisal process (see Annex A and Annex D).

To maximise the credibility and accuracy of the literature reviewed, we only included peer-reviewed articles. However, we recognise that this could have excluded relevant grey literature.

The critical appraisal aimed to assess both the relevance of the studies to the review questions and the quality of their methodologies. All studies were assessed and included regardless of their rating. Although some studies were less robust (i.e., risk of bias), we have indicated where this was applicable. The decision to include all studies was based on their relevance to the research questions, ensuring a comprehensive synthesis of the available evidence.

Results

This review includes a total of 19 articles published between 2012 and 2023. The articles represent 18 studies conducted across a range of locations: Europe (n=10), North America (n=5) and Australasia (n=3). Three studies were conducted within the UK. An overview of the included studies is in Annex E.

The following sections report the findings for each research question (RQ).

RQ1: At what moments of change have interventions or policies aimed at travel behaviour change been implemented?

The review identified studies on the following moments of change:

- residential relocation (sometimes combined with starting a new job or starting university)
- workplace relocation
- transport-related events: holding a provisional driving license and driving cessation
- health-related events: COVID-19 and health problems
- having first child

While most of the included studies implemented an intervention at a specified moment of change, one study took a more exploratory approach, using interviews to understand the circumstances and factors that influenced cycling behaviour (Chatterjee et al., 2013). In this study, participants reported moments of change related to life events (education and employment, relationships and residential location, children's development, physical health, leisure and fitness interests), transport related events (car and bicycle availability, bicycle riding skills) and changes to the external cycling environment. Further, Thronicker & Klinger (2019), focused on residential relocation but also broadened their investigation by asking participants about recent or approaching life changes that may have potentially prompted the decision to move. Participants were presented with a variety of changes (under the categories of family, work or education, and mobility, housing and neighbourhood) that might influence or prompt residential relocation.

In three studies, combinations of events were explored. Guo and Peeta (2020) examined residential relocation alongside starting a new job, and residential relocation alongside starting university was explored by Rodriguez and Rogers (2014) and Ralph and Brown (2019).

The following sections describe each moment of change identified in this review.

Residential relocation

The most frequently studied moment of change in this review was residential relocation, with 10 studies identified. Of those 10, the majority targeted sustainable travel behaviour using public transport, active travel, or both (rather than car) – after the move. One study looked at interest in engaging with an intervention to promote sustainable travel following residential relocation (Thronicker & Klinger, 2019), and one at residential choice and sustainable travel behaviours (Guo & Peeta, 2020).

Studies included individuals in the decision-making phase of relocation or those who had recently moved. Recruitment avenues for the studies varied, with participants being recruited both before and after their relocation. Studies that recruited participants before their relocation employed strategies such as advertisements on property websites, as well as obtaining contact details from housing agencies and property developers who held tenancy information (Bhattacharyya et al., 2019; Johansson et al., 2019; Thronicker & Klinger, 2019). In three studies where participants were recruited before their move, combined moments of change were investigated, specifically residential relocation alongside starting a new job or starting university (Guo & Peeta, 2020; Ralph & Brown, 2019; Rodriguez & Rogers, 2014). To recruit participants for these studies, researchers sourced contact details from the relevant institutions, namely the university and future employer who held records of eligible individuals.

For studies that recruited participants after relocation, different strategies were employed. Two studies conducted in Germany sourced contacts through local municipal offices, where new residents are required to register their change of address (Bamberg & Rees, 2017; Schäfer et al., 2012). Another study used a combination of cold calling at doorsteps after identifying recent movers through property websites and collaborating with property developers active in the recruitment areas (Verplanken & Roy, 2016).

Workplace relocation

Two studies explored workplace relocation (Frater et al., 2020; Walker et al., 2015). The studies targeted sustainable travel behaviour, with one focusing on travel habit formation and decay during an office move (Walker et al., 2015).

Frater et al. (2020) studied the relocation of businesses to central Christchurch, New Zealand. They described the relocation as a “planned change or disruption” as opposed to one that was “unplanned”, such as in the case of change associated with natural disasters or the frailty of infrastructure. Walker et al. (2015) described workplace relocation as a “disruptive travel event in a real-world setting”. This study focused on a pro-environmental charity relocating its UK headquarters from one town to another. Due to the nature of the

organisation, the researchers assumed that people working at the organisation were motivated by pro-environmental goals.

Participants for both workplace relocation studies were recruited via the relocating organisations.

Transport-related events

Three studies were conducted during transport-related moments of change. Of these three studies, two focused on the period of holding a provisional driving license, targeting reducing risky driving behaviour (Meuleners et al., 2023) and improving risk awareness (McDonald et al., 2015). One study targeted travel mobility during the period of driving cessation (Gustafsson et al., 2012; Liddle et al., 2014). Both of these moments of change can influence an individual's opportunity to use certain modes of transport, in this case, driving a private car or similar vehicle.

Recruitment to the provisional driving licence studies was done via mailings from paediatric primary care facilities, driving schools, word of mouth, social media advertising and email flyers distributed through youth organisations. These studies were conducted in Australia, which has a different licensing system compared to the UK. This may influence how transferable the findings are to UK policy settings.

The driving cessation study recruited participants via media, health, and seniors' services and groups and word of mouth.

Health-related events

Three studies focused on different health-related moments of change. Two studies were conducted during COVID-19 and investigated cycling behaviour and acceptance of pop-up bicycle lanes (Becker et al., 2022), and car-sharing intentions (Garaus & Garaus, 2021). One study focussed on people who had developed health problems for which they were recommended to undertake more exercise and targeted active travel behaviour (Sulikova & Brand, 2022).

In response to the COVID-19 pandemic, limitations were placed on a variety of activities, including mobility and travel. This resulted in a moment of change, as people's routine behaviours and habits were disrupted.

Having first child

One study focussed on having a first child as a moment of change (Schäfer et al., 2012). This study targeted sustainable consumption patterns, including travel behaviour. Like some of the residential relocation studies, this study recruited participants through a mailing list obtained by sourcing contacts through local municipal offices.

RQ2: What interventions targeting travel behaviour change have been introduced during moments of change?

The following sections describe the 'hard' and 'soft' interventions identified in this review (for definitions of 'hard' and 'soft', see the Glossary). Details of the interventions used in the included studies can be found in Annex E.

Hard interventions

Three studies included hard interventions, of which two related to improved bicycle lanes (Becker et al., 2022; Chatterjee et al., 2013) and one improved the frequency and speed of public transport (Sulikova & Brand, 2022). Two included soft interventions alongside the hard intervention. For example, training and marketing were used to complement improved bicycle lanes (Chatterjee et al., 2013), and provision of information and support was used to supplement improved public transport (Sulikova & Brand, 2022).

Soft interventions

The studies used the following soft interventions:

- provision of information (e.g., bus routes, location of bike sheds)
- financial incentives (e.g., temporarily subsidised or free public transport)
- personalised travel planning – includes provision of (often tailored) information and financial incentives tailored information, plus support designed to persuade people to shift to more sustainable travel modes (Bonsall, 2009)
- mobility services (e.g., car clubs)
- behaviour change (e.g., barrier identification, problem solving)

Most studies used a soft intervention, and some used a combination of soft interventions - for example, both provision of information and a financial incentive. Of the 17 studies that included soft interventions, all but two provided information (sometimes as part of the suite of interventions that make up personalised travel planning). For example, maps showing public transport routes and stops (Bamberg & Rees, 2017), the location of bike sheds (Ralph & Brown, 2019), and personalised information based on the neighbourhood, journey purpose and mode (Guo & Peeta, 2020). One study, a lab experiment, did not provide information (Bhattacharyya et al., 2019); a second provided insufficient detail of the intervention for us to know whether information was provided (Walker et al., 2015).

Financial incentives were used in six studies. These included discounted car and taxi hire (Johansson et al., 2019), and public transport tickets lasting two days (Schäfer et al., 2012), a week (Frater et al., 2020), a month (Thronicker & Klinger, 2019) or a year (Johansson et al., 2019). Financial incentives were always used in combination with information provision or as part of personalised travel planning, rather than in isolation.

When the provision of information and incentives was combined with personalised support, it was considered as personalised travel planning and was used in five studies. Personalised travel planning is based on understanding an individual's travel behaviours, and tailoring information and support. For example, the programme implemented in Frater et al. (2020) included a personalised travel discussion, provision of personalised information, identification of barriers, assistance registering with relevant websites, a visual reminder and information card, and a free one-week ticket and cycling accessories.

One study went beyond provision of information and incentives, by providing access to mobility services. In this Swedish study, residents who had moved to apartment blocks with intentionally limited parking, were provided with access to car clubs with electric cars and bike clubs with electric bikes, in addition to easy parking for bikes, and information and incentives (Johansson et al., 2019).

Other studies employed interventions categorised as behaviour change techniques. For example, a lab-based study used decision-making interventions to influence residential choices and travel behaviour. Participants were encouraged to take a different perspective by rethinking their priorities and reflecting on their desired life changes (Bhattacharyya et al., 2019). A six-week driving cessation study provided education and supplemented this with a group support programme to help with planning and adjustment to life without a car (Gustafsson et al., 2012; Liddle et al., 2014).

Overall, both the hard and soft interventions focused on enabling behaviours by providing education, training, incentivisation, and environmental restructuring rather than constraining behaviours.

Delivery mode

The majority of interventions, particularly those that provided information and incentives, were delivered at a distance. For example, using mail, phone (Bamberg & Rees, 2017), text message (Meuleners et al., 2023) and online (Garaus & Garaus, 2021). Those that aimed to deliver personalised support tended to be delivered in person (e.g., Frater et al., 2020; Gustafsson et al., 2012; Liddle et al., 2014).

RQ3: What impact do interventions have on travel behaviour and other relevant outcomes when they are delivered during moments of change?

This section presents findings about the impacts of interventions when they are delivered at moments of change. It considers their impacts on active travel, car use, public transport, driver safety behaviours and some other outcomes. Notably, and in distinction to the subsequent section, it does not explore how much of this impact can be attributed to the timing of the intervention and how much would have been experienced even if the interventions had not been timed to coincided with moments of change.

Studies that report several outcomes of interest are cited in each of the relevant sections.

Both this section and the subsequent one distinguish between studies that our critical appraisal determined to have no risk of bias and those it determined to have risk of bias (see Annex A and Annex D). None of the studies included in this review were determined to have a high risk of bias.

