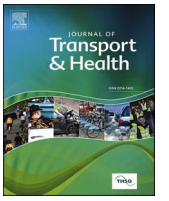
Journal of Transport & Health 42 (2025) 102015

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth



Influence of mobility and technological factors of mobility on the quality of life of older adults: An empirical study focused on mobility as a mediator

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ARTICLE INFO

Keywords:
Mobility factors
Technology
Health
Financial security
Quality of life
Older adults
Mediation analysis

ABSTRACT

Background: Quality of life in older adults is becoming increasingly recognized, however, there is a paucity of research on the association between subjective perceptions of mobility and health in this age group.
Objective: This study aimed (i) to explore the basis of mobility factors in older adults and their relationship with quality of life; (ii) to examine the effects of older adults' perceived levels of health, financial security, and mobility on their quality of life; (iii) to elucidate whether the influence of mobility factors on the perceived quality of life in older adults is mediated by perceived mobility.
Methods: A questionnaire survey was conducted among older adults living in the Czech Republic in January 2023. Older adults were interviewed by computer-assisted telephone interviewing and computer-assisted web interviewing. Quota sampling was used to obtain a sample size of 559 respondents.
Results: Age, car availability, smart device use, and perceived health were identified as statistically significant factors influencing older adults' mobility. Smart device use, internet use, perceived health, perceived financial security, and perceived mobility were found to be significant factors influencing quality of life. Mobility in nearby areas outside the home (zone 2) played a pivotal role in older adults' perceived quality of life, with perceived mobility acting as a mediating factor.
Conclusion: These findings emphasise the need to address mobility-related issues, such as the impact of emerging technologies, assessing the effectiveness of government programs, and the role of healthcare interventions in enhancing the well-being of older adults.

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https://doi.org/10.1016/j.jth.2025.102015
Received 7 October 2024; Received in revised form 11 January 2025; Accepted 26 February 2025
Available online 9 March 2025

1. Introduction

Promoting healthy aging and improving the quality of life in older adults are essential goals for societies worldwide (*WHO's work on the UN Decade of Healthy Ageing (2021–2030)*, 2023a). Understanding the factors that influence older people's mobility and relationship of mobility with their quality of life is crucial to achieving these objectives.

As they grow older, many adults prefer to stay in their residences, a concept known as 'ageing in place' (Sánchez-González and Rodríguez-Rodríguez, 2016; Pedersen et al., 2024). This preference is often due to established social networks and a sense of belonging within their communities (Jørgensen et al., 2016; Menconi et al., 2018). Another age-related factor is the gradual shrinkage of their radius of movement owing to physical limitations and cognitive impairment. Consequently, the neighbouring environment becomes their primary outdoor environment (Zhang et al., 2020; Rispoli, 2008; Akhavan and Vecchio, 2018; Cao et al., 2010). The relationship between individuals and their living environments is a complex and continuous process, and understanding this interaction is crucial for improving the quality of life of older adults (Zhang et al., 2020).

Like many other developed regions of the world, Europe is experiencing a significant demographic shift, with its population aged >65 years expected to more than double by 2036 (Eurostat, 2023, *Population projections in the EU*). Recognising this trend, there is a need to investigate the mobility patterns of older adults and their connection to their quality of life.

Several studies have found links between different modes of mobility and quality of life in older adults (Oxley and Whelan, 2008; Ravulaparthy et al., 2013; Van Hoven and Meijering, 2019; Webber et al., 2010). One approach focuses on declining physical performance in older adults (Baydan et al., 2020; Da Silva Costa et al., 2020; Kahiel et al., 2021), which prevents them from navigating their environment and fulfilling their activities of daily living (ADL). Another way is to examine older adults' paths outside their own homes, considering potential infrastructural difficulties, accessibility, or barriers to transport systems, and their potential implications for older adults' well-being, autonomy, and self-sufficiency (Oxley and Whelan, 2008; Gharaveis, 2020; Alves et al., 2020).

To date, few studies have explored the association between subjective perceptions of mobility and health (Euteneuer et al., 2021; Gugushvili, 2021; Präg and Gugushvili, 2020). Active Assisted Living (AAL) is an approach aimed at supporting older adults to age in place while enhancing their quality of life. AAL (McLean, 2011; Van Der Vorst et al., 2016; Zeitler et al., 2012) seamlessly incorporates technological devices and systems into the homes and everyday lives of older adults, to assist them with mobility and improvement in health, inclusion, and daily activities. However, to successfully implement emerging technologies and support older adults, it is important to consider their perceived aging experiences and quality of life.

Although the domain of mobility has been actively addressed, certain topics are yet to be explored. Gorman et al. (2019) provided an initial assessment of the state of knowledge regarding the ways in which older people's mobility is affected by issues such as health, well-being, social (dis)engagement, and gender. They found a major gap in research on mobility patterns across generations, with little attention paid to relational mobilities, despite the clear importance of intergenerational connections, notably (but not exclusively) related to caregiving. Additionally, older adults' mobility and the role of transportation in relation to transportation affordability, economic needs, subsidy issues, and income categories need to be addressed. Venter (2011) showed that while the potential value of virtual connectivity (for example, through mobile phones) to replace or complement physical forms of mobility has been examined, both the benefits and costs of virtual connectivity remain to be researched further (Porter et al., 2018).

