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REVIEW ARTICLE

Understanding older adults' travel behaviour and mobility needs during the COVID-19 pandemic through the lens of the hierarchy of travel needs: a systematic review

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Abstract

The aim of this article is to critically review the scientific literature about the changes in travel behaviour and mobility amongst older adults caused by the COVID-19 pandemic across various countries, identify unmet travel needs and highlight patterns of inequalities in older adults' mobility. We have collected articles from four academic databases: PubMed, Scopus, Transportation Research International Documentation (TRID) and Web of Science. Papers were considered for inclusion if they were published online in 2020 or later, written in English, and referred to urban or rural changes in travel behaviour and mobility of older adults over 50 years old. We examined the pre-existing models developed before the outbreak and classified the articles based on Musselwhite and Haddad's hierarchy of older adults' travel needs. The synthesis of the selected 25 articles shows a general decline in literal mobility amongst older adults, an increased share of virtual travel and their decreased capacity to fulfil different levels of travel needs. Findings also indicate an increased gap in older adults' mobility across geographical regions with various levels of transport infrastructure and digital capital. We conclude the paper with the lessons learned, the opportunities ahead, and the challenges that must be overcome to achieve sustainable development and the United Nations Decades of Healthy Ageing goals in the post-pandemic world.

Keywords: mobility; travel behaviour; older people; COVID-19; hierarchy of needs; systematic review

Introduction

The COVID-19 pandemic has caused significant disruptions and long-term effects to global transportation systems, travel behaviour and mobility of various population groups (Toger *et al.*, 2021; Farooq *et al.*, 2022). The changes in travel behaviours and mobility were more pronounced for older adults, who have been a highlighted target of lockdown policies in various countries, due to their perceived vulnerability and propensity to worse outcomes from contracting the virus (Savulescu and Cameron, 2020; Falvo *et al.*, 2021; Derrer-Merk *et al.*, 2022).

Older adults' mobility is studied separately by researchers from various disciplinary backgrounds and their subfields, and various approaches are adopted (Pantelaki *et al.*, 2021). While the term 'mobility' in transportation and geriatric research is typically defined as physical movement from point A to point B independently or by any other means such as a vehicle (*e.g.* Dickerson *et al.*, 2007; Reijnierse *et al.*, 2023), social scientists associate the term with older adults' connectivity and social inclusion (Parkhurst *et al.*, 2014) and agency, choice and capacity to be mobile (Schwanen *et al.*, 2012; Kaufmann, 2021; Yazdanpanahi and Hussein, 2021) within the broader umbrella of wellbeing and quality of life (Metz, 2000; Musselwhite and Haddad, 2010, 2018; Webber *et al.*, 2010; Mollenkopf *et al.*, 2011; Cuignet *et al.*, 2020).

Influenced by the new paradigm of mobility and the recognition of social and cultural dimensions underneath mobility (Urry, 2007), the definition of mobility in social sciences extends beyond literal or corporeal travel to include potential, virtual and imaginative types of mobility and connectivity and their societal implications (Kenyon *et al.*, 2002; Parkhurst *et al.*, 2014; Dowds *et al.*, 2018). Potential mobility defined as 'the perceived ability to be able to go anywhere, when and how often an individual wants' (Metz, 2000 cited in Musselwhite, 2018a, p.228), is recognised as an important psychological component of mobility-related wellbeing amongst older adults by several scholars, contributing to feelings of independence and social connectedness (*e.g.* Davey, 2007; Schwanen *et al.*, 2012; Parkhurst *et al.*, 2014; Kaufmann, 2021).

Virtual mobility pertains to Urry's (2007) notion of 'virtual travel', which involves experiencing places without physical movement, *e.g.* via ICTs, and accessing goods and services without having to travel physically (Parkhurst *et al.*, 2014). Imaginative mobility involves enhancing connectedness with activities previously addressed by physical mobility through reminiscing about previous travel or indirect participation in society, *e.g.* through window watching (Parkhurst *et al.*, 2014; Dowds *et al.*, 2018; Musselwhite and Haddad, 2018; Musselwhite, 2018*b*). This broader definition of mobility is well situated to explain older adults' mobility and travel behaviour during the pandemic, given the increased role of digital technologies in older adults' ability to meet their essential or non-essential mobility needs in the post-COVID world (Sixsmith *et al.*, 2022). In this context, studying the available transport options for literal mobility amongst older adults is also important given the decreased safety of public transport as a travel mode for older adults as a group highly susceptible to severe outcomes from contracting the virus and reduced accessibility of literal mobility options (Carteni *et al.*, 2021; Ravensbergen *et al.*, 2022).

One of the most comprehensive models explaining older adults' mobility and its links with wellbeing was proposed by Musselwhite and Haddad (2010). In a needs-

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based approach adapted from Maslow's hierarchy of needs theory, the model distinguishes three levels of mobility needs, representing older adults' awareness of their travel needs: primary/utilitarian or practical ('the need to get from A to B as quickly, cheaply, and efficiently as possible'), secondary/affective or psychosocial ('the need for independence, control, and status') and tertiary/discretionary or aesthetic ('the need for travel for its own sake') (Musselwhite and Haddad, 2010, 2018; Musselwhite, 2018*a*). Influenced by transport economist understanding of the term mobility, utilitarian travel needs are defined as access to desired places and activities (Musselwhite and Haddad, 2018). Due to the emphasis of the original model on car driving, affective travel needs are articulated in terms of independence, control and presentation of self as an independent choice-making adult linked with identity, age and gender norms within societies (Metz, 2000; Webber *et al.*, 2010). Aesthetic travel needs in the original model are considered as travelling to beauty spots (Musselwhite and Haddad, 2010).

Indeed, the model is compatible with its other contemporaneous models, such as the comprehensive framework of older adults' mobility of Webber *et al.* (2010), which identifies five fundamental categories of determinants (cognitive, psychosocial, physical, environmental and financial), influencing older adults' travel behaviour and mobility in ways that cross-cut with gender, culture and biography. It is worth noting that Webber's model is focused on older adults' life-space as a concept concerned with older adults' movement across environments and the frequency of travel within a specific time by any means of transport that corresponds to utilitarian travel needs in Musselwhite and Haddad's (2010, 2018) hierarchy (Rantanen *et al.*, 2012; Kuspinar *et al.*, 2020; Felipe *et al.*, 2023). While Webber's model is useful in understanding the factors shaping older adults' travel patterns, psychosocial factors associated with mobility have been explored in more depth by Mollenkopf *et al.* (2011). Mollenkopf *et al.* (2011) identify seven interrelated themes explaining aspects of perceived and experiential mobility, related to affective and aesthetic travel needs in Musselwhite and Haddad's (2010, 2018) model. One of the important features of Musselwhite and Haddad's (2018) model is the incorporation of virtual and imaginative travels into the original model in an attempt to accommodate the studies published in later years, such as the continuum of Parkhurst *et al.* (2013, 2014) linking literal and corporeal travel with ideational mobilities, namely virtual, potential and imaginative travels (Figure 1).

The revised model unpacks the tertiary mobility needs to reflect three categories of aesthetic need:

> (1) kinaesthetic mobility; mobility for its own sake, for example, the kinaesthetic property of movement and of being mobile; (2) immersive mobility; mobility to visit and immerse in beauty, encompassing being surrounded by and of reaching beautiful destinations; and (3) imaginative mobility, for example, watching and observing the movement of others and reminiscing and discussing prior mobility and movement. (Musselwhite and Haddad, 2018: 97)

The important feature of this model that makes it appropriate for the purpose of this review article is its focus on older adults' travel behaviour within the broader context of mobility and considering the social environment within which travel

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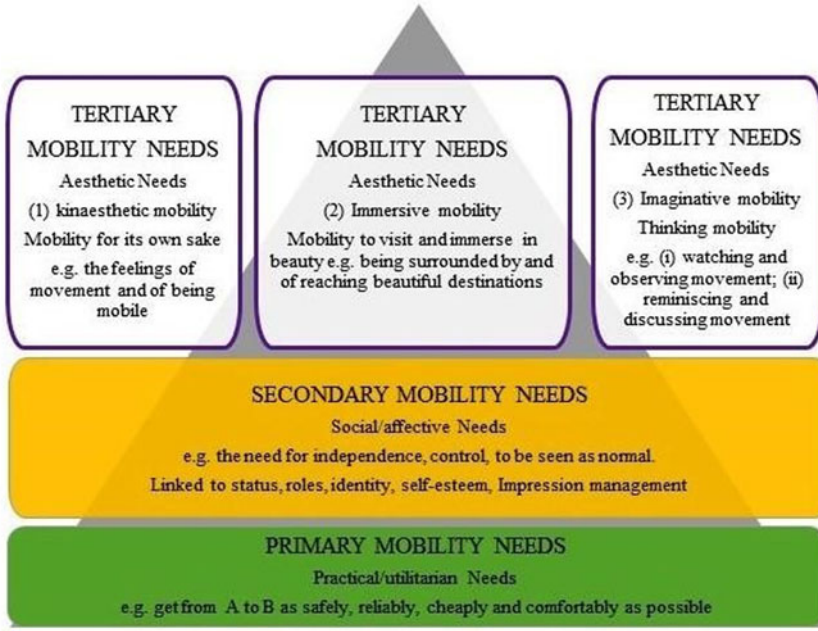

