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Older Adults' Adoption of Technology-Mediated Mobility Solutions: A Review and Agenda

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ABSTRACT

Mobility is important to older adults' independent living. However, not all older adults' experience mobility seamlessly; instead, they often encounter challenges in mobility. The advent of technology has led to the development of technology-mediated mobility solutions. Many studies have been conducted to examine older adults' adoption of technology-mediated mobility solutions. Yet, no study, to date, has attempted to systematically review the progress of research in the field, thereby depriving researchers of an overview of older adults' adoption of technology-mediated mobility solutions, which may be useful for early career researchers to gain entry insights and established researchers to gain an updated understanding of the field. To address this gap, this study systematically reviews the literature on older adults' adoption of technology-mediated mobility solutions, encompassing the progress of research in the field, as well as the antecedents and consequences of adopting technology-mediated mobility solutions among older adults. In doing so, this study delivers seminal state-of-the-art insights on a comprehensive encapsulation of antecedents (i.e. ethical considerations, social influences, personal factors, usability elements, and environmental conditions) and consequences (i.e. quality of life) of older adults' adoption of technology-mediated mobility solutions, as well as directions to stimulate future research in the field.

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Introduction

The world's population is aging rapidly (Kim et al., 2023; Mobasseri et al., 2024), with approximately two billion people expected to be aged 60 years and above in 2050 (World Health Organization [WHO], 2018). The deterioration in health and physical capacities that come with becoming older is generally accompanied by the loss of enthusiasm in trying new things (Milanović et al., 2013; Walker et al., 2024). The fast-moving technology-mediated environment has made many older adults

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feel that they must keep up and stay in touch with technology, or risk being left behind (Chua et al., 2024; Fischer et al., 2014; Wan et al., 2024). Thus, it is no surprise that the rate of technology adoption among older adults continues to rise (Ewe et al., 2024), though they may use the Internet and health information technology differently than their younger counterparts (Chua et al., 2023; Fischer et al., 2014; Fristedt et al., 2021; Tsai et al., 2020).

The increase in life expectancy has also led to new positive aging models in which older adults competently lead happy lives and independently adapt to progressive changes to preserve their functional abilities, autonomy, and quality of life as they age (Gonot-Schoupinsky et al., 2022; Wongsala et al., 2023; Yusif et al., 2016). Mobility is an essential part of daily living – be it going to work, shopping for groceries, or traveling for medical checkups and treatments (Cao & Vivoda, 2023; Chua et al., 2023; Fraade Blanar et al., 2021). Noteworthily, moving around is easier today than in the past for older adults with the development of various assistive mobility technologies (Brandon, 2020). Nevertheless, the design and development of assistive mobility technologies need to be cognizant of the challenges and experiences that older adults encounter, as well as the antecedents and consequences that would promote its adoption – otherwise, the supposed benefit of improved mobility would not realize its full potential, particularly when the adoption of such technologies among older adults is limited (Tang et al., 2022).

Functional challenges tend to compound with age, thereby limiting active life choices among older adults. The work of Yusif et al. (2016) indicate that about 40% of individuals aged 60 years and above are limited in physical activity, which could lead to dysfunctional lifestyles, and that approximately two out of five older adults reported having a "physical or health condition, rendering reading difficult or problematic" or "disability or chronic disease, which hinder their full involvement in everyday activities." Their work also reveals that most studies on older adults and general assistive technologies sought to address any one or a combination of eight challenges, namely (1) autonomy living, (2) fall risks, (3) chronic disease, (4) dementia, (5) social ostracization, (6) depression, (7) inadequate well-being, and (8) inadequate medication treatment. Noting that being physically active contributes to a healthy social lifestyle, their study concludes that research on prevalent age-related health concerns could inform assistive technology developers, gerontologists, and policymakers about the design, promotion, and suitability of assistive technologies for older adults.

Families' provision of care and support for older adults with functional decline has become increasingly challenging due to changing household structures over time (e.g., living together to living independently, working husbands to working couples). Recognizing this challenge, the work of Lee et al. (2020) and Vandemeulebroucke et al. (2018) advocate for the integration of robots into older adults' dwellings to preserve and improve their mobility,

safety, and quality of life. They argue that technology can enable older adults to remain autonomous in living, and that this autonomy should be made a principle of forward-looking health and social care policies.

Assistive technologies encapsulate a broad range of devices, services, strategies, and practices designed and implemented using technology to mitigate the challenges faced by older adults and support them to experience seamless aging and quality of life (Liu et al., 2016). For example, assistive technologies such as technology assistive canes, wheelchairs, and power mobility devices can support older adults who have difficulty balancing, coordinating, or stabilizing (Vandemeulebroucke et al., 2018). Similarly, automated windows and curtain controls, autonomous automobiles, floor purification robots, automatic climate control temperature sensors, and day-to-day electric showers can ease older adults' daily living, whereas assistive technologies that are packaged together with telecare or telehealth (e.g., Internet of Things (IoT) gadgets linked to response teams through a person's telephone, such as community alarm services, fire alarms, or falls) can improve older adults' connectivity to health, care, and emergency services (Yusif et al., 2016). The latter is especially noteworthy because telecare and telehealth services can help older adults to manage chronic diseases, leading to fewer hospitalizations (Bailey et al., 2011).

Of particular interest in this study are technology-mediated solutions relating to mobility. Many assistive mobility technologies exist (e.g., walking canes, activator poles, crutches, e-scooter up-lift seat assists, stair elevators), and they enable older adults to maintain independence, supporting their mobility indoors and outdoors (Brandon, 2020), as well as their social lifestyles (Shergold et al., 2015). Similarly, many studies have been conducted to develop technology-mediated mobility solutions and promote its adoption. While the former (solutions) has received review scrutiny in the past (e.g., Salminen et al., 2009; Sun et al., 2018), the latter (adoption) has, surprisingly, not been reviewed.

The study of technology adoption is *important*—without technology adoption (which can manifest through usage, purchase, and even willingness to pay more, as seen through this study), the intended benefits of that technology would not materialize; however, technology adoption studies, when taken independently, have traditionally been confined to niche perspectives (i.e., a single rather than integrated perspective), thereby limiting the level of informed understanding (Lim, 2018). Furthermore, the contextualization of technology adoption is *critical* to account for existential peculiarities and mitigate overgeneralization biases (i.e., cognitive distortions that assume what works in one context would work in another context). The advocacy for contextualization is particularly *relevant* for older adults (e.g., baby boomers) due to their inherent differences (e.g., lower familiarity with technology and lower level of mobility) as compared to their younger counterparts (e.g., millennials, zoomers) (Lim & Bowman, 2022), as well as the nature of technological solutions, which may be

developed for varying reasons (e.g., solutions that address mobility [e.g., travel] and non-mobility [e.g., cognitive] issues) (Tang et al., 2022). Moreover, the study of technology adoption of mobility solutions is *urgent* given the proliferation of technology-mediated mobility solutions in the marketplace (Sun et al., 2018), and thus, any delay of such a study could lead to potential product market failure, particularly in the event of low product adoption. The significance of this issue is *substantial* due to two major logics: business logic and public health logic. In terms of business logic, low product adoption could cause product market failure, which may transpire when sales are insufficient to not only breakeven or recoup investment but also make decent profits to satisfy shareholders, who are typically not philanthropists, and thus, they often invest in the options that hold the greatest potential to reap the highest returns on investment (Cumming et al., 2023). In addition, product market failure could also deter new entrants, which may drive product price upwards due to the lack of competition in the marketplace (Jackson & Jabbie, 2020). In terms of public health logic, there is a clear need to ensure that the solutions aiming to improve and support older adults' quality of life succeed, especially given that the population of older adults are growing over time (Lee et al., 2020; Lim & Bowman, 2022). More importantly, despite the availability of reviews on technology adoption of assistive technologies among older adults, such reviews are either too general (e.g., general assistive technologies; Yusif et al., 2016) or too specific (e.g., care robots; Vandemeulebroucke et al., 2018), and thus, they cannot provide a representative view of the extant literature dedicated to the adoption of technology-mediated mobility solutions (*limitation*). Therefore, the *need* for a review in this direction is warranted, which is in line with Lim et al. (2022) and Paul et al. (2021), who stipulated that a review of the field is *valuable* because a field can only progress when it advances existing knowledge and *justified* when no prior reviews of the field exist and when shortchanges exist in closely-related reviews. To the best of our knowledge, no study, to date, has systematically reviewed the extant literature on the adoption of technology-mediated mobility solutions among older adults. Reviews, when done systematically, also constitute an established and rigorous form of research (Graybill et al., 2014; Kraus et al., 2022; Sanyal et al., 2018). Given the *nine major rationales for review* (i.e., importance, criticalness, relevance, urgency, substantialness, limitation, need, value, and justifiability), this study *aims* to provide a comprehensive overview of (1) the progress of existing research and (2) the antecedents and consequences of older adults' adoption of technology-mediated mobility solutions, as well as (3) the avenues for future research to advance the field. Using a systematic literature review approach focusing on current insights (RQ1 and RQ2) and ways forward (RQ3) in line with Donthu et al. (2021), Kraus

et al. (2022), Lim et al. (2022), and Paul et al. (2021), this study *contributes* by answering the following research questions (RQs):

RQ1. What is the *progress of existing research* focusing on older adults' adoption of technology-mediated mobility solutions?

