Final report on loneliness and transport systematic review

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Summary

Loneliness is a risk to health that has been equated with smoking or obesity. Within the UK, governments are developing policies to address loneliness, however, there is little evidence of population-wide approaches to reducing loneliness. Transport related social exclusion has been recognised since the 1970s, however there is less research on whether transport and loneliness are connected. Subsequently, we undertook a systematic review of nine research databases. From the 12,656 papers retrieved we found 46 papers which had examined the relationship between transport and loneliness. These papers were published between 1983 and 2021, originated from 27 different countries, and included around 188,850 participants. The studies used qualitative as well as observational quantitative methods, including both cross sectional and cohort methods to study private transport, public transport, community transport, active travel and transport infrastructure. There was consistent evidence that transport was associated with loneliness, some papers highlighting that those who used more modes of transport reported less loneliness. Three themes were identified across the literature:

1. Transport as a means of reaching destinations where you meet with other people
2. Transport as a 'third space' in which you meet other people
3. Transport as a positive source of isolation

Subsequently, we reached the following recommendations:

1. Interventions are needed to support people in phases of life when driving is not an option, such as older age and single parents. Even when transport options are available, these groups may need support accessing them such as bus passes, low-level buses or easy to read timetables.
2. Public and community transport, and active travel routes need to support people reaching friends and family, not just places of work or retail.
3. Some people value opportunities to connect while travelling, while other appreciate the time to disconnect. Modes of travel and transport policy should consider both of these desires.
4. Transport policy and interventions should consider all road users not just drivers, with the assessment of loneliness or social connections providing valuable insights into the effects of these interventions.

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Background

The health risks of loneliness have been equated with the risks from smoking, obesity or alcoholism (Campaign to End Loneliness, n.d., Holt-Lunstad *et al.*, 2015). The neuroscientist John Cacioppo likened loneliness to other bodily signals like pain or hunger, reflecting humanities essentially social nature. Research has demonstrated physiological, psychological, behavioural and social mechanisms through which loneliness leads to disease and death, including stress and difficulties accessing health services (Hodgson *et al.*, 2020). Consequently, each of the four nations of the United Kingdom have or are in the process of developing policies addressing loneliness and social isolation (Department for Digital *et al.*, 2018, Local Government and Communities Directorate, 2018, Spence, 2020, The Loneliness Taskforce, 2018, Welsh Government, 2020). Reducing loneliness is now recognised in multiple areas of policy and practice as an important outcome, but there is a lack of evidence on effective population-wide approaches to reducing social isolation and loneliness.

Surveys in the UK and other high-income countries tend to identify two age groups who report higher levels of loneliness (Barreto *et al.*, 2020, Kantar Public, 2016, Pyle and Evans, 2018). These are late teens/young adults (Eccles and Qualter, 2021) and older adults (Ten Bruggencate, Luijkx and Sturm, 2018), reflecting a U-shaped association between age and loneliness (Lasgaard, Friis and Shevlin, 2016, Solmi *et al.*, 2020, Victor and Yang, 2012). Nevertheless, the data show that anyone can experience loneliness and social isolation (Barreto *et al.*, 2020, Kantar Public, 2016, Pyle and Evans, 2018, Solmi *et al.*, 2020). Life events like divorce or retirement are recognised as triggers for loneliness (Department for Digital *et al.*, 2018). Loneliness can also be facilitated by illness and disability, including sensory loss (Shukla *et al.*, 2020), intellectual disability (Alexandra, Angela and Ali, 2018, Eccles and Qualter, 2021, Mooney, Rafique and Tilly, 2019) and depression (Wang *et al.*, 2018). Overall, the evidence is that loneliness and social isolation are common experiences that often coincide with stages of life when people may be experiencing transport difficulties.

Appleyard and Lintell (1972) found that people living on roads in San Francisco, USA with higher speed limits had fewer social connections with people living on the opposite side of the street than those living on roads with lower speed limits. More recently, Hart and Parkhurst (2011) replicated this study in Bristol, UK finding similar effects, in that people reported having significantly fewer friends and acquaintances when living on streets with higher volumes of motor traffic and that their sense of "home territory" reduced as traffic increased. This field of research has focus primarily on transport related social exclusion and transport disadvantage (Anciaes *et al.*, 2016, Gašparović, 2016, Newman and Matan, 2012). Transport disadvantage is defined in terms of the opportunities to travel, which is distinct from the subjective experiences of loneliness and social isolation. It is widely recognised that someone can be objectively isolated, but not feel lonely, while another person can have a wide network of friends but still feel lonely (Campaign to End Loneliness, n.d., Cornwell and Waite, 2009). Subsequently, the associations between transport disadvantage and social exclusion cannot simply be extrapolated to loneliness. Therefore, a systematic review was undertaken to investigate the relationship between social disconnection (specifically loneliness and social isolation) and transportation activities (particularly active transport).

Specific objectives
1. To clarify the existing evidence base that has investigated the relationship between social disconnection (specifically loneliness and social isolation) and transportation activities.
2. To determine key factors and variables that are important for the robust assessment of the impact of transportation activities on the social disconnection.
3. To comprehensively identify promising transportation-related intervention, or characteristics of transportation-related interventions, that may promote social cohesion and/or alleviate social disconnection.
4. To determine gaps in the current evidence base and compile recommendations for future research in the areas of social disconnection and transportation activity.

Methods

The systematic review was registered in the International prospective register of systematic reviews (PROSPERO) prior to commencement:
https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=232445. We searched the following bibliographic databases using the search string described in Table 1: Medline; ASSIA; CINAHL; Embase; Scopus; PsycInfo; Web of Science; Sociological Abstracts; ProQuest Public Health.

Table 1. Search sting

Search no.	Search terms
1	transport* OR traffic* OR travel* OR commut* OR cycling OR walk* OR pedestrian* OR bike OR bicycl* OR motorbik* OR automobile* OR car OR cars OR bus OR train OR rail* OR subway OR underground OR tube OR metro
2	lonel* OR "social isolation" OR "social deprivation" OR "social alienation" OR "social segregation" OR "psychosocial deprivation" OR "social disconnec*" OR "social exclusion"
3	"social support" OR "social supports" OR "social participation" OR "social capital" OR "social cohesion"
4	(#1 AND #2) OR (#1 AND #3)

Once duplicates were removed the papers were screened by title, abstract and finally full text against the inclusion and exclusion criteria listed in Table 2. This screening was undertaken by CM and AJW.

Table 2. Inclusion and exclusion criteria

PICOS	Criteria
Population, or participants and conditions of interest	No planned restriction on the study population.
	Although much of the exiting evidence on social disconnection focuses on older adults, this review did not restrict the population based on age.
	A focus on loneliness and social isolation was required, therefore a range of psychosocial issues or conditions may be present in the study population and were of interest.
	Evidence was not be restricted on the basis of country of origin, although it was anticipated that most evidence would come from high HDI (human development index) countries. Only studies accessible in English were included.
Interventions or exposures	Studies detailing the development and/or evaluation of a transportation-related intervention to alleviate social disconnection or promote social cohesion were included. Interventions targeting social disconnection without a clear transport or physical activity component would not be included.