This empirical study aims to explore the multifaceted relationship between mobility and quality of life in older adults in the Czech Republic. Specifically, it aims to investigate how various factors, including technological factors, influence this relationship and to emphasise the mediating role of mobility in enhancing the overall quality of life in older adults.

2. Research design

2.1. Research goal and hypotheses

The first goal was to evaluate the impact of selected demographic, social, lifestyle, and technological factors on the perceived mobility of older adults and, together with economic aspects, on the quality of life in older adults, as shown in Fig. 1.

Seventeen research hypotheses were established in the context of the diagram in Fig. 1. The first five hypotheses relate to mobility as the dependent variable.

H1. Demographic factors have an effect on the perceived mobility of older adults.

H2. Social factors have an effect on the perceived mobility of older adults.

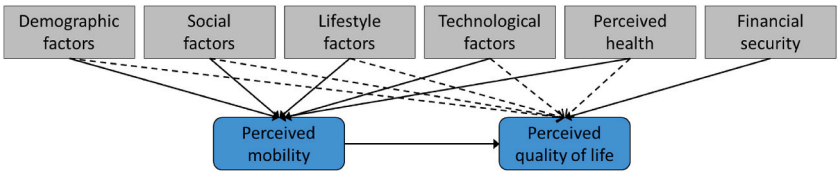

Fig. 1. Basic diagram of envisaged relationships considered for perceived mobility and quality of life in older adults (the dashed arrow indicates that mediation through perceived mobility was also considered here).

H3. Lifestyle factors have an effect on the perceived mobility of older adults.

H4. Technological factors have an effect on the perceived mobility of older adults.

H5. Perceived health has an effect on the perceived mobility of older adults.

Another seven research hypotheses focus on the quality of life as a dependent variable.

H6. Demographic factors influence the perceived quality of life in older adults.

H7. Social factors influence the perceived quality of life in older adults.

H8. Lifestyle factors influence the perceived quality of life in older adults.

H9. Technological factors influence the perceived quality of life in older adults.

H10. Perceived health affects the perceived quality of life in older adults.

H11. Perceived mobility affects the perceived quality of life in older adults.

H12. Financial security affects the quality of life in older adults.

The second goal was to assess whether the influence of these factors on the perceived quality of life in older adults was mediated by their perceived mobility. This research goal was further expounded into five hypotheses.

H13. Perceived mobility mediates the relationship between demographic factors and perceived quality of life in older adults.

H14. Perceived mobility mediates the relationship between social factors and perceived quality of life in older adults.

H15. Perceived mobility mediates the relationship between lifestyle factors and perceived quality of life in older adults.

H16. Perceived mobility mediates the relationship between technological factors and the perceived quality of life in older adults.

H17. Perceived mobility mediates the relationship between perceived health and quality of life in older adults.

A quantitative approach in the form of a questionnaire survey was chosen to investigate the envisaged relationships displayed in Fig. 1 and to verify hypotheses H1 to H17.

2.2. Data collection

Data were obtained using a questionnaire survey, administered to older adults (≥65 years of age) living in the Czech Republic in January 2023. The study was approved by the Ethical Committee for Science of the University of Hradec Kralove on November 14, 2022, as No. 14/2022. At the beginning of the questionnaire, respondents were informed about the purpose of the research study and voluntary participation. They started filling out the questionnaire only after agreeing to participate in the research.

A pilot study involving 31 older adults preceded the main questionnaire survey. Considering the target population of older adults, two addressing techniques were chosen. They were interviewed by the research agency STEM/MARK via computer-assisted telephonic interviewing (CATI) and computer-assisted web interviewing (CAWI, i.e., online surveys). Quota sampling was used to obtain a research sample of respondents. Quotas were established based on the proportional representation of sex, age categories, educational

Table 1
Overview of various factors analysed in the study (except smart device use).

Factor	n	%	% in Pop.	Factor	n	%	% in Pop.
Sex				**Residence**			
Male	246	44.1	42.1	0–1999	151	27.1	26.5
Female	312	55.9	57.9	2000–9999	115	20.6	21.7
Age				10,000–49,999	126	22.6	22.7
65–69	177	31.7	29.6	50,000–199,999	72	12.9	11.7
70–74	165	29.6	27.8	2 00,000 and more	94	16.8	17.5
75–79	108	19.4	21.6	**Car**			
80–84	69	12.4	12.1	Not an option	71	12.7	
85 and more	39	7.0	9.0	Taxi	25	4.5	
Education				Relatives	172	30.8	
Primary	87	15.6	16.6	I drive	290	52.0	
Apprenticeship	236	42.3	39.5	**Internet**			
Secondary (with diploma)	158	28.3	30.7	Not at all	81	14.5	48.0
Tertiary	77	13.8	13.2	Little	46	8.2	17.0
Status				Daily	431	77.2	35.0
Living alone	208	37.3	31.9				
Living with somebody	350	62.7	68.1				

Note. Data are expressed as numbers (n) and percentages (%). Population data (% in Pop.) were obtained from the Czech Statistical Office website (CZSO, 2021, 2022a,b, 2023).

structure, size of place, and region of residence in the population of older adults 65+. As of December 31, 2022, there were 2.2 million older adults aged 65+ living in the Czech Republic (CZSO, 2023).