Figure 1. Updated model of Musselwhite and Haddad's (2010) hierarchy of older peoples' travel needs. *Note*: TRID: Transportation Research International Documentation.

behaviour is shaped (Musselwhite and Haddad, 2018). Additionally, the model's versatility in addressing various types of mobility and modes of travel in different settings is noteworthy, despite its initial focus on older adults' driving behaviour in the United Kingdom (UK) (Musselwhite and Haddad, 2018). Since its emergence, the model has been applied to different modes of travel in different countries in the European continent (Clayton, 2012; Berg *et al.*, 2014; Dikas, 2014; Yanguas, 2014; Siren *et al.*, 2015; Mifsud *et al.*, 2017), North America (Campana, 2013), Australia (Buys *et al.*, 2012; Zeitler and Buys, 2015) and Israel (Vitman-Schorr *et al.*, 2019). However, it is still a shortcoming of the model that its inception and application has been in the context of developed countries where utilitarian needs are met to a greater extent than low- and lower middle-income countries where older adults face higher levels of difficulty in meeting their essential or utilitarian travel needs (*e.g.* Porter, 2002; Odufuwa, 2006). Although in the latest revision of the model the authors highlight that all of these three levels of mobility needs are equally important and need to be fulfilled to achieve wellbeing (Musselwhite and Haddad, 2018), in the original model presented in 2010, secondary and tertiary travel needs are perceived to be more related to older adults' quality of life (Musselwhite and Haddad, 2010).

In the original model of the hierarchy of older adults' travel and mobility needs and subsequent publications by the same authors, utilitarian or primary travel needs are perceived as essential travel needs, while secondary/affective and tertiary/aesthetic travel needs are associated with discretionary travel

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needs (Musselwhite and Haddad, 2010; Musselwhite, 2017). What utilitarian, affective and aesthetic travel needs entail and the boundaries between them are highly context dependent and subjective. For example, utilitarian travel needs in Musselwhite and Haddad's (2010: 28) model encompass a wide range of daily trips such as 'visiting shops, accessing services, fulfilling appointments, visiting friends, attending social events, going to work and helping others'. Siren *et al.* (2015) classify trips associated with leisure and social activities as a part of a discretionary category of older adults' travels. During the COVID-19 pandemic the essential or non-essential binary in classification of literal trips became more than ever evident in the policy discourse and older adults' decisions around mobility, albeit with variations across countries and different socio-economic groups, with individuals belonging to lower socio-economic groups facing more challenges in meeting their higher-order travel needs beyond mere survival (Kar *et al.*, 2021).

Considering the pre-existing inequalities in older adults' mobility across geographies with various levels of development (Gorman *et al.*, 2019), the aim of this article is to critically synthesise the scientific literature about the changes in travel behaviour and mobility amongst older adults caused by the COVID-19 pandemic in various countries and identify patterns of inequalities in older adults' ability to meet different levels of their mobility and travel needs that may have been further exacerbated during this time. Building on Musselwhite and Haddad's (2010, 2018) hierarchy of older adults' travel needs, the paper aims to provide insights for future research and inform policies aimed at promoting the wellbeing of older adults.

Methods

Search terms and strategy

We followed the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for this systematic review (Page *et al.*, 2021). Before undertaking the systematic literature review, a preliminary search was conducted to identify the keywords related to the topic and available literature on older adults' travel behaviour and mobility during the pandemic. After trials with different keywords, the following keyword strings were agreed upon to be applied in the Web of Science, Scopus, TRID and PubMed databases, using the TITLE-ABS-KEY (Title-Abstract-Keyword) function (Table 1).

All empirical studies published in peer-reviewed journals from inception until 2022 were considered for inclusion in the study. The last search was performed on 25 August 2022. We limited the search to articles published in the English language and no geographical restrictions were applied. We excluded the articles that contained keywords such as 'patients' and 'physical activity' in their title, abstract or keywords using the AND NOT operator. It is worth noting that in some databases such as TRID, the function of TITLE-ABS-KEY is not available. For these databases, the searching style was adjusted to ensure the inclusion of all relevant publications across the databases. Records from different databases were imported into a single spreadsheet where duplicate citations were identified and removed both automatically and manually.

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Table 1. The keywords for searching

Group 1	Group 2	Group 3
'old* people' OR 'old* adult*' OR ageing OR aging OR 'later life' OR elderly OR senior*	pandemic* OR covid OR coronavirus	transport* OR travel OR mobility OR trip OR transit

Inclusion and exclusion criteria

Regarding the aim and objectives of the research, the review focused on articles whose primary topic or theme was older adults' travel behaviour and mobility during the pandemic. This included studies that did not focus solely on physical movement as a means of transport. We focused on the experiences of community-dwelling older adults over 50. The definition of older adults' mobility focused on 'out of home' travel and mobility in the locale. Studies discussing any modes of urban/rural transport for older adults, including paratransit[1] services, were included. The review also included articles focused on virtual mobility and their digital access during the pandemic.

It is worth noting that articles that contained words like 'physical activity' and 'patients' or had a medical focus on bodily mobility were not eligible for inclusion. In a similar vein, articles that made only a brief reference to older adults or that did not include older adults as one of their primary target populations were excluded. Additionally, studies for which data collection was not conducted during the pandemic were omitted.

Screening

The article selection process adhered to a rigorous screening procedure, following the PRISMA guidelines (Page *et al.*, 2021). A total of 2,535 records were obtained from various databases, the records were entered to a single file for identifying duplicates and ineligible studies based on title scan by MY, EP and AR, independently. All records were screened by at least two independent reviewers to ensure the inclusion of relevant studies. The same procedure was repeated for the next stage which involved screening of the abstracts by MY, EP and AR, to identify studies with potential relevance for inclusion in the review. In the next phase, the identified records were further categorised based on the collective include/exclude assessments of the aforementioned authors. Agreed-upon articles that met the inclusion criteria were compiled into a new Excel sheet, forming the final list of selected articles. Articles that all three authors unanimously agreed to exclude were eliminated. In cases of mixed evaluations, discussions among the three authors ensued until a consensus was reached regarding their inclusion or exclusion. At this stage 1,449 records were excluded for reasons such as not having a peer-reviewed status, medical focus, considering tourism, freight transport and air travel, non-availability of full-text in the English language, absence of a reference to COVID-19 or focus on virus transmission, data collected pre-COVID-19 pandemic, lack of relevance to older adults' mobility, among others. The remaining 53 articles underwent a comprehensive analysis, with at least two independent reviewers (involving all authors)

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evaluating each aspect, including methodology, findings, strengths and limitations, focus on primary, secondary or tertiary aspects of mobility, recommendations and policy implications. Final consensus on the inclusion or exclusion of these articles for the review was achieved. During this detailed assessment, a number of articles were excluded for various reasons, such as insufficient information about older adults' mobility or data that could not be separated from other population groups (18 articles), reliance on data from younger cohorts to infer older adults' mobility (two articles), focus on older adults' mobility with medical conditions or those living in institutionalised settings (three articles), non-empirical studies (three articles), different conceptualisation of mobility that included inside-home activities (one article), and lack of focus on primary-, secondary- or tertiary-travel needs (one article). At all stages, in cases where disagreements occurred between two authors, resolution was facilitated by the involvement of a third author. It is worth noting that the inclusion and exclusion criteria were piloted by MY, EP and AR prior to the screening process to ensure consistency and reduce bias during the screening process. The PRISMA diagram is shown in Figure 2.

Risk of bias assessment

We employed the mixed-methods appraisal tool (MMAT) (Hong *et al.*, 2018) to assess the quality of the studies included in the review. For each article, the appraisal process was implemented by two authors independently, and any discrepancies were addressed by a third reviewer. All authors were involved in this process. Within MMAT, different sets of questions are applied to different research methods. Table 2 shows the research methods applied in the selected articles in this review.

As Table 2 shows, 76 per cent of studies were quantitative, 16 per cent qualitative and others were mixed-method research. MMAT categorises the quantitative studies into three groups: (a) randomised controlled trials, (b) non-randomised studies and (c) quantitative descriptive studies, which represented 8, 28 and 40 per cent of the total studies included in the review, respectively.