RQ2. What are the *antecedents* and *consequences* of older adults' adoption of technology-mediated mobility solutions?

RQ3. What are the *avenues for future research* to advance understanding of older adults' adoption of technology-mediated mobility solutions?

Methods

The present systematic literature review on older adults' adoption of technology-mediated mobility solutions is conducted using the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol by Paul et al. (2021). The SPAR-4-SLR protocol consists of three stages: assembling, arranging, and assessing (see Figure 1). The use of this protocol enables the study's review to be conducted systematically and reported transparently (Lim et al., 2022).

Assembling

The *assembling* stage involves *identifying* and *acquiring* an initial set of documents in a domain for review (Paul et al., 2021). In the case of the present study, the review *domain* resides at the intersection of "older adults," "adoption," and "technology-mediated mobility solutions." Noteworthily, this study employs Scopus and Web of Science as its *search engines and databases* as they are the largest scientific databases that index sources that have met stringent quality criteria (Donthu et al., 2021; Mukherjee et al., 2022). Though other search engines and databases (e.g., EBSCO, Google Scholar, ProQuest) may return a larger set of documents and thus appear to be more comprehensive, using them may come at the expense of quality due to the absence of stringent quality criteria for indexing (as in the case of Scopus and Web of Science); such quality mechanism, though not completely perfect, provides a decent level of confidence that is necessary in the age where misinformation and predatory publishing are rampant (Kumar, Sahoo, Lim, Kraus, et al., 2022). In this regard, though some scholars advocate the use of multiple search engines and databases (beyond Scopus and Web of Science) on the basis of comprehensiveness (Harari et al., 2020; Hiebl, 2021), the present review takes the

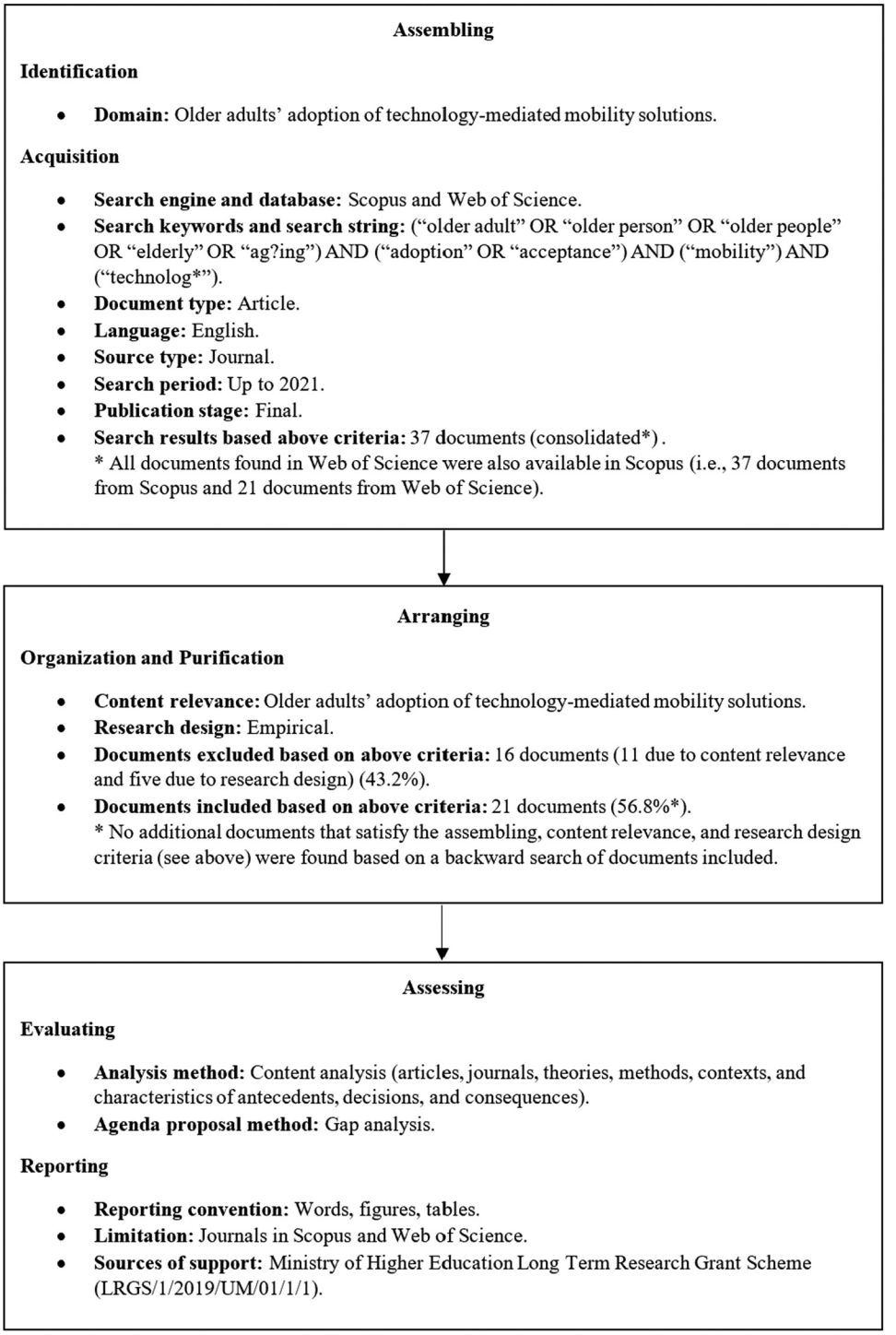


Figure 1 Review procedure using the SPAR-4-SLR protocol.

position that the use of Scopus and Web of Science as its only search engines and databases is justified based on (i) the aforementioned rationale in terms of indexing quality as well as (ii) recent publications in premier journals that have also relied on Scopus and/or Web of Science only for their reviews (e.g., Kumar, Sahoo, Lim, & Dana, 2022; Kumar, Sahoo, Lim, Kraus, et al., 2022).

Moreover, through Scopus and Web of Science, several selection criteria can be specified upfront, thereby creating efficiency for review. More specifically, this study considers only "articles" (*document type*) written in "English" (*language*) and published in "journals" (*source type*) up to 2021 (*search period*) that have been finalized (i.e., assigned volume and/or issue) (*publication stage*) because they encapsulate the latest original, first-hand (i.e., conceptual or empirical) insights (note: other types such as reviews are excluded to avoid replication) that receive the highest level of peer review scrutiny (note: alternative sources such as books, book chapters, and conference proceedings may receive little to no peer review) (Lim et al., 2021; Paul et al., 2021). The *search keywords* around the focused areas in the review domain (i.e., "older adults," "adoption," and "technology-mediated mobility solutions") were brainstormed by two authors based on their expertise and experience as well as cross-checking the literature. Several related synonyms for "older adults" were included—i.e., "older person," "older people," "elderly," and "ag?ing" – in line with Bowman and Lim (2021); here, "?" is a wildcard used to capture both the spellings of "aging" and "ageing" in line with Paul et al. (2021). Similarly, a related synonym for "adoption" was also included—i.e., "acceptance" – in line with Lim (2018). However, no related synonyms were included for "mobility" due to pragmatic reasons in line with Lim et al. (2021), namely (i) the adequacy of "mobility" as a global concept to capture the intended meaning and (ii) the need to mitigate irrelevant search results. With regards to the latter (or "(ii)"), the use of alternative terms such as "mobile" resulted in a plethora of irrelevant results, such as mobile device, which is focused on cognition and usability over actual mobility (Iancu & Iancu, 2020), and mobile shopping. Noteworthily, the use of "mobility" as a single keyword to represent this area of the review domain also helps to avoid instances where initial search results are not parsimonious (e.g., *n*=thousands of documents) and show an oddly large gap with the final set of documents used for review (e.g., *n*=tens of documents) (e.g., 4,692 documents to 16 documents on older adults' acceptance of technology for aging in place in Peek et al. (2014) and 1,163 documents to 21 documents on older adults' experience on social networking sites in Newman et al. (2021)). Next, "*" is a truncation used to capture related terms for "technology" such as "technologies" and "technological" in line with Paul et al. (2021). Finally, Boolean operators such as "OR" and "AND" have been included and used to organize the search keywords into a search string, taking into

account the above criteria, which returned a total of 37 documents (consolidated), wherein 37 documents were found in Scopus and 21 documents were returned by Web of Science. Noteworthily, all the documents found from Web of Science were also available in Scopus, indicating that documents indexed in Web of Science are often indexed in Scopus, though documents indexed in Scopus are not necessarily indexed in Web of Science, thereby reaffirming that Scopus is generally larger and more inclusive than Web of Science (Singh et al., 2021).