Active travel

The studies included in the review provided little evidence to suggest that interventions at moments of change can effectively promote active travel. The evidence on information-based interventions was contradictory. Infrastructure-based interventions were found to effectively promote cycling by one study, but no other study evaluated this type of intervention.

Nine of the studies captured by this review evaluated the impacts of interventions on active travel. Four of these had a low risk of bias; five, a risk of bias. In addition, a qualitative study explored cyclists' views on the links between moments of change, interventions and cycling.

Of the low risk of bias studies, one (Becker et al., 2022) reported year-long impacts on cycling and one (Gustafsson et al., 2012; Liddle et al., 2014) reported short-term impacts on walking. Two studies reported finding no statistically significant impacts on active travel (Bamberg & Rees, 2017; Ralph & Brown, 2019). Overall, the evidence from these four studies suggests that information-based interventions are unlikely to increase active travel. There is some evidence to suggest that the provision of new cycling infrastructure can promote cycling. This is supported by a qualitative study that suggests that infrastructure interventions can catalyse active travel if they coincide with life events (Chatterjee et al., 2013).

The following studies were assessed having a low risk of bias:

- a before-and-after study of the impact on cyclists of erecting a pop-up cycle lane during the COVID-19 pandemic reported that participants' cycle trips on the affected route increased from 171,000 the year before the lane was installed to 300,000 the year after its installation (Becker et al., 2022). This increase of 73% compares to a 20-23% increase in cycle trips for the city as a whole.

- one RCT evaluated a weekly community-based education and support programme aimed at people who were about to (or had already) ceased driving due to deteriorating driving abilities (Gustafsson et al., 2012; Liddle et al., 2014). It found that the intervention led to higher incidence of walking immediately postintervention

but had no statistically significant impacts in the longer term. No effect sizes were provided (Liddle et al., 2014).

- one RCT evaluated an intervention for people about to move home that comprised information about local public transport, cycling and walking, and the offer of a one-week travel card. This study found no statistically significant impacts on either walking or cycling. (Bamberg & Rees, 2017)

- one RCT evaluated the impact of providing a travel guide to students about to start a graduate course. The authors of this study concluded that the intervention had no impact on active travel. (Ralph & Brown, 2019)

- one study conducted a qualitative analysis of interviews with people in urban areas of England that had benefitted from improvements to cycle routes, cycle training for children and/or marketing and promotion work. Participants reported that changes in cycling behaviour were 'almost always' triggered by life events rather than changes in the cycling environment. Young adults tended to report that they were prompted to increase cycling by changes in educational and employment status or location. Relationship and residential changes were said to have been influential factors by participants from across the age span. The authors reported the interview data as showing that children's development has a major influence on parents' (and especially mothers') cycling behaviours. For example, some parents reported that they started cycling when they had children because they were motivated to do so by the perceived health and enjoyment benefits; some, that they reduced their cycling when their children were too big for child seats; some, that they cycled less when they no longer needed to accompany their children to school, and some, that they cycled more when the increasing independence of their children afforded the parents more time to cycle. Some older adults reported that health problems sometimes prompted physical difficulties with cycling but also increased the motivation to cycle. Improvements to the cycling infrastructure sometimes facilitated changes catalysed by the above factors. Some people reported that cycle route improvements were important; others, cycle parking facilities; yet others reported that the influential factor was information, training, organised rides or seeing more people cycling. In some cases, a number of these factors were reported as having encouraged them to cycle. The study further states that whether people sustained increases in cycling was determined by their subjective evaluation of the (dis)benefits of cycling for them personally (Chatterjee et al., 2013).

In addition to those studies that had a low risk of bias, five studies were evaluated by our critical appraisal as having a risk of bias. These studies provide some support for the provision of information or focalism to promote walking to people that are moving job and/or home. However, the evidence is inconsistent, and these studies included no evidence of impacts on cycling.

The following studies were assessed as having a risk of bias:

- one RCT evaluated the provision of personalised neighbourhood accessibility information prior to residential relocation and a new job. The authors found that those receiving the intervention relied on walking for 25% of retail/grocery shopping trips after the intervention, whereas those that did not receive the intervention relied on walking for 15% of these trips. The intervention had no statistically significant impact

on the extent to which participants used walking as their mode of travel for other types of trip. Nor did it have any such impact on levels of cycling (Guo & Peeta, 2020).

- a before-and-after study evaluated the impacts of two interventions on choice of area amongst people looking for a rental home. This study found that focalism increased the number of participants that walked, cycled or e-cycled to work (from 27 before the intervention to 39 after the intervention) and to visit family/friends (from 38 before the intervention to 52 after the intervention). It found no statistically significant impact of visualisation on active travel and no statistically significant impacts of focalism on the use of active travel for visits to shops, services and restaurants (Bhattacharyya et al. 2019).

- an RCT evaluated an intervention that offered personalised mobility consultancy and information to people living in an area that had recently benefited from enhanced transport infrastructure and who were either moving home or had been prescribed exercise for a chronic health problem. Participants were also given access to technology that tracked activity levels and provided motivational feedback. Participants were asked to report on their walking at two points after the intervention (though note that the timing of these was not reported). At the first timepoint, the average reported number of days walked per week was 0.7 days higher for those in the intervention group than for those in the control group. At the second time-point, there was no statistically significant difference between the two groups. This study reported that there were no statistically significant impacts on cycling. It reported a short-term increase in the use of e-bikes – but did not report the size of this effect (Sulikova & Brand, 2022).

- one before-and-after study evaluated an intervention that provided an opportunity for people to discuss their commuting preferences before they moved offices and then provided information tailored to those preferences. This study reported that there were no statistically significant impacts on either walking or cycling (Frater et al., 2020).

- one RCT evaluated an intervention that delivered information on the accessibility of different areas to university students who had yet to choose where they would live. This study reported that there were no statistically significant impacts on either walking or cycling (Rodriguez & Rogers, 2014).

Car use

Eight studies tested the impacts of interventions designed to reduce dependence on cars. Interventions were tested with participants that were looking for a home, moving home, changing job or experiencing ill health.

The evidence on car use suggests that providing information about alternative modes while people are deciding on the location of a new home can reduce the use of privately-owned cars. No evidence was provided on the impacts of designing new accommodation with restricted parking opportunities. Similarly, there was some indication that promotion of ecological benefits might increase car-sharing, but no low risk of bias evidence on the impacts on car-sharing/-pooling of other interventions.

Use of privately-owned cars

Seven studies evaluated the impacts of interventions on people's use of cars that they already owned. Given that four of these reported evidence of impacts on car use (and that this was the conclusion of both of the low risk of bias studies) it is likely the provision of information at a moment of change can sometimes reduce the use of privately owned cars.

The authors of two low risk of bias RCT reports concluded that their interventions had reduced car use:

- an RCT of a travel guide for people moving to a new area to start graduate studies concluded that the intervention reduced the average number of weekly private vehicle trips to campus by 0.2 trips and reduced the average weekly miles driven to the campus by 0.84 (Ralph & Brown, 2019)

- an RCT of an intervention that provided information about local public transport, cycling and walking to people who were about to move home and offered them a 1-week travel card showed that those that received the intervention used cars 5.6% less than those that did not (Bamberg & Rees, 2017)

Of the other five studies (all of which had a risk of bias) two reported statistically significant impacts:

- an RCT that evaluated the provision of personalised neighbourhood accessibility information to people about to move residence and job. This study concluded that the intervention led to less time being spent as sole occupant of a car for journeys related to work, social/recreational activities, restaurants, and retail/grocery shopping. For example, the average weekly time spent driving alone for work purposes was found to be 81.85 minutes for the intervention group but 93.47 for the control group; that for social/recreational trips, 27.60 minutes for the intervention group but 32.65 for the control group; that for shopping trips, 16.19 minutes for the intervention group but 19.29 for the control group (Guo & Peeta, 2020).

- an RCT of delivering information on the accessibility of different areas to university students who had yet to choose where they would live. Participants in this study attended one of two university campuses. In one of these, those receiving the intervention travelled an average of 4.5 km by car per day, compared with 14.5 km for those who did not use the map. In the other, there was no statistically significant change (Rodriguez & Rogers, 2014).

The other three risk of bias studies found no evidence to suggest that the interventions they evaluated had reduced car use (Bhattacharyya et al., 2019; Frater et al., 2020; Sulikova & Brand, 2022).

- one RCT evaluated the provision of personalised mobility consultancy, information and physical activity tracking technology to people who were moving home or had been prescribed exercise for a chronic health problem after the enhancement of transport infrastructure (Sulikova & Brand, 2022).

- another RCT evaluated the impacts of providing focalism or visualisation interventions prior to the selection of a new home (see above for details). For neither intervention was there any impact on car use (Bhattacharyya et al. 2019).

- a third, a non-randomised controlled study evaluated an intervention that involved discussing commuting preferences with people before they moved offices and providing information tailored to those preferences (Frater et al., 2020).

Access to a privately-owned car

The only study to look at access to private cars was a low risk of bias before-and-after study (Johansson et al., 2019). This examined how access to private cars changed when people moved into apartments that had a restricted supply of parking but access to a car club, bicycle club (with electric bikes and cargo bikes), subsidised taxis and rental cars, and free monthly passes on public transport. The authors report that participants were less likely to have access to a private car after moving to such an apartment than they were before moving. However, they acknowledge that the reduction in access to private cars is likely to have been affected by factors other than the intervention – for example, participants moving from parental homes where they had access to cars owned by others, or participants experiencing changes to their employment.

Use of car-sharing or car-pooling

One low risk of bias study found evidence of impacts on car-pooling/-sharing and two risk-of-bias studies found no statistically significant evidence of impacts.

The low risk of bias study was an RCT conducted during a COVID-19 lockdown (Garaus & Garaus, 2021). This study concluded that mentioning ecological benefits in an advert for a car-sharing scheme increased intentions to use such a service by 30%.

One of the risk of bias studies tested the impacts of focalism and visualisation on the use of motorised alternatives (including car pool or care share schemes to driving a private car as the sole occupant (Bhattacharyya et al. 2019). No disaggregated findings were provided in the report of this study, so we do not know whether there was a statistically significant impact on car-pooling/sharing. The other tested the impacts on car-pooling of providing participants with an opportunity to discuss their commuting preferences before they moved offices, and providing information tailored to those preferences (Frater et al., 2020). This study reported no statistically significant effects on car-pooling.