All articles in the review met the two initial screening questions about the clarity of research questions and the appropriateness of data to address them. Each included study was assessed against five questions of methodological quality criteria as recommended by MMAT and the following responses were possible: 'Can't tell' (the paper does not report appropriate information to answer yes or no); 'Yes' (the paper reported the information) or 'No' (the paper did not report the information), The findings of the methodological quality in MMAT show any bias of our conclusions (*see* Table 3).

There were four studies where all aspects of quality assessed were clearly described with 'Yes' answers for all questions, but all others had some uncertainties in that the answer to the question was not clear in the description ('Can't tell') or it was clear the characteristic was not present ('No'). There were two papers where only one of the questions other than the initial screening items could be answered with a clear 'Yes' (Fischer *et al.*, 2022; Ottoni *et al.*, 2022) and three where only two items other than the initial screening questions were possible to be answered with a 'Yes' (Liu *et al.*, 2021; Shaer and Haghshenas, 2021*b*; Nie *et al.*, 2022). In line with guidance (Hong *et al.*, 2018), quantitative scores were not calculated and no papers

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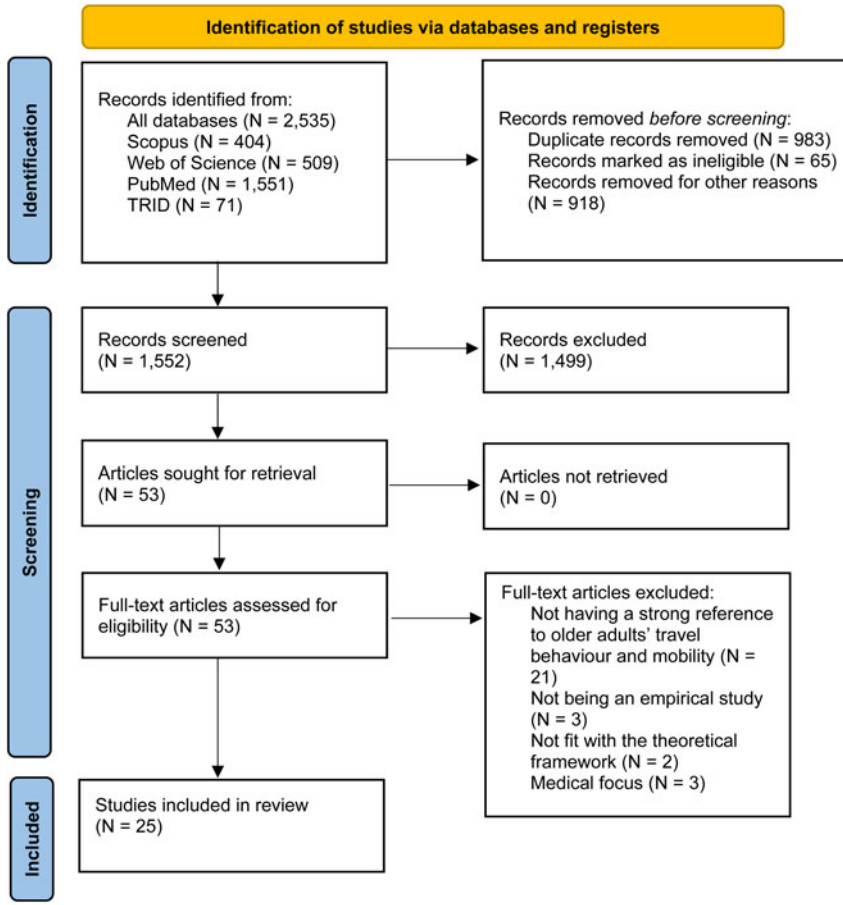

Figure 2. Prisma flow diagram.

were rejected based on their quality appraisal. However, the quality appraisal was taken into account in the synthesis of the papers below.

Synthesis

Given the heterogeneity of included studies and the diversity of their methodological approaches, meta-analysis was not possible. A narrative synthesis, as a textual approach to systematising findings in systematic reviews, was adopted to describe and interpret the findings considering the aim of the review and its theoretical framework (Popay *et al.*, 2006).

Results

We identified 25 papers meeting our inclusion criteria. Table 4 summarises the characteristics of the selected publications based on the studied population group

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Table 2. Research methods

			Quantitative		
	Qualitative	Mixed-method research	Randomised controlled trials	Non-randomised studies	Quantitative descriptive studies
Number	4	2	2	7	10
Percentage	16	8	8	28	40

Table 3. Quality appraisal of included studies

	Screening questions		Qualitative					Randomised control trials					Non-randomised studies					Quantitative descriptive studies					Mixed methods				
Author(s) (year)	1	2	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
Abootalebi *et al.* (2021)	Y	Y	Y	Y	Y	N	CT																				
Betz *et al.* (2022)	Y	Y						Y	Y	Y	CT	Y															
Cabalquinto (2022*a*)	Y	Y	Y	Y	Y	Y	Y																				
Cabalquinto (2022*b*)	Y	Y	Y	Y	Y	Y	Y																				
Carney *et al.* (2022)	Y	Y																Y	Y	Y	Y	Y					
Dinhobl *et al.* (2022)	Y	Y																					Y	Y	Y	N	Y
Fischer *et al.* (2022)	Y	Y											CT	Y	N	CT	CT										
Geldsetzer *et al.* (2020)	Y	Y																Y	Y	Y	CT	Y					
Giebel *et al.* (2022)	Y	Y	Y	Y	Y	Y	Y																				
Gladwin and Duncan (2022)	Y	Y																CT	N	Y	Y	Y					
Guida and Carpentieri (2021)	Y	Y											Y	Y	Y	CT	CT										
Hino and Asami (2021)	Y	Y											Y	Y	Y	Y	CT										
Hua *et al.* (2021)	Y	Y											Y	Y	CT	Y	CT										
Leppä *et al.* (2021)	Y	Y						Y	CT	Y	Y	Y															
Liu *et al.* (2021)	Y	Y																Y	CT	Y	CT	CT					
Nie *et al.* (2022)	Y	Y											CT	Y	CT	Y	CT										
Ottoni *et al.* (2022)	Y	Y																					CT	Y	N	N	CT

Park and Cho (2021)	Y	Y							Y	Y	Y	CT	Y	
Roe *et al.* (2021)	Y	Y							Y	N	Y	Y	Y	
Roe *et al.* (2022)	Y	Y							Y	N	Y	Y	Y	
Ross (2021)	Y	Y	Y	Y	N	Y	CT							
Saunders *et al.* (2023)	Y	Y							Y	CT	Y	CT	Y	
Shaer and Haghshenas (2021*a*)	Y	Y							Y	N	Y	CT	Y	
Shaer and Haghshenas (2021*b*)	Y	Y							Y	CT	Y	CT	CT	
Wang *et al.* (2021)	Y	Y	Y	Y	CT	Y	CT							

Notes: Y: Yes. N: No. CT: Can't tell.

(focusing solely on older adults or studying other population groups alongside older adults; the age threshold considered for the definition of old age), country, study setting (urban, rural, suburban), considered modes of travel (car, public transport, walking, cycling, shared services such as car and bike sharing, ride hailing, paratransit and specialist services), travel type (literal, virtual, potential, imaginative), methods and main findings. In the second part, articles are classified into three major categories based on Musselwhite and Haddad's (2018) hierarchy and the dominant themes in the papers under each category are discussed.

Characteristics of the articles included in the review

Age groups

From the papers selected for inclusion in the review, 16 articles specifically focused on older adults as a target population (Geldsetzer *et al.*, 2020; Abootalebi *et al.*, 2021; Guida and Carpentieri, 2021; Leppä *et al.*, 2021; Liu *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Betz *et al.*, 2022; Carney *et al.*, 2022; Fischer *et al.*, 2022; Giebel *et al.*, 2022; Nie *et al.*, 2022; Roe *et al.*, 2022; Cabalquinto, 2022*a*, 2022*b*; Saunders *et al.*, 2023). The minimum age thresholds for the definition of old age differed across studies. In eight articles, the minimum age of 65 years was considered for the inclusion of participants in the study (Guida and Carpentieri, 2021; Hino and Asami, 2021; Liu *et al.*, 2021; Roe *et al.*, 2021, 2022; Wang *et al.*, 2021; Carney *et al.*, 2022; Gladwin and Duncan, 2022). In nine papers, 60 is used as the marker of entry into old age (Geldsetzer *et al.*, 2020; Abootalebi *et al.*, 2021; Hua *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Giebel *et al.*, 2022; Nie *et al.*, 2022; Cabalquinto, 2022*a*, 2022*b*), and in two papers, this number is stated as 55 (Fischer *et al.*, 2022; Ottoni *et al.*, 2022). Four articles have higher minimum age thresholds, such as 66, 70 and above (*e.g.* Leppä *et al.*, 2021; Roe *et al.*, 2021; Betz *et al.*, 2022; Saunders *et al.*, 2023). The latter is especially the case for driving cessation studies in high-income countries (*e.g.* Roe *et al.*, 2021; Betz *et al.*, 2022). Remaining studies considered different age cohorts; however, older adults were a significant part of the studied population groups (*e.g.* Ross, 2021). It is important to note that for the latter group, we explicitly included data from studies that focused on individuals aged 50 and older, as stated in our inclusion criteria. If a study sampled individuals below the age of 50 and did not present separate results for older adults, we ensured that those papers were excluded from our analysis.