Comparisons or control groups	Some studies may contain a control or comparison population (e.g. socially connected, physically active, living in areas with less traffic) however the presence of this population was not an inclusion criterion.
Outcomes of interest	A broad range of outcomes were of interest to this review which would not be fully apparent until studies had been identified and data extraction had been completed. Anticipated outcomes of interest include, but were not limited to: • prevalence of social disconnection related to transportation • methodological approaches to the assessment and measurement of social disconnection related to transportation • outcomes of any interventions targeting social disconnection related to transportation
Setting	No planned restrictions on the study setting.
Study design	No planned restrictions on study design. Evidence was required to be peer-reviewed original research. Meta-analyses, systematic reviews, expert opinions, conference abstracts and grey literature were excluded.

The included studies underwent data extraction and appropriate quality appraisal before being summarised narratively. Data extraction and quality appraisal was undertaken by CC and AJW. To ensure that we have transparently reported our methods and findings, we have reported against the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, Page *et al.*, 2021).

Results

Study selection
Figure 1 is the PRISMA flow diagram of the screening process (Page *et al.*, 2021). Across all nine databases 12,656 records were retrieved, with 5,880 remaining after duplicates were removed. Following the screening process 46 relevant papers were retained. Those excluded based on study design had measured loneliness and transport but did not report specific findings about the association between them.

Figure 1. PRISMA flow diagram

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┌──────────────────────┐         ┌──────────────────────┐
│ Records identified   │────────▶│ Duplicate records    │
│ from databases       │         │ removed              │
│ n=12,656             │         │ n=6,776              │
└──────────┬───────────┘         └──────────────────────┘
           │
           ▼
┌──────────────────────┐         ┌──────────────────────┐
│ Titles screened      │────────▶│ Records excluded      │
│ n=5,880              │         │ n=4,988              │
└──────────┬───────────┘         └──────────────────────┘
           │
           ▼
┌──────────────────────┐         ┌──────────────────────┐
│ Abstracts screened   │────────▶│ Records excluded      │
│ n=892                │         │ n=705                │
└──────────┬───────────┘         └──────────────────────┘
           │                     ┌─────────────────────────────────────┐
           │                     │ Records excluded:                    │
           ▼                     │  • No measure of transport (n=35)    │
┌──────────────────────┐────────▶│  • No measure of loneliness (n=64)   │
│ Full texts screened  │         │  • Study design (n=42)               │
│ n=187                │         └─────────────────────────────────────┘
└──────────┬───────────┘
           │
           ▼
┌──────────────────────┐
│ Studies included in  │
│ review               │
│ n=46                 │
└──────────────────────┘
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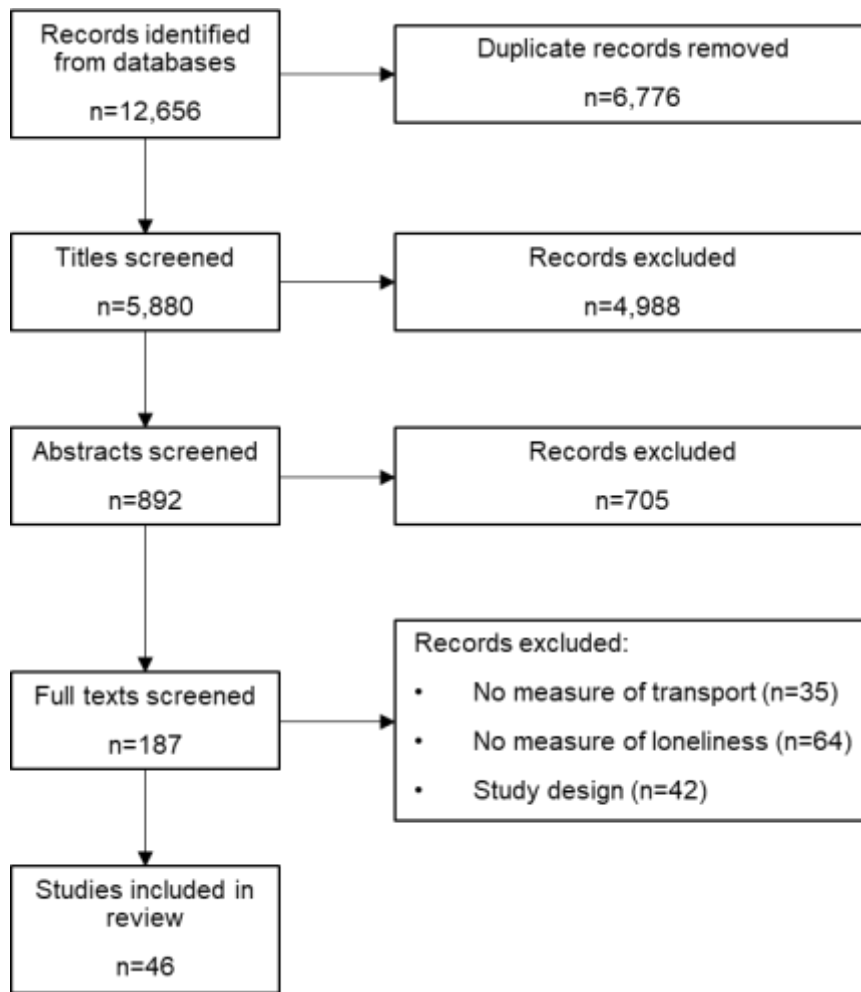
Study characteristics

The characteristics and key findings of included papers are summarised in Table 3. Included papers were published from 1983 up to 2021, including one study examining the relationship between transport and loneliness during the COVID-19 pandemic (Yang and Xiang, 2021). The studies were conducted in over 27 countries across Europe, North America, Asia and Australasia. Across the studies there are data from approximately 188,850 participants, from small qualitative studies with less than a dozen participants up to multi-country studies with more than 100,000 participants. Participants were aged from adolescence through to older age with no studies of children identified. Most studies included male and female participants, with the occasional single-gender study. A broad range of study designs were employed including interview studies and participatory methods, but the most common approach was regression analysis of cross-sectional survey data (either primarily collected, or secondary use of existing datasets).

Papers were identified which examined the relationship between loneliness and the following aspects of travel: private motor vehicles (25 papers), active travel (15 papers), transport infrastructure (12 papers), public transport (10 papers) and community transport (3 papers) (Table 3). Fourteen papers had assessed more than one mode of travel. The majority of studies were observational studies of existing travel behaviours, with only five papers focused on specific transport interventions: Let's Go community mobility programme (Mulry *et al.*, 2020, Mulry *et al.*, 2017, Mulry and Piersol, 2014), subsidised bus passes (Green, Jones and Roberts, 2014, Reinhard *et al.*, 2018) and an extension to a motorway in Glasgow, UK (Nimegeer *et al.*, 2018). Transport was

most often assessed using questions designed for each study, with existing instruments mostly being used to assess constructs like walkability (e.g. Cerin *et al.*, 2006, Raggi *et al.*, 2014). The bespoke questions used in most studies either assessed whether someone did or did not use a mode of travel (binary response) or frequency of use, with the latter being considered more useful for research on this topic.