Public transport

Seven of the studies captured by this review evaluated the impacts of interventions on the use of public transport: six RCTs and a before-and-after study (Frater et al., 2020). Of these, we evaluated three (reported in four articles: Bamberg & Rees, 2017; Gustafsson et al., 2012; Liddle et al., 2014; Ralph & Brown, 2019) as having a low risk of bias; the remaining four, as having a risk of bias. Five evaluated an intervention with people who were selecting a location for a new home; one, people changing their job; one, people experiencing health problems; one, people relocating their place of work, and one, people who had (or were about to) given up driving for reasons of health or infirmity.

Four studies found evidence of increases in the use of public transport; one found an increase in bus patronage but not in the use of other modes of public transport. The two that found no evidence of increases in public transport use were both evaluated as having a risk of bias. Although the evidence is mixed, these findings suggest that information about transport options might form an effective intervention for increasing the use of public transport amongst people who are moving home, moving jobs or giving up driving for health reasons.

Two low risk of bias studies reported interventions as having prompted increases in the use of public transport. One found no statistically significant impacts:

- an RCT of an intervention that provided information about local public transport, cycling and walking to people who were about to move home (Bamberg & Rees, 2017). The intervention also included a 1-week travel card. Those that received the intervention were reported to have used public transport 9.8% more than those that did not receive the intervention.

- an RCT of a weekly community-based education and support programme that was facilitated by a trained health professional and a peer leader and provided for people who were about to (or had already) ceased driving due to deteriorating driving abilities (Gustafsson et al., 2012; Liddle et al., 2014). This research found that the intervention led to higher use of public transport immediately after the intervention but not in the longer term. No effect size was provided.

- an RCT with students who were about to start a graduate course found that provision of a travel guide did not have a statistically significant impact on the use of buses (Ralph & Brown, 2019).

The remaining four studies that reported on impacts on public transport were all evaluated by our critical appraisal as having a risk of bias. One of these reported that the interventions it tested did impact on public transport use; the others, that they found no statistically significant effects:

- a before-and-after study found that giving people the opportunity to discuss their commuting preferences before a work relocation (and providing information tailored to those preferences) can increase the use of buses (Frater et al., 2020). No effect size was provided.

- an RCT of the provision of personalised neighbourhood accessibility information prior to residential relocation and a new job reported that it found no statistically significant effects on the use of public transport (Guo & Peeta, 2020)

- an RCT of the provision of personalised mobility consultancy, information and physical activity tracking technology after the enhancement of transport infrastructure (Sulikova & Brand, 2022). This intervention was provided for people who were moving home or had been prescribed exercise for a chronic health problem. The intervention had no statistically significant effects on the use of public transport.

- an RCT of the impacts of delivering information on the accessibility of different areas to students that were new to a university and about to choose the area in which to

live (Rodriguez & Rogers, 2014). This identified no statistically significant impacts on the use of buses.

Other outcomes

Change in travel to work time

In a before-and-after study, Bhattacharyya et al. (2019) concluded that applying a focalism intervention prior to the selection of a new home reduced the average weekly number of hours spent commuting from 7.24 to 6.49. No such effect was reported for a visualisation intervention or control group. This study had a risk of bias.

How often people leave home

Gustafsson et al. (2012) and Liddle et al. (2014) reported an RCT with people that were giving up (or had given up) driving. They evaluated an intervention that was intended to prevent this change from causing social isolation: a weekly community-based education and support programme facilitated by a trained health professional and a peer leader. They concluded that the intervention increased the number of weekly trips made away from home immediately postintervention. No effect size was provided, and the increase was not maintained at 3-month follow-up. This study had a low risk of bias.

Confidence with participation in life roles and activities without driving

Liddle et al. (2014) also concluded that, immediately after the intervention (described above), those receiving the intervention were on average four times as confident as those in the control group that they would be able to ‘stay involved in their community’ after they stopped driving.

Driver safety

Amongst the studies captured by this review, two low risk of bias RCTs tested the impacts of interventions on the safety of driving behaviours. Meuleners et al. (2023) assessed the impact on teenage Australians with a provisional driving license of providing personalised (weekly) feedback from telemetric data. McDonald et al.’s (2015) online simulation tested the impacts of online risk awareness perception training on behavioural responses to junction situations. Neither study reported evidence of a positive impact.

Interest in interventions

Thronicker and Klinger (2019) reported that interest in their intervention (information; a free one-month travel card; three months membership of a car sharing scheme – and limited free usage; and a free bike check-up) reduced when people were experiencing two moments of change at the same time: a home move and a life change. This study had a low risk of bias. Its findings point to the potential for moments of change to have contradictory impacts on the likelihood of behaviour change. While some characteristics of

a moment of change might encourage behaviour change, increases in cognitive load that are associated with that moment might, at the same time, act as a discouragement.

It indicated that people might be less interested in engaging with an intervention when they are experiencing numerous moments of change at the same time perhaps due to cognitive overload.

In fact, I think there is room for more commentary on why cognitive overload is not a major inhibiting factor for change. Moments of change can be stressful and even overwhelming. Might this not act against change, rather than encourage it? This is a plausible counter-theory. Or, at least, there may be a U-shaped dose-response: some change enables more, up until a point where cognitive overload kicks in.

The role of habit

A low risk of bias before-and-after study explored what happens to people's travel habits in the period surrounding workplace relocation (Walker et al., 2015). It used as its case study the relocation of the WWF's UK headquarters and an intervention consisting of 'activities' to prepare staff to travel sustainably and some initial payments towards post-relocation travel costs. The authors conclude that the strength of the impulse to use the previous commuting mode decayed rather than disappearing instantly – and was in some cases still present four weeks after the transition. They also conclude that the endurance of the impulse did not predict who changed mode: spatial and infrastructural factors were found to be more important determinants of travel behaviour after a moment of change than internal cognitions, such as impulses, or socio-demographic variables.

RQ4: Are travel interventions more effective when delivered during moments of change?

Four of the studies captured in this review compared the impacts of interventions during a moment of change with their impacts at other times. Of these four studies, the findings of one low risk of bias study suggest that intervention is more effective during a moment of change and another low risk of bias study revealed no evidence to support this proposition. A third, risk of bias, study supported the proposition.

The study that did not support the proposition is an RCT that compared the impact of phone-based marketing during life-events with its impact at other times. This study found no statistically significant evidence to suggest that the impactfulness of its intervention was affected by whether people were experiencing a moment of change (Schäfer et al., 2012).

Two other studies suggested that interventions are, in fact, more effective at moments of change. The first of these, a low risk of bias RCT, concluded that a low-cost information intervention altered the travel patterns of students that moved home at the start of a new course - and that it did not affect non-movers (Ralph & Brown, 2019). The second was a risk of bias qualitative study with cyclists; this study reported that participants themselves tended to describe life-events as a trigger for changes in cycling behaviours (Chatterjee et al., 2013).

The last of the four studies provides no evidence relevant to RQ4 because it did not disaggregate findings relating to travel behaviour from those on other sustainable behaviours (Verplanken & Roy, 2016).

Conclusions

Main findings

This study aimed to understand what existing research reveals about interventions that aim to affect travel behaviour and that are delivered at moments of change.

Behavioural theory suggests that moments of change – such as moving to a new home, changing jobs, retiring, or starting a family – should be promising times for intervention because they disrupt routine travel patterns, creating opportunities for individuals to reconsider their travel choices. For example, in the theory of managed learning (Schein, 1999) it is argued that "whether at the individual or group level, [change is a] profound psychological dynamic process [involving] painful unlearning [and] difficult relearning as one cognitively attempt[s] to restructure one's thoughts, perceptions, feelings, and attitudes" (p. 59). Notably, the review did not identify interventions at all the moments of change in the life course, or in the broader context that wider literature suggests could impact travel behaviour.

Interventions identified through this review targeted travel mode use (including shifting from car travel to more sustainable modes such as active and public transport), safe driving behaviours, residential location choices and social participation. Most studies explored soft interventions, though these were sometimes introduced to complement changes in infrastructure.

Analysis of impacts on travel behaviour was mixed in its conclusions and varied by the type of travel behaviour. Additionally, there was a lack of robust evidence about the comparative impact of applying such interventions outside of these moments of change.

There was evidence in some studies that providing information and support at moments of change can encourage increased use of public transport. However, there was no evidence of this type of intervention increasing active travel; in fact, the evidence on cycling and walking did not point to the effectiveness of any intervention type apart from behaviour change techniques leveraging heuristics, specifically focalism. The use of focalism prior to a home move was found, after the move, to have reduced commuting time and increased the use of active travel for some types of trip. It had no statistically significant impact on car use.

One of the studies in this review suggests that emphasising ecological benefits can increase interest in car-sharing schemes, but there was no evidence on whether this translated into real-world behaviour change. There was a lack of robust evidence to suggest that the provision of information prior to a workplace relocation increased the likelihood of carpooling.

Interventions providing information about public transport options at moments of change (e.g., transport guides and personalised accessibility information) tended to be effective in increasing public transport use, at least in the short term. However, a community-based initiative for those ceasing driving only increased public transport use in the short term and some information-based interventions demonstrated no statistically significant impacts.

An intervention that aimed to keep people involved in their community after driving cessation had some short-term impact. In contrast, two that aimed to increase safe driving practices had no statistically significant effects at all.

The review also suggested conclusions that relate to interventions or moments of change in general rather than to particular interventions. It indicated that people might be less interested in engaging with an intervention when they are experiencing numerous moments of change at the same time perhaps due to cognitive overload. Habits were slow to decay, and motivation to change needed to be supported by a facilitating environment.

Even in the absence of targeted interventions, it is possible that moments of change might lead to shifts in travel behaviour due to habit disruption, or changes in opportunity. We found no consistent evidence of an effect of moment of change alone on travel behaviours. For some individuals, the presence or absence of enabling factors, such as supportive infrastructure or awareness of alternatives, plays a role in determining whether they adopt new travel habits or revert to previous patterns.

In summary, interventions during moments of change can be effective in shifting travel behaviour. However, their effectiveness is not always consistent, and context-specific factors play a role. As discussed throughout the report, robust evidence is lacking for certain behaviours, particularly cycling, where studies often had design limitations or failed to isolate the impact of the intervention from other influences. There is also very limited evidence on the role of changes in infrastructure.

Implications for policymakers and practitioners

The findings from the literature review have several implications for policy and practice regarding promoting sustainable travel behaviour and other positive outcomes:

- policies and practices that aim to encourage sustainable or active travel habits, should target the moments of change that have been shown to facilitate changes to travel behaviours—such as moving home or starting a new job

- even when a moment of change removes the environmental factors that hold old habits in place, the impulse to follow these habits only decays slowly. It therefore appears likely that interventions will have greater long-term impact if they include elements that help maintain new behaviours after the moment of change is over.