Location at a country level

In terms of geographical distribution, as Table 4 shows, three studies were conducted in the European Union and UK (Guida and Carpentieri, 2021; Leppä *et al.*, 2021; Carney *et al.*, 2022), nine in North America (Roe *et al.*, 2021, 2022; Wang *et al.*, 2021; Betz *et al.*, 2022; Dinhobl *et al.*, 2022; Fischer *et al.*, 2022; Gladwin and Duncan, 2022; Nie *et al.*, 2022; Ottoni *et al.*, 2022; Saunders *et al.*, 2023), three in the Middle East (Abootalebi *et al.*, 2021; Ross, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*), two in Africa (Geldsetzer *et al.*, 2020; Giebel *et al.*, 2022), four in the Far East (Hino and Asami, 2021; Hua *et al.*, 2021; Liu *et al.*, 2021; Park and Cho, 2021) and one in Australia (Cabalquinto, 2022*a*, 2022*b*).

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Table 4. Overview of the selected publications

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Abootalebi *et al.* (2021)	15 older adults in Shiraz (above 60 years)	Iran	Lower middle income	Urban	Driving	Literal	Qualitative	The pandemic and restrictions in public transport created a condition called double jeopardy for older adults who had to quit driving
Betz *et al.* (2022)	301 older drivers in San Diego, California; Denver, Colorado; Indianapolis, Indiana (above 70 years)	USA	High income	98% of participants lived in urban, 1.7% in suburban and 0.3% in rural areas	Mainly driving	Literal	Quantitative	Compared to those enrolled pre-COVID-19 more participants enrolled during COVID-19 reported driving reductions (26% *versus* 70%) and more often for personal preference (*versus* medical/ emotional reasons)
Cabalquinto (2022*a*)	15 older migrants in Victoria (60–90 years)	Australia	High income	Not specified	None	Virtual	Qualitative	Individuals who did not have access to a stable internet connection, with low levels of technological competencies, and lacking support networks to solve technical issues were paralysed in and excluded from digital environments

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Cabalquinto (2022*b*)	15 older migrants in Melbourne (60–90 years)	Australia	High income	Not specified	None	Virtual	Qualitative	Ageing migrants deployed a range of strategies to reclaim and activate mobile intimacy. Building on these insights, the author coins the term '(im)mobile intimacy' to capture and explain the intimacies performed, felt and negotiated by the ageing migrants through modes of movements and stasis in and with online platforms
Carney *et al.* (2022)	152,061 older adults in the West Midlands (above 65 years)	UK	High income	Urban and suburban	Bus	Literal	Quantitative	Older adults living in suburban geographies were more likely to be access-deprived essential transit users during the pandemic
Dinhobl *et al.* (2022)	Leaders from 30 of the 36 Texas rural transit districts	USA	High income	Rural	Paratransit services	Literal	Mixed methods	Older adults' ridership decreased, with many transit districts expressing concern about social isolation among their older adult riders

Fischer *et al.* (2022)	Older adults (55 years or above) living in the City of Vancouver, British Columbia	Canada	High income	Urban	Cycling	Literal	Quantitative	Older adults' cycling patterns showed increases near green and blue spaces and on street reallocations that increased access to parks. Commute ridership highlighted distinct patterns of increase around the hospital district. Most increases occurred on bicycle facilities (pre-existing or provisional), with a strong preference for high-comfort facilities
Geldsetzer *et al.* (2020)	Older adults in Sub-Saharan Africa (above 60 years)	Sub-Saharan Africa	Low income	Not specified	Not specified	Potential	Quantitative	Most countries in Sub-Saharan Africa contain areas in which older adults have little or no physical access to a hospital and (albeit to a lesser extent) health-care facilities of any type

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Giebel *et al.* (2022)	30 older adults in Mukono district (60 years and above)	Uganda	Low income	Rural	All modes of travel/ general mobility	Potential	Qualitative	Participants raised transport difficulties affecting their daily lives since the pandemic break out, including those participants who no longer leave the house due to frailty and old age. Strict lockdown measures and increased cost of public transport made access to essentials such as food and health care difficult

Gladwin and Duncan (2022)	198 previous cyclists and 13 new cyclists in relation to maintaining habits post-pandemic in Tallahassee (65 years and above)	USA	High income	Urban	Cycling	Literal	Mixed methods	Cycling during the pandemic was associated with feelings of accomplishment, enjoyment, improved self-esteem and increased freedom by allowing older people to get out despite social distancing requirements. Furthermore, among respondents reporting increased cycling, 79% plan to maintain cycling habits post-pandemic, citing reasons such as personal health, enjoyment and the social aspect of cycling
Guida and Carpentieri (2021)	Older adults in Milan (65 years and above)	Italy	High income	Urban and suburban	Walking and public transport	Potential	Quantitative	Entire neighbourhoods' older people populations suffer from very poor accessibility to primary health services, especially in the city suburbs, and their condition deteriorates even more because of limited services and activities

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Hino and Asami (2021)	18,817 citizens in Yokohama (65 years is the cut-off for younger and older people)	Japan	High income	Urban	Walking	Literal	Quantitative	Built environment factors had a greater impact on older rather than younger participants' step counts. Older women were more susceptible to the neighbourhood environment
Hua *et al.* (2021)	90,500 bike-sharing users in Nanjing (60 years and above)	China	Upper middle income	Urban and suburban	Bike-sharing	Literal	Quantitative	Pandemic control strategies sharply reduced user demand, and commuting trips decreased more significantly. Some stations around health and religious places become more important. Men and older adults may be more dependent on bike-sharing systems. Central urban areas have more user close contacts and higher transmission risk than suburban areas

Leppä *et al.* (2021)	Participants in AGNES study, Jyväskylä (75, 80 and 85 years)	Finland	High income	Not specified	Walking	Literal and potential	Quantitative	Daily time spent in 'leisure walking' had increased on average by 5.3 minutes among all participants at follow-up during the COVID-19 restrictions. However, decline in life-space mobility and autonomy in participation in outdoor activities during the first wave of COVID-19 exceeded the decline that would naturally have occurred due to the ageing process over a 2-year period
Liu *et al.* (2021)	30 older adults in Kunming (above 65 years)	China	Upper middle income	Urban	All modes of travel/ general mobility	Literal and virtual	Qualitative	Social and cultural environment play an important role in older adults' travel behaviour and choices

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Nie *et al.* (2022)	800 older people (above 60 years)	USA	High income	Not specified	Paratransit services	Literal	Quantitative	Older people used paratransit mainly for nutrition-related trips before 13 March 2020. After that date, however, all older people's centres in Alabama were closed in compliance with COVID-19 guidelines, and the same rider was found only to make a few medical trips
Ottoni *et al.* (2022)	31 community-dwelling older adults living in the West End of Vancouver (55 years or above)	Canada	High income	Urban	Walking	Literal	Qualitative	Participants who interacted with strangers while out walking pre-pandemic now perceived strangers as a health threat
Park and Cho (2021)	Subway users in Seoul (65 years and above)	South Korea	High income	Urban	Subway	Literal	Quantitative	The results showed that in the period with both the highest and lowest number of infections of SARS-CoV-2, users aged 65 years and over reduced their subway trips more than people aged between 20 and 64 years

Roe *et al.* (2021)	214 adults living in Missouri and Illinois (between 66 and 92.8 years)	USA	High income	Not specified	Driving	Literal	Quantitative	Participants reduced driving during the pandemic compared with the same period the year before. Trips per day showed a similar decline. Participants also took shorter trips, drove slower, had fewer speeding incidents and had different trip destinations
Roe *et al.* (2022)	199 older adults in five states (above 65 years)	USA	High income	Not specified	Driving	Literal	Quantitative	Older adults decreased the number of days driving, number of trips per day, as well as average driving speed, and had fewer speeding incidents following COVID-19 onset. Female and African American older adults engaged in more positive coping and cleaning behaviours, and had greater decreases in the number of days driving during the pandemic