The University of California, Los Angeles loneliness scales were the most frequently used validated and reliable instrument for assessing loneliness (Hughes *et al.*, 2004). However, the following instruments were also used to gather participants feelings of loneliness: the Woodward (1967) scale, the Lubben (1988) scale, the Social and Emotional Loneliness Scales for Adults (SELSA, DiTommaso, Brannen and Best, 2004) , the Gierveld and Tilburg (2006) scale, and Impact on Autonomy and Participation Questionnaire (IPAQ, Magasi and Post, 2010). Qualitative studies included those where transport was a topic of the study from which loneliness was an emergent theme and vice versa.

Table 3. Characteristics and findings of the included studies

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Arat and Wong (2017), 6 Middle Income Countries (China, Philippines, Indonesia, Sri Lanka, Thailand, Pakistan), Secondary analysis of data from the cross-sectional Global School-based Health Survey (GSHS)	23,372 adolescents 11-17 years old, part of GSHS (Global School-based Health Survey)	During the past 12 months, how often have you felt lonely? Likert scale of never, rarely, sometimes, most of the time, always	-	-	-	During the past 7 days, on how many days did you walk or ride a bicycle to and from school? Responses dichotomised to Yes (1-7 days) or No (0 days)	-	Walking or cycling to school was correlated with higher odds of loneliness among the respondents from the Philippines, but lower odds of loneliness among respondents from Sri Lanka. The correlation between active transportation and loneliness was not statistically significant in the other included countries. Sociocultural, environmental and climate differences between countries were cited as responsible for the differences in physical activity behaviours.
Avila-Palencia *et al.* (2018), 7 European cities (Antwerp, Barcelona, London, Orebro, Rome, Vienna, Zurich), Analysis of data from the Physical Activity through Sustainable Transport Approaches (PASTA) cohort study	3,567 participants, median aged 41 years (interquartile range 20), 53% female	6 statements based on UCLA loneliness scale	How often do you currently use car/van/motorcycle/moped? Daily or almost daily, 1-3 days/week, 1-3 days/month, <1 per month, Never	-	How often do you currently use public transport? Daily or almost daily, 1-3 days/week, 1-3 days/month, <1 per month, Never	How often do you currently walk, cycle or use an electric bike? Daily or almost daily, 1-3 days/week, 1-3 days/month, <1 per month, Never	-	More frequent use of a bicycle or car was associated with fewer feelings of loneliness. Frequency of use of public transport, motorbike or walking were not statistically significant. Less lonely cyclists and walkers felt young people were less threatening on the streets than car users and perceived higher social cohesion.
Azad *et al.* (2002), Canada, Cross-sectional survey	79 participants attending a memory disorder clinic, mean age 75.3 years (range 60-86), 48% female	Socialisation was a potential reason for driving and sense of isolation was a potential reason for why driving was important	All participants had received advice to stop driving minimum of 6 months prior to study	-	-	-	-	49.3% of participants listed sense of isolation as an important reason for driving. 74% said socialisation was a reason for driving. Leisure activities were most curtailed by ceasing driving

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
		within the questionnaire						
Bergefurt *et al.* (2019), Netherlands, Path analysis of a cross-sectional survey	200 participant, 25.5% aged 18-35 years, 27.5% aged 36-55 years, and 47.0% aged ≥56 years, 72.5% female	UCLA Loneliness scale 3-item	Frequency of car use (as passenger or driver) from never to (almost) daily (7-point scale)	-	Frequency of bus and train use from never to (almost) daily (7-point scale)	Frequency of walking or cycling in neighbourhood for different purposes	Neighbourhood Environment Walkability Scale	The results showed that personal, neighbourhood, and mobility characteristics influence specific uses of public spaces, loneliness, and life satisfaction. However, the associations between public space use and loneliness are limited. Within the path analysis none of the specific modes of transport were found to be associated with loneliness.
Bonnel (1999), USA, Secondary analysis of qualitative data from a larger interview study	15 older adult women ages 80-96 living independently (moderate to high functionality)	Qualitative - emergent theme from the analysis	12 participants had ceased driving, of the remaining three one was planning to stop driving with 1 year	-	-	-	-	Two major themes: Coping with Loss and Finding another way. Loss of social activities is a major issue. Loss of car did result in some informal support networks like paying for fuel or providing meals to people who provide transport informally.
Bryanton, Weeks and Lees (2010), Canada, Interview study	11 Caucasian women aged from 70–88 years old. 82% widows	Qualitative - emergent theme from the analysis	All participants had ceased driving	-	-	-	-	"The women, and their families, placed a higher priority on continued attendance in activities outside the home relating to their physical needs, and attending to social needs became an extravagance." "The lack of attention to the social needs of the women had an impact on their ability to play an active and meaningful role in their communities and families."
Chen, While and Hicks (2014), China, Cross-sectional survey	521 community-dwelling older people who live alone, mean age 76.5 (range 60-	UCLA Loneliness scale version 3 (RULS-V3)	-	-	-	Self-reported engagement in 30 mins moderate to strenuous	-	No significant difference in reported loneliness between groups with adequate and inadequate physical activity levels (p>0.05). Participants with more social support reported

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
	99) years, 66% female					activity (which included walking or cycling) on 5 or more days of the week.		more adequate physical activity compared to inadequate physical activity group (p<0.001).
Chesser *et al.* (1981), USA, Cross-sectional survey	31 adolescent mothers, 13 to 19 years old (mean age 18.8)	Loneliness Inventory (Woodward, 1967)	-	-	-	-	Transport accessibility assessed, but not described in detail	Loneliness scores increased as transportation became less available to participants (r = 0.3169, p = 0.041). Low-income, single, adolescent mothers experience statistically greater loneliness compared to other populations. Accessibility of transport was a significant predictor of loneliness amongst adolescent mothers.
Deka (2017), USA, Analysis of data from 5 waves of the Americans' Changing Lives cohort study	1,427 participants	Yes/No question	Car ownership	-	-	Participants reported if they had difficulty walking a few blocks	-	Neither walking ability or car ownership had a discernible effect on feeling lonely.
Domenech-Abella *et al.* (2020a), 3 European Countries (Spain, Poland, Finland), Cross-sectional study part of COURAGE in Europe	5,912 participants, 52.0% aged 50-64 years, 38.2% aged 65-79 years and 9.8% aged ≥80 years, 54.9% female	UCLA Loneliness scale 3-item and social network size	-	-	-	-	Built environment useability and walkability derived from the Courage Built Environment self-reported questionnaire (CBE-SR)	For older adults who are not experiencing depression both built environment useability and walkability were associated with reduced feelings of loneliness. However, for those experiencing depression, built environment walkability was more important to feelings of loneliness than useability. Subsequently, interventions to improve walkability are needed to support older people experiencing depression.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Domenech-Abella *et al.* (2020b), Belgium, Secondary analysis of cross-sectional data from the Detection, Support and Care for older people – Prevention and Empowerment (D-SCOPE) research project	869 participants mean age 75.2 years, standard error 0.27 years, 49.4% female	Social and emotional loneliness measured through short version of De Jong Gierveld scale	-	-	-	-	Neighbourhood Environment Walkability Scale	Loneliness mediated the association between mobility and mental health. This mediation was primarily related to emotional rather than social loneliness.
Donoghue, McGarrigle and Kenny (2019), Ireland, Analysis of data from The Irish Longitudinal Study on Ageing	8,092 participants mean age 63.8 years (range 50–105 years), 54.1% were female and 48% lived in rural areas	UCLA Loneliness Scale 5-item	Were they a driver themselves, driven by their partner/spouse or driven by family/friends or taxi	-	Did they use public transport?	-	-	Driving was associated with better psychosocial health and higher levels of social participation compared to being driven by family/friends/taxi. Being driven by a partner/spouse or taking public transport were also associated with better outcomes. Driving less frequently was associated with poorer outcomes and these effects were more pronounced for non-drivers and those who have stopped driving. Men using public transport experienced significantly higher loneliness. Social activities were the first to be dropped.
Dos Santos *et al.* (2020), Brazil, Cross-sectional analysis of data from the National School–based Health Survey (PeNSE)	102,301 participants, mean age 14.33±1.06 years, 51.7% female	In the past 12 months, how often have you felt alone? Never, Rarely, Sometimes, Most of the time or Always.	-	-	-	In the last 7 days, what was the average daily time accumulated with commuting from home to school and from	-	Longer weekly time spent in active commuting was associated with greater likelihood of feeling lonely for both sexes