Arranging

The *arranging* stage involves *organizing* and *purifying* the set of documents returned from the assembling stage (Paul et al., 2021). The records of the 37 documents were downloaded, organized, and reviewed based content relevance and empirical research design. In total, 11 documents were excluded because they do not shed light on the antecedents and consequences of adopting technology-mediated mobility solutions among older adults (i.e., non-relevant content) and five documents were excluded as they are not empirical (i.e., non-relevant research design). The remaining 21 documents were subjected to a backward search using their references (Tham et al., 2023) as a cross-check mechanism to ensure that no relevant documents were overlooked (Harari et al., 2020; Wohlin et al., 2022); no additional documents that met the assembling, content relevance, and research design criteria were found. Thus, a total of 21 documents were retained in this stage and progressed for review in the next stage (note: small review corpus is appropriate and common for reviews on older adults and technology based on prior records in "Q1" journals—e.g., 16 documents on older adults' acceptance of technology for aging in place inPeek et al. (2014) and 21 documents on older adults' experience on social networking sites in Newman et al. (2021)).

Assessing

The *assessing* stage involves *evaluating* and *reporting* the insights from the documents that were retained from the arranging stage (Paul et al., 2021). The documents were evaluated using a *content analysis* guided by the research questions (i.e., RQ1 and RQ2— articles, journals, theories, methods, contexts, and characteristics of antecedents, decisions, and consequences), and the *trustworthiness* (i.e., reliability and validity) of that analysis is informed by Guba (1981), Lincoln and Guba (1985), and Lim (2019), whereby the *credibility* (i.e., internal validity) is assured using multiple sources of data (i.e., articles across different journals) and coders (i.e., two authors), the *transferability* (i.e., external validity) is established by acknowledging the limitations and additional research

needed, the *dependability* is ensured by adopting an established review protocol (i.e., SPAR-4-SLR) and transparently reporting the decisions taken in each stage of the review process, and the *confirmability* is supported by only including documents whose publication has been finalized.

What do we know?

Publication trend

The publication trend of journal articles on older adults' adoption of technology-mediated mobility solutions is presented in Figure 2. The figure indicates that the first journal article in the field was published in 2010 (Govercin et al., 2010), and that the field's progress has remained modest throughout the subsequent years, with 2019 being the year with the highest number of journal article publication ($n = 6$).

Articles

The top 10 journal articles on older adults' adoption of technology-mediated mobility solutions are presented in Table 1. The table indicates that Peek

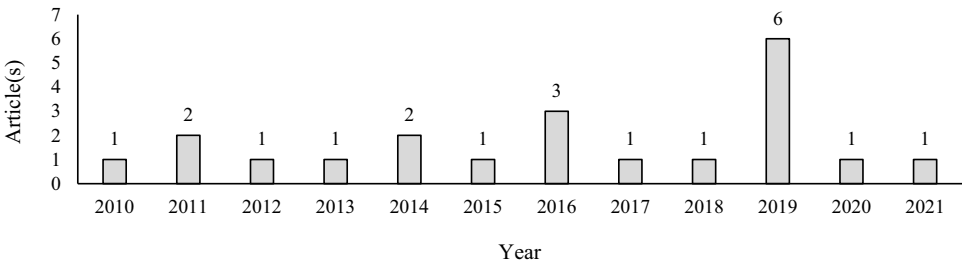


Figure 2 Publication trend of research on older adults' adoption of technology-mediated mobility solutions.

Table 1. Ten Most-Cited Articles on Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Author(s)	Total citations ($n = 519$)	Author(s)	Citations per year ($n = 184.2$)
Peek et al. (2019)	160	Peek et al. (2019)	80.0
Wolf and Seebauer (2014)	112	Wolf and Seebauer (2014)	56.0
Silveira et al. (2013)	66	Leger et al. (2019)	12.5
Govercin et al. (2010)	40	Rahman et al. (2019)	12.5
Seelye et al. (2012)	30	Silveira et al. (2013)	8.3
Bailey et al. (2011)	26	Govercin et al. (2010)	3.6
Leger et al. (2019)	25	Seelye et al. (2012)	3.3
Rahman et al. (2019)	25	Marschollek et al. (2014)	2.7
Marschollek et al. (2014)	19	Russell et al. (2015)	2.7
Russell et al. (2015)	16	Bailey et al. (2011)	2.6

Citations per year = Total citations ÷ [Current year (2021) − Year of publishing].

et al.'s (2019) article on the long-term use of assistive mobility technologies among older adults ($n = 160$), Wolf and Seebauer's (2014) article on technology adoption of electric bicycles among older adults ($n = 112$), and Silveira et al.'s (2013) article on tablet-based strength-balance training to improve older adults' mobility ($n = 66$) are the top three journal articles with the highest total citations. However, when citations per year are considered to provide a fairer comparison that accounts for publication year, the table indicates that Peek et al. (2019) ($n = 80.0$) and Wolf and Seebauer (2014) ($n = 56.0$) remained as the top two journal articles with the highest citations per year, and they are joined by Leger et al.'s (2019) article on older adults' adoption of e-bikes and Rahman et al.'s (2019) article on older adults' acceptance of e-driving vehicles with 12.5 citations each per year.

Journals

The journals that have published empirical insights pertaining to older adults' adoption of technology-mediated mobility solutions are presented in Table 2. The table indicates that a total of 18 different journals have published empirical research in this area, with *Gerontology* ($n = 160$), *Transportation Research Part A: Policy and Practice* ($n = 137$), and *Journal of Medical Internet Research* ($n = 66$) being the top three most-cited journals in the field. The table also indicates that only three journals have published more than one article in the area (i.e., $n = 2$), namely *BMC*

Table 2. List of Journals for Research on Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Journal title	Article(s) ($n = 21$)	Citation(s) ($n = 597$)	Scopus field (Highest quartile 2021)	Scopus quartile (2021)
Gerontology	1	160	Geriatrics and gerontology	Q1
Transportation Research Part A: Policy and Practice	2	137	Transportation	Q1
Journal of Medical Internet Research	1	66	Health informatics	Q1
Informatics for Health and Social Care	2	59	Health informatics	Q2
Telemedicine and e-Health	1	30	Health informatics	Q1
Ageing and Society	1	26	Geriatrics and gerontology	Q2
Transportation Research Part F: Traffic Psychology and Behaviour	1	25	Transportation	Q1
BMC Geriatrics	2	20	Geriatrics and gerontology	Q1
Journal of Telemedicine and Telecare	1	16	Health informatics	Q1
International Journal of Older People Nursing	1	16	Gerontology	Q2
Assistive Technology	1	11	Rehabilitation	Q3
Transportation	1	10	Transportation	Q1
JMIR mHealth and uHealth	1	5	Health informatics	Q1
Journal of Safety Research	1	5	Safety, risk, reliability and quality	Q1
Preventive Medicine Reports	1	4	Health Informatics	Q1
Universal Access in the Information Society	1	3	Information systems	Q2
Accident Analysis and Prevention	1	3	Safety, risk, reliability and quality	Q1
Traffic Injury Prevention	1	1	Safety research	Q1

Geriatrics, *Informatics for Health and Social Care*, and *Transportation Research Part A: Policy and Practice*. Noteworthily, the extant studies on older adults' adoption of technology-mediated mobility solutions have been published in a range of disciplines, such as gerontology (e.g., *Ageing and Society*, *Gerontology*), medicine (e.g., *BMC Geriatrics*, *Journal of Telemedicine and Telehealth*), nursing (e.g., *International Journal of Older People Nursing*), information systems and technology (e.g., *Assistive Technology*, *Universal Access in the Information Society*), safety (e.g., *Accident Analysis and Prevention*, *Journal of Safety Research*), and transportation (e.g., *Transportation Research Part A: Policy and Practice*, *Transportation Research Part F: Traffic Psychology and Behaviour*). The insights herein suggest that older adults' adoption of technology-mediated mobility solutions is a multidisciplinary area of research that remains modest and thus requires fertilization to expand its body of knowledge.

Theories

Theories are tools for advancing academic knowledge, and like a compass, they guide researchers in their search for solutions to research questions in order to accomplish their research objectives (Lim et al., 2021). Guided by theories in the form of the theories, contexts, and methods (TCM) and antecedents, decisions, and consequences (ADC) frameworks (Paul et al., 2021), the present review of journal articles on older adults' adoption of technology-mediated mobility solutions reveals pertinent insights into the areas covered by these frameworks. This section concentrates on theories, while the next sections shed light into the other areas.