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Ross (2021)	302 adults living in Tel Aviv (20–75 years)	Israel	Upper middle income	Urban	Public transport (DRT, bus) *versus* taxi	Literal	Quantitative	The choice between buses and DRT is explained by intermediate relationship. The relationship between promotion focus and choice is moderated by risk perception whereas the relationship between prevention focus and choice is moderated by age. Reporting that DRT is riskier than taxis decreases with increasing strength of promotion focus for individuals older in age. As a result, the probability of choosing DRT increases with increasing strength of promotion focus for older people
Saunders *et al.* (2023)	247 older adults in Hamilton (mean age 78 ± 7.3 years)	Canada	High income	Not specified	Walking	Literal	Quantitative	Physical and environmental factors may help explain poorer mobility amongst older adults during lockdowns

Shaer and Haghshenas (2021*a*)	453 older adults in Isfahan (above 60 years)	Iran	Lower middle income	Urban	Walking and cycling	Literal	Quantitative	The results reveal that active modes have an effective role in older adults' mobility in the post-pandemic era
Shaer and Haghshenas (2021*b*)	453 older adults in Isfahan (above 60 years)	Iran	Lower middle income	Urban	Walking and cycling	Literal	Quantitative	Increase in density and mixed land use reduces travel distance, and landscaping with vegetation makes walking routes more attractive. Travel distance and safety from traffic are significant to older adults' travel

(*Continued*)

Table 4. (*Continued.*)

Author(s) (year)	Population (definition of older people)	Country	Classification of countries based on income	Study setting (urban, rural, suburban)	Mode(s) of transport	Travel type	Study methods	Main findings
Wang *et al.* (2021)	Residents of North Carolina (above 65 years)	USA	High income	Six types of area classification from National Centre for Health Statistics: large central metropolitan, large fringe metropolitan, medium	Not specified	Literal	Quantitative	Census Block Groups with higher percentages of elderly persons, minorities, low-income individuals and people without vehicle access are areas most at risk for decreased health-care access during the pandemic and exhibited lower health-care access prior to the pandemic. The results suggest that the ability to conduct in-person medical visits during the pandemic has been unequally distributed

Notes: UK: United Kingdom. USA: United States of America. DRT: Demand Responsive Transport.

We used the World Bank's latest statistics to classify the articles based on their levels of income and economic development as indicated in Table 4 (Hamadeh *et al.*, 2022). It is worth noting that some papers in the list of included studies in this review are two different reports and analyses of the same dataset (Roe *et al.*, 2021, 2022; Shaer and Haghshenas, 2021*a*, 2021*b*; Cabalquinto, 2022*a*, 2022*b*), therefore, the number of distinct studies included in the list is lower than the total number of selected articles.

Urban/rurality levels of the study settings

Although the criteria used to distinguish urban and rural areas differ across countries, there are only five studies that have classified the study area based on levels of urbanity/rurality or have considered both areas in their analysis (Guida and Carpentieri, 2021; Hua *et al.*, 2021; Wang *et al.*, 2021; Betz *et al.*, 2022; Carney *et al.*, 2022). Nine studies have clearly focused on urban areas (Abootalebi *et al.*, 2021; Hino and Asami, 2021; Liu *et al.*, 2021; Park and Cho, 2021; Ross, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Fischer *et al.*, 2022; Gladwin and Duncan, 2022; Ottoni *et al.*, 2022) and two on rural areas (Dinhobl *et al.*, 2022; Giebel *et al.*, 2022). Others do not provide any explanation about the urban/rural nature of the studied area.

Travel type

The majority of the selected articles have focused on the literal/actual travel behaviour of the population group studied (76%). Only two papers dwelled on older adults' access to digital technologies and virtual travel (Cabalquinto, 2022*a*, 2022*b*), and one paper examined both the literal and virtual travel behaviour of its participants (Liu *et al.*, 2021). However, the majority of the papers make a reference to the importance of digital access for older adults during the pandemic, either in their discussions or recommendations. We defined potential travel as the available opportunities for older adults' mobility and their access to essential or non-essential travel options and destinations during the pandemic. Based on this definition, we could identify three papers studying older adults' potential travel (Geldsetzer *et al.*, 2020; Giebel *et al.*, 2022; Gladwin and Duncan, 2022) and one study considering both literal and potential travel (Leppä *et al.*, 2021). None of the studies in this review contained debates around imaginative travel.

Modes of travel

Nearly half of the articles included in the review studied individual modes of transport during the pandemic, and the other half focused on shared mobility options. More specifically, three studies focused on driving behaviour and driving cessation among older adults (Abootalebi *et al.*, 2021; Roe *et al.*, 2021, 2022; Betz *et al.*, 2022), four on walking as a travel mode (Hino and Asami, 2021; Leppä *et al.*, 2021; Ottoni *et al.*, 2022; Saunders *et al.*, 2023), three on cycling (two studies on cycling as an individual mode of travel; Fischer *et al.*, 2022; Gladwin and Duncan, 2022) and one on bike-sharing (Hua *et al.*, 2021), and one on both walking and cycling as active modes of travel (Shaer and Haghshenas, 2021*a*, 2021*b*). In terms of public transportation, one study focused on subway (Park and Cho, 2021), one on the bus (Carney *et al.*, 2022), two on paratransit services (Dinhobl *et al.*, 2022; Nie

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et al., 2022), one on Demand Responsive Transport and bus (Ross, 2021), and some studies focused on the combination of public transport and active modes of travel (*e.g.* Guida and Carpentieri, 2021).

Classification of articles

Based on Musselwhite and Haddad's (2018) hierarchy, we classified the articles into three major categories: primary/utilitarian, secondary/affective and tertiary/discretionary mobility needs. The typology of older adults' mobility of Parkhurst *et al.* (2013, 2014) was used for the identification of travel types under each category.

Primary travel needs

Out of the 25 papers chosen for this review, 13 studies considered older adults' primary travel needs during the pandemic (Geldsetzer *et al.*, 2020; Abootalebi *et al.*, 2021; Guida and Carpentieri, 2021; Hua *et al.*, 2021; Liu *et al.*, 2021; Wang *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Carney *et al.*, 2022; Dinhobl *et al.*, 2022; Fischer *et al.*, 2022; Giebel *et al.*, 2022; Nie *et al.*, 2022; Roe *et al.*, 2022), with eight studies focusing specifically on older adults' access to essential or primary needs such as food and health care (Geldsetzer *et al.*, 2020; Guida and Carpentieri, 2021; Liu *et al.*, 2021; Wang *et al.*, 2021; Carney *et al.*, 2022; Fischer *et al.*, 2022; Giebel *et al.*, 2022; Nie *et al.*, 2022). In other studies, concerned with older adults' primary travel needs, either there has not been a clear distinction between essential and discretionary travel, or information about participants' trip purposes is not provided (Abootalebi *et al.*, 2021; Hua *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Dinhobl *et al.*, 2022; Roe *et al.*, 2022).

The majority of studies in this category are concerned with literal or actual trips and monitor older adults' travel behaviour using GPS tracking systems, data linked to smart cards or surveys (Hua *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Carney *et al.*, 2022; Nie *et al.*, 2022; Roe *et al.*, 2022). A relatively smaller number of studies have focused on the location of essential facilities and estimated the patterns of older adults' travel to these places to assess the accessibility of these areas during the pandemic (Geldsetzer *et al.*, 2020; Guida and Carpentieri, 2021). We consider the latter as objectively measured potential travel *versus* perceived mobility (Leppä *et al.*, 2021). One of the studies in this category considered virtual travel and the importance of digital skills to satisfy one's primary travel needs during the pandemic (Liu *et al.*, 2021). In a study conducted in China, Liu *et al.* (2021) show the division in digital skills across generations that negatively influences older adults' access to essentials such as food and public transport services.

In terms of travel modes used to satisfy primary needs, two studies focused on driving (Abootalebi *et al.*, 2021; Roe *et al.*, 2022), three papers on active modes of travel including walking and cycling (Hua *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*), two on paratransit services (Dinhobl *et al.*, 2022; Nie *et al.*, 2022) and one on public transport (Carney *et al.*, 2022). Roe *et al.* (2022) investigated the changing patterns of driving among older Americans. They observed a general decline in the numbers of days driving and distances amongst older drivers, as well as a change in trip destinations after the pandemic that were more likely to be for necessities. The other study was conducted with 15 older adults living in Shiraz

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(Iran) who gave up driving at the beginning of the pandemic. The authors observed that the synergy between driving cessation and the pandemic has created a situation that can be described as 'double jeopardy' in the absence of alternative safe travel options, resulting in participants' struggling to meet their basic needs (Abootalebi *et al.*, 2021).

