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Travel Behaviour and Mobility Challenges Among Older Adults with Chronic Morbidity in Urban Malaysia: Findings from an Explanatory Mixed-Methods Study

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Highlights

Public health relevance—How does this work relate to a public health issue?

- Community mobility is a key component of healthy ageing, influencing older adults' independence, healthcare access, and social participation.
- Understanding mobility barriers among older adults with chronic morbidity is increasingly important as Malaysia transitions towards an ageing society.

Public health significance—Why is this work of significance to public health?

- This study demonstrates that late-life mobility is shaped by the interaction between individual characteristics, health status, transport factors, and the built environment.
- The mixed-methods findings reveal that transport availability alone may not ensure mobility, as accessibility, usability, safety, and perceived independence influence the travel behaviour of older adults with chronic morbidity.

Public health implications—What are the key implications or messages for practitioners, policy makers and/or researchers in public health?

- Age-friendly transport and urban planning strategies should move beyond physical accessibility by addressing transport usability, safety, and the diverse mobility needs of older adults.
- Integrated public health, transport, and urban planning approaches are needed to support independence, community participation, and healthy ageing among older adults with chronic morbidity.

Abstract

Mobility is a critical determinant of healthy ageing, yet evidence remains limited on how clinical, environmental, and structural factors jointly influence community mobility in car-dependent Asian metropolitan settings. Using an explanatory sequential mixed-methods design, this study examined factors of trip frequency among 374 community-dwelling older adults aged 55 years and above living with chronic morbidity in Klang Valley, Malaysia. Quantitative survey data were analysed using multivariable linear regression, while qualitative interviews were analysed thematically. Multivariable regression revealed that being male ($\beta = 1.056$, $p = 0.020$), having no formal education ($\beta = -2.888$, $p < 0.001$), actively driving ($\beta = 1.059$, $p = 0.023$), and reporting higher mobility satisfaction ($\beta = 0.714$, $p = 0.043$) were associated with greater trip frequency. Conversely, advanced age ($\beta = -0.103$, $p = 0.001$) and availability of a bus stop near home ($\beta = -1.040$, $p = 0.007$) were associated with lower trip frequency. Thematic analysis contextualised these findings by highlighting the influence of physiological decline, transport convenience, perceived independence, environmental safety, gendered transport reliance, and a disconnect between public transport

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proximity and usability. The integrated findings suggest that late-life mobility is shaped by health status, transport accessibility and the broader built environment. These results highlight the need for age-friendly transport and urban planning strategies that support mobility and community participation in rapidly urbanising settings.

Keywords: older adults; chronic morbidity; community mobility; travel behaviour; healthy ageing; age-friendly cities; urban health; built environment; mixed-methods research; Malaysia

1. Introduction

Mobility, as defined by the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF), refers to an individual's capacity to move within and between environments [1]. Among older adults, community mobility extends beyond physical movement, serving as a key component of healthy aging, healthcare access, social participation, and quality of life [2]. Accordingly, as an indicator of community mobility, higher trip frequency has been consistently associated with better self-rated health and social connectedness, while lower trip frequency is linked to functional decline, social isolation, and increased care dependency [3–5].

Within the ICF framework, mobility is conceptualised as a dynamic activity shaped by the interaction between an individual's functional capacity and contextual factors. This interaction becomes particularly crucial in later life, when multimorbidity, defined as the coexistence of two or more chronic conditions, becomes increasingly prevalent [6]. Chronic pathologies such as cardiovascular and pulmonary conditions, Parkinson's disease, and malignancies accelerate physical and functional decline and progressively restrict life-space mobility from the broader neighbourhood to the immediate home environment [7–11]. This contraction triggers adverse public health outcomes, including unmet medical needs, sedentary behaviour, sarcopenia, and increased mortality risk [12–14]. Key life transitions, such as driving cessation or sudden hospitalisation, may further precipitate these declines and lead to long-term life-space restrictions [15–17].

Crucially, the extent of this restriction is heavily moderated by the surrounding built and transport environment [18,19]. Inadequate public transport, poor pedestrian infrastructure, and poor satisfaction with public amenities significantly suppress an older adult's willingness to travel [20–23]. Consequently, two individuals with comparable disease burdens may exhibit vastly different mobility outcomes depending on local urban configurations. This perspective is reflected in the WHO Age-Friendly Cities (AFC) framework, which emphasises the importance of supportive physical, social, and service environments that accommodate the diverse functional capacities of older adults [24]. Hence, integrating the ICF and AFC frameworks positions community mobility not only as an individual functional outcome, but also as a modifiable product of urban design, transport policy, and community support systems.

Recent research has increasingly emphasized that older adults' mobility requires consideration of both transport system characteristics and the capabilities and circumstances of older users. A meta-analysis found that, although physical and medical conditions are among the most common factors that may impair older adults' driving ability, the driving environment, including road and transport system characteristics, traffic conditions, and unfamiliarity, also plays an important role in their self-regulation practices to maintain road safety [25]. Furthermore, synthesizing evidence from 67 studies, a study highlighted that age-friendly public transport is also shaped by the interaction between individual factors,

such as health, socioeconomic circumstances, and functional capabilities, and structural factors, including accessibility, affordability, availability, adaptability, acceptability, and safety [26]. This perspective is complemented by system-level evidence from a study using an iterative Data Envelopment Analysis (DEA) approach to evaluate public transport transfer efficiency for older users in a super-aging society. The finding demonstrated that transfer efficiency can vary between older and general users and highlighted the importance of transfer time and walking-related facilities in improving the usability of public transport for older adults [27]. Taken together, these studies indicate that age-friendly mobility depends on the alignment between the capabilities and needs of older users and the accessibility and performance of the transport systems available to them.