The theories that have been used for research on older adults' adoption of technology-mediated mobility solutions are presented in Table 3. In total, nine different theories relating to *behavior* (Knowledge, Attitudes, and Practices (KAP) Theory; Theory of Planned Behavior (TPB); Transtheoretical Model (TTM)), *mobility* (Webber's Comprehensive Mobility Framework), *needs* (Needs Analysis Framework), and *technology* (Automation Acceptance Model (AAM); Dynamics in Technology Use by Seniors (DITUS) Framework; Technology Acceptance Model (TAM); Unified Theory of Adoption and Use of Technology (UTAUT)) have been used across 10 journal articles in the field. The TAM is the most popular theory, having been used in four journal articles (Haghzare et al., 2021; Rahman et al., 2019; Russell et al., 2015; Tural et al., 2020). This is unsurprising given that the journal articles in this review examined a wide range of attributes associated to technology-mediated mobility solutions, which resonates with the call and premise of the TAM for using the theory as a foundational theoretical lens that can be contextualized and expanded for multi-attribute investigations (Lim, 2018). Noteworthily, only one

Table 3. List of Theories Used in Research on Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Theory	Area	Article(s)	Source(s)
Automation Acceptance Model (AAM)	Technology	1	Rahman et al. (2019)
Dynamics in Technology Use by Seniors (DITUS) Framework	Technology	1	Peek et al. (2019)
Knowledge, Attitudes, and Practices (KAP) Theory	Behavior	1	Robertson et al. (2019)
Needs Analysis Framework	Needs	1	Seaborn et al. (2016)
Technology Acceptance Model (TAM)	Technology	4	Haghzare et al. (2021), Rahman et al. (2019), Russell et al. (2015), and Tural et al. (2020)
Theory of Planned Behavior (TPB)	Behavior	1	Rahman et al. (2019)
Transtheoretical Model (TTM)	Behavior	1	Silveira et al. (2013)
Unified Theory of Adoption and Use of Technology (UTAUT)	Technology	1	Wolf and Seebauer (2014)
Webber's Comprehensive Mobility Framework	Mobility	1	Leger et al. (2019)
With theory		10	Haghzare et al. (2021), Leger et al. (2019), Peek et al. (2019), Rahman et al. (2019), Robertson et al. (2019), Russell et al. (2015), Seaborn et al. (2016), Silveira et al. (2013), Tural et al. (2020), and Wolf and Seebauer (2014)
Without theory		11	Bailey et al. (2011), Chung et al. (2017), Govercin et al. (2010), Isaacson et al. (2016), Marschollek et al. (2014), Nikitina et al. (2018), Oxley et al. (2019), Park et al. (2019), Peek et al. (2016), Seelye et al. (2012), and Wang et al. (2011)

journal article pursued theoretical integration, namely Rahman et al. (2019) (i.e., AAM, TAM, and TPB). The rest of the 11 articles in this review did not rely on any theory in their investigation (Bailey et al., 2011, Chung et al., 2017; Govercin et al., 2010, Isaacson et al., 2016; Marschollek et al., 2014; Nikitina et al., 2018; Oxley et al., 2019; Park et al., 2019; Peek et al., 2016, Seelye et al., 2012; Wang et al., 2011).

Methods

Methods are techniques that researchers use to conduct research (Lim et al., 2021). Of the 21 empirical studies on older adults' adoption of technology-mediated mobility solutions included in this review, the qualitative research design was used in nine studies, and the mixed (qualitative and quantitative) and qualitative research designs were used in seven and five studies, respectively (Figure 3).

The types of research data relied on in the empirical studies in this review are also presented in Table 4. The table indicates that qualitative and quantitative data were relied upon in 14 and 18 studies For qualitative data, in-depth and focus group interviews were most commonly employed with seven studies each.In contrast, four studies employed activity logs and diaries were used for

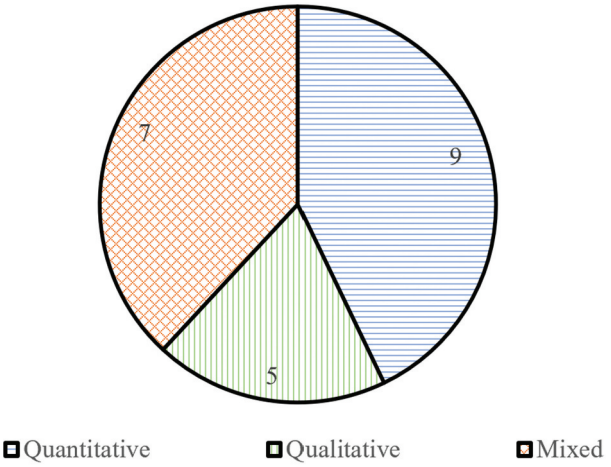


Figure 3 Research design distribution for older adults' adoption of technology-mediated mobility solutions research.

Table 4. Research Data on Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Data type	Article(s)	Source(s)
Qualitative (*n* = 14)		
In-depth interviews	7	Bailey et al. (2011), Chung et al. (2017), Leger et al. (2019), Peek et al. (2016), Peek et al. (2019), Marschollek et al. (2014), and Wang et al. (2011).
Focus group interviews	7	Govercin et al. (2010), Leger et al. (2019), Park et al. (2019), Robertson et al. (2019), Seaborn et al. (2016), Tural et al. (2020), and Wang et al. (2011).
Quantitative (*n* = 18)		
Activity logs and diaries	4	Bailey et al. (2011), Chung et al. (2017), Isaacson et al. (2016), and Marschollek et al. (2014).
Offline survey	7	Haghzare et al. (2021), Nikitina et al. (2018), Park et al. (2019), Seaborn et al. (2016), Silveira et al. (2013), Tural et al. (2020), and Wang et al. (2011).
Online survey	5	Rahman et al. (2019), Robertson et al. (2019), Russell et al. (2015), Seelye et al. (2012), and Tural et al. (2020).
Postal survey	1	Wolf and Seebauer (2014)
Telephone survey	1	Oxley et al. (2019)

quantitative data. Offline and online surveys were most commonly used with seven and five studies,respectively, while postal and telephone surveys were each employed in one study.

Contexts

Contexts are environments in which research is conducted (Lim et al., 2021). In the case of the present review, the context pertains to the technology-mediated mobility solution that is being studied against older adults' adoption of that solution. Referring to Table 5, nine types of technology-mediated mobility solutions available for older adults' adoption were revealed by 18 out of 21 studies in this review, with six solutions

Table 5. Types of Technology-Mediated Mobility Solutions Available for Older Adults' Adoption.

Technology-mediated mobility solution	Source(s)
Indoor	
Home-based sensor system	Chung et al. (2017), Govercin et al. (2010), and Marschollek et al. (2014).
Mobile app (active lifestyle, virtual gym)	Nikitina et al. (2018) and Silveira et al. (2013).
Power wheelchair	Seaborn et al. (2016) and Wang et al. (2011).
Robot (active space, telecommunication)	Park et al. (2019) and Seelye et al. (2012).
Stair mobility	Tural et al. (2020).
Telehealth service	Russell et al. (2015).
Outdoor	
Electric bicycle	Leger et al. (2019) and Wolf and Seebauer (2014).
Fully automated and self-driving vehicle	Haghzare et al. (2021), Rahman et al. (2019), and Robertson et al. (2019).
Vehicle safety	Oxley et al. (2019).

Three articles considered technology-mediated mobility solution in general (Bailey et al., 2011; Peek et al., 2016; Peek et al., 2019).

concentrating on indoor mobility (e.g., home-based sensor system, mobile app, power wheelchair, robot, stair mobility, and telehealth service) and three solutions focusing on outdoor mobility (e.g., electric bicycle, fully automated and self-driving vehicle, vehicle safety). The remaining three studies considered technology-mediated mobility solution in general (Bailey et al., 2011; Peek et al., 2016; Peek et al., 2019).

Antecedents

Antecedents embody the reasons for participating or not engaging in an activity, and therefore, they have a direct impact on decisions and an indirect influence on consequences (Lim et al., 2021). Through a content analysis of journal articles, this review reveals five categories of antecedents that affect older adults' adoption of technology-mediated mobility solutions, namely *ethical considerations*, *social influences*, *personal factors*, *usability elements*, and *environmental conditions*. These categories of antecedents show that the adoption of technology-mediated mobility solutions among older adults is complex rather than straightforward. Specifically, each category of antecedent contains a collection of factors that could either enable or impede older adults' adoption of technology-mediated mobility solutions. Therefore, it is important to always consider and remain aware on the range of antecedents and their underlying effects when developing and implementing strategies that aim to promote the adoption of technology-mediated mobility solutions among older adults. Figure 4 and Table 6 present a summary and the next sections shed additional light on the details pertaining to each category of antecedents that was uncovered through this review.