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
		Dichotomised to No (Never, Rarely or Sometimes) and Yes (Most of the time or Always)				school to home performed on foot or by bicycle in the last 7 days prior to the survey (in minutes)		
Drennan *et al.* (2008), Ireland, Cross-sectional survey	683 participants aged ≥65 years old (mean 73.5±7.1 years)	Social and Emotional Loneliness Scale for Adults (SELSA-S)	-	-	-	-	Access to transport (binary response)	Social loneliness was not found to be associated with access to transport, but those living in rural areas had fewer daily interactions than those in urban areas. Family loneliness was associated with access to transport, and romantic loneliness was not. Good transport facilitates family and social contacts, while the absence of transport can reduce the older person's opportunities for interaction, which can in turn contribute to loneliness.
Franke *et al.* (2020), Canada, Photovoice study	13 rural living participants aged ≥65 years old, 85% female	Qualitative - emergent theme from the analysis	-	-	-	Qualitative - emergent theme from the analysis	-	Activities that allow participants to "share thoughts and life experiences" help to reduce feelings of loneliness and build enthusiasm. Such activities help to counter effects of declining independence (e.g. being housebound, having to give up driver's license). Participants with mobility aids stressed that mobility aids help to increase social connectedness by making connections more accessible. Participants saw transportation as a gateway to expose them to the community.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Gibney, Moore and Shannon (2019), Ireland, Analysis of data from the Healthy and Positive Ageing Initiative Age friendly Cities and Counties Survey	10,540 respondents, 46.5% aged 55-64 years, 31.5% aged 65-74 years and 22.0% aged ≥75 years, 52.7% female.	5-item UCLA Loneliness Scale	-	-	-	Difficulty walking in local area (yes/no)	Difficulty with transport most or all of the time (yes/no)	Respondents who had difficulty with transport had significantly higher loneliness scores compared to those with no difficulty.
Gibney, Zhang and Brennan (2020), Ireland, Analysis of data from the Healthy and Positive Ageing Initiative Age friendly Cities and Counties Survey	2,094 respondents from the cities of Dublin, Cork, Limerick or Galway, 40.9% aged 55-64 years, 32.7% aged 65-74 years and 26.4% aged ≥74 years, 54.8% female	5-item UCLA Loneliness Scale	Remaining a driver	-	-	-	-	Within adjusted regression models being a driver did not statistically significantly predict loneliness score among this sample of older people living in cities.
Gormley and O'Neill (2019), Ireland, Cross-sectional analysis of data from The Irish Longitudinal Study on Ageing	8,163 participants, mean age 63.68±9.16 years, 54.2% female	UCLA Loneliness Scale	Fifteen questions were posed relating to travel choices, behaviour and experiences	-	-	-	-	Only driving status was found to have a meaningful impact on loneliness and quality of life, with being a current driver conferring an advantage over having ceased driving or never haven driven.
Grant and Rice (1983), Canada, Cross-sectional survey within a needs assessment	1,675 participants, mean age 73 years (range 60-104), 41.3% female	Survey questions about the frequency and adequacy of social contact	-	-	-	-	Survey questions about difficulty with transportation to a variety of destinations	Transport disadvantage was associated with involuntary withdrawal from community (including loneliness), physical frailty and accessibility of a vehicle, and was particularly common among women and widowers.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Green, Jones and Roberts (2014), England, Individual and small group interview study	47 participants aged ≥60 years old, 70% female	Qualitative - emergent theme from the analysis	-	-	Study focused on the provision of free bus travel for older people in London (The Freedom Pass).	-	-	Key topic from the analysis was: 'a defence against loneliness: the bus as a place for interaction'. The bus pass facilitated easy access to interaction, particularly opportunistic interaction, especially for those who might otherwise have few opportunities to meet and socialise with others. Waiting at bus stops and being on the bus were one of the few places where it was acceptable to engage strangers in conversations. For older people who live alone, the freedom to take a bus to be out and about was a major and non-stigmatising defence against isolation. Bus pass also helped in maintaining friendship networks as it allowed for friends to go out and meet more often.
Hagan (2019), Northern Ireland, Interview study	11 participants aged 62- 87 years, 91% female	Qualitative - emergent theme from the analysis	-	All participants were users of a dial-a-lift service in a rural area	-	-	-	The three emergent themes from the analysis were: Escaping isolation, loss and loneliness; Being able to execute autonomy; and Making connections on the bus (third space).
Hand et al. (2017), USA, Community-based participatory research cross-sectional survey	161 participants, 61.4$ aged 50-64 years, 21.5% aged 65-74 years and 17.1% aged ≥75 years, 62.5% female	Adapted 3-item UCLA Loneliness Scale	-	-	-	-	Access to transportation was assessed with the question, "Are you able to get transportation to places you want to go?" Response	Participants who were isolated from family reported similar availability of transportation compared with non-isolated participants. Conversely, participants who were isolated from friends reported less availability of transportation compared with non-isolated participants.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
							options included always or almost always, sometimes, or not often.	
Johnson (1995), USA, Interview study	75 participants, mean age of 83.6 years, 60% female	Qualitative - emergent theme from the analysis	All participants had made the decision to stop driving within 2 years of data collection	-	-	-	-	Strong social support helped rural living older people decide to stop driving, but people reported often feeling isolated when they had given up driving and regretted their decision.
Johnson (1998), USA, Interview study	60 rural living adult participants, mean age 84.2 years (range 71-98), and their influential family members and best friends	Qualitative - emergent theme from the analysis of the transcripts	All participants had given up driving	-	-	-	-	Support from friends and family helped participants make the decision to give up driving, but they still experienced loneliness once their ability to travel as they pleased was gone.
Johnson (1999), USA, Interview study	285 metropolitan living participants aged ≥70 years old, 66% female	Qualitative - emergent theme from the analysis of the transcripts	All participants had forfeited their license within 1 year of the study	-	-	-	-	75% of participants reported feeling lonely. Urban living older people had little influence on the decision to stop driving, often feeling regret, loneliness, and immobility afterwards.
Johnson (2002), USA, Interview study	45 participants living in isolated communities, mean age 81.9 years (range 71.1 to 91.4), 64.4% female	Qualitative - emergent theme from the analysis of the transcripts	All participants had been advised not to drive, but continued to do so	-	-	-	-	Fear of isolation meant some people kept driving against advice. "I can't imagine being without my car-it's too scary. I'd be alone and lonely with no way to get anywhere. No, I wouldn't do it. I need to see my friends and stay busy-otherwise I'd just sit and get