A sample of 559 respondents (CATI: 200; CAWI: 359) was obtained by addressing 2299 older adults (CATI: 1640; CAWI: 659), representing approximately 0.1% of the Czech senior population 65+. The response rate for completed questionnaires was 24.3%. However, 1166 (50.7%) of the selected respondents could not be reached (CATI: 971, CAWI: 195) and additional 166 (7.2%) individuals were excluded by the research agency due to quota requirements. In both cases, the non-response was unrelated to the content of the questionnaire. The remaining 408 (17.7%) people contacted refused to participate in the study. Additionally, only one participant resided in a residential facility for older adults. As a result, responses from this questionnaire were excluded from further analyses. Consequently, the study focuses on older adults (n = 558) living in private dwellings, as members of independent households or large families.

2.3. Selection of factors

In this study, four types of factors were identified. 'Demographic' factors included sex and age. 'Social status' included the level of education and living status (living alone or with someone). 'Lifestyle' factors were characterised using the size of their place of residence and car availability. The use of Internet and smart devices were selected as 'technological factors'. Table 1 summarises the aforementioned factor variables, except for the use of smart devices, which were measured using scaled items. Table 1 also presents data on the representation of individual characteristics in the population (% in Pop.) of older adults 65+ if such data were obtained.

2.4. Variable measurement

The Smart device use variable characterised the use of various mobile applications or smart watches for various purposes such as 1) communication with loved ones or friends; sending photos; making video calls; 2) learning new things; searching for information or for entertainment purposes; 3) counting steps or distance during movement and walking; 4) orientation (navigation) or route planning outdoors; 5) measurement of vital functions; and 6) use of 'at hand-held' devices that can help in case crisis situations. This variable was therefore measured using six items (corresponding to the previous list) on a five-point scale (0 = never; 1 = rarely/exceptionally; 2 = sometimes; 3 = often; and 4 = very often). The internal consistency of the items was checked by Cronbach's alpha, which in our case was 0.81. The smart device usage variable was then calculated as the average score of the given items.

Satisfaction with health and financial security was measured using an ordinal scale (0 = dissatisfied; 1 = rather dissatisfied; 2 = neutral; 3 = rather satisfied; and 4 = satisfied). Perceived mobility was assessed through a living-space assessment (LSA), ranging from 0 to 120 points (Peel et al., 2005). The evaluation refers to the activities of the last four weeks. The mobility areas are divided into five living-space zones as follows: 1 = apartment/house outside the bedroom; 2 = nearby areas outside the apartment/house; 3 = neighbourhood/surroundings of the apartment/house; 4 = city/village where the older adult lives; and 5 = outside the city/village where the older adult lives. The overall point score considers the living zones categorized in terms of frequency per week (1 = less than once; 2 = once to three times; 3 = four to six times; 4 = daily) and independence of mobility in the individual zones (1 = with personal assistance; 1.5 = using equipment only; 2 = without help). The Brief Older People Quality of Life (OPQOL-brief) questionnaire (Bowling et al., 2013) was used to measure older adults' perceived quality of life. The OPQOL-brief questionnaire has 13 five-point items and it is also validated in the Czech version (Bužgová et al., 2022). The total score ranges from 13 to 65 points, with a higher score indicating a higher quality of life. Table 2 presents the descriptive statistics for the aforementioned variables, including the variables for the use of smart devices.

2.5. Statistical analysis and software

The relationships described by the two regression models were verified through Structural Equation Modelling (SEM) using the R package lavaan (Rosseel, 2012). Categorical exogenous variables (sex, age, education, status, residence, car, and Internet) were entered into the model in the form of dummy (0–1) variables, where the reference categories were always the first categories listed in Table 1. Mediation analysis for the categorical independent variables was performed using relative indirect effects (Hayes and Preacher, 2014).

Table 2
Overview of descriptive statistics of the participants.