Ethical considerations

The first category of antecedents comprises *ethical considerations*. In essence, ethical considerations are thoughts that people hold with regards to the

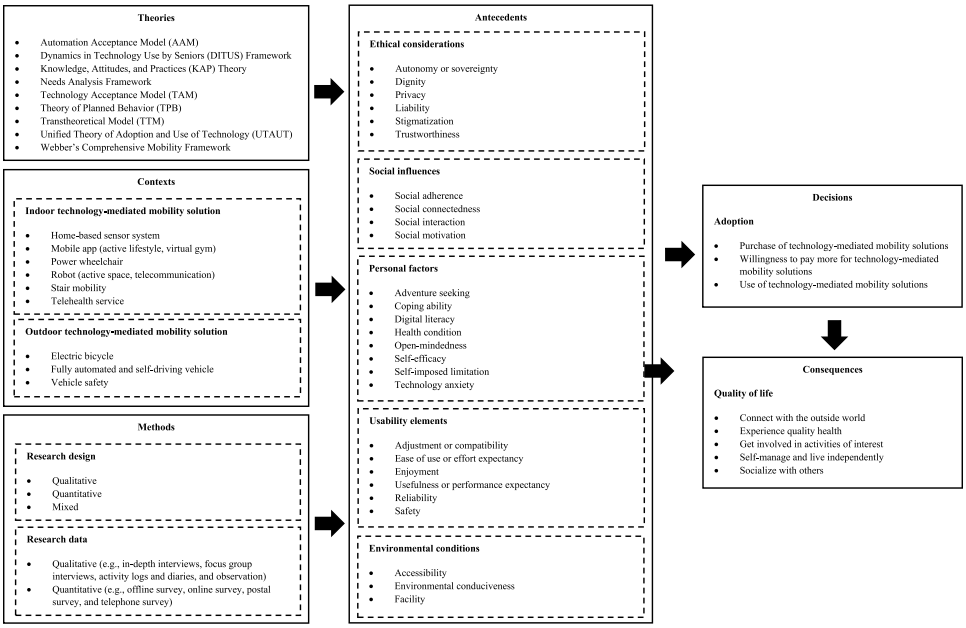


FIGURE 4 State-of-the-art overview of the antecedents, decisions, and consequences of older adults' adoption of technology-mediated mobility solutions and its supporting theories, contexts, and methods.

principles and values that are important to human functioning. This review finds that older adults consider ethical issues such as *autonomy* or *sovereignty* (Park et al., 2019; Wolf & Seebauer, 2014), *dignity* (Park et al., 2019; Tural et al., 2020), *privacy* (Chung et al., 2017, Govercin et al., 2010; Isaacson et al., 2016), *liability* (Peek et al., 2016), *stigmatization* (Leger et al., 2019; Tural et al., 2020), and *trustworthiness* (Rahman et al., 2019; Russell et al., 2015) when they decide whether or not to adopt and use technology-mediated mobility solutions. Specifically, older adults are unlikely to consider adopting technology-based mobility solutions when such solutions take away their autonomy or sovereignty to live independently (Park et al., 2019; Wolf & Seebauer, 2014), and thus, hurting their dignity as a human being (Park et al., 2019; Tural et al., 2020). However, older adults are willing to relinquish a reasonable degree of this autonomy provided that this technology-based mobility solutions are positioned as a friend or helper without necessarily removing human interaction (Park et al., 2019), and do not make them feel low or incapable of living autonomously or independently (Park et al., 2019; Tural et al., 2020). Nonetheless, older adults could still avoid adopting technology-mediated mobility solutions when they are concerned that such solutions would infringe their privacy, for example, their right to data (e.g., confidentiality and right to control over third-party access and use) and personal privacy (e.g., right to be left alone or not be monitored by third parties) (Chung et al., 2017, Govercin

Table 6. Antecedents of Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Antecedents	Source(s)
Ethical considerations	
Autonomy or sovereignty	Park et al. (2019) and Wolf and Seebauer (2014).
Dignity	Park et al. (2019) and Tural et al. (2020).
Privacy	Chung et al. (2017), Govercin et al. (2010), and Isaacson et al. (2016).
Liability	Peek et al. (2016)
Stigmatization	Leger et al. (2019) and Tural et al. (2020).
Trustworthiness	Rahman et al. (2019) and Russell et al. (2015).
Social influences	
Social adherence	Nikitina et al. (2018) and Silveira et al. (2013).
Social connectedness	Seelye et al. (2012).
Social interaction	Nikitina et al. (2018) and Silveira et al. (2013).
Social motivation	Nikitina et al. (2018), Peek et al. (2019), and Silveira et al. (2013).
Personal factors	
Adventure seeking	Seaborn et al. (2016).
Coping ability	Bailey et al. (2011), Peek et al. (2019), and Wolf and Seebauer (2014).
Digital literacy	Peek et al. (2019) and Seaborn et al. (2016).
Health condition	Isaacson et al. (2016) and Wang et al. (2011).
Open-mindedness	Park et al. (2019).
Self-efficacy	Bailey et al. (2011) and Haghzare et al. (2021).
Self-imposed limitation	Chung et al. (2017) and Russell et al. (2015).
Technology anxiety	Haghzare et al. (2021) and Russell et al. (2015).
Usability elements	
Adjustment or compatibility	Bailey et al. (2011), Oxley et al. (2019), Peek et al. (2016), and Rahman et al. (2019).
Ease of use or effort expectancy	Leger et al. (2019), Peek et al. (2016), Peek et al. (2019), Russell et al. (2015), and Wolf and Seebauer (2014).
Enjoyment	Nikitina et al. (2018), Seaborn et al. (2016), and Wolf and Seebauer (2014).
Usefulness or performance expectancy	Govercin et al. (2010), Nikitina et al. (2018), Rahman et al. (2019), Tural et al. (2020), Wang et al. (2011), and Wolf and Seebauer (2014).
Reliability	Oxley et al. (2019).
Safety	Govercin et al. (2010), Haghzare et al. (2021), Oxley et al. (2019), Rahman et al. (2019), and Wang et al. (2011).
Environmental conditions	
Accessibility	Leger et al. (2019).
Environmental conduciveness	Haghzare et al. (2021), Park et al. (2019), Peek et al. (2016), Peek et al. (2019), and Wolf and Seebauer (2014).
Facility	Robertson et al. (2019).

Table 7. Decisions Reflecting Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Decisions	Source(s)
Adoption	
Purchase of technology-mediated mobility solutions	Govercin et al. (2010) and Oxley et al. (2019).
Use of technology-mediated mobility solutions	Bailey et al. (2011), Chung et al. (2017), Govercin et al. (2010), Haghzare et al. (2021), Isaacson et al. (2016), Leger et al. (2019), Marschollek et al. (2014), Nikitina et al. (2018), Oxley et al. (2019), Park et al. (2019), Peek et al. (2016), Peek et al. (2019), Rahman et al. (2019), Robertson et al. (2019), Russell et al. (2015), Seaborn et al. (2016), Seelye et al. (2012), Silveira et al. (2013), Tural et al. (2020), Wang et al. (2011), and Wolf and Seebauer (2014).
Willingness to pay more for technology-mediated mobility solutions	Oxley et al. (2019)

et al., 2010; Isaacson et al., 2016). They may also be deterred from adopting technology-mediated mobility solutions when in doubt about the coverage of liability in the event of a misfortune resulting from the use of such solutions (Peek et al., 2016). These instances, in turn, accentuate the importance of

Table 8. Consequences of Older Adults' Adoption of Technology-Mediated Mobility Solutions.

Consequences	Source(s)
Quality of life	
Connect with the outside world	Nikitina et al. (2018) and Silveira et al. (2013).
Experience quality health	Nikitina et al. (2018) and Silveira et al. (2013).
Get involved in activities of interest	Chung et al. (2017), Haghzare et al. (2021), Isaacson et al. (2016), Leger et al. (2019), and Rahman et al. (2019).
Self-manage and live independently	Peek et al. (2016)
Socialize with others	Russell et al. (2015) and Seelye et al. (2012).

trustworthiness of technology-mediated mobility solutions and their makers (Rahman et al., 2019; Russell et al., 2015). Finally, the feelings of being forced to use or watched or monitored through technology-based mobility solutions due to the unwarranted stigmatization associated to older adults (e.g., dependency and frailty) may also act as a barrier to older adults' adoption of such solutions (Leger et al., 2019; Tural et al., 2020).