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
								stiffer and depressed. It's just not worth the chance."
Johnson (2008), USA, Interview study	75 rural living female participants aged ≥75 years old (mean 88.5 years, range 77.9-94.7)	Qualitative - emergent theme from the analysis of the transcripts	All participants had voluntarily ceased driving, but 48% had subsequently resumed driving	-	-	-	-	Participants who continued to not drive had larger social networks than those who resumed driving. Feeling alone and frightened were reasons for resuming driving.
Lauder et al. (2006), Australia, Analysis of data from the Central Queensland Social Survey (CQSS) cross-sectional survey	1,289 participants, mean age 46.25±15.61 years, 50.1% female	Loneliness Scale (Gierveld and Tilburg, 2006)	-	-	-	Physical activity derived from Active Australia Survey (2003), including the following item: time spent in the last week walking to shops/work	-	19.0% of participants who did not feel lonely were classified as sedentary, while 21.9% of participants who felt lonely were sedentary. Adjusted odds of being sedentary if they report feeling lonely were 1.21 (95% CI 0.88-1.51) compared to those who did not report feeling lonely. Participant who did and did not feel lonely were equally likely to believe that walking 30 min a day would improve their health. But individuals who feel lonely were less confident about their ability to walk for recreation, leisure, or transportation for at least 30 min per day on most days of the week.
Matsuda et al. (2019), Japan, Cross-sectional survey study	31 rural-dwelling participants, mean age 77.5±5.1 years, 35.5% female	UCLA Loneliness Scale 6-item	-	-	Frequency of public transport use: once per week, more often or less often	-	-	Public transport use was significantly associated with less loneliness in elderly who stopped driving. Participants who used public transport less than once a week reported more loneliness than more frequent users. Lack of public transport was significant associated with loneliness.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Mulry and Piersol (2014), USA, Uncontrolled pre-post mixed methods evaluation of the Let's Go programme	7 participants aged ≥60 years old, 57% female	Impact on Autonomy and Participation Questionnaire (IPAQ)	-	All participants were part of the Let's Go community mobility programme	-	-	-	All participants maintained or improved their autonomy outdoors post-programme, and reported their social life and relationships were fair or better 4-weeks post-programme. All participants could identify 3 transportation alternatives post-programme and at follow-up.
Mulry et al. (2020), USA, Uncontrolled pre-post mixed methods evaluation of the Let's Go programme	9 participants aged >18 years old with self-reported major mental disorders, 33% female	Impact on Autonomy and Participation Questionnaire (IPAQ)	-	All participants were part of the Let's Go community mobility programme	-	-	-	78% of participants improved their autonomy outdoors post-programme, but only 33% maintained or improved their social like and relationships post-programme. Reliance on family and friends, walking and use of taxis/service cars decreased post-programme, while use of personal cars, paratransit, shuttles, buses, trains increased post-programme. Loneliness did not change statistically significantly.
Nimegeer et al. (2018), Scotland, Interview and photovoice study	30 residents along 400m of the M74 motorway extension, mean age 52±15 years, 64% female	Qualitative - semi-structured interview topic	-	-	-	-	An extension to the M74 motorway in Glasgow, built in 2011. This was hypothesised to disrupt transportation for local residents	The motorway extension made social connections for car users, but not non-users. The extension increased traffic on roads in the local area and the noise and emissions pollution disrupted local green spaces. However, these changes and others such as the installation of a footbridge increased use of the local space, increasing interaction which made some people feel safer in the area.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Nixon (2014), Canada, Participatory and interview study	34 participants	Qualitative - semi-structured interview topic	Participants included car or motorcycle drivers	-	-	Participants included pedestrians and cyclists	-	Vehicle speed and structure isolated drivers from the community around them in a way that cycling, or walking did not. Cars were described as a "little steel protection box", with time in the car positively seen as alone time by some. However, others reported communication asymmetry, with the ability of drivers to observe and communicate to those outside the car unbalanced with the ability of those outside the car to communicate with those inside, producing a negative sense of isolation for the driver. There was a sense of community among cyclists.
Rajé (2003), England, Focus group study	105 participants, 13% aged <20 years, 51% aged 20-55 years and 35% >55 years, 55% female	Qualitative - focus group topic	-	-	-	-	The study was focused on the potential impact of road user pricing policies on various aspects of social exclusion. The main question was: 'Can congestion charges promote social inclusion?'	Existing transport infrastructure was seen to be exacerbating loneliness through cost barriers and routes that did not meet local needs. Therefore, some participants felt road-user pricing might reduce loneliness, if the revenue was used to fund more appropriate transport options or routes. However, the road-user pricing might also increase loneliness through making public transport busier and making it too costly for people to offer lifts to people living within affected areas. Within some areas in the study cars that had been stolen were being used to provide trips for older people with social capital benefits.

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
Reinhard et al. (2018), England, Analysis of data from seven waves of the English Longitudinal Study of Ageing (ELSA)	18,453 participants age ≥50 years old and their partners	UCLA Loneliness Scale 3-item	-	-	User of transport or not as working of question changes between survey sweeps.	-	-	Transport use was associated with less loneliness, and an increase in volunteering at least monthly. Eligibility for free bus travel was associated with increased odds of using public transport. Transport use was associated with increased face-to-face contact with children and friends, but less contact with other family members.
Smith (2012a), USA, Interview study	12 community-dwelling older adults (>70 years old, not depressed) who had experienced loneliness in the previous 6 months	UCLA Loneliness Scale and pre-defined interview topic	Qualitative - emergent theme from the analysis of the transcripts	-	-	-	-	Loss of transportation interfered with participants' ability to get out an connect with others.
Smith (2012b), USA, Interview study	12 participants between the ages of 74 and 98 years of age who had experienced loneliness in the previous 6 months, 67% female	UCLA Loneliness Scale, Version 3 plus loneliness coping interview	Giving up the car' was a major theme in relation to the loneliness experience	-	-	-	-	Many participants expressed loneliness as a result of disrupted meaningful engagement with others, which for many participants resulted from the loss of car
Stanley et al. (2010), Australia, Cross-sectional survey study	535 participants aged ≥15 years old	Social capital assessed through network bonding and bridging	Frequency of difficulty accessing activities using private transport	-	Frequency of difficulty accessing activities	-	-	Those experiencing greater social exclusion make fewer and shorter journeys by private or public transport. Strong bridging capital as associated with undertaking more