- community-based education and support programmes can increase public transport usage and reduce the risk of social isolation when moments of change reduce people's capability to drive

- as the evidence base on the impact of interventions and the durability of behaviour change is limited, robust evaluation of the long-term effects of interventions is needed for the refinement of strategies

Implications for future research

Robust evidence of impact was limited in much of the literature reviewed, partly because of the study designs used. It is important that future research compares the impacts of interventions delivered during moments of change with impacts when they are delivered at other times.

The value of pilots of future interventions would also be enhanced by the use of quasi-experimental methods (with robust control group design) to facilitate causal conclusions, and by the use of longitudinal designs that allow an assessment of the duration of behaviour change.

It would also be useful to explore interventions at those moments of change that were not explored in the studies captured by this review but that the broader literature suggests could disrupt travel behaviour. These include starting secondary school, entering the labour market, getting married and experiencing travel disruption.

Additional research could also usefully fill gaps in the evidence base around the inclusivity, value for money and optimum mix of future interventions. Suggested topics include further explorations of:

- how long the 'window of opportunity' around a moment of change is open. I.e. the length of the period of flux around an event, when an intervention is likely to be particularly effective

- the optimum point or points during a moment of change to intervene (e.g., before or immediately after residential relocation)

- heterogeneity in response to interventions and the role of demographic factors

- the factors which impact upon the relative promise of different moments of change to help decide when/whether to implement an intervention. This might include practical considerations such as ease of contact with affected individuals; or assessing factors such as the likelihood of individual's being receptive to an intervention at a particular moment of change.

- the impact of synergies between multiple concurrent interventions, including between hard and soft interventions

- the economic costs and benefits of interventions at moments of change compared to other times

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Annex A: Methodology

To identify evidence about the impact of interventions delivered at or close to a moment of change on travel behaviour, the research team conducted a rapid evidence assessment (REA). “A rapid evidence assessment provides a more structured and rigorous search and quality assessment of the evidence than a literature review but are not as exhaustive as a systematic review. They can be used to:

- gain an overview of the density and quality of evidence on a particular issue
- support decisions by providing evidence on key topics
- support the commissioning of further research by identifying evidence gaps” (Collins et al., 2015)

A rapid evidence assessment typically follows six stages:

1. scoping the review and defining the research questions
2. carrying out the literature search
3. screening against inclusion and exclusion criteria
4. data extraction
5. critical appraisal
6. synthesising the evidence

The approach the research team took for each of these stages is described under the corresponding headings that follow.

1. Scoping the review and defining the research questions

The aim of this study was to understand what existing research reveals about interventions aimed at promoting travel behaviour change that are implemented at moments of change.

The research team developed the research questions based on previous work on travel behaviour change at moments of change.

- **RQ1:** At what moments of change have interventions or policies aimed at promoting travel behaviour change been implemented?
- **RQ2:** What interventions or policies targeting travel behaviour change have been introduced during moments of change?
- **RQ3:** What is the impact of interventions implemented during moments of change on travel behaviour and other relevant outcomes?
- **RQ4:** How do moments of change alone affect travel behaviour?

2. Carrying out the literature search

The research team identified peer-reviewed academic literature using Scopus, Transport Research International Documentation (TRID), Web of Science and Google Scholar in July 2024.

Search strings were developed to cover the concepts in the review:

- **moment of change**: moment of change, life event, disruptive event, life stage, context change, trigger point, turning point, habit discontinuity, mobility milestone, decision point, mobility biography, structural change, changing circumstances
- **travel**: travel, mobility, commuting, journey, trip
- **behaviour**: behaviour, choice, decision, habit, pattern
- **intervention**: intervention, initiative, strategy, policy, program, measure, campaign.

Boolean operators were used. Terms within each concept were combined with OR, and the concepts were combined with AND. Search strings were adapted for each database, with the specific search strings for each database provided in Annex B. Filters for English language and publication dates were used. For each database, except Google Scholar, all search results returned were downloaded. For Google Scholar, the first 91 records (9 pages) were downloaded.

3. Screening against inclusion and exclusion criteria

One researcher imported the search results into a reference management application (Zotero) and deduplicated them using the ‘duplicate items’ function. Zotero currently (July 2024) uses the title, DOI, and ISBN fields to determine duplicates. If these fields match (or are absent), Zotero also compares the years of publication (if they are within a year of each other) and author/creator lists (if at least one author last name plus first initial matches) to determine duplicates. The deduplicated results were imported into a systematic review application (Rayyan) for title and abstract screening.

Three researchers screened the records based on the information available in the title and abstract. Each record was screened by one researcher to save time. If a researcher was uncertain about a record based on the title and abstract, it was included for full-text screening. The list of records selected for full-text screening was then downloaded and transferred to an Excel spreadsheet.

The three researchers who conducted the title and abstract screening also completed the full text screening. If the first reviewer determined that a full text should be included, it was not screened by a second reviewer. However, if the first reviewer excluded a full text, it was screened by a second reviewer. Any conflicts were resolved through discussion with a third reviewer. Reasons for excluding full texts were provided, with the first identified reason being recorded, though multiple reasons for exclusion may have applied.

Literature reviews included at the full-text screening stage were excluded, but the research team screened the reference lists of relevant literature reviews for potential additional studies. One researcher screened the reference lists of included articles for further relevant studies.

Exclusion and inclusion criteria were used to determine which articles should be included in the review. The inclusion criteria used are presented in Table 1. These criteria were used to guide the development of search terms, restrict the search to ensure the records identified were relevant and manageable in number) and to screen titles, abstracts and full texts to determine whether they should be included in the review.

Inclusion criteria	Justification
Date	Articles published between January 2010 and July 2024.
Location	Studies conducted in the United Kingdom, Europe, North America, Australia and New Zealand.
Language	English.
Publication status	Peer-reviewed journal publications.
Study design	Any study design.
Participants	Human populations of any age.
Moment of change	Any moment of change: events that – by affecting capability, opportunity and motivation in any combination – make it more likely that people will make different choices.
Intervention	Any intervention, policy or communication implemented during or close to a moment of change that aims to promote travel behaviour change.
Outcomes	The outcomes of interest in this review were travel behaviours (e.g., use of a mode of transport, purchase of a vehicle, distance travelled). Additionally, we also sought information about other relevant outcomes, for example predictors of behaviour and the impact of behaviour changes (such as environmental impact).

Table 1 Inclusion criteria

The exclusion criteria applied were:

- studies that did not meet the inclusion criteria
- literature reviews
- studies focused on travel as a leisure or fitness activity (e.g., open top bus tours, cycling for fitness) or freight transportation. These studies were excluded because they involve different motivations, patterns and contexts to everyday travel behaviour (such as commuting).

The database searches identified 9,982 records. After deduplication, 6,981 unique records were available for screening. After screening by title and abstract, a remaining 94 records were screened by full text and 14 included. A further four studies were identified through searching reference lists of included studies and relevant literature reviews. In addition, one study initially excluded during full-text screening as a conference paper was later identified as a published journal article. In total, 19 articles representing 18 studies were included in the review. The PRISMA flow chart can be found in Annex C.

4. Data extraction

The research team developed a data extraction form to guide the consistent collection of information from the included articles. This form captured items across the categories of study design and methods, data collection and analysis, results, and conclusions. The full list of data extraction items is in Table 2. After trialling and adapting the form, two researchers from TRL and three researchers from DfT completed the data extraction across the 19 included articles.

Item	Description
Citation	APA citation
Publication year	The year the article was published
Journal or source name	The name of the journal or source in which the study was published
Study aim	Study aim, objectives or research questions
Theoretical / conceptual framework	Description of the theoretical or conceptual framework for the study
Moment of change	Description of the moment of change
Study design	Type of study (e.g., randomised controlled trial, cohort study)
Recruitment & sampling procedures	Description of how participants were recruited to the study
Inclusion and exclusion criteria	Description of the inclusion and exclusion criteria used to screen participants
Participants	Description of the study population
Study location	Country, city in which the study was conducted
Sample size	Number of participants recruited (at start of study)
Intervention	Description of the intervention(s)
Comparison / control	Description of any comparison or control group
Outcome measures	Description of the outcomes measured
Data collection methods	Description of how data were collected
Data analysis methods	Description of the analysis methods used
Follow-up or observation period	Length of time participants were followed up or observed
Number of participants analysed	Number of participants included in the final analysis
Travel behaviour outcomes	Description of outcomes related to travel behaviour
Other travel outcomes	Description of other travel-related outcomes (e.g., attitude towards travel)
Other outcomes	Description of any other relevant outcome (e.g., environmental changes)
Conclusions	Author's conclusions based on the study findings
Implications	Implications for policy, practice or research as reported by the authors.
Limitations	Limitations of the study as reported by the authors

Table 2 Data extraction items

5. Critical appraisal

The DfT team conducted a critical appraisal (sometimes known as a ‘risk of bias’ assessment) to evaluate the robustness of the included articles and their relevance to the research question. The team used the criteria suggested by Defra guidance (Collins et al.,

2015) and developed a description of each criterion and its scoring to enable a consistent approach (see Table 3 and Table 4).

The critical appraisal was first piloted by two DfT researchers double coding one article. All remaining articles were then assessed: one researcher critically appraised the quantitative articles and another the qualitative articles. Articles were given a rating between 1 and 3 on each criterion[1], with 1 indicating that the article was of high relevance to the research questions or low risk of bias in terms of methodology, and 3 representing the opposite. The total score for each article was the sum of the criteria: Possible scores ranged from 12 to 36 for quantitative studies, and from 9 to 27 for qualitative articles. For quantitative articles, the mean score was 20.5 (range 17-26) and both qualitative articles were scored 16.

Robustness classes were then determined based on the frequency of the three possible scores assigned to the robustness-related questions (see Annex D). For example, if an article's most frequent robustness score was 1, it was assigned to Class 1. In cases where an article had an equal frequency of scores (e.g., an equal number of 1s and 2s), it was assigned to the lower class as a conservative approach. The classes were:

- **class 1 – low risk of bias:** all or most of the methodological criteria appropriate for the study type have been fulfilled
- **class 2 – risk of bias:** some of the methodological criteria appropriate for the study type have been fulfilled and those criteria that have not been fulfilled or not adequately described are thought unlikely to alter the conclusions
- **class 3 – high risk of bias:** few or no methodological criteria have been fulfilled. The conclusions of the study are thought likely or very likely to alter

Twelve articles were classed as 1 – low risk of bias, and seven classed as 2 – risk of bias. Because none of the included articles were classed as high risk of bias, all articles were included in the synthesis of findings. The text in the Results section indicates where findings are based on studies with a risk of bias (Class 2). A complete summary of the critical appraisal results is reported in Annex D.