Social influences

The second category of antecedents contains *social influences*. In essence, social influences explain how people's attitudes, beliefs, and behavior can be shaped by others. This review reveals that older adults' adoption of technology-mediated mobility solutions can be influenced by *social adherence* (Nikitina et al., 2018; Silveira et al., 2013), *social connectedness* (Seelye et al., 2012), *social interaction* (Nikitina et al., 2018; Silveira et al., 2013), and *social motivation* (Nikitina et al., 2018; Peek et al., 2019; Silveira et al., 2013). Noteworthily, past scholars show that technology-mediated mobility solutions such as mobile apps can assist older adults in their daily living, and that the social motivation for using solutions is a reason for its adoption (Nikitina et al., 2018; Peek et al., 2019; Silveira et al., 2013). Specifically, the adoption of such solutions is more likely to happen when older adults are part of social groups – as opposed to individually – due to the influence of social adherence that manifest in social groups (Silveira et al., 2013). Moreover, older adults experience social connectedness and interaction when they are a part of a group, and thus, they are likely to adopt technology-mediated mobility solutions when such solutions are adopted by the group so as to maintain their membership with the group (Nikitina et al., 2018, Seelye et al., 2012; Silveira et al., 2013).

Personal factors

The third category of antecedents consists of *personal factors*. In essence, personal factors relate to individual characteristics that explain why people perceive and behave the way they do. This review finds that the adoption of

technology-mediated mobility solutions can be shaped by individual characteristics such as *adventure seeking* (Seaborn et al., 2016), *coping ability* (Bailey et al., 2011; Peek et al., 2019; Wolf & Seebauer, 2014), *digital literacy* (Peek et al., 2019; Seaborn et al., 2016), *health condition* (Isaacson et al., 2016; Wang et al., 2011), *open-mindedness* (Park et al., 2019), *self-efficacy* (Bailey et al., 2011; Haghzare et al., 2021), *self-imposed limitation* (Chung et al., 2017; Russell et al., 2015), and *technology anxiety* (Haghzare et al., 2021; Russell et al., 2015). Specifically, existing studies indicate that the way in which older adults cope with uncertainties and new events or environments play an important role in predicting their adoption of technology-mediated mobility solutions, with higher coping ability leading in higher likelihood of adoption (Bailey et al., 2011; Peek et al., 2019; Wolf & Seebauer, 2014). Similarly, self-efficacy is highlighted to be equally important given that older adults' belief in their own ability to use technology-mediated mobility solutions competently can affect their adoption of such solutions (Bailey et al., 2011; Haghzare et al., 2021). The same can be said when older adults self-impose limitations to their own capabilities and needs, which can have a similarly strong but opposite effect on their adoption of such solutions (Chung et al., 2017; Russell et al., 2015). However, genuine limitation in health condition (e.g., frailty) does make the adoption of technology-mediated mobility solutions sensible to older adults (Isaacson et al., 2016; Wang et al., 2011). Besides that, having digital literacy or IT skills and less technology anxiety can also foster older adults' adoption of technology-mediated mobility solutions (Haghzare et al., 2021; Peek et al., 2019; Russell et al., 2015; Seaborn et al., 2016). Noteworthily, past scholars have noted the importance of pre- and post-exposure to technology-mediated mobility solutions to influence older adults' acceptance and adoption of such solutions (e.g., ease initial skepticism and lack of interest) (Haghzare et al., 2021). Moreover, older adults who can learn and are supported in their learning would also have a higher chance of adopting and succeeding in using technology-mediated mobility solutions (Seaborn et al., 2016). More importantly, crucial to the success of learning is the open-mindedness of older adults (Park et al., 2019) as well as their adventuring-seeking tendencies (Seaborn et al., 2016) as such characteristics allow technology-mediated mobility solutions to be presented as an opportunity rather than a challenge for their daily living.

Usability elements

The fourth category of antecedents includes *usability elements*. In essence, usability elements relate to the effectiveness, efficiency, and experience of using technology-mediated mobility solutions. This review reveals that the *adjustment* or *compatibility* (Bailey et al., 2011; Oxley et al., 2019; Peek et al., 2016; Rahman et al., 2019), *ease of use* or *effort expectancy* (Leger et al., 2019; Peek et al., 2016; Peek et al., 2019; Russell et al., 2015; Wolf & Seebauer, 2014),

enjoyment (Nikitina et al., 2018, Seaborn et al., 2016; Wolf & Seebauer, 2014), *usefulness* or *performance expectancy* (Govercin et al., 2010; Nikitina et al., 2018; Rahman et al., 2019; Tural et al., 2020; Wang et al., 2011; Wolf & Seebauer, 2014), *reliability* (Oxley et al., 2019), and *safety* (Govercin et al., 2010; Haghzare et al., 2021; Oxley et al., 2019; Rahman et al., 2019; Wang et al., 2011) of a technology-mediated mobility solution can influence older adults' adoption of that solution. Noteworthily, existing studies indicate that older adults are a utility conscious consumer segment, and thus, technology-mediated mobility solutions need to be useful, reliable, and safe (Govercin et al., 2010; Nikitina et al., 2018; Oxley et al., 2019; Rahman et al., 2019; Wang et al., 2011; Wolf & Seebauer, 2014). Moreover, the enjoyment of use should not be neglected due to its positive influence on adoption (Nikitina et al., 2018, Seaborn et al., 2016; Wolf & Seebauer, 2014). More importantly, past scholars highlight that the utility of technology-mediated mobility solutions alone is inadequate for such solutions to be deemed usable and adopted, as the factors that enable the realization of this utility must be considered, which typically depends on the ease of use and adjustment or compatibility of solutions (Bailey et al., 2011; Leger et al., 2019; Oxley et al., 2019; Peek et al., 2016; Peek et al., 2019; Rahman et al., 2019; Russell et al., 2015; Wolf & Seebauer, 2014).

Environmental conditions

The fifth and final category of antecedents is made up of *environmental conditions*. In essence, environmental conditions encapsulate the aspects of the environment where people live and move around, be it within or outside the home environment. This review finds that older adults' adoption of technology-mediated mobility solutions can be affected by aspects of *accessibility* (Leger et al., 2019), *environmental conduciveness* (Haghzare et al., 2021; Park et al., 2019; Peek et al., 2016; Peek et al., 2019; Wolf & Seebauer, 2014), and *facility* (Robertson et al., 2019) in older adults' living and surrounding environment. Specifically, the accessibility of technology-mediated mobility solutions (e.g., electric bicycle stations) and the environmental conduciveness (e.g., bicycle lanes, weather conditions) to use them have been highlighted by past scholars to have a substantial influence on older adults' adoption and usage of such solutions (Haghzare et al., 2021; Leger et al., 2019; Park et al., 2019; Peek et al., 2016; Peek et al., 2019; Wolf & Seebauer, 2014). Similarly, the lack of facility available (e.g., driver, parking lots) could also motivate older adults to consider adopting and using technology-mediated mobility solutions (e.g., electric bicycle, fully automated vehicles) (Leger et al., 2019; Robertson et al., 2019).

Decisions

Decisions encapsulate the behaviors that people perform or do not perform (Lim et al., 2021). In the context of this review, the decision of

focus is older adults' adoption of technology-mediated mobility solution. Upon detailed scrutiny, all articles considered *adoption* in terms of the *use* of technology-mediated mobility solution among older adults, though this use could be *intended* if not yet in use, or *actual* if already in use. Other manifestations of adoption include older adults' *purchase* of (Govercin et al., 2010; Oxley et al., 2019) and *willingness to pay more* (Oxley et al., 2019) for technology-mediated mobility solutions. Table 7 lists down the decisions reflecting older adults' adoption of technology-mediated mobility solutions.

Consequences

Consequences refer to the evaluation of outcomes subsequent to the decisions that people make (Lim et al., 2021), and in the present case, the outcomes of using technology-mediated mobility solutions. Unlike the highly multi-faceted antecedents that were uncovered, this review reveals only a single but highly encompassing category of consequences as a result of older adults' adoption of technology-mediated mobility solutions – namely, *quality of life*. In essence, quality of life is the subjective evaluation of one's life across multiple aspects of living. Specifically, the studies in this review indicated that using technology-mediated mobility solutions can lead to better quality of live when older adults can *connect with the outside world* (Nikitina et al., 2018; Silveira et al., 2013), *experience quality health* (Nikitina et al., 2018; Silveira et al., 2013), *get involved in activities of interest* (Chung et al., 2017; Haghzare et al., 2021; Isaacson et al., 2016; Leger et al., 2019; Rahman et al., 2019), *self-manage and live independently* (Peek et al., 2016), and *socialize with others* (Russell et al., 2015; Seelye et al., 2012). Noteworthily, older adults who experience the benefits of using technology-mediated mobility solutions have expressed their preference for technological over human assistance (Seaborn et al., 2016). Table 8 presents a summary of the consequences of older adults' adoption of technology-mediated mobility solutions.

Where should we be heading?