Age Range (in years)		65–69		70–74		75–79		80–84		85+		Total	
Variable	Range	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Smart Device Use	0–4	1.4	1.0	1.3	1.1	1.1	1.0	1.1	1.0	0.9	0.9	1.3	1.0
Perceived Health	0–4	2.4	1.1	2.2	1.1	2.1	1.2	2.3	1.1	1.8	1.3	2.3	1.1
Financial Security	0–4	2.5	1.2	2.5	1.1	2.5	1.2	2.6	1.1	2.8	1.1	2.5	1.1
Mobility	0–80	73.3	30.7	66.5	31.8	60.3	31.8	51.3	30.5	51.4	34.5	64.5	32.4
Quality of Life	13–65	56.3	7.9	55.3	7.8	54.0	9.0	53.9	8.6	51.2	11.1	54.9	8.5

Note. *Data are expressed as means (M) and standard deviations (SD).*

3. Results

3.1. Main results based on the model

Based on our data, the model corresponding to the diagram in Fig. 1 had acceptable characteristics (χ^2 test: $p = 0.28$, comparative fit index [CFI] = 1.00, Tucker-Lewis index [TLI] = 0.98, root mean square error of approximation [RMSEA] = 0.02, standardised root mean square residual [SRMR] < 0.01). Table 3 presents the results of our model with two dependent (endogenous) variables (DVs): mobility (DV1) and quality of life (DV2). The estimates of the effects of the explanatory variables are presented in both unstandardised and standardised versions.

Table 4 focuses on evaluating the statistical significance of the original mobility factors. For the categorical variables (Table 1), sub-models with zero regression parameters for the corresponding dummy variables were tested. **The statistically significant factors of older adults' mobility include age (as a demographic factor), availability of a car (as a lifestyle factor), use of smart devices (as a technological factor), and perceived health.** According to the effect estimates (Table 3), perceived mobility was the lowest for the fourth age category (i.e., 80–84 years), which is the second oldest age group. Older adults that drove a car had greatly increased mobility. The use of smart technologies and perceived health positively affected the mobility of older adults. Note that although the *p*-values in Table 3 (left panel) were <0.05 for all dummy variables Residence2 to Residence5, we do not reject the null effect of the categorical variable 'Residence' on 'perceived mobility' ($p = 0.075$) (Table 4). This was because the *p*-values in Table 3 were not adjusted for multiple comparisons.

Based on the analysis (Tables 3 and 4), **technological factors (the use of the Internet and smart devices), perceived health, financial security, and perceived mobility were significant predictors for the quality of life in older adults**. It is worth noting that Internet use had a negative effect on the quality of life in older adults, whereas using smart devices had a positive effect (Table 3, right panel). Focusing on the other three significant predictors according to the standardised effects (Std. β), the major positive influence was generated by perceived health, followed by perceived financial security. Perceived mobility ranked third, in that order. Furthermore, the results suggest that the perceived mobility of older adults and their perceived quality of life do not significantly depend on sex, residence and social factors (education and status). The significant relationships are shown in Fig. 2.

Mediation analysis was subsequently performed for statistically significant mobility factors (Table 5). The results of the mediation analysis demonstrated significant indirect effects for the use of smart devices (unstandardised: 0.26, standardised: 0.03) and perceived health (unstandardised: 0.41, standardised: 0.06), confirming the mediating role of perceived mobility.

Table 5 presents the relative indirect effects of dummy variables representing age and car availability. Compared to the youngest age group (65–69 years), the largest absolute value of the relative indirect effect was for the fourth age category (80–84 years) owing to the largest absolute difference in the effect on perceived mobility. Perceived mobility was 19.6 points lower for older adults aged

Table 3
SEM results for our model with inclusion of categorical variables using dummy variables.

Model	DV1: Mobility ($R^2 = 0.254$)				DV2: Quality of Life ($R^2 = 0.405$)			
Variable	Effect	Std. β	SE	*p*-value	Effect	Std. β	SE	*p*-value
Sex	−4.14	−0.06	2.96	0.161	0.70	0.04	0.70	0.316
Age2	−6.29	−0.09	3.08	0.041	−0.26	−0.01	0.73	0.718
Age3	−8.94	−0.11	3.52	0.011	−0.58	−0.03	0.83	0.488
Age4	−19.61	−0.20	4.22	<0.001	−1.76	−0.07	1.01	0.083
Age5	−15.95	−0.13	5.24	0.002	−3.23	−0.10	1.25	0.010
Edu2	0.93	0.01	3.75	0.804	−0.07	−0.00	0.88	0.941
Edu3	7.33	0.10	4.01	0.068	1.60	0.08	0.95	0.093
Edu4	3.59	0.04	4.80	0.454	0.12	0.00	1.14	0.917
Status	3.06	0.05	2.70	0.256	−0.88	−0.05	0.64	0.166
Residence2	−7.49	−0.09	3.52	0.033	0.61	0.03	0.83	0.466
Residence3	−7.01	−0.09	3.49	0.044	0.31	0.02	0.82	0.705
Residence4	−8.58	−0.09	4.12	0.037	0.31	0.01	0.97	0.753
Residence5	−9.27	−0.11	3.86	0.016	−0.16	−0.01	0.91	0.863
Car2	0.25	0.00	6.63	0.970	0.57	0.01	1.56	0.716
Car3	6.51	0.09	4.14	0.116	2.02	0.11	0.98	0.039
Car4	13.07	0.20	4.19	0.002	2.00	0.12	1.00	0.045
Internet2	−2.41	−0.02	5.42	0.657	−4.01	−0.13	1.29	0.002
Internet3	−0.76	−0.01	3.95	0.847	−3.94	−0.19	0.94	<0.001
Smart Device Use	4.98	0.15	1.34	<0.001	0.85	0.10	0.32	0.008
Perceived Health	7.91	0.28	1.08	<0.001	2.28	0.31	0.28	<0.001
Financial Security					1.83	0.24	0.27	<0.001
Mobility					0.05	0.20	0.01	<0.001