Shaer and Haghshenas (2021*a*, 2021*b*) reported an increased use of active travel modes in the city of Isfahan; however, they were less clear about the essential or discretionary nature of these trips. A study on bike-sharing in China found that older adults in Nanjing are increasingly reliant on this mode of transportation for essential trips such as shopping and access to pharmacies (Hua *et al.*, 2021). One study on public transport examined older adults' reliance on public transport by analysing smart card travel data before and during the UK's nationwide lockdowns (Carney *et al.*, 2022). Carney *et al.* (2022: 3) identify 'access deprived essential transit users' and show the lack of diversity in transport options for older adults from lower socio-economic backgrounds living in car-dependent suburbs and rural areas of the West Midlands, despite the relative affluence of the area. Two studies that focused on paratransit services in the United States of America (USA) reported a decrease in older adults' ridership during the pandemic, implying decreased mobility amongst frequent riders who depended on these services for essential trips in the absence of alternative travel options (Dinhobl *et al.*, 2022; Nie *et al.*, 2022). Nie *et al.* (2022) report a shift in paratransit riders' travel purposes from visits to senior centres before the nation-wide lockdowns to a few trips to access health-care facilities after this date in central Alabama.

The majority of the aforementioned studies were conducted in urban or suburban settings (Guida and Carpentieri, 2021; Hua *et al.*, 2021; Liu *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Carney *et al.*, 2022; Fischer *et al.*, 2022; Nie *et al.*, 2022). Shaer and Haghshenas (2021*a*, 2021*b*) explore the relation between built environment characteristics and older adults' tendency to walk and cycle in an Iranian city. They conclude that age-friendly neighbourhoods with mixed land uses, high densities, accessible destinations, and safe pedestrian and cyclists' networks can enhance older adults' active mobility in emergency situations such as the COVID-19 pandemic. Hua *et al.* (2021) compared the risk of virus transmission via bike-sharing facilities between urban and suburban areas in Nanjing, China. While central urban areas may be more age-friendly in terms of access to amenities, their findings suggest that these central urban areas have a higher transmission risk than suburban settings. Carney *et al.* (2022) highlight suburban geographies of public transport reliance in England, which are at risk of being overlooked in the theoretical approaches and policy discourse attributing public transport dependency mainly to deprivation. Two studies on paratransit services are conducted in the USA, one of them in rural Texas (Dinhobl *et al.*, 2022) and the other one in central Alabama, composed of areas with a range of urbanity and rurality levels (Nie *et al.*, 2022).

Dinhobl *et al.* (2022) identified a pattern of need-based rather than choice-based clients in rural Texas who continued to rely on these services during the pandemic. In the second study, the differences between urban and rural areas in terms of the levels of dependency on paratransit services are not outlined. However, there is a higher demand for these services in areas with a higher proportion of ethnic

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minority populations (Nie *et al.*, 2022). The location of critical facilities, such as health-care centres and hospitals, has also been used to estimate travel patterns and accessibility for older adults during the pandemic. Geldsetzer *et al.* (2020) examined access to health-care facilities amongst older adults across Sub-Saharan Africa (SSA) and found that most countries in SSA contain areas in which older adults have little to no physical access to a hospital and (albeit to a lesser extent) health-care facilities of any type. Another study conducted in Milan uncovered the changing pattern of access to hospitals as a result of the COVID-19 pandemic amongst older residents. Findings indicate a sharper decrease in accessibility of health-care centres in the urban core than in suburban areas due to the closure of all hospitals in the metropolitan area at the very early stage of the outbreak (Guida and Carpentieri, 2021).

Other factors such as the social environment, policies and attitudes, in addition to the physical environment, were important in older adults' ability to meet their primary travel needs independently (Liu *et al.*, 2021). A study conducted in rural Uganda showed the negative impact of lockdown policies adopted by the government, which resulted in a lack of transport for older adults, reducing their ability to access food in turn (Giebel *et al.*, 2022). The increased cost of public transport in the same study also acted as a barrier to travel to food environments (Giebel *et al.*, 2022). However, in recognition of travel costs and the detriment to more vulnerable travellers, paratransit services in rural Texas waived the riding fee for their older passengers (Dinhobl *et al.*, 2022). These findings can partly depict the uneven landscape of access to public transport for older adults across geographies with various levels of income and deprivation.

Secondary travel needs

In this domain, we considered the articles discussing the social/affective needs associated with mobility/immobility during the pandemic. We identified 15 papers concerned with secondary travel needs (Abootalebi *et al.*, 2021; Hino and Asami, 2021; Leppä *et al.*, 2021; Liu *et al.*, 2021; Park and Cho, 2021; Roe *et al.*, 2021, 2022; Ross, 2021; Betz *et al.*, 2022; Dinhobl *et al.*, 2022; Giebel *et al.*, 2022; Gladwin and Duncan, 2022; Ottoni *et al.*, 2022; Cabalquinto, 2022*a*, 2022*b*) of which 12 articles focused on older adults' actual trips (Abootalebi *et al.*, 2021; Hino and Asami, 2021; Leppä *et al.*, 2021; Liu *et al.*, 2021; Park and Cho, 2021; Roe *et al.*, 2021, 2022; Ross, 2021; Betz *et al.*, 2022; Dinhobl *et al.*, 2022; Gladwin and Duncan, 2022; Ottoni *et al.*, 2022), two papers derived from one study on virtual mobility via digital technologies (Cabalquinto, 2022*a*, 2022*b*) and one on potential travel (Giebel *et al.*, 2022).

Four articles are focused on driving behaviour amongst older adults during the pandemic (Abootalebi *et al.*, 2021; Roe *et al.*, 2021, 2022; Betz *et al.*, 2022). In the original and revised model of Musselwhite and Haddad (2010, 2018), the feelings associated with driving are identified as independence, control and being seen as normal. These are linked to relevant feelings such as identity and self-esteem. During the pandemic, one of the most important secondary travel needs was a sense of safety and security, which provided additional benefits for solo modes of travel. Not owning a car or driving cessation in the absence of alternative safe travel options could not only put older adults' physical health at risk but also

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contribute to social isolation and negative mental conditions (Abootalebi *et al.*, 2021). Nonetheless, Roe *et al.* (2021) compared the driving behaviour of a group of American older adults before and during the pandemic. Their findings indicated that older adults reduced the number of days they spent driving, made shorter trips and drove slower than before the outbreak, due to pandemic-related concerns. In a subsequent study, Roe *et al.* (2022) examined the relationship between older adults' individual characteristics and driving behaviour and found that female and African American older adults engaged in more protective behaviours such as social distancing and had greater decreases in the number of days driving during the pandemic. Similarly, Betz *et al.* (2022) reported a decrease in driving amongst a sample of community-dwelling older adults in the USA during the pandemic. However, unlike the driving cessation study in Iran (Abootalebi *et al.*, 2021), the reduction in driving amongst the largely white and well-educated sample of this study, recruited from urban and suburban areas, did not result in increased rates of depression and poor health outcomes (Betz *et al.*, 2022).

Amongst the selected articles for this review, there was only one article investigating the social dynamics of public transport and its impact on older riders during the pandemic. Liu *et al.* (2021), in an exploratory study conducted in Kunming, China, observed unfriendly attitudes and behaviours towards older passengers in public transport from younger passengers after the outbreak, blaming them for making a trip during the pandemic and choosing such a high-risk transport mode. Fear of being infected by the virus in public transportation and shared modes of mobility was shared by all passengers, particularly older adults who prioritised feelings of safety and security over other affective needs. A number of articles in this category mainly focused on older adults' perceived safety of public transport and its relationship with their travel behaviour and mode choice during the pandemic (*e.g.* Park and Cho, 2021; Ross, 2021). Hua *et al.* (2021) objectively measured older adults' safety when using bike-sharing facilities in Nanjing, China. Findings from the aforementioned studies indicate a decrease in ridership across modes of public transport and shared mobility options. Similarly, a study investigating paratransit services in rural Texas reported a decrease in older adults' ridership due to safety concerns (Dinhobl *et al.*, 2022). However, unlike other shared mobility options that had lost their social function during the pandemic, paratransit services were reported to continue to play a part in decreasing social isolation amongst their older riders by checking in with them (Dinhobl *et al.*, 2022). It is worth noting that the reported findings regarding older adults' use of paratransit services during the pandemic in the study by Dinhobl *et al.* (2022) were obtained from interviews with Texas Rural Transit District leaders rather than older riders, therefore conclusions made based on this study might be subject to bias.