Criteria	Scoring
Hypotheses: Are the question(s) and hypothesis/hypotheses addressed by the study clearly identified?	1: Hypotheses/research questions are clearly stated without ambiguity. They might be numbered or separated from the text. 2: Hypotheses/research questions are hard to find and identify, and/or contain some degree of ambiguity and require interpretation by the reader. 3: Cannot identify the hypotheses/research questions.
Research/theories: Are related existing research and theories acknowledged?	1: Relevant existing research and/or theories are described in the literature review, clearly situating the study within the context of existing research. 2: Relevant existing research and/or theories are described but NOT clearly related to current research. 3: Relevant existing research and/or theories are not described.
Funding/Conflict of interest: Are sources of funding and vested interests declared?	1: Funding source (where applicable) declared AND all authors declare no conflicts of interest. 2: Either funding source (where applicable) not declared OR conflicts of interest not declared. 3: Funding source (where applicable) not declared AND conflicts of interest not declared. OR authors declare a conflict of interest.

[1] Except for analytical methods which were scored a binary ‘largely appropriate (1)/inappropriate (3)’.

Criteria	Scoring
Sample population: Is the sample population used in the study representative of the overall population that is the subject of the study and is it relevant in the context of the evidence statement (e.g., relevant to England/UK)	1: Sample population is a representative sample from England or UK. 2: Sample is a non-representative sample from England or UK. 3: Sample is from somewhere other than UK.
Intervention: Were the experimental/management interventions well described?	1: The intervention was described in sufficient detail that it could be replicated using the paper and supplementary materials. 2: The intervention was described in some detail but not sufficiently to enable a replication. 3: The intervention was briefly described with essential information missing.
Randomisation: Was the allocation of the management/experimental interventions random? If not are confounding factors likely?	1: Allocation to intervention groups was randomised. OR randomisation is not relevant. 2: Allocation to intervention groups was NOT randomised, but efforts were made to control for confounding factors. 3: Allocation to intervention groups was NOT randomised, and this is potentially problematic.
Control: Was an adequate control group used? Was this similar to the population receiving the management/experimental intervention?	1: A control group was used and they were similar to the intervention group. OR a control group is not relevant. 2: A control group was used but they were NOT similar to the intervention group. 3: No control group was used and this is potentially problematic.
Outcome measures: Were outcome variables/measures reliable (i.e. were outcome variables/measurements objective, was there any indication that measures had been validated or subjected to another QA processes)?	1: Measures are objective, with clear documented evidence of validation or QA processes (e.g., details in a supplement, or measures of reliability etc). 2: Measures were mostly objective, with some indication of validation or QA processes, but not fully documented or explained. 3: Measures mostly lack objectivity, with little to no indication of validation or QA processes.
Representative: Were the experimental/management interventions applied representative in the context of the evidence statement (e.g., relevant to England/UK)?	1: The study conditions closely mirror those found in England/UK, and the intervention could be applied without adaptation. 2: There are some differences between the study conditions and those in England/UK, but the interventions are generally applicable with minor adaptations. 3: Substantial differences exist between the study conditions and those in England/UK, making the interventions impractical or irrelevant for use in this context.
Analysis: Were the analytical methods appropriate?	1: The analytical methods are largely appropriate. 3: The analytical methods are largely inappropriate and raise concerns about the validity of the research. OR the analytical methods are not clearly described.
Effect sizes: Were the estimates of effect size given?	1: (Where relevant) effect sizes are reported for ALL tests that confirm the experimental hypotheses. OR not relevant. 2: (Where relevant) effect sizes are reported for SOME tests that confirm the experimental hypotheses. OR some effect sizes are reported, but it's not clear which tests relate to confirming the experimental hypotheses. 3: Effect sizes are not reported.
CIs/p-values: Was the precision of the intervention effects given? I.e. Were confidence intervals and or p-values for the effect estimates given?	1: (Where relevant) p-values and CIs are reported for ALL tests that confirm the experimental hypotheses. OR not relevant. 2: (Where relevant) p-values and CIs are reported for SOME tests that confirm the experimental hypotheses. OR either p-values and CIs are reported for SOME tests that confirm the experimental hypotheses. OR p-values and CIs are reported, but it's not clear which tests relate to confirming the experimental hypotheses. 3: Neither p-values nor CIs are not reported.

Criteria	Scoring
Overall score: Overall how well was bias minimised by the study and how relevant is it to the evidence review/ statement? I.e. how well are the criteria above met?	Sum of the scores for each question. Lower scores indicate that the research is more robust/relevant. Higher scores indicate that the research is less robust/relevant.

Table 3 Critical appraisal scoring - quantitative studies

Criteria	Scoring
Study aim: Was the aim of the interview/elicitation clearly stated?	1: Aims/research questions are clearly stated without ambiguity. They might be numbered or separated from the text. 2: Aims/research questions are hard to find and identify, and/or contain some degree of ambiguity and require interpretation by the reader. 3: Cannot identify the aims/research questions
Funding/Conflict of interest: Are sources of funding and vested interests declared?	1: Funding source (where applicable) declared AND all authors declare no conflicts of interest. 2: Either funding source (where applicable) not declared OR conflicts of interest not declared. 3: Funding source (where applicable) not declared AND conflicts of interest not declared. OR authors declare a conflict of interest.
Consultation: Was the consultation method tested to ensure suitability?	1: The consultation method was piloted or tested in some way (e.g., cognitively testing) prior to the main study. 3: The consultation method was not piloted or tested.
Questions: Are the questions asked clearly identified?	1: The questions asked are reported verbatim and in full in the body of the text or an appendix. 2: The majority of the questions are well described. 3: Only topline details of the questions are described.
Sample identity: Are the experts/interviewees asked clearly identified?	1: The interviewees are clearly and explicitly identified. Relevant demographics are reported. 2: Basic information about the interviewees is provided but lacks detail or specificity. 3: There is little to no information provided about who the interviewees are.
Sample suitability: Are the experts/interviewees the most suitable and representative (i.e. was the size of the group suitable for the diversity of opinions)?	1: The sample is highly suitable and participants hold characteristics that are highly relevant to the study aims. 2: The sample is generally suitable, but there may be minor concerns about their alignment with the study aims (e.g., using parents as a proxy for children's experiences) 3: The sample is not suitable, participants do not hold characteristics relevant to the study aims.
Minority opinions: Were minority opinions stated?	1: Minority opinions were clearly identified and stated in the study. 2: Minority opinions were briefly mentioned, but not fully articulated. 3: Minority opinions were not mentioned or were inadequately articulated.
Conclusions: Were the conclusions based on the information gained from the experts/interviewees?	1: Conclusions are grounded in the study data. Where conclusions go beyond the study data this is clearly indicated. 3: It is unclear whether conclusions are grounded in the study data, or whether inferences are being made.
Opinions: Were the range and diversity of opinions clearly stated?	1: A range of opinions were clearly stated. 2: A range of opinions were briefly mentioned, but not fully articulated. 3: Synthesis focused on majority opinions (e.g., "most participants thought x".
Overall score: Overall how well was bias minimised by the study and how relevant is it to the evidence review/statement (i.e. how well are the criteria above met)?	Sum of the scores for each question. Lower scores indicate that the research is more robust/relevant. Higher scores indicate that the research is less robust/relevant.

Table 4 Critical appraisal scoring - qualitative studies

6. Synthesising the evidence

The evidence was synthesised through a structured, collaborative process. First, a workshop was held with the research team to provide an overview of the evidence and outline the patterns in the data. Following this, the relevant information for each research question was organised and synthesised. The synthesised findings were then presented to the research team for feedback and then written up.

To describe the interventions, the research team used the ‘hard’ and ‘soft’ characterisation (Semenescu et al., 2020). Hard interventions alter behaviour by changing the physical environment (e.g., building bicycle lanes) or through regulations (e.g., congestion charges), and often require substantial capital investment (Semenescu et al., 2020). Soft interventions are a broader category of lower cost options that aim to encourage voluntary changes by modifying perceptions, attitudes, values or norms (Semenescu et al., 2020). These interventions change behaviour using available infrastructure and without enforcing strict regulations.

Annex B: Search strings

Transport Research International Documentation (TRID)

((intervention* OR initiative OR strateg* OR polic* OR program* OR measure* OR campaign*) AND (travel* OR transport* OR mobilit* OR commut* OR trip*) AND (behaviour* OR behavior* OR choice* OR decision OR habit* OR pattern*) AND (((event* OR transition* OR stage* OR course) AND life) OR ((moment* OR circumstance* OR condition* OR structural OR context*) AND change*) OR ((decision OR trigger OR turning) AND point*) OR mileston* OR discontinuit* OR biograph* OR relocat* OR “disruptive events”))

In addition, filters for language (English), date (2010-2024) and result type (articles and papers) were applied.