Note. Abbreviation Std. β stands for standardised β-coefficient, and SE stands for standard error. With respect to the chosen reference categories, the rows for the dummy variables mean for Sex: Female vs. Male; Age2: 70–74 vs. 65–69 years; Age3: 75–79 vs. 65–69 years; Age4: 80–84 vs. 65–69 years; Age5: ≥85 vs. 65–69 years; Edu2: Apprenticeship vs. Primary; Edu3: Secondary vs. Primary; Edu4: Tertiary vs. Primary; Status: Living with somebody vs. Living alone; Residence2: 2000–9999 vs. 0–1999 inhabitants; Residence3: 10,000–49,999 vs. 0–1999 inhabitants; Residence4: 50,000–199,999 vs. 0–1999 inhabitants; Residence5: 200,000 and more vs. 0–1999 inhabitants; Car2: taxi vs. not an option; Car3: relatives vs. not an option; Car4: I drive vs. not an option; Internet2: little vs. not at all; Internet3: daily vs. not at all.

Table 4
Testing sub-models (zero-effect testing for mobility factors) within SEM analysis.

Predictor	Mobility	Life Quality	Both
	p-value	*p*-value	*p*-value
Sex	0.162	0.316	0.227
Age	<0.001	0.078	<0.001
Education	0.158	0.115	0.084
Status	0.257	0.167	0.202
Residence	0.075	0.931	0.312
Car	0.008	0.152	0.008
Internet Use	0.903	<0.001	0.001
Smart Device Use	<0.001	0.008	<0.001
Perceived Health	<0.001	<0.001	<0.001

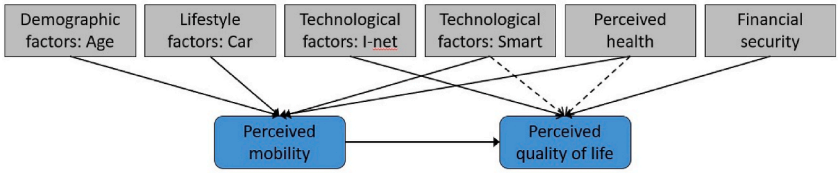

Fig. 2. The significant relationships found.

Table 5
(Relative) indirect effects of age, availability of car, smart device use, and perceived health on quality of life through perceived mobility using SEM analysis.

Variable	Group Difference	Effect	Std. β	SE	p-value
Age2	*70–74 vs. 65–69 years*	−0.33	−0.02	0.17	0.057
Age3	*75–79 vs. 65–69 years*	−0.47	−0.02	0.20	0.022
Age4	*80–84 vs. 65–69 years*	−1.02	−0.04	0.29	0.001
Age5	*≥85 vs. 65–69 years*	−0.83	−0.02	0.32	0.009
Car2	*taxi vs. not an option*	0.01	0.00	0.35	0.970
Car3	*relatives vs. not an option*	0.34	0.02	0.23	0.132
Car4	*I drive vs. not an option*	0.68	0.04	0.25	0.007
Smart	–	0.26	0.03	0.09	0.002
Health	–	0.41	0.06	0.10	<0.001

Note: Abbreviation Std. β stands for standardised β-coefficient, and SE stands for standard error.

84–89 years compared to the 65–69 year age group (Table 3); therefore, the indirect effect on quality of life through mobility was 1.02 points lower. In the case of car availability, a significant relative indirect effect of 0.68 was found for older adults who drive a car versus those who have no opportunity to travel by car (Table 5). Table 6 summarises the results with respect to the established hypotheses.

3.2. Complementary results for mobility

A more detailed analysis of mobility with respect to the living-space zones was conducted. The responses showed that 10 (1.8%) respondents did not leave the bedroom and therefore did not move in Zones 1 to 5. Another 16 respondents moved only to Zone 1,

Table 6
Evaluation of established hypotheses.

Factor	Effect on Mobility		Effect on Quality of Life		Mobility as a mediator	
	Hypothesis	Supported	Hypothesis	Supported	Hypothesis	Supported
Demographic	H1	1/2	H6	0/2	H13	1*/2
Social	H2	0/2	H7	0/2	H14	0/2
Lifestyle	H3	1/2	H8	0/2	H15	1*/2
Technological	H4	1/2	H9	2/2	H16	1/2
Health	H5	1/1	H10	1/1	H17	1/1
Mobility			H11	1/1		
Financial			H12	1/1		

Note. * The mediation (indirect) effect through mobility is significantly different from the reference category for at least one factor group.

while 373 respondents (66.8%) moved to Zone 5. A total of 323 respondents moved to Zone 5 without help, and 43 respondents moved with aid. For more information on respondents' mobility limits (maximal zones), see Table 7.