Despite the quality (mostly Q1), the quantity ($n = 21$) of empirical studies on older adults' adoption of technology-mediated mobility solutions appears to be extremely modest despite more than a decade footprint (2010–2021) across multidisciplinary literature (e.g., gerontology, health informatics, transportation), which is consistent with a recent review on mHealth and healthy aging (2011–2020) (Tajudeen et al., 2022), yet the insights that these studies have contributed are reasonably rich. As discussed in the previous sections and summarized in Figure 4, a good diversity of *theories*, *contexts*, *methods*, and

constructs (*antecedents*, *decisions*, *consequences*) avail for examining and explaining older adults' adoption of technology-mediated mobility solutions. Moving forward, it is important that future studies are designed to meaningfully build and extend prior insights in the field to better promote and support older adults' adoption of technology-mediated mobility solutions. As mentioned in the earlier sections of this article, new research in this space is *important*, *urgent*, *needed*, *valuable*, and *justified*. To assist future research in this endeavor, several noteworthy gaps are identified and the equivalent suggestions to address them are provided.

Directions for theoretical advancement and development

In terms of theory, this review finds that existing studies have utilized a range of theories to explain the aspects of *behavior*, *mobility*, *needs*, and *technology* in relation to older adults' adoption of technology-mediated mobility solutions. However, two noteworthy gaps are apparent. First, about half (10 out of 21) of existing studies in this review are predicated on theory (nine different theories in total) – the rest are not. The use of a theory is valuable as it can provide a strong theoretical foundation to guide research explorations (Paul et al., 2021). In this regard, the scarcity of theories and theory utilization signals the need for future research to search and employ alternative theories in the quest to contribute novel insights to the field. For example, alternative theories across disciplines such as the theory of behavioral control (psychology), which posits that the intention-behavior gap could be explained by covert (internal—e.g., self-efficacy) and overt (external—e.g., availability, accessibility, and affordability) controls that impede behavioral performance despite intention to perform a given behavior (Lim & Weissmann, 2023), and the theory of social influence (sociology), which theorizes the relationships between social connectedness, social distancing, social norms, social identification, social interaction, social inclusion, and social isolation (Lim, 2022), could be adopted to explain the complexities in social influence as well as the low adoption of technology-mediated mobility solutions among older adults. Second, to date, only a single study has employed more than one theory in a single study (i.e., Rahman et al., 2019—AAM, TAM, and TPB). Though employing a single theory could provide a sharper research focus (depth), using a combination of theories could offer a big-picture view of the multifaceted considerations and issues associated to older adults' adoption of technology-mediated mobility solutions (breadth). Given that firms and policymakers have scarce resources, it is important that scientific research equip these stakeholders with comprehensive insights that could help them plan and prioritize investments over time (as some factors may be more significant than others for different segments of older adults). For example, future research could employ the diffusion of innovation theory (i.e., considerations such as

compatibility, complexity, observability, relative advantage, and trialability, and segments such as innovators, early adopters, early majority, late majority, and laggards), motivation theory (i.e., intrinsic versus extrinsic motivation), and the expectation-(dis)confirmation theory (Lim et al., 2021) to examine what motivates and shapes different segments of older adults intention and behavior to adopt technology-mediated mobility solutions, including the speed of their adoption.

Directions for contextual advancement and development

In terms of context, this review reveals that existing studies have explored a range of indoor and outdoor technology-mediated mobility solutions. This dual-context lens is sensible because older adults move within and outside their home environment as part of daily and independent living, and thus, technology-mediated mobility solutions should be developed to cater to the equivalent mobility needs of older adults. However, upon detailed scrutiny, this review observes that the coverage of indoor technology-mediated mobility solutions is about double than its outdoor counterpart, which suggests that future research that expands the breadth of the latter is needed and promising. Moreover, the outdoor technology-mediated mobility solutions that have been investigated thus far have either assumed that older adults remain highly mobile (e.g., electric bicycles) or have strong economic means (e.g., fully automated vehicles). Though the two aforementioned conditions are likely to avail for "young-old" older adults (60–69 years), it may not necessarily be the case over time as older adults transition to "old" (70–79 years) and "oldest-old" (≥80 years) stages in their life. In this regard, technology-mediated mobility solutions, especially those for outdoor use, will need to account for the different biological (e.g., age, frailty) and socioeconomic conditions of older adults. Interestingly, the mobile and platform revolution has spurred indoor (e.g., active lifestyle, virtual gym) but not outdoor technology-mediated mobility solutions in the adoption literature. Future research could therefore explore the feasibility and potential of mobile apps that will help older adults to travel seamlessly, for example, mobile apps that integrate information and purchase of a wide range of public transportation (e.g., bus, taxi, train) as well as options to travel alone, in group, or with a volunteer. More importantly, future research should remain cognizant that not all older adults are equal due to their diverse backgrounds and circumstances, for example, cultural (e.g., language), educational (e.g., high and low literacy), and geographical (e.g., urban, rural) differences, and thus, contextualizing research in a way that demonstrates such awareness and inclusivity. Similarly, as intergenerational shifts occur, it is important

that future research remains cognizant about the characteristics of older adults (e.g., the current generation of older adults are baby boomers who are digital immigrants, whereas the future generation of older adults are millennials or newer who are digital natives) (Lim & Bowman, 2022), implying that future revisits of existing factors and the exploration of new factors that could affect older adults' adoption of technology-mediated mobility solutions are highly encouraged so as to account for potential differences in adoption (or resistance) behavior among older adults across different generations.

Directions for methodological advancement and development

In terms of methods, this review finds a good mix of qualitative and quantitative research designs and data types, which bodes well for the development of both exploratory and confirmative insights on older adults' adoption of technology-mediated mobility solutions. However, causal investigations (pre-/post-) and field studies (actual interaction and use of actual technology) remain a rarity in the field. Engaging in causal investigations is important to ascertain the cause-and-effect of older adults' adoption of technology-mediated mobility solutions, including the effectiveness of strategies to encourage their adoption and mitigate their resistance (e.g., generational representation in observational training materials) (Ma et al., 2020), whereas field studies with the actual technology-mediated mobility solution is important to gain insights into actual realities and overcome the intention-behavior gap typically associated to studies in controlled or laboratory environments (Lee et al., 2020; Lim & Weissmann, 2023). While causal investigations and field studies are often avoided due to the higher costs associated as compared to non-causal and laboratory research, this does not necessarily have to be the case with advancement of innovative research designs such as cohort partnership (Witte & James, 1998), group dissertations (Browne-Ferrigno & Jensen, 2012), and data partitioning (Lim et al., 2019), among others. Besides that, longitudinal studies are also highly valuable as they enable the detection of potential changes in older adults' adoption and continuance of using technology-mediated mobility solutions. To this end, future research is highly encouraged to explore these methodological options, and the equivalent techniques for doing so (e.g., conditional approach; Lim, 2015, 2021), to contribute new and rigorous insights to the field.

Directions for construct advancement and development

In terms of constructs, this review reveals five categories of antecedents (i.e., ethical considerations, social influences, personal factors, usability

elements, environmental conditions) and one category each for decisions (i.e., adoption) and consequences (i.e., quality of life) of older adults' adoption of technology-mediated mobility solutions. Therefore, the field is at a state where there is breadth in antecedents, but not in decisions and consequences. In this regard, future research is encouraged to explore new ways in which older adults can express their adoption of technology-mediated mobility solutions (e.g., recommendation), as well as the corresponding outcomes (e.g., aspirational values) that older adults experience and expect as a result of adopting such solutions. Nonetheless, it unlikely that the categories of decisions and consequences will outweigh those of antecedents, and thus, the goal is to curate additional manifestations of decisions and consequences without making quantifiable comparisons with the antecedents. Similarly, future research should not neglect making new inroads to deepen the depth of each category of antecedent, decision, and consequence revealed through this review. For example, future research could expand the list of constructs under personal factors by exploring older adults' biological conditions (e.g., height, weight), personal preferences (e.g., color, design), and learning styles (e.g., auditory, visual, read/write, kinesthetic), as well as the manifestations of quality of life specific to older adults and seamless aging. Such insights could be discovered through qualitative explorations (e.g., interviews) or extrapolated from systematic reviews of other domains (e.g., technology acceptance among digital immigrants). Scale adaptation and development to contextualize these constructs for older adults and technology-mediated mobility solutions should also be potentially useful for precise and relevant measurement of older adults' perception and behavior toward technology-mediated mobility solutions.