Scopus

((TITLE-ABS-KEY (milestone OR discontinuity OR biography OR relocation OR "disruptive events")) OR (TITLE-ABS-KEY ((decision OR trigger OR turning) AND point)) OR (TITLE-ABS-KEY ((moment OR circumstance OR condition OR structure OR context) AND change)) OR (TITLE-ABS-KEY ((event OR transition OR stage OR course) AND life))) AND (TITLE-ABS-KEY (intervention OR initiative OR strategy OR policy OR program OR measure OR campaign)) AND (TITLE-ABS-KEY (travel OR transport OR mobility OR commute OR trip)) AND (TITLE-ABS-KEY (behaviour OR choice OR decision OR habit OR pattern)) AND PUBYEAR > 2009 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (AFFILCOUNTRY , "United States") OR LIMIT-TO (AFFILCOUNTRY , "United Kingdom") OR LIMIT-TO (AFFILCOUNTRY , "Germany") OR LIMIT-TO (AFFILCOUNTRY , "Australia") OR LIMIT-TO (AFFILCOUNTRY , "Canada") OR LIMIT-TO (AFFILCOUNTRY , "Italy") OR LIMIT-TO (AFFILCOUNTRY , "Netherlands") OR LIMIT-TO (AFFILCOUNTRY , "France") OR LIMIT-TO (AFFILCOUNTRY , "Spain") OR LIMIT-TO (AFFILCOUNTRY , "Sweden") OR LIMIT-TO (AFFILCOUNTRY , "Switzerland") OR LIMIT-TO (AFFILCOUNTRY , "Norway") OR LIMIT-TO (AFFILCOUNTRY , "Belgium") OR LIMIT-TO (AFFILCOUNTRY , "Portugal") OR LIMIT-TO (AFFILCOUNTRY , "Denmark") OR LIMIT-TO (AFFILCOUNTRY , "Poland") OR LIMIT-TO (AFFILCOUNTRY , "New Zealand") OR LIMIT-TO (AFFILCOUNTRY , "Austria") OR LIMIT-TO (AFFILCOUNTRY , "Ireland") OR LIMIT-TO (AFFILCOUNTRY , "Finland") OR LIMIT-TO (AFFILCOUNTRY , "Greece") OR LIMIT-TO (AFFILCOUNTRY , "Undefined") OR

LIMIT-TO (AFFILCOUNTRY , "Czech Republic") OR LIMIT-TO (AFFILCOUNTRY , "Romania") OR LIMIT-TO (AFFILCOUNTRY , "Ukraine") OR LIMIT-TO (AFFILCOUNTRY , "Hungary") OR LIMIT-TO (AFFILCOUNTRY , "Croatia") OR LIMIT-TO (AFFILCOUNTRY , "Slovenia") OR LIMIT-TO (AFFILCOUNTRY , "Luxembourg") OR LIMIT-TO (AFFILCOUNTRY , "Slovakia") OR LIMIT-TO (AFFILCOUNTRY , "Iceland") OR LIMIT-TO (AFFILCOUNTRY , "Estonia") OR LIMIT-TO (AFFILCOUNTRY , "Cyprus") OR LIMIT-TO (AFFILCOUNTRY , "Lithuania") OR LIMIT-TO (AFFILCOUNTRY , "Bulgaria") OR LIMIT-TO (AFFILCOUNTRY , "Bosnia and Herzegovina") OR LIMIT-TO (AFFILCOUNTRY , "Malta") OR LIMIT-TO (AFFILCOUNTRY , "Georgia") OR LIMIT-TO (AFFILCOUNTRY , "Gibraltar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (EXCLUDE (EXACTKEYWORD , "Animal") OR EXCLUDE (EXACTKEYWORD , "Animals") OR EXCLUDE (EXACTKEYWORD , "Nonhuman") OR EXCLUDE (EXACTKEYWORD , "Major Clinical Study") OR EXCLUDE (EXACTKEYWORD , "Clinical Article") OR EXCLUDE (EXACTKEYWORD , "Metabolism") OR EXCLUDE (EXACTKEYWORD , "Genetics") OR EXCLUDE (EXACTKEYWORD , "Pathophysiology") OR EXCLUDE (EXACTKEYWORD , "Sediment Transport") OR EXCLUDE (EXACTKEYWORD , "Unclassified Drug") OR EXCLUDE (EXACTKEYWORD , "Chemistry")) AND (EXCLUDE (SUBJAREA , "DENT") OR EXCLUDE (SUBJAREA , "PHAR") OR EXCLUDE (SUBJAREA , "VETE") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "CHEM") OR EXCLUDE (SUBJAREA , "MATE") OR EXCLUDE (SUBJAREA , "PHYS") OR EXCLUDE (SUBJAREA , "BIOC") OR EXCLUDE (SUBJAREA , "MEDI"))

Web of Science

TS=(mileston* OR discontinuit* OR biograph* OR relocat* OR “disruptive events”) OR TS=((decision OR trigger OR turning) AND point*) OR TS=((moment* OR circumstance* OR condition* OR structural OR context*) AND change*) AND TS=((event* OR transition* OR stage* OR course) AND life) AND TS=(behaviour* OR behavior* OR choice* OR decision OR habit* OR pattern*) AND TS=(travel* OR transport* OR mobilit* OR commut* OR trip*) AND TS=(intervention* OR initiative OR strateg* OR polic* OR program* OR measure* OR campaign*)

In addition, filters for document type (article), time span (01/01/2010 to 10/07/2024) and counties/regions (exclude China) were applied.

Google Scholar

("Moment of change" OR "Life event" OR "Habit discontinuity" OR "Habit disruption" OR "Life transition") AND (Travel OR Transport) AND (behaviour OR choice) AND (intervention OR strategy OR program OR policy)

Annex C: PRISMA process

1. Our search returned 9,982 references: 3,727 from TRID, 3,188 from Scopus, 2,976 from Web of Science and 91 from Google Scholar.

2. We removed 3,001 of these references. 2,989 were duplicates that were identified and removed by Zotero. Twelve were identified by Rayyan and removed manually.

3. We screened all the remaining 6,981 references.

4. Of these 6,981, we sought to retrieve 94 and successfully retrieved all 94.

5. Of these 94, we excluded 80: one for being a book chapter; three for being commentaries; fifteen for being conference papers; one for being outside the date inclusions criteria; one for being a duplicate; one for not involving any behavioural intervention; one for not involving any moment of change; one for not having any outcome of interest; one for not being written in English, and six for being reviews.

6. Subsequently, we added five articles that had been included in the bibliographies of papers identified in the search.

7. We therefore included nineteen articles in the review.

▼

Annex D: Critical appraisal results

	Bhattacharyya et al., 2019	Walker et al., 2015	Verplanken & Roy, 2016	Frater et al., 2020	Thronicker & Klinger, 2019	Sulikova & Brand, 2022	Ralph & Brown, 2019	Schäfer et al., 2012	Guo & Peeta, 2020	Bamberg & Rees, 2017	Becker et al., 2022	Garaus & Garaus, 2021	Meuleners et al., 2023	Gustafsson et al., 2012	Liddle et al., 2014	McDonald et al., 2015	Rodriguez & Rogers, 2014
Hypotheses: Are the question(s) and hypothesis/hypotheses addressed by the study clearly identified?	2	2	2	2	1	2	1	1	2	2	1	1	2	2	2	1	2
Research/theories: Are related existing research and theories acknowledged?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Funding/Conflict of interest: Are sources of funding and vested interests declared?	2	1	2	3	1	2	2	2	2	3	1	2	1	2	1	2	3
*Sample population: Is the sample population used in the study representative of the overall population that is the subject of the study and is it relevant in the context of the evidence statement (e.g., relevant to England/UK)	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Intervention: Were the experimental/management interventions well described?	1	2	2	2	3	2	1	2	3	2	2	1	2	2	2	2	1
Randomisation: Was the allocation of the management/experimental interventions random? If not are confounding factors likely?	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	3
Control: Was an adequate control group used? Was this similar to the population receiving the management/experimental intervention?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Outcome measures: Were outcome variables/measures reliable (i.e. were outcome variables/measurements objective, was there any indication that measures had been validated or subjected to another QA processes)?	2	1	2	2	3	2	1	2	2	2	2	1	1	2	1	2	2

	Bhattacharyya et al., 2019	Walker et al., 2015	Verplanken & Roy, 2016	Frater et al., 2020	Thronicker & Klinger, 2019	Sulikova & Brand, 2022	Ralph & Brown, 2019	Schäfer et al., 2012	Guo & Peeta, 2020	Bamberg & Rees, 2017	Becker et al., 2022	Garaus & Garaus, 2021	Meuleners et al., 2023	Gustafsson et al., 2012	Liddle et al., 2014	McDonald et al., 2015	Rodriguez & Rogers, 2014
*Representative: Were the experimental/management interventions applied representative in the context of the evidence statement (e.g., relevant to England/UK)?	2	1	1	3	2	2	2	2	2	2	2	2	2	2	2	2	2
Analysis: Were the analytical methods appropriate?	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Effect sizes: Were the estimates of effect size given?	3	3	2	3	1	2	3	3	3	1	1	3	3	3	3	3	3
CIs/p-values: Was the precision of the intervention effects given? (i.e., Were confidence intervals and or p-values for the effect estimates given)?	2	2	2	2	1	1	2	2	2	1	1	1	1	1	2	2	2
Overall score: Overall how well was bias minimised by the study and how relevant is it to the evidence review/statement (i.e. how well are the criteria above met)?	23	18	19	26	19	20	19	21	23	20	17	18	19	21	20	21	25
Robustness class: The most frequent score assigned to each study for the robustness-related questions. Class 1 – low risk of bias, Class 2 – risk of bias.	2	1	2	2	1	2	1	1	2	1	1	1	1	1	1	1	2

Table 5 Critical appraisal results - quantitative. Note: * indicate scores related to relevance to the research question, and were therefore not included in robustness class calculations. All other questions were included in the calculation.

	Chatterjee et al., 2013	Johansson et al., 2019
Study aim: Was the aim of the interview/elicitation clearly stated?	1	1
Funding/Conflict of interest: Are sources of funding and vested interests declared?	2	1
Consultation: Was the consultation method tested to ensure suitability?	3	3
Questions: Are the questions asked clearly identified?	2	3
Sample identity: Are the experts/interviewees asked clearly identified?	2	2
Sample suitability: Are the experts/interviewees the most suitable and representative (i.e., was the size of the group suitable for the diversity of opinions)?	1	1
Minority opinions: Were minority opinions stated?	2	2
Conclusions: Were the conclusions based on the information gained from the experts/interviewees?	1	1
Opinions: Were the range and diversity of opinions clearly stated?	2	2
Overall score: Overall how well was bias minimised by the study and how relevant is it to the evidence review/ statement? I.e. how well are the criteria above met?	16	16
Robustness class: The most frequent score assigned to each study for the robustness-related questions. Class 1 – low risk of bias, Class 2 – risk of bias.	2	1

Table 6 Critical appraisal results - qualitative. Note: All questions relate to robustness and were therefore included in the robustness class calculations.