For further analysis, mobility was represented by five partial variables Mob(1), …, Mob(5), characterizing the level of mobility in individual zones, with values ranging from 0 to 8, taking into account both the independence of movement (with values of 1, 1.5, and 2) and its frequency (0–4, with 0 indicating no movement in the given zone). The partial variables Mob(i), i = 0, 1, .., 5, were determined as the product of the values for independence and frequency in Zone i. The total mobility variable is then the weighted sum of the partial variables Mob(1) to Mob(5), with weights indicating the respective zones, i.e., $Mobility = \sum_{i=1}^{5} i\,Mob(i)$. Table 8 characterizes the mobility partial variables with regard to age categories. As expected, mobility in the last age category shifted to the closest zones (first two) compared with that in the youngest age category.

The dependence of quality of life on mobility partial variables and all other considered predictors (see Table 3, first column) was tested using multiple regression. The results for only the mobility partial variables are listed in Table 9. The results demonstrate that quality of life is significantly related to mobility in Zone 2 (i.e., nearby areas outside the apartment/house).

4. Discussion

Knowledge of the relationship between the factors of mobility (including technological factors) in older adults and their quality of life is pivotal for propelling the research and development of innovative solutions that enhance the mobility and quality of life in older adults. Present study was undertaken to augment our knowledge in this specific area. Our results showed that age (as a demographic factor), availability of a car (as a lifestyle component), use of smart devices (as a technology element), and perceived health were factors that significantly affected the mobility of older adults. The use of smart devices and Internet, as well as perceptions of one's health, financial security, and mobility, were all key determinants of older adults' quality of life. It is noteworthy that while utilising smart devices had a positive impact, accessing the Internet had a negative impact on their quality of life.

Present results are in line with those of other studies that partially focused on similar research goals. Johnson et al. (2020) found that the main factors influencing mobility were age, sex, education, health issues, physical capabilities, and activities. Similarly, our findings confirmed the main roles of age, health issues, and physical capabilities. Tanjani et al. (2015) showed that the social factors that may place older adults with mobility limitations at a higher risk of developing disabilities include precarious financial situations or lack of housing. Among the most discussed factors, age and health perceptions were also considered. The influence of age groups on mobility and life satisfaction among older adults was confirmed by Lättman et al. (2019) and Du et al. (2020) among others. Alsnih and Hensher (2003) argued that reduction in mobility becomes more evident as people reach 80 years of age, while Ramezani et al. (2021) recommended a threshold of 75 years when activities start to decline, which is often related to individual health limitations. The results of our study support Alsnih and Hensher' (2003) findings, as older adults aged 80–84 perceived their mobility the worst. Mobility has been closely linked to health status (Groessl et al., 2007; Fiedler, 2007; Yeom et al., 2008; Webber et al., 2010).

Our findings are also consistent with the results of other studies regarding the relationship of perceived mobility to car availability and financial security. Specifically, Du et al. (2020), Shoval et al. (2010), Ahern and Hine (2012), Lättman et al. (2019), and Plazinić and Jović (2018) confirmed the significant role of car availability (mainly with a driver or family assistance) in the mobility of older adults. Joukl et al. (2022) emphasised the role of cars in the independence and mobility of older adults. Van Leeuwen et al. (2019) distinguished financial security as one of nine quality of life domains in a synthesis of 48 qualitative studies; however, it has been less consistently covered across studies. They state that financial security seems to be very important for specific groups or individuals.

Rantakokko et al. (2016) emphasises the importance of ensuring out-of-home mobility for older adults, explicitly stating that a more than ten-point reduction in LSA is key to a decline in their quality of life. Our additional analysis of the dependency of Quality of Life on mobility partial variables (after elimination of the influence of demographic, lifestyle, and technological factors, and perceived health, and financial security) also demonstrated the significant effect of mobility outside the door (Zone 2). However, the results suggest that the maximum extent of outdoor mobility is not such important for perceived quality of life. Impossibility to overcome an entrance space of apartment/house is the first and essential barrier for outdoor mobility (Vidovičová et al., 2013; Petrová Kafková, 2013). The main home barriers are narrow spaces, stairs, missing lifts and missing rails (eg. Bartoszek et al., 2011). (Un)ability or (im) possibility to go out alone is the critical point in a construction of the personal identity (Peace et al., 2005). Furthermore, limited spatial mobility is also associated with social isolation and loneliness (Frantál et al., 2020; Yu et al., 2024).

The current literature reveals ambivalent findings regarding the influence of the Internet and smart devices on the quality of life in

Table 7
Overview of mobility to the highest zones (categorized as 'independent movement or otherwise', 'without personal assistance', 'without any help').

Maximum	In any way		No personal assist.		No help	
zone	n	%	n	%	n	%
0	10	1.8	19	3.4	72	12.9
1	16	2.9	18	3.2	33	5.9
2	17	3.0	21	3.8	22	3.9
3	23	4.1	24	4.3	22	3.9
4	119	21.3	110	19.7	86	15.4
5	373	66.8	366	65.6	323	57.9

Note. Data are expressed as numbers (n) and percentages (%).