Conclusion

This article has delineated the progress of research on older adults' adoption of technology-mediated mobility solutions (RQ1), as well as the antecedents and consequences of adopting technology-mediated mobility solutions among older adults (RQ2), and the directions for new research that would advance and stimulate the field based on the insights derived from the present review (RQ3). Noteworthily, this review has made an original contribution by offering a comprehensive and seminal encapsulation of the antecedents (i.e., ethical considerations, social influences, personal factors, usability elements, and environmental conditions) and consequences (i.e., quality of life) of older adults' adoption of technology-mediated mobility solutions (RQ2). In this regard, companies operating in technological development and policymakers concerned about the wellbeing of older adults can leverage on these antecedents, which have been summarized in Figure 4 and the Appendix, to promote the adoption of technology-mediated mobility solutions and enhance the quality of life of the

aging population. Nonetheless, this review has also (i) revealed that older adults' adoption of technology-mediated mobility solutions varies and remains understudied (RQ1), and (ii) provided equivalent suggestions to overcome these issues through theoretical, contextual, methodological, and construct advancement and development (RQ3). Future research is therefore encouraged to use the seminal insights from this review to develop new research and position the novelty of their contributions against the extant knowledge in the field.

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Data availability statement

A data availability statement is not applicable because this study is based exclusively on published literature.

Statement of ethics

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Appendix. Study characteristics

Study	Scope	Sample(s)	Method(s)	Findings(s)
Haghzare et al. (2021)	Exposure to automated vehicle technology (pre-post exposure), driving style (manual versus automatic type), driving circumstances (clear, rain, traffic ally), and age are used to examine the acceptability of fully autonomous vehicles by older individuals.	36 healthy older adults aged 65 to 90 years.	Quantitative	Age and driving style influence the acceptance of fully automated vehicles by older adults.
Tural et al. (2020)	Older adults' attitudes toward and intentions to use stair assistive mobility devices.	Quantitative: 56 participants aged 50 years and above. Qualitative: 15 older adults (three participants aged between 65 and 74 years, 11 participants aged between 74 to 84 years, and one participant aged 85 years and above).	Mixed	Survey findings showed that perceived usefulness consistently predicts older adults' attitudes toward three examined stair mobility products and their intentions to use them in their homes. Most survey participants held positive attitudes toward stair assistive products, but intentions to use them in their own homes were low. Interviews show ongoing stigma against disability and the value of aesthetics regarding home modifications.
Oxley et al. (2019)	Use of safer automobiles among older adults.	501 active drivers aged 65 to 92 years.	Quantitative	The driver's safety features were less known, especially among oldest-old drivers. Only 1/4 of drivers were open to additional security characteristics, and they had no interest to pay more for driverless vehicles.

(*Continued*)

Study	Scope	Sample(s)	Method(s)	Findings(s)
Robertson et al. (2019)	Older drivers' knowledge, attitudes, and perceptions toward limited self-driving vehicles (LSDVs).	Quantitative: 2,662 participants aged 16 to 93 years. Qualitative: 38 older adults consisting of 20 females and 18 males who are licensed drivers over the age of 65, with a mean age of 73 years.	Mixed	Survey findings indicated a favorable relationship between security sentiments and knowledge of LSDVs with perceived ease of use and technology adoption. Focus groups showed that the safety and expertise of LSDVs are essential to the likelihood of adopting this technology and revealed a high receptivity among older drivers to educational strategies and tools to increase their understanding of LSDVs.
Peek et al. (2019)	Changes and stability in using technologies by independent-living seniors.	33 community-dwelling older adults.	Qualitative	A core of six interrelated factors was closely linked to the frequency of technology use: emotional attachment, need compatibility, cues to use, proficiency to use, the input of resources, and support. Disruptive forces (e.g., social influences, competition with alternative means, changes of personal needs) induce change by affecting these six factors. Long-term technology use was in some cases more resilient to disruption than in other cases.
Park et al. (2019)	Critical demands of community-dwelling older adults regarding living robotics (Connected Active Space Technology) to support daily living.	Quantitative: 234 older adults aged 65 years and above. Qualitative: 23 older adults aged 65 years and above.	Mixed	Strong outlook for robotic services to support daily live performance. Priority was given to fast response to emergencies, early detection of emergencies, aid to find items, mobility support, and help in memory recall. The most wanted feature of a robot service was the attribute of being a friend or assistant.

(*Continued*)

Study	Scope	Sample(s)	Method(s)	Findings(s)
Rahman et al. (2019)	Older adults' perception of self-driving vehicles from the perspective of users and pedestrians.	173 older adults aged 60 and above.	Quantitative	Older adults perceive self-driving vehicles positively alongside perceived usefulness, trust, social norm, and acceptance as users. However, their perception was neutral or negative as pedestrians, except for perceived usefulness.
Leger et al. (2019)	Potential for e-bikes to support independent mobility and active aging among older adults.	17 community stakeholders and 37 older adults.	Qualitative	Constraints included road safety, safety, and cycling infrastructure, legislation, and hurdles to stigmatization.
Nikitina et al. (2018)	Technology usage and adherence to training, as well as the effects of technology-supported intervention.	44 older adults aged 59 to 83 years.	Quantitative	The study established the feasibility and effectiveness of technology-supported physical interventions, particularly online group exercise, among older adults. Results in terms of subjective well-being are promising but enabling interaction has proved inadequate to observe a decrease in loneliness.
Chung et al. (2017)	Feasibility of a home-based sensor system designed to assess mobility and daily activity patterns among older adults and sensor technology acceptance.	Six older adults aged 65 years and above.	Mixed	Sensor data had natural fluctuation over time, and different 24-hour patterns were observed across homes. The GLM model estimates showed that effect sizes of the time variables vary across individuals. Overall, sensors were acceptable for all participants, despite some privacy concerns.
Seaborn et al. (2016)	Mixed reality gaming platform that explores the impact of technology and interaction paradigms on older powered chair users' well-being.	11 older adults aged 55 and above.	Mixed	Powered chair users' community-dwelling older adults are a technology progressive population. They welcomed synchronizing assistive and un-assistive technology to promote social enjoyment, advanced training, and the promotion of comprehension and empathy in others.

(*Continued*)

Study	Scope	Sample(s)	Method(s)	Findings(s)
Peek et al. (2016)	Factors influencing the use of various types of aging-in-place technology by older adults.	53 older adults aged 68 to 95 years.	Qualitative	Six factors affect the degree of technology usage in the context of aging: difficulties in the area of self-employment; behavioral alternatives; unique ideas about the use of technologies; the effect of social network; the influence of organizations; and the function of the physical environment.
Isaacson et al. (2016)	GPS for mobility compliance monitoring.	89 older adults aged 63 to 92 years.	Quantitative	Healthy older men and women with cognitive impairment have typically been found to conform better to GPS mobility monitoring.
Russell et al. (2015)	Older adults' intention to adopt telehealth.	306 participants aged 50 to 68 years.	Quantitative	Telehealth trust, technology acceptance, health habits, and traditional healthcare discontent motivate telehealth adoption intention.
Wolf and Seebauer (2014)	Characteristics of early adopters of e-bikes, how they reshape their mobility patterns due to the adopted technology, and what motivations or product attributes drive their behavioral change.	1,398 older adults aged 60 years and above who own e-bikes.	Quantitative	Early adopters predominantly comprised of older adults who mainly use e-bikes for leisure trips.
Marschollek et al. (2014)	Acceptance of home health monitoring using a set of ambient and wearable sensors among older adults with functional deficits.	14 older adults aged 71 to 90 years.	Mixed	Older adults showed strong acceptance of technology, especially ambient components of home health monitoring devices.
Silveira et al. (2013)	IT-mediated motivation strategies adherence to physical exercise training plans in older adults and the impact of Active Lifestyle app on physical activity behavior change and health outcome.	44 older adults aged 65 years and above.	Quantitative	App demonstrated its ability to help and inspire independent living and healthy older adults to engage in strength – balance workouts.
Seelye et al. (2012)	Feasibility of using and accepting a remotely controlled robot with video-communication capability in independently living, cognitively intact older adults.	Eight older adults aged 64 to 92 years.	Quantitative	Older adults responded positively to a remote-controlled robot with video-communication capabilities.

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Study	Scope	Sample(s)	Method(s)	Findings(s)
Wang et al. (2011)	Anti-collision power wheelchair's ability to enable safe, independent mobility in nursing home residents with dementia.	Six older adults aged 82 to 91 years.	Mixed	Power wheelchairs improve the mobility and well-being of nursing home residents with complex physical and cognitive impairments.
Bailey et al. (2011)	Ethical implications of new care and support technologies, such as how well they fit with everyday challenges and needs without reducing an older adult to just a faller or someone with a fear of falls.	Eight older adults aged 70 to 87 years.	Qualitative	Acceptance among some older adults, while others struggle to get through the day and live comfortably.
Govercin et al. (2010)	Ergonomic and functional requirements for assistive devices and user-centered development process.	22 older adults aged 50 years and above.	Qualitative	Fall prediction system considered to be as important as a fall detection system. Although the ambient, unobtrusive character of the optical sensor system was appreciated, wearable inertial sensors were preferred because of their wide range of use, which provides higher levels of security. Security and mobility were two significant reasons people at risk of falling buy a wearable and optical fall prediction and fall detection device.