Annex E: Results tables

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
Becker et al., 2022	COVID-19	Berlin citizens, Strava app users. Germany, Berlin	Investigate the potential of temporary infrastructure as a niche innovation, in particular PUBLs (pop-up bike lanes) to: - accelerate 'regime change' from car-dominated to bicycle-friendly cities - show whether PUBLs can contribute to faster implementation of the transport transition and - under which conditions it effectively contributes to more sustainable cities.	Before-and-after study	Cycling usage	The number of cycle trips made on the affected route by its 1,661 participants increased from 171,000 the year before the pop-up lane was installed to 300,000 the year after its installation – an increase of 73%. This compares to a 20-23% increase in cycle trips for the city as a whole.
Garaus & Garaus 2021	COVID-19	Adults with a driver's license and a general interest in car sharing Germany (Munich, Berlin, Frankfurt, Stuttgart, Düsseldorf, Cologne, or Hamburg)	H1. Environmental claims increase perceived ecological benefits of carsharing. H2. Perceived ecological benefits increase car-sharing intentions. Interactions between the above.	Online RCT	Carsharing usage intention	Mentioning ecological benefits in an advert for a car-sharing scheme increased by 30% intentions to use such a service.
Liddle et al., 2013 and	Driving cessation	Adults (>60 years) retiring from driving	Evaluate the effectiveness of UQDRIVE intensive support at promoting	In-field RCT	Primary outcome: episodes of leaving the home in the week prior to data	The intervention led to:

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
Gustafsson et al., 2011		Australia, Queensland	community engagement & mobility amongst older people retired/retiring from driving.		collection week ('episode' = an instance of leaving home). Secondary outcomes: • Modes of transport used • Subjective satisfaction with transport • Self-efficacy with community mobility	• Higher incidence of walking immediately post-intervention but had no statistically significant longer-term impacts. • Higher use of public transport immediately after the intervention but not in the longer term. • More weekly trips away from home immediately postintervention but not at 3-month follow-up. No effect sizes were provided. Immediately post intervention, recipients were on average four times as confident as those in the control group that they would be able to 'stay involved in their community' after they stopped driving.
Sulikova & Brand, 2022	Health problems OR residential relocation (rental/purchase not specified)	Adults relocating or with health problems Austria, Vienna	Evaluate measures implemented as part of the European Physical Activity Through Sustainable Approaches (PASTA) study in Vienna (Austria)	In-field RCT	Mode use (days per week) for walk, bike, e-bike, public transport, driving, motorbike	No statistically significant impact on car use or public transport. Walking had increased by average 0.7 days at first follow up; by 0.4 days at second follow-up. **Effects of moments of change on travel behaviour in the absence of an intervention** In Vienna walking increased in both control and intervention groups. At FU2, in the control group there was an increase in walking of 1.1day/week and bike use of 0.6days/week; public transport use increased by 0.8days/week; and driving decreased by 0.3.
Meuleners et al., 2023	Holding a provisional driving licence	Provisional license holders (17-20 years) Australia, Western Australia	Determine whether personalized feedback (via a smartphone app) reduces risky driving behaviours of young provisional drivers aged 17–20 years.	In-field RCT	Overall driving performance score: an average of the speeding, deceleration and acceleration scores	No statistically significant impact.

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
			Feedback was on speeding, harsh decelerations (braking), harsh acceleration and overall driving performance.			
McDonald et al., 2015	Holding a provisional driving licence	Provisional license holders (16-18 years) USA, Pennsylvania	To determine if RAPT-3 training, as is, improves intersection turning behaviours among novice teen drivers	RCT using driving simulator	Behaviour in simulated left-turn stop-sign controlled intersections: Intersections: • Gap selection errors • Collisions • Eye tracker (traffic check) errors.	No statistically significant impact.
Chatterjee et al., 2013	Life & transport related events, and changes to the external cycling environment	Adult (16+ years) residents of Cycling City and Towns, cyclists and non-cyclists UK (Greater Bristol, Blackpool, Cambridge, Chester, Colchester, Leighton-Linslade, Shrewsbury, Stoke, Southend, Southport, Woking and York)	To understand the circumstances and factors that influenced people to start, stop or significantly change their amount of cycling.	In-depth interviews	Changes in travel behaviour during the CCT investment period and influencing factors.	Cycling interventions were more effective if they coincided with life-events. Whether people sustained increases in cycling was determined by their subjective evaluation of the personal (dis)benefits of cycling.
Bhattacharyya et al., 2019	Residential relocation (purchase & rental)	Adults planning to relocate within 3 months USA, not specified	Can focalism or visualisation trigger residential choices that result in more sustainable travel patterns and higher well-being?	In-field RCT with survey evaluation	• Change in stated priorities for the location of the new home (post-intervention): Physical aspects of house; multimodal travel accessibility; proximity to social network and activities; non-transport neighbourhood aspects. • Changes in commute time, travel mode and well-being.	Sustainable behaviours in general are more susceptible to interventions during relocation than at other times. Focalism increased the number of participants that walked, cycled or e-cycled to work (from 27 before the intervention to 39 after the intervention) and to visit family/friends (from 38 before the intervention to 52 after the intervention). No evidence of visualisation impacting on active travel.

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
						No impacts of focalism on the use of active travel for visits to shops, services and restaurants. Focalism reduced from 7.24 to 6.49 the average weekly number of hours spent commuting. No such effect was reported for a visualisation intervention or control group. **Effects of moments of change on travel behaviour in the absence of an intervention** Hours spent commuting per week (workers only, control n=38) pre- post move (6.42h to 6.48h respectively, p=0.96. Changes in n. of people taking different modes for various activities (control n=44): (a) Bike, walk bike-share when commuting pre-move n=21, post n=22, p=0.82; when shopping etc. pre n=19, post n=20, p=0.83; when visiting family, friends pre n=18 post n=19 p=0.83);(b) Drive alone, motorcycle when commuting pre n=16, post n=17, p=0.81; when shopping etc pre n=21, post n=20, p=0.83; when visiting family etc. pre n=16, post n=16, p=1; (c) Carpooling, carshare, Public transport when commuting pre n=11, post n=12, p=0.80; when shopping etc. pre n=9, post n=8, p=0.79; when visiting family pre n=10, post n=10, p=1.00.
Verplanken & Roy, 2016	Residential relocation (purchase & rental)	Adults who had relocated within 6 months and non-movers UK, Peterborough	The hypothesis was tested that higher frequencies of behaviour are reported in the intervention versus control group eight weeks later, but that this effect is stronger when participants had recently relocated.	In-field clustered RCT with survey evaluation	Frequency of 25 environmentally relevant behaviours. For reducing car use for short journeys: • Habit strength • Behavioural intention • Perceived behavioural control • Personal norms	Sustainable behaviours (in general, not necessarily travel behaviours) are more susceptible to interventions during relocation than at other times **Effects of moments of change on travel behaviour in the absence of an intervention**

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
						The main effect of relocation status was not significant. Multiple regression predicting behaviour at Time 2 (i.e. 8 weeks later) (this included aggregate 25 sustainable behaviours including travel) B= -0.00 (SE B=0.01, beta= 0.01, t=-0.30, n.s.)
Guo & Peeta, 2020	Residential relocation (purchase & rental) AND new job	Adults relocating within 6 months to start a new job USA, Indiana (relocation destination)	Test a personalized neighbourhood accessibility information intervention that's designed to influence the residential location decision-making process and foster formation of more sustainable travel behavior after relocation.	In-field RCT	• Self-reported average driving time of 'drive alone' trips made before and after relocation • Mode share for different purposes before and after relocation	Those receiving the intervention relied on walking for 25% of retail/grocery shopping trips after the intervention, whereas those that did not receive the intervention relied on walking for 15% of these trips. The intervention had no statistically significant impact on the extent to which participants used walking as their mode of travel for other types of trip. Nor did it have any such impact on levels of cycling or use of public transport. The intervention led to less time being spent as sole occupant of a car for journeys related to each of work, social/recreational activities, restaurants, and retail/grocery shopping. For example, the average weekly time spent driving alone for work purposes was found to be 81.85 minutes for the intervention group but 93.47 for the control group; that for social/recreational trips, 27.60 minutes for the intervention group but 32.65 for the control group; that for shopping trips, 16.19 minutes for the intervention group but 19.29 for the control group
Johansson et al., 2019	Residential relocation (purchase)	Adults who had relocated (purchased an apartment) Sweden, Stockholm	Understand how limiting the number of parking spaces in housing developments shapes residents' travel habits and affects use of 'capacity-efficient' means of transport.	Before-and-after study	Changes in: • Whether someone has access to a private car (owned by them or a.n.other) • Proportion of journeys by bike • Membership of car club) • Use of public transport	Participants were less likely to have access to a private car after moving to apartments than they were before moving. However, the reduction in access to private cars is likely to have been affected by factors other than the intervention – for example, participants moving from parental homes where they had access to cars owned by others, or participants

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
						experiencing changes to their employment.
Thronicker & Klinger, 2019	Residential relocation (rental)	Adults about to relocate & non-movers Germany, Leipzig	Hypotheses: 1. "residential relocation and the occurrence of life changes independently enhance interest in a proposed intervention that promotes sustainable travel options; there might also be a positive interaction effect" 2. "low mobility habit strength, high consideration to reduce car use, and high perceived accessibility independently enhance openness to change one's travel behaviour, while the effect of perceived accessibility might additionally be qualified by low mobility habit strength and a high consideration to reduce car use "	Survey	• Interest in the mobility package • Whether they would like to receive the mobility package.	Interest in the mobility package reduced when people were experiencing two moments of change at the same time: a home move and a life change. **Effects of moments of change on travel behaviour in the absence of an intervention** A logistic regression model on interest (yes/no) indicated that neither relocation nor life changes predicted interest (B= 0.132, SE(B)= 0.211, p= 0.530, odds ratio 1.141, 95% CI [0.755, 1.724] and B= -0.042, SE(B)= 0.201, p= 0.835, odds ratio 0.959, 95% CI [0.646, 1,422] respectively. Life changes in combination with a residential relocation significantly reduced the odds in terms of interest (B= -0.943, SE(B)= 0.401, p= 0.019, odds ratio 3.389, 95% CI [0.177, 0.855]. R2CS=0.02 (Cox & Snell) R2N=0.03 (Nagelkerke) R2L=0.87 (Hosmer-Lemeshow), Model X2(9)=15.65. p=.075.
Ralph & Brown, 2019	Residential relocation (rental)	Incoming graduate students USA, Los Angeles	Do travel behaviour change programs work? Do they work for movers but not non-movers? Test 2 hypotheses for why they tend to work for movers but not non-movers: 1. habit pathway: by breaking travel habits	In-field RCT	For each of bus/automobile/active travel – in relation to travel to university: • Share of students who always use that mode • Share who use that mode at least once in a typical week • Number of trips to campus by that mode per week • Miles of travel by automobile to campus per week	The intervention altered the travel patterns of students that moved home at the start of a new course but not those of non-movers. No statistically significant impact on active travel or on the use of buses. Amongst movers, the intervention reduced the average number of weekly private vehicle trips to campus by 0.2 trips and reduced the average weekly miles driven to the campus by 0.84.