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
					using public transport			journeys, while bonding capital was not associated with journeys.
Tong *et al.* (2019), USA, Cross-sectional survey	1,235 participants aged ≥18 years old	UCLA Loneliness Scale 3-item	Households without vehicle data within the Zip Code Tabulation Areas (ZCTAs) dataset	-	-	-	Mean travel time data within the ZCTA dataset	Participants living in ZCTAs with a higher mean travel time and with higher percentages of households with no vehicle had higher levels of loneliness.
Tsunoda *et al.* (2015), Japan, Analysis of a cross-sectional survey data from the Kasama cohort study	629 participants, mean age 73.3±5.2 years, 53.7% female	Lubben social network scale (LSNS) 10-item	Frequency of travel by motor vehicle per week	-	-	Frequency of travel by bicycle per week	-	There was a positive relationship between social network scale and frequency or car and bicycle travel, however neither trend was statistically significant.
van den Berg *et al.* (2016), Netherlands, Cross-sectional survey	344 participants, 21.8% aged <35 years, 23.8% aged 35-64 years, 33.7% aged 56-75 years and 20.6% aged >75 years, 48.5% female	To what extent do you agree with the statement: I experience social isolation/ loneliness? Likert scale with Agree and Fully agree options merged for analysis	Did the participants use a car? Yes/No	-	Did the participant use public transport? Yes/N	Did the participant use a bicycle? Yes/No	-	Car and public transport use were associated with less feelings of loneliness. Bicycle use was associated with less feelings of loneliness among those aged <35 years. Once mode of travel was added to the model, the associations between age and loneliness became non-significant. Transportation modes provide access to social relations outside the neighbourhood and may be essential to maintain one's social network. In addition, public transport provides a space where people are in close proximity and where social interactions can take place.
Ward, Freeman and McGee (2015), New Zealand, Photovoice study	18 participants who were secondary school students (aged 16-18 years old), 50% female	Qualitative - emergent findings from the analysis	Qualitative - topic for the photovoice	-	Qualitative - topic for the photovoice	Qualitative - topic for the photovoice	-	Walking and public transport use were described by the participants as sociable activities but also opportunities for positive isolation (alone time) with benefits for

Author (Year), Location, Study design	Sample size and characteristics	Ascertainment of loneliness	Private vehicles	Community transport	Public transport	Active transport	Transport infrastructure	Key findings
								wellbeing. Driving was not seen as a social activity.
Weijs-Perrée *et al.* (2015), Netherlands, Path analysis of a cross-sectional survey	177 participants, 46% aged <40 years, 49% aged 40-65 years and 35% aged >65 years, 62% female	UCLA Loneliness scale 3-item	Number of cars per household	-		Frequency of walking or cycling	-	Car ownership was associated with reduced feelings of loneliness. Frequency of walking was associated with higher social satisfaction and frequency of cycling was associated with higher number of social interactions.
Windle (2004), Wales, Survey and interview study	423 participants, mean age 78 years. 58.9% female	Qualitative - emergent theme from the analysis	Survey questions on transportation and transport difficulties	-	Survey questions on transportation and transport difficulties	-	-	Those without access to a car and who also did not use the bus reported significantly higher levels of loneliness than the rest of the respondents. Declining health contributed to the decision to give up the car and limited their use of public transport.
Wormald, McCallion and McCarron (2019), Ireland, Cross-sectional analysis of data from TILDA cohort	708 adults with intellectual disability, mean age 56.2 years (95% confidence interval 55.2-57.1), 59.3% female.	UCLA Loneliness scale 3-item and an item which asked whether the participant labelled themselves as lonely	-	-	-	-	A variable indicating whether the participants experienced transport difficulties, no further details provided.	Older people with learning disabilities who have no functional limitation tend to lead more independent but experiencing transport difficulties increase their feelings of loneliness.
Yang and Xiang (2021), USA, Surveys conducted during the COVID-19 pandemic	2,667 participants, 54.6% aged 18-34 years, 38.0% aged 35-59 years and 7.4% aged ≥60 years, 46.0% female	UCLA Loneliness scale 3-item and an established neighbourhood social cohesion scale	Change in neighbourhood traffic during the pandemic	-	-	Change in neighbourhood walkability during the pandemic	-	Neighbourhoods where traffic reduced during the pandemic saw an increase in feelings of loneliness. While increased walking in the neighbourhood was not significantly associated with feelings of loneliness. Disparities in physical activity and mental health were exacerbated during the COVID-19 pandemic.

Table 4. Critical appraisal criteria and scores for the included studies

Author (Year)	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Percent
Qualitative (CASP)	Clear aims	Qualitative methods appropriate	Appropriate study design	Clear recruitment strategy	Appropriate data collection	Researcher relationship considered	Ethical implications considered	Rigorous analysis	Clear findings	-	-	
Bonnel (1999)	Yes	Yes	Yes	Can't tell	Yes	Can't tell	No	Can't tell	Yes			72%
Bryanton, Weeks and Lees (2010)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes			94%
Franke *et al.* (2020)	Yes	Yes	Yes	Can't tell	Yes	No	Can't tell	Yes	Yes			78%
Green, Jones and Roberts (2014)	Yes	Yes	Yes	Yes	Can't tell	No	Can't tell	Yes	Yes			78%
Hagan (2019)	Yes	Yes	Yes	No	Can't tell	No	Yes	Can't tell	Yes			67%
Johnson (1995)	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes			89%
Johnson (1998)	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes			89%
Johnson (1999)	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes			89%
Johnson (2002)	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes			89%
Johnson (2008)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes			89%
Mulry and Piersol (2014) – Qualitative	Yes	Yes	Yes	Can't tell	Yes	No	Can't tell	Can't tell	Yes			72%
Mulry *et al.* (2020) - Qualitative	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes			89%
Nimegeer *et al.* (2018)	Yes	Yes	Yes	Yes	Yes	No	Yes	Can't tell	Can't tell			78%
Nixon (2014)	Yes	Yes	Yes	Yes	Can't tell	No	No	Can't tell	Yes			67%
Smith (2012a)	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes			94%
Smith (2012b)	Yes	Yes	Yes	Can't tell	Yes	Can't tell	Yes	Yes	Yes			89%
Ward, Freeman and McGee (2015)	Yes	Yes	Yes	Yes	Yes	No	Can't tell	Can't tell	Yes			78%
Windle (2004)	Yes	Yes	Can't tell	Can't tell	Yes	Can't tell	Yes	Can't tell	Yes			78%
Cohort (CASP)	Focused issue	Acceptable recruitment	Valid and reliable exposure measurement	Valid and reliable outcome measurement	Identified confounding factors	Accounted for confounding factors	Adequate completeness of follow-up	Adequate length of follow-up	Believable results	Clear implications of results	-	
Avila-Palencia *et al.* (2018)	Yes	No	Can't tell	Yes	Yes	Yes	Can't tell	Can't tell	Can't tell	Yes		70%
Deka (2017)	Yes	Yes	No	No	Yes	No	No	No	Yes	No		40%
Donoghue, McGarrigle and Kenny (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		100%
Mulry and Piersol (2014) - Quantitative	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Can't tell	Yes	Yes	Can't tell		80%
Mulry *et al.* (2020) - Quantitative	Yes	Yes	Yes	Yes	Can't tell	Can't tell	No	Can't tell	Yes	Yes		75%