Although the added priority of feelings of safety and security during the pandemic promoted the use of alternative individual modes of travel such as walking and cycling, studies have documented a decrease in the capacity of active modes of travel to meet older adults' affective and social travel needs (Hino and Asami, 2021; Liu *et al.*, 2021; Gladwin and Duncan, 2022; Ottoni *et al.*, 2022). Hino and Asami (2021) conducted a longitudinal comparative study on the change in walking steps and association with built environments during the COVID-19 state of emergency in Yokohama (Japan). Their findings indicated a decrease in walking around

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densely populated neighbourhoods and a reduction in group exercise amongst older adults. Ottoni *et al.* (2022) reported a decrease in the role of walking to create positive encounters and feelings of connectedness amongst older adults when walking in their neighbourhood due to their perceived susceptibility to infection by the virus that induced them to avoid others. However, Cabalquinto (2022*a*) shows the emergence of new mixtures of virtual and literal travelling, such as using a smartphone to share photos of the surroundings with friends while walking in the park, that could compensate for the lack of opportunities to meet secondary travel needs on the go. Gladwin and Duncan (2022), studying the cycling patterns amongst older adults in a small, auto-centric town in the USA, reported a decreased frequency of cycling amongst participants after the outbreak due to the cancellation of group ride events. In the same study, cycling has been found to be linked with feelings of freedom, joy, self-esteem and accomplishment amongst older adults.

We identified two papers specifically focused on older adults' virtual travel and its role in meeting affective travel needs during the pandemic (Cabalquinto, 2022*a*, 2022*b*); however, in other studies, there is also a reference to the use of digital technologies to connect with family and friends as an alternative to literal or actual mobility, though this was not the main focus of the research (*e.g.* Abootalebi *et al.*, 2021; Betz *et al.*, 2022). Cabalquinto (2022*a*, 2022*b*) investigated the everyday digital behaviour of 15 migrant older adults living in Victoria (Australia) during multiple lockdowns and demonstrated the critical role of digital technologies in enabling cultural and social connectedness during times of forced immobility. Findings also revealed inequalities in network/digital capital across and within countries, as older adults who lacked reliable internet connections, possessed only rudimentary technological skills and lacked access to support networks for resolving technical issues were paralysed in and excluded from digital environments. The uneven digital landscape across countries also prevented transnational social connections for older migrants whose social networks were located in countries with less-developed network infrastructures (Cabalquinto, 2022*a*). For potential travel, there was only one article discussing the impact of a perceived lack of access to transport on older adults' feelings of connectedness (Giebel *et al.*, 2022). According to Giebel *et al.* (2022), as a result of public health measures and tough lockdown policies implemented in rural Uganda, older adults felt cut off from society and distressed because they could not meet their friends and family members face to face.

Tertiary travel needs

Few studies have directly focused on aesthetic travel needs due to the nature of the COVID-19 pandemic and the close association between mobility and virus spread, which caused almost all age groups to prioritise essential travel over aesthetic or discretionary travel. We found two studies having an indirect reference to kinaesthetic mobility (Leppä *et al.*, 2021; Gladwin and Duncan, 2022). Gladwin and Duncan's (2022) study of COVID-19's impact on cycling behaviour amongst older adults in a small auto-centric town in the USA shows that participants were able to maintain their cycling habits, although with less-frequent rides. They continued to enjoy cycling in itself, without focusing on the destination, even though group ride activities were cancelled. It is important to note that in this study the authors did not

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distinguish between essential and discretionary travel (Gladwin and Duncan, 2022). This could also be said about the study by Leppä *et al.* (2021) of older Finnish adults' physical activity patterns before and during the pandemic (walking outside), compromising its limited and indirect reference to aesthetic travel needs.

During the coronavirus outbreak, a few studies included in the review reported an increased share of travels to urban parks and other green and blue spaces, which can be explained by the suspension of other trips such as commuting to work and some governments' advice on daily exercise (*e.g.* Hino and Asami, 2021; Fischer *et al.*, 2022). Active modes of travel have been used for the majority of these trips and other discretionary purposes (Hino and Asami, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Fischer *et al.*, 2022). Hino and Asami's (2021) study of older Japanese adults' step counts showed increased steps around large parks in Yokahama. Similarly, Fischer *et al.* (2022) found that older adults in Vancouver (Canada) cycled more in blue and green spaces. However, the findings of these studies are less consistent when it comes to other types of discretionary activities, such as visiting social clubs, religious places and eating at restaurants, depending on the location and stage of the lockdown during which the study was conducted.

Studies reporting an increase in walking and cycling amongst older adults show a strong correlation with the built environment characteristics and lockdown policies (*e.g.* Liu *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Saunders *et al.*, 2023). Liu *et al.* (2021) refer to inequalities in access to green space and recreational walking between older adults living in gated *versus* non-gated communities in Kunming (China) due to the closure of public parks. Saunders *et al.* (2023), in a cross-sectional tele-survey of older adults in Hamilton (Canada), suggested that environmental design features, *i.e.* walkability of a neighbourhood, play a significant role in older adults' mobility. Shaer and Haghshenas (2021*a*, 2021*b*), similarly, found a correlation between Iranian older adults' active mode choice and age-friendly design of the built environment.

Three out of four studies focused on driving in this review reported a decline in overall driving, especially in trips made for discretionary purposes such as visiting places of worship and eating at restaurants (Roe *et al.*, 2021, 2022; Betz *et al.*, 2022). In the fourth paper, there was no clear distinction between essential and discretionary travel; however, from participants' accounts, it can be observed that a lack of driving has restricted older adults' access to non-local parks and recreational destinations (Abootalebi *et al.*, 2021). No study in our list discussed the use of public transport modes to meet aesthetic travel needs during the pandemic. However, results of one study concerned with older Chinese adults' reliance on bike-sharing facilities in Nanjing indicate an increased use of these facilities for recreational purposes (Hua *et al.*, 2021).

Besides literal or actual travel, virtual means of mobility can play a role in meeting older adults' aesthetic travel needs by offering them the possibility to view images of beautiful places or by providing opportunities for enjoyment and self-actualisation (Cabalquinto, 2022*a*, 2022*b*). In terms of potential travel, our search results did not include any article discussing the perceived or objective accessibility of beautiful routes and destinations; however, in some articles there is a brief reference to the perceived availability of different transport modes to meet aesthetic or tertiary travel needs (*e.g.* Abootalebi *et al.*, 2021; Shaer and Haghshenas, 2021*a*,

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2021*b*). Leppä *et al.* (2021) report a decrease in older Finnish adults' perceived opportunities to enjoy the outdoors during the pandemic, and this has been more pronounced for older adults with fewer physical and psychological resources. No article in our list explored imaginative types of travel.

Discussion

The synthesis of the selected articles shows a general decline in mobility and literal travel amongst older adults, and a decreased perceived safety of the shared and public modes of transportation, constraining older adults' mobility independence and choices around transport options for literal travels (Park and Cho, 2021; Carney *et al.*, 2022; Dinhobl *et al.*, 2022).

Different types of ideational mobility, especially virtual travel, became important during the pandemic to meet utilitarian travel needs such as access to food and health care. The reduction in the number of trips made by older adults for grocery shopping and the increased use of telehealth services in countries with better ICT infrastructure are reported in a number of studies included in this review (*e.g.* Liu *et al.*, 2021; Wang *et al.*, 2021). Virtual means of travel, such as videocalls to connect with family and friends, were also increasingly used to meet affective travel needs (Cabalquinto, 2022*a*, 2022*b*). While the replacement of literal travels with virtual ones may be promising in terms of environmental sustainability, one of the major concerns was the digital divide across and within countries, making it difficult for older adults to fulfil their mobility needs in the face of a decreasing share of actual or literal trips in older adults' mobilities, compromising social sustainability and equal opportunities for healthy ageing (Abootalebi *et al.*, 2021; Betz *et al.*, 2022).