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
			during a period of self-reflection 2. residential location pathway: by improving the transit quality of one's home neighbourhood.			**Effects of moments of change on travel behaviour in the absence of an intervention** A multivariate regression showed that, on average, students who moved made 1.1 more trips per week by transit and 1.5 more trips by active travel compared to non-movers (p=0.01). Movers also made 1.6 fewer trips per week by vehicle and drove 23.9 fewer miles per week to campus (p=0.01).
Rodriguez & Rogers 2014	Residential relocation (rental)	Incoming undergraduate transfer students and graduate students USA, North Carolina	Impact on location choices & travel behaviours of providing bundled travel and residential information Hypotheses: the intervention: reduces reliance on single-occupancy vehicle travel increases bus use increases in walking & cycling.	In-field RCT	Related to travel behavior: • Daily round-trip solo driving between home and school (in km) • Share of home-to-school trips by bus, walking, or bicycle Related to location selection: • Transit accessibility of the residential location chosen • Pedestrian and bicycle friendliness of the residential location. Separate data collected on bus-use, walking and cycling.	No statistically significant impacts on walking, cycling or the use of buses. In one of the two university campuses, those receiving the intervention travelled an average of 4.5 km by car per day, compared with 14.5 km for those who did not use the map. Amongst participants from the other campus, there was no statistically significant difference between control and intervention group.
Bamberg & Rees, 2017	Residential relocation (rental/purchase not specified)	Adults who had registered as new residents one month prior Germany, Munich	Test the effectiveness of a personal travel planning strategy with people who recently moved to Munich	In-field RCT	Actual travel modal choice (walking, cycling, PT, car - modal split share in %) for daily trips over 3 days	No statistically significant impacts on either walking or cycling Those that received the intervention used cars between 0% and 11% less than those that did not; they used public transport between 4% and 15% more than those that did not receive the intervention.
Schäfer et al., 2012	Residential relocation (rental/purchase not specified) OR having first child	Adults with access to a car who had relocated or had their first child within 6 months Germany, Munich	Hypotheses: 1. Life events show independent main effects on consumption behaviour.	In-field RCT	Changes in unsustainable consumption behaviours – pooled variable that included data for walking, cycling, public transport, car use.	No evidence to suggest that the intervention was more effective amongst people experiencing life-events than it was amongst others.

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
			2. The consultative intervention has significantly stronger main effect on consumption behaviour than the information mailing intervention. 3. People who participate in the interventions during life-course transitions should exhibit a stronger behavioural change effect than persons in stable life situations.			**Effects of moments of change on travel behaviour in the absence of an intervention** Relocation had a significant effect on car use and public transport (PT) use. In comparison with newly parents and persons in stable life situations, Games-Howell post hoc tests indicate a significantly lower car and significantly higher PT use for the group of persons who moved (car use for stable M= 3.6, parents M=3.4, movers M=2.9, F(2,289)=5.46, p<.01; PT use for stable M=2.9, parents M=2.9, movers M=3.8, F(2,289)=11.30, p<.001).
Walker et al., 2015	Workplace relocation	Employees of recently relocated company UK, Godalming (pre-move), Woking (post-move)	What happened to people's habits (i.e. behavioural automaticity/habit impulse) in the period sur-rounding relocation. Look at the potential disappearance and/or re-appearance of an already established behaviour around the point of the disruptive event	Before-and-after study	Strength of the habit impulse for original mode before relocation, immediately after relocation and a while after relocation. Main travel mode after relocation.	The impulse to use the same commuting mode as before residential relocation decayed rather than disappearing instantly on relocation – and was in some cases still present four weeks after the transition. The endurance of the habit impulse did not predict who changed mode: "spatial and infrastructural factors are a bigger determinant of travel behaviour after a [moment of change] than internal cognitions [such as impulses] or socio-demographic variables".
Frater et al., 2020	Workplace relocation	Employees of companies planning to relocate in the next 12 months. New Zealand, Christchurch	examine the effectiveness of personal travel planning in promoting alternatives to private motor vehicle use – in particular, amongst staff of businesses relocating to a city centre	Non-randomised controlled, study	Post intervention mean number of trips per week for each mode for each individual; whether their way of commuting had changed;	No statistically significant impacts on walking, cycling, car-pooling or car use. Statistically significant increase in bus use (no effect size provided). **Effects of moments of change on travel behaviour in the absence of an intervention** Relocation was associated with an increase in walking (pre-move M=0.43, SD=1.81, BCa 95% CI [0.21,0.65]; post-move M=0.63, SD=2.12, BCa 95% CI [0.37,0.88], cycling (pre-move M=1.74, SD=3.41, BCa 95% CI [1.32,2.16]; post-

Study reference(s)	Moment(s) of change	Study population and location (country, city/state)	Study aims or research questions	Study design	Outcome measures	Findings
						move M=2.42, SD=3.89, BCa 95% CI [1.83,2.61], bussing (pre-move M=0.49, SD=1.90, BCa 95% CI [0.25,0.72]; post-move M=1.51, SD=3.05, BCa 95% CI [1.14,1.88], carpooling (pre-move M=0.14, SD=0.95, BCa 95% CI [0.03,0.26]; post-move M=0.39, SD=1.48, BCa 95% CI [0.21,0.57], and a decrease in using car (pre-move M=6.41, SD=4.18, BCa 95% CI [5.90,6.92]; post-move M=4.25, SD=4.35, BCa 95% CI [3.71,4.78].

Table 7 Summary of included studies

Study reference(s)	Moment(s) of change	Target behaviour	Intervention details	Intervention type(s)	Duration	Mode of delivery
Becker et al., 2022	COVID-19	Cycling behaviour & acceptance of pop-up bike lanes installed during COVID-19	Pop-up bike lanes	Infrastructure[1]	Usage evaluated over 12 months	Physical infrastructure installation
Garaus & Garaus 2021	COVID-19	Carsharing usage intention during COVID-19	Participants were exposed to different types of information (environmental, safety, or no claim) to assess impact on perceptions and intentions to use carsharing services	Behaviour change; Provision of information	Online	Experimental session
Sulikova & Brand, 2022	Health problems OR residential relocation (rental/purchase not specified)	Increase in active travel	Personalised mobility consultancy; Provision of general information; Mobile apps and GPS trackers; Improved frequency & speed of PT; Festivals to promote cycling; Feedback initiatives	Personalised travel planning; Behaviour change; Infrastructure1	Unclear, approx. 36 months	Various including app, in person, & physical infrastructure installation
Meuleners et al., 2023	Holding a provisional driving licence	Reducing risky driving behaviour	Personalised weekly feedback about the participant's risky driving behaviour based on driving data collected by an app; General road safety tips	Provision of information; Behaviour change	8 weeks	Text message

Study reference(s)	Moment(s) of change	Target behaviour	Intervention details	Intervention type(s)	Duration	Mode of delivery
Chatterjee et al., 2013	Life & transport related events, and changes to the external cycling environment	Cycling behaviour (starting, stopping or changing) in locations with substantial investment in cycling infrastructure	Programme of DfT & DoH investment to improve cycle routes, train children, & marketing & PR	Infrastructure[1]; Behaviour change; Provision of information	Programme rolled out for approx. 30 months	Various but unspecified
Bamberg & Rees, 2017	Residential relocation	Sustainable travel behaviour post moving to Munich	Welcome letter; PT information; Map showing PT routes & stops; Service card used to provide more information and a free one-week PT ticket; Phone call with the option of more info & order form for season ticket	Personalised travel planning; Financial incentive	Phone call (length unspecified)	Mail & phone
Bhattacharyya et al., 2019	Residential relocation (purchase & rental)	Consider sustainable travel options when choosing a new home	Reflective planning via visualisation & focalism*	Behaviour change	Experimental session (length unspecified)	Online survey
Verplanken & Roy, 2016	Residential relocation (purchase & rental)	Twenty-five environmental-related behaviours after residential relocation	Tailored interview; Tailored and general information; Selection of sustainable items; Newsletter	Personalised travel planning; Provision of information	Various points across 8 weeks	Interview & mail
Guo & Peeta, 2020	Residential relocation (purchase & rental) AND New job	Residential location choice and travel behaviours of individuals relocating	Interactive online accessibility mapping application showing ease of access for various journey types using walking, cycling, public transport, or car	Provision of information	Experimental session (length unspecified)	Online
Johansson et al., 2019	Residential relocation (purchase)	Use of sustainable travel options after moving to flats with limited parking availability	Mobility services (e.g., a car club or bicycle clubs); Information and financial incentives to use public transport; Personalised travel planning; Discounts on taxis and car hire; Free one-month or one-year public transport car	Personalised travel planning; Financial incentive	Services were typically provided for up to one year	Access to services
Thronicker & Klinger, 2019	Residential relocation (rental)	Interest in engaging with an intervention to promote sustainable travel, following residential relocation	Information to use public transport, car sharing, and cycling; Free one month ticket for public transport, free 3-month membership at car sharing and limited free usage, and a free bike check-up and bike city map	Provision of information; Financial incentive	NA	NA
Ralph & Brown, 2019	Residential relocation (rental)	Changing travel behaviours from car to active travel and PT	Transport guide highlighting PT and cycling routes and bike sheds	Provision of information	Experimental session (length unspecified)	Email
Schäfer et al., 2012	Residential relocation (rental/purchase not specified) OR Having first child	Change consumption behaviours to be more sustainable during life events (residential relocation and having first child)	Information via brochures, leaflets, and flyers from a range of institutions OR personal consultation and incentives (e.g., Free two-day PT ticket)	Provision of information; Financial incentive	NA (info) /1 month (consultation)	Mail or phone

Study reference(s)	Moment(s) of change	Target behaviour	Intervention details	Intervention type(s)	Duration	Mode of delivery
Walker et al., 2015	Workplace relocation	Commuting habits following workplace relocation. Theoretical study investigating habit decay and formation in relation to sustainable travel	Unspecified organisational programme to encourage sustainable travel; Paid price difference between car and rail for 6 months after the move	Unspecified; Behaviour change; Financial incentive	Various points across approx. 24 months	Comms (further details unspecified)
Frater et al., 2020	Workplace relocation	Use of sustainable travel options when returning to work in a city rebuilt after earthquakes	Personalised travel discussion; Provision of personalised information; Barrier identification; Assistance registering on relevant websites; Commitment to travel using sustainable mode with a visual reminder & info card; Free one-week ticket/cycling accessories	Personalised travel planning; Financial incentive	Interview session (length unspecified)	In person one-to-one interviews

Table 8 Intervention characteristics. Note: 1 In the 'intervention type(s)' indicates a hard intervention. All other interventions are classed as soft. * Focalism occurs when people focus on the prominent aspects of a decision while neglecting other important factors.