Table 8
Overview of five mobility variables by age.

Age category (in years)	65–69		70–74		75–79		80–84		≥85		Total	
Variable	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Mob(1)	6.3	3.0	5.9	3.2	5.8	3.1	6.2	2.8	6.5	2.6	6.1	3.0
Mob(2)	6.3	2.6	6.0	2.8	5.5	3.0	4.9	3.0	5.1	3.3	5.8	2.9
Mob(3)	5.8	2.7	5.3	2.7	4.9	3.1	4.3	3.0	3.7	3.1	5.2	2.9
Mob(4)	5.2	2.6	4.6	2.8	4.2	2.8	3.4	2.9	3.5	2.7	4.5	2.8
Mob(5)	3.2	2.5	2.8	2.5	2.4	2.4	1.7	2.0	1.9	2.4	2.7	2.5

Note. Data are expressed as means (M) and standard deviations (SD).

Table 9
Regression analysis results for the dependence of quality of life on mobility variables when adjusting the influence of demographic, lifestyle, and technological factors, and perceived health, and financial security.

Variable	Effect	SE	p-value
Mob(1)	0.09	0.11	0.400
Mob(2)	0.30	0.14	0.037
Mob(3)	0.30	0.17	0.081
Mob(4)	0.26	0.16	0.121
Mob(5)	−0.22	0.15	0.147

older adults. Positive effects on psychological functioning and well-being are linked to enhanced interpersonal interactions and social inclusion (Forsman et al., 2018; Román Graván et al., 2021), reduced loneliness and depression (Aggarwal et al., 2020), and increased access to community resources, including awareness, education (Forsman et al., 2018), skill development, and improved cognitive functioning (Czaja and Lee, 2007). These benefits also include enhanced self-efficacy, self-esteem, and self-determination (Aggarwal et al., 2020). Extensive surveys, such as a subset of the European Social Survey (n = 11,000 in Lelkes, 2012), support these findings, showing decreased social isolation and greater life satisfaction among seniors who regularly use the Internet.

Conversely, a second group of studies reports no significant differences between seniors who use the Internet and those who do not (e.g., Dorin, 2007; Firth and Mellor, 2009), including large surveys like that of Elliot et al. (2014) (n = 6443).

The final group highlights negative impacts. For older adults, extensive Internet use appears to have a cumulative negative effect, with increased usage correlating with reduced ability to move independently and decreased face-to-face interactions (Neves et al., 2018; Khalaila and Vitman-Schorr, 2018). These elements increase their vulnerability to isolation and lower their sense of worth and quality of life. According to Zywica and Danowski's (2008) social compensation hypothesis, older adults attempt to compensate for offline life deficiencies by engaging in more online experiences that lower their life satisfaction and self-esteem (this may be because of poor health, lack of autonomy, and lack of social connections). Consequently, older adults spend more time online trying to find what they need. Benvenuti et al. (2020) found that the more time older adults spend online, the greater the decrease in autonomy and face-to-face contact opportunities, causing isolation and a negative effect on their self-esteem and life satisfaction. Older individuals prefer meeting relatives and friends in person rather than communicating online (Lelkes, 2013).

One reason for these differences appears to be the style and frequency of Internet usage. While essential (short-term) use of the Internet helps seniors maintain social connections and access information, extended (long-term) use increases the risk of replacing traditional face-to-face interactions and out-of-home activities with online activities such as shopping and entertainment. This substitution may contribute to the observed negative impact. In our study, the sample includes an unusually high proportion of advanced Internet users (e.g., double the proportion of daily users), which may be associated with extended Internet use and explain this negative relationship.

In our study, 78.9% of respondents used a smart device for at least one of the six purposes examined. Compared to Internet use, smart device use had a positive effect on both mobility and quality. According to Hung et al. (2019), smart devices can reduce older adults' emotional anxiety and enhance their ability to communicate with others. This is also consistent with our findings, where the item communication with loved ones and friends reached the highest mean value of 1.8 (on a scale of 0–4), which is half a point higher than the overall mean. Aggar et al. (2023) conducted a longitudinal pilot study and found that Smart Home technology supports the quality of life in older people, particularly their satisfaction with "achieving in life" and "future security". Moreover, Smart Home technologies that support older people in performing activities of daily living (particularly those activities that may have become difficult due to mobility issues or disabilities, such as gardening and cleaning) have been reported to improve satisfaction with life (Carnemolla, 2018). Mobility is a significant mediator of the perceived quality of life, and its intensity can be influenced by the use of smart devices. Older adults' mobility is derived from their overall approach to life, which can be distinguished based on their attitudes toward limiting outdoor mobility in the context of personal autonomy.