	Focused issue	Appropriate study design	Clear participation selection process	Risk of selection bias*	Representative sample	Pre-study power calculation	Satisfactory response rate	Valid and reliable survey	Statistical significance assessed	Confidence intervals reported	Unaccounted for confounding factors*	
Reinhard *et al.* (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes		95%
Critical appraisal of a survey (CEBM)	Focused issue	Appropriate study design	Clear participation selection process	Risk of selection bias*	Representative sample	Pre-study power calculation	Satisfactory response rate	Valid and reliable survey	Statistical significance assessed	Confidence intervals reported	Unaccounted for confounding factors*	
Arat and Wong (2017)	Yes	Yes	No	No	Can't tell	No	Yes	Can't tell	Yes	Yes	No	73%
Azad *et al.* (2002)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Can't tell	No	No	Yes	50%
Bergefurt *et al.* (2019)	Yes	Yes	Yes	Can't tell	No	No	Can't tell	Can't tell	Yes	No	Yes	59%
Chen, While and Hicks (2014)	Yes	Yes	Yes	No	Can't tell	No	Yes	Yes	Yes	Yes	Yes	77%
Chesser *et al.* (1981)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Can't tell	59%
Domenech-Abella *et al.* (2020a)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	Yes	No	82%
Domenech-Abella *et al.* (2020b)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	Yes	No	82%
Dos Santos *et al.* (2020)	Yes	Yes	Yes	No	Yes	No	Can't tell	Can't tell	Yes	Yes	Yes	82%
Drennan *et al.* (2008)	Yes	Yes	Yes	Can't tell	No	No	Can't tell	Yes	Yes	No	No	64%
Gibney, Moore and Shannon (2019)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	Yes	No	82%
Gibney, Zhang and Brennan (2020)	Yes	Yes	Yes	No	Can't tell	Can't tell	Can't tell	Yes	Yes	No	No	77%
Gormley and O'Neill (2019)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	No	Yes	64%
Grant and Rice (1983)	Yes	Yes	Yes	No	No	No	Can't tell	No	Yes	No	Yes	50%
Hand *et al.* (2017)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	64%
Lauder *et al.* (2006)	Yes	Yes	Yes	No	Yes	No	Can't tell	Yes	Yes	Yes	No	86%
Matsuda *et al.* (2019)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Can't tell	Yes	Yes	No	77%
Stanley *et al.* (2010)	Yes	Yes	Can't tell	Yes	No	No	No	Can't tell	Yes	No	No	45%
Tong *et al.* (2019)	Can't tell	No	Yes	Yes	Can't tell	No	Can't tell	Yes	Yes	No	Yes	41%
Tsunoda *et al.* (2015)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	No	No	73%
van den Berg *et al.* (2016)	Yes	Yes	Yes	Can't tell	No	Can't tell	Can't tell	No	Yes	No	No	59%
Weijs-Perrée *et al.* (2015)	Yes	Yes	Can't tell	Yes	No	No	No	Yes	Yes	No	No	50%
Wormald, McCallion and McCarron (2019)	Yes	Yes	Yes	No	Can't tell	No	Can't tell	Yes	Yes	Yes	No	82%
Yang and Xiang (2021)	Yes	Yes	Yes	Yes	Can't tell	No	Can't tell	Yes	Yes	Yes	No	89%

Each item scored 2 for Yes, 1 for Can't tell and 0 for No except * items which are reverse scored

Quality assessment
As a result of the study designs used in the included papers, the following three tools were used to quality appraise the included papers: the CASP checklist for qualitative studies, the CASP checklist for cohort studies and the Centre for Evidence Based Medicine checklist for surveys. Each of these checklists asks you to assess whether the paper does or does not report against each criterion, or whether you cannot tell. To summarise the scores when the criteria was met, a paper was scored two, one point was given if we could not tell, and zero points were given for the criteria was clearly not met. These scores were then summed and presented as a percentage of the total possible score for each tool in Table 4. When mixed methods were employed in the paper, both a qualitative and quantitative quality appraisal was undertaken. Only twelve of the papers failed to achieve two-thirds (66%) or more of the available marks, indicating that study quality was high overall. Most of the lower scoring papers employed cross-sectional survey methods. For qualitative studies, lower scores were attributed to lack of description and reflection on the relationship between the researchers and participants. Few cohort studies commented on whether the completeness of follow-up was adequate, and cross-sectional survey studies did not regularly describe the representativeness of the sample and the adequacy of the response rate.

Narrative synthesis
There were three key themes within the literature:

1. Transport as a means of reaching destinations where you meet with other people
2. Transport as a 'third space' in which you meet other people
3. Transport as a positive source of isolation

These themes highlight strong associations between transport and loneliness. Studies identified associations between private transport, public transport, community transport, active travel, transport infrastructure and lower feelings of loneliness. However, these associations vary across the life course and circumstances of individuals. The evidence found related to each topic are described below.

Theme 1: Transport as a means to reach destinations where you meet with other people
Tong *et al.* (2019) and Yang and Xiang (2021) found that less travel was associated with loneliness in a sample with a broad range of ages, whereas Bergefurt *et al.* (2019) and Deka (2017) did not find this association in samples with similarly broad age ranges. Other studies, that focused on specific age groups, found more consistent associations between travel and loneliness. Older life and early parenthood were highlighted as stages of the life course when transportation difficulties were particularly associated with loneliness. Chesser *et al.* (1981) heard about how transportation difficulties increased feelings of loneliness for adolescent mothers, but this study is now 40 years old so this association may need to be reassessed.

The association between transport and loneliness in older age has been consistently documented across countries and genders within 12 papers. This association was more often, but not exclusively reported for those living in remote and rural areas. The critical event during older age was the decision to give up driving. Within these studies participants frequently spoke about feeling lonelier once they had given up their car. Johnson (2002, 2008) reported that for some older people the fear of loneliness was sufficient for them to continue driving against advice. Older people who had stronger friendship networks described how this supported their decision to stop driving (Hand *et al.*, 2017, Johnson, 1995, 1998, 2008). This included having peers who could share their own experience, as well as other friends who could offer lifts to the person who stopped driving. Azad *et al.* (2002), Bryanton, Weeks and Lees (2010) and Donoghue, McGarrigle and Kenny (2019) found that when participants gave up driving and required greater support with transport they were more likely to cease social activities, which were considered an extravagance.

In the absence of a car, public and community transport (including subsidised bus passes) become more important, with several studies documenting reduced feelings of loneliness among older people who more regularly use public transport (Franke *et al.*, 2020, Hagan, 2019, Matsuda *et al.*, 2019, Reinhard *et al.*, 2018, van den Berg *et al.*, 2016, Windle, 2004). Similarly, when there was inadequate public or community transport, studies documented greater feelings of loneliness (Matsuda *et al.*, 2019, Rajé, 2003, Stanley *et al.*, 2010, Wormald, McCallion and McCarron, 2019). However, Donoghue, McGarrigle and Kenny (2019) found that the men among their sample of older people who used public transport reported more feelings of loneliness than women. This may reflect the change in status from driving independently to being dependent on public transport.