Inequalities in older adults' capacities to meet their different levels of travel needs was highly dependent on regions' levels of economic development, transport infrastructure and digital capital. Evidence provided by the articles included in this review suggest an overall decreased capacity across the world to meet older adults' travel needs. However, meeting primary travel needs has been more challenging in low-income countries and in less well-off areas in high-income countries (Liu *et al.*, 2021; Wang *et al.*, 2021; Betz *et al.*, 2022; Carney *et al.*, 2022; Giebel *et al.*, 2022). The same is true for secondary travel needs. As mentioned before, feelings of safety and security was the dominant feeling in this category dictating transport mode choice. Older adults living in lower-income countries with lack of diversity in transport options were less likely to have access to safe and hygienic transport options during the pandemic (*e.g.* Giebel *et al.*, 2022). Studies conducted in the global North were less likely than other geographical regions to report negative feelings associated with travel. For example, driving cessation studies in the USA reported lower degrees of negative mental health outcomes than a study conducted in Iran (Abootalebi *et al.*, 2021; Roe *et al.*, 2021, 2022; Betz *et al.*, 2022). Similarly, using digital technologies to respond to secondary travel needs were more prevalent in countries with higher levels of digital capital (Cabalquinto, 2022*a*, 2022*b*). In terms of tertiary mobility needs, meeting kinaesthetic and immersive mobility needs was difficult in countries with strict lockdown measures, a lack of safe transport options as well as a lack of local green spaces (*see* Liu *et al.*, 2021). None of the

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studies included in this review analysed imaginative mobility which might be explained by overemphasis of the scholarly research concerned with older adults' mobility on literal travel and the lack of recognition of the health benefits of ideational mobilities (Parkhurst *et al.*, 2014). Despite this, a few studies conducted before the pandemic have shed light on the potential of imaginative mobilities to promote healthy ageing, especially in the context of reduced opportunities for literal travel among older adults (Dowds *et al.*, 2018; Musselwhite, 2018*b*). It is essential for future research to explore and leverage the benefits of imaginative mobility and integrate it into policies aimed at enhancing the mobility and wellbeing of older adults.

There is widespread recognition of the role of public transport and active modes of travel in achieving economic and environmental as well as social sustainability and healthy ageing (Laird *et al.*, 2018; Ravensbergen *et al.*, 2022). The functionalities of various modes of transportation changed dramatically during the pandemic. The space of a bus and other modes of public transport as a third space could play a part in meeting some affective travel needs, such as the need for social connection for older passengers, despite being less successful than a car in fulfilling other secondary travel needs, like independence and control (Musselwhite and Haddad, 2018). However, during the lockdown, these experiences were seen as risk-laden (Park and Cho, 2021; Ross, 2021), leading to increased preferences for solo modes of travel in countries with varying levels of income (Hua *et al.*, 2021; Shaer and Haghshenas, 2021*a*, 2021*b*; Fischer *et al.*, 2022). Affective and aesthetic travel needs were less met by individual travel modes other than the car, and driving became an increasingly important travel option to meet utilitarian needs, imposing potential threats for the environmental aspects of sustainability (Abootalebi *et al.*, 2021; Roe *et al.*, 2021, 2022; Betz *et al.*, 2022). The pandemic also made the role of affective factors more pronounced in older adults' travel behaviour, as fears of infection with the virus made all travellers, and older adults to a greater extent, negotiate meeting their utilitarian travel needs in the absence of car ownership or driving cessation (Abootalebi *et al.*, 2021), compromising the social aspects of sustainability. Nevertheless, this increased proclivity for solo travel has been directed towards more environmentally friendly options such as cycling and walking, sometimes as a result of pro-environmental policies adopted by governments and the advancement of active travel infrastructures during the pandemic (*e.g.* Fischer *et al.*, 2022), and in other cases as a result of tough lockdown policies and lack of alternative safe and hygienic transport options (Hua *et al.*, 2021; Liu *et al.*, 2021). While the first situation can be considered a positive move towards environmental sustainability, not being a choice-based cyclist or walker can be an impediment to achieving social sustainability.

During the pandemic, older adults' available options for travel, their travel behaviour, and its link with health and wellbeing became more than ever dependent on their physical health status (Leppä *et al.*, 2021), financial situation (Liu *et al.*, 2021), psychological factors (Ross, 2021), and the levels of support provided by the physical and social environment (Hino and Asami, 2021; Liu *et al.*, 2021; Saunders *et al.*, 2023) articulated earlier in the model of Webber *et al.* (2010). Proximity and accessibility of destinations were also very important during the pandemic, as lockdown policies further restricted older adults' life-space mobility to the immediate

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environment beyond the home (Leppä *et al.*, 2021). However, findings of the studies across urban, rural and suburban settings are less consistent, as the definitions of urban and rural, as well as the socio-spatial characteristics differentiating these areas, vary across countries. Although rural areas may suffer from a lower-density and lack of accessibility of destinations and public transport (Guida and Carpentieri, 2021; Giebel *et al.*, 2022; Nie *et al.*, 2022), they have been advantageous in some aspects, such as risk of virus transmission, as a result of lower density that made use of shared mobility options safer (Hua *et al.*, 2021).

The findings offer compelling evidence supporting the robustness of Musselwhite and Haddad's hierarchy and its applicability in emergency situations, such as a pandemic. In this research, we operationalised primary travel needs as access to food and health care, as trips to hospitals, health-care centres and grocery stores were more likely to be the only kinds of trips recognised as essential by policy makers, particularly in countries with stricter lockdown measures (Giebel *et al.*, 2022). It should be acknowledged, however, that this was not the case in certain countries, particularly those within northern Europe where one-hour daily exercise was recommended, and access to parks and recreational areas were considered as primary travel needs for older adults in governments' virus contamination measures and lockdown policies (Constandt *et al.*, 2020; Metcalfe, 2020; Kar *et al.*, 2021). This observation highlights the disparities in agency and choice around mobility among older adults across the globe. However, our findings clearly reveal the stark disparities in meeting essential primary travel needs necessary for survival during the pandemic, as discussed earlier. The predominance of safety concerns as secondary travel needs is also a significant finding (Park and Cho, 2021; Ross, 2021; Dinhobl *et al.*, 2022). While other secondary travel needs, such as control and independence still existed during the pandemic, they assumed a less-prominent role due to the emergency nature of the situation, with individuals and communities prioritising survival and essential travel needs over discretionary ones (Roe *et al.*, 2021, 2022; Betz *et al.*, 2022). Moreover, when comparing studies conducted in different settings, disparities in older adults' capacity to address their secondary travel needs were evident (Abootalebi *et al.*, 2021; Betz *et al.*, 2022). Although fewer studies in this review examined tertiary travel needs during the pandemic, the geographic concentration of these studies in high- and upper middle-income countries highlights the existing inequalities in older adults' ability to fulfil their tertiary travel needs in lower-income countries. One exception to this pattern might be the study conducted in Iran (Shaer and Haghshenas, 2021*a*, 2021*b*); however, limited information regarding the discretionary or essential nature of travels and participants' socio-economic status makes definitive judgement challenging.

Limitations and future research

This study is confined to a specific timeframe within the COVID-19 pandemic, with the search concluding on 25 August 2022. As a result, any articles published after this date are not accounted for in this review. Consequently, we recommend researchers who have collected data on older adults' mobility in the first and second years of the outbreak to continue to monitor participants' mobility and travel behaviour going forward. By doing so, we can gain comprehensive insights into

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the enduring impact of the COVID-19 pandemic on older adults' mobility and the longevity of these changes. These findings will be instrumental for policy makers in devising effective strategies to mitigate the negative consequences of the pandemic on older adults' mobility in the post-pandemic era.

We acknowledge the fact that the inception of Musselwhite and Haddad's hierarchical model in the UK and its subsequent adaptation in countries predominantly inhabited by people with European ancestry backgrounds makes universal application of the model debatable. Testing the model's applicability across continents and diverse population groups is recommended to better understand the role of culture in shaping older adults' mobility needs and quality of life across geographies. In addition, we identified a significant gap in research examining the model's validity in lower-income countries. There is a need for further empirical studies to explore the utility of the model to developing countries with less-robust travel infrastructure. Such studies are pivotal for a comprehensive understanding of the model's strengths and limitations in a broader global context.

Conclusion

The findings indicate an increased gap in older adults' ability to meet different levels of their travel and mobility needs as a result of the COVID-19 pandemic, especially aesthetic and affective travel needs that were largely compromised due to the virus contamination measures. A comparison of the geographical locations of the studies included in this review indicates growing disparities across the world in older adults' opportunities for literal mobility, especially in less-economically developed regions with a lack of diversity in transport options for older adults. The digitalisation of access to essentials and the increased importance of digital skills to meet travel needs are observable in the post-pandemic world. While the replacement of literal travel with virtual travel might help to tackle current ecological concerns, this can create new forms of social inequalities given the uneven distribution of digital capital across geographic regions and population groups, hindering the full realisation of sustainability goals. In the light of the United Nations' designation of 2020–2030 as the Decade of Healthy Ageing, and the centrality of mobility to the healthy ageing discourse, policies aimed at achieving sustainability in the transportation sector should pay greater attention to the travel and mobility needs of older individuals going forward.

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Ethical standards. This project did not collect empirical data so ethical approval was not required.

Note

1 Paratransit refers to transportation services in North America, also known as community transport in the UK, that complement traditional mass transit systems by offering personalised rides without fixed routes or schedules.

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