In summary, present study emphasises the importance of understanding the relationship between different factors (i.e., demographic, social, lifestyle, and technological) and the perceived mobility and quality of life in older people of the Czech Republic. Our findings suggest that smart-home technologies and their appropriate use can play a significant role in improving the well-being and overall quality of life in older adults. This study contributes to the existing literature on quality of life by demonstrating the relevance

of using 'perceived mobility' as a mediator between selected factors and the perceived quality of life in older adults. It underscores the need for further exploration and development of solutions that meet the unique challenges and opportunities faced by this demographic group in the context of an aging population (Barakovic et al., 2020a, 2020b).

These findings can be used to provide directions to stakeholders interested in building national programs for age-friendly cities and communities (AFCC) as proposed by the World Health Organization (WHO) guidelines (WHO, 2023b). Building national AFCC programs is a vital step toward realising the goals set forth by the UN Decade of Healthy Aging to enhance the quality of life of older adults, their families, and communities, by improving their living environments. Such programs can help ensure that communities actively cultivate the capabilities of older people while promoting a transformation in societal attitudes, emotions, and behaviours concerning the aging process. In this context, our study supports the following sustainable development goals (SDGs): SDG3, to ensure healthy lives and promote well-being for all at all ages; and SDG11, to build cites and human settlements that are inclusive, safe, resilient, and sustainable.

4.1. Study limitations and recommendations for further research

Our study has certain limitations. First, this study focuses on older adults living in the Czech Republic, a Central European country. Because of quota selection, the research sample had a demographic structure similar to that of the older population of Czech, but it was not based on random sampling, therefore, some results may have been distorted. It should also be noted that the proportion of Internet users, as well as daily Internet users, is higher compared to the overall senior population. This is likely due to the dominant use of the CAWI method in data collection and the smaller proportion of the CATI method, where only 14.5% of respondents are non-Internet users. This may have partly influenced the relationship between Internet usage and quality of life.

Second, other factors (e.g., environmental), which are widely discussed in the literature in the context of 'age-friendly environments' using qualities, such as accessibility, visitability, walkability, and perceived safety (Vidovićová, 2018), were not considered. Future research should be aimed towards verifying the determinants of local physical and social environments that are well perceived by older adults, exploring methods to operationalise them, determining how undertaken measures are perceived by older adults, and recording their feedback regarding the reduction of environmental barriers and the sustainability and effectiveness of the AFCC concept in general.

Furthermore, it is necessary to emphasise that this study used a cross-sectional design. Therefore, it is appropriate to use panel data to verify whether established relationships are stable over time. These data will enable a more targeted monitoring of the relationship between changing mobility, factors, and quality of life in a sample of the same (or similar) older adults over a longer period.

Another intriguing aspect that our study brings to light is the exploration of additional factors and determinants that influence the use of smart technologies by older adults and to what extent they can become a stimulus for their mobility and contribute to their quality of life. Given their diverse life situations, it seems expedient to follow up on this quantitative research with a qualitative approach, enabling a deeper understanding of the mechanisms that support the use of smart technologies to strengthen the mobility of older adults and their quality of life. Such research could help (i) implement products and services as part of smart solutions that could make our society more age-friendly, (ii) develop business models in the area of age-friendly cities and communities, and (iii) propose age-friendly policies and practice guidelines and recommendations.

5. Conclusion

Given the rapidly growing share of older adults in society, their quality of life is becoming an extremely important topic in modern societies. By combining and researching the aforementioned avenues, present study contributes to the research community in several ways.

First, it approaches the research gap in terms of the impact of perceived health and mobility factors, including demographic, social, lifestyle and technological factors, on the quality of life in older adults in a novel manner by modelling relationships that consider mediation through perceived mobility.

Second, the proposed statistical model identifies the impacts of mobility factors, especially technological factors, along with perceived mobility, perceived health, and financial security, on the quality of life in older adults. Specifically, perceived mobility was found to be affected by age, car availability, smart gadget use, and perceived health. Their mobility, together with the use of smart gadgets, financial security, and health perception, were found to be key determinants of improved quality of life.

In addition, this survey confirms, based on real collected data in the Czech Republic, that the quality of life in older adults is a multidimensional concept that needs to be addressed from various perspectives. To contribute to the research community as well as to individuals and organisations working on improving the life conditions of older adults, we have proposed future research opportunities covering extension, development, validation, and verification, as well as the utilisation of older adults' mobility and quality of life models.

CRediT authorship contribution statement

Petra Maresova: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Conceptualization. **Lenka Komarkova:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Data curation. **Zuzana Truhlarova:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Signe Tomsone:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis. **Miroslav Joukl:** Writing – review & editing,

Writing – original draft, Methodology. **Lucie Vítková:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Sabina Barakovic:** Writing – review & editing, Writing – original draft, Formal analysis. **Jasmina Barakovic Husic:** Writing – review & editing, Writing – original draft, Formal analysis. **Jiří Horák:** Visualization, Resources, Project administration.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [PM], upon reasonable request.

Funding

This project was supported by project GAČR 21–22276s Modelling of accessibility for seniors, perception of accessibility and determinants of their spatial mobility, solved by VSB - TU Ostrava, UHK.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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