There was less discussion of active modes of travel for getting to places to meet people to address loneliness. This might suggest that the purpose of travel in these studies was to meet with people who you already know, such as seeing family or meeting up with friends who may live further away than can be accessed through active means (Drennan *et al.*, 2008). Nimegeer *et al.* (2018) identified that a motorway extension reduced loneliness for those who now had better routes to drive but had more negative consequences for those using other modes of travel. The Let's Go community mobility programme was designed to address loneliness among older people with mental health difficulties, and later piloted with a broader age range of adults with mental ill-health (Mulry *et al.*, 2020, Mulry *et al.*, 2017, Mulry and Piersol, 2014). The programme was found to improve participants sense of autonomy through increasing their knowledge and confidence in relation to local transport options. These changes were not found to have an impact on sense of loneliness within the study timeframe. However, this programme demonstrates the potential for interventions to support those who cease driving in older age.

Theme 2: Transport as a 'third space' in which you meet other people

Twelve papers discussed modes of travel as spaces in which you meet other people, including a number of studies related to cycling and walking. Public transport was particularly noted as a space where you can meet other people.

> 'Waiting at bus stops and being on the bus were, it was widely agreed, one of the few places in the city where it was acceptable to engage strangers in conversation.'
>
> Green, Jones and Roberts (2014, p.480)

Reinhard *et al.* (2018) noted that public transport use was associated with increased face-to-face contact with children and friends, but less contact with other family members. Secondary school students in a study in New Zealand reported that traveling on the bus was a social activity, whereas driving was a lonely activity (Ward, Freeman and McGee, 2015). One participant in a study from Canada described a car as a 'little steel protection box', reflecting a belief that cars were spaces disconnecting those inside from the world around them (Nixon, 2014). Nixon (2014) reported a communication asymmetry between road users. Cyclists, pedestrians and those on the bus could communicate with each other in a way that drivers could not, which 50% of drivers spoke about as making them feel lonely; observing but not participating in the world around them. Avila-Palencia *et al.* (2018) found that cycling was associated with reduced feelings of loneliness, noting that pedestrians and cyclists met more people and felt greater social cohesion. Four other studies noted an association between social network size and use of public transport or active travel (Chen, While and Hicks, 2014, Tsunoda *et al.*, 2015, van den Berg *et al.*, 2016, Weijs-Perrée *et al.*, 2015). These are mostly cross-sectional studies and therefore we cannot be sure whether people with large social networks have more opportunities to travel, or whether the journeys themselves provide more opportunities to connect with other people.

There appear to be socio-cultural differences between countries in relation to whether public transport and active travel are places where you can meet other people. Dos Santos *et al.* (2020) in their study of secondary school children in Brazil found that longer weekly time spent in active commuting was associated with greater likelihood of feeling lonely for both sexes, where that commuting time might be taking away from time with friends or family. Similarly Arat and Wong

(2017) found that active commuting to school was associated with greater loneliness in the Philippines but lower loneliness in Sri Lanka, suggesting that active travel as a group activity might be important to avoid loneliness, which they attributed to sociocultural, environmental and climate differences between the countries. The culture around public transport and active travel are critical to whether these are modes of travel where there is opportunity, and it is acceptable to interact with strangers.

Theme 3: Transport as a positive source of isolation
The final theme is included as a counterpoint to theme 2 and to ensure that this perspective is recognised as part of any practice and policy development in this area. Travelling alone can also be beneficial for mental health and wellbeing. Physical activity is known to improve mental wellbeing and recommended as part of the treatment for conditions like depression and anxiety. Domenech-Abella *et al.* (2020a) and Domenech-Abella *et al.* (2020b) found that self-assessments of the useability and walkability of the local environment were associated with less feelings of loneliness among those experiencing mental ill-health. This was associated with emotional rather than social loneliness. Some of the secondary school students in the study by Ward, Freeman and McGee (2015) described wellbeing benefits from time alone walking or on the bus listening to their music. This was echoed in the study by Nixon (2014) but in relation to driving.

> '[In] the car, you're completely isolated. You can turn on the radio, you don't have to talk to anyone, you don't have to see anything. . . So you're not really experiencing; all you're experiencing is other people driving. . . [William(C)]' (p.94)

There may be a conflict between people seeking to connect with others and those seeking to disconnect on public transport or while walking or cycling, which we need to consider.

Strengths and limitations
This study has followed a rigorous and pre-specified systematic review approach. This resulted in the inclusion of a wealth of literature contributing insights from across the world and throughout the life course. Additional studies may have been identified through citation searching or from the grey literature. However, this is already a large systematic review, which has identified a number of consistent findings across multiple studies, so the potential for completely novel insights is reduced.

Although loneliness is a subjective experience, most of the included studies used reliable and valid methods to assess loneliness, whereas modes of travel which can be objectively assessed were mostly self-reported. Newer forms of data like accelerometery and GPS may permit future studies to include more objective assessment of travel (e.g. Müller *et al.*, 2020). However, the finding that travel can be an opportunity to disconnect as well as connect means that some more qualitative data on the context of the journey will be required alongside the objective travel data.

The wealth of evidence on transport related social exclusion made it difficult to sometimes distinguish whether studies were examining the subjective experience of loneliness or a more externally defined concept like social exclusion or transport disadvantage. We have limited our focus to those studies where participants reported loneliness or a related concept. Future studies should be explicit in focusing on either loneliness or social exclusion, and the findings of this review suggest that more research on loneliness and transport would be valuable. Similarly, distinguishing walking or cycling for exercise or travel was difficult. Again, future studies should be clear as to whether participants are walking or cycling for exercise or to make a journey.

Experimental research demonstrating a causal link between loneliness and transport is unlikely to be developed as being randomised to use a specific mode of travel may not be acceptable and the ethics of placing people in situations which might make them lonely are problematic. However, the assessment of loneliness within the evaluation of transport interventions like subsidised bus passes, infrastructure changes or even specifically designed programmes like Let's Go will contribute to the evidence base.

Recommendations

Overall the findings of this systematic review align with the idea of 'social biome' proposed by Hall and Merolla (2020). The idea of the social biome is that we need a mix of social contacts in our lives, not just deep trusted friendships which will might travel long distances for, but also casual and opportunistic encounters, like those in the street or on the bus. By using the term biome, Hall and Merolla (2020) relate our social lives to biological systems or ecosystems, and the findings of this systematic review suggest that societies need a system of mixed transport options to avoid people feeling lonely.

1. Interventions are needed to support people in phases of life when driving is not an option, such as older age and single parents. Even when transport options are available, these groups may need support accessing them such as bus passes, low-level buses or easy to read timetables.
2. Public and community transport, and active travel routes need to support people reaching friends and family, not just places of work or retail.
3. Some people value opportunities to connect while travelling, while other appreciate the time to disconnect. Modes of travel and transport policy should consider both of these desires.
4. Transport policy and interventions should consider all road users not just drivers, with the assessment of loneliness or social connections providing valuable insights into the effects of these interventions.

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