Despite growing evidence on mobility restrictions in later life, important knowledge gaps remain. Much of the existing literature focuses on general older adult populations, leaving limited understanding of how transport challenges affect vulnerable subgroups, particularly those living with chronic disease. This gap is especially relevant in Malaysia, which is undergoing a rapid demographic transition towards an ageing population, with individuals aged 65 years and above accounting for 8.4% of the population in 2026, up from 5.0% in 2010 [28]. Moreover, 40.6% of Malaysian older adults have been reported to live with chronic morbidity [29]. Additionally, several local studies have reported that health-related factors are among the leading factors restricting community mobility among older adults, affecting both private and public transport use [30,31]. Older adults with chronic illnesses may experience greater functional limitations, increased dependence on others for transportation, and difficulties accessing essential destinations, including healthcare facilities [32,33].

This situation is particularly relevant given the local transport context. Petrol price affordability, safety concerns, poorly maintained road signage, road conditions, complex road networks, unfamiliar places, and limited parking spaces have been identified as factors influencing older adults' driving decisions [34]. In addition, older adults who rely on public transport continue to experience barriers related to service reliability, affordability, safety, accessibility, and operational complexity [32]. Specifically, urban older adults have identified reliability and safety as major concerns, whereas rural older adults have reported reliability and affordability as prominent challenges [32]. For older adults living with chronic morbidity, these transport barriers may interact with existing health and functional limitations, potentially further constraining their ability to travel independently.

Furthermore, objective indicators of spatial transport availability alone may not fully capture the lived mobility experiences of older adults, including physical and cognitive demands of travel, transport-related fatigue, perceived safety, and reliance on family support networks. A mixed-methods approach can therefore provide a more comprehensive understanding by examining both measurable factors associated with travel behaviour and the contextual barriers and enabling factors underlying daily mobility. Accordingly, this study examines the factors associated with community mobility and explores the personal, transport-related, environmental, and social influences on travel behaviour among community-dwelling older adults with chronic morbidity in urban Malaysia, aiming to inform integrated care planning and age-supportive infrastructure development.

2. Materials and Methods

2.1. Study Design and Setting

This study utilised an explanatory sequential mixed-methods design consisting of an initial community-based cross-sectional survey followed by semi-structured qualitative in-depth interviews. The study was conducted in the Klang Valley, the most densely populated and urbanised metropolitan region in Malaysia. Covering approximately 2793 km^2 across

five administrative zones (Kuala Lumpur, Gombak, Ulu Langat, Petaling, and Klang), the region features a highly complex multimodal transport network consisting of roadways, comprehensive rail networks (MRT, LRT, KTM Komuter), municipal buses, and commercial e-hailing networks. This structurally complex environment serves as an ideal urban setting for evaluating late-life community mobility and environmental barriers among older adults with chronic morbidity.

Data collection was conducted from June 2022 to February 2023. As data collection occurred after the major COVID-19 movement restriction period in Malaysia, participants were specifically instructed to report their usual mobility activities and travel behaviour during the period before the implementation of COVID-19-related movement restrictions. This approach was adopted to minimise potential situational confusion and to distinguish participants' usual mobility patterns from temporary travel restrictions and behavioural changes associated with the pandemic. Participants were asked to recall their mobility activities under their usual pre-pandemic circumstances, including their typical travel frequency, destinations, and modes of transportation.

2.2. Quantitative Phase: Sampling, Sample Size, and Recruitment

The target population comprised community-dwelling older adults aged 55 years and older residing in the Klang Valley. Although 60 years is commonly used as the conventional threshold for older adulthood in Malaysia, a lower threshold of 55 years was selected to capture the early transition into later life, a period during which changes in health, functional capacity, employment status, driving behaviour, and transport needs may begin to emerge [35]. Including adults aged 55–59 years allows mobility and travel behaviour to be examined across a broader range of later-life stages, thereby providing evidence to inform the development of age-friendly transport interventions before more pronounced mobility limitations occur. Nevertheless, participants aged 55–59 years may differ systematically from those in older age groups in terms of driving capability, employment status, and physical functioning [36,37]. Therefore, age was retained as a continuous variable in the multivariable analysis to account for age-related variation in mobility and travel behaviour. Institutionalised individuals, those with severe cognitive or communication impairments, and individuals facing absolute language barriers were excluded.

A multi-stage cluster sampling approach was executed. Three residential clusters were randomly selected from each of the five administrative zones, and door-to-door household visits were conducted within each cluster to invite eligible residents. The baseline sample size was determined using a two-proportion comparison formula based on previously reported Malaysian driving preservation rates (61.8% continuing vs. 38.2% ceased) [38]. Assuming a 95% confidence level and 90% statistical power, the initial calculation yielded 184 participants. To account for cluster sampling design effects (1.5) and anticipated non-response rate of 20%, the final minimum required sample size was established at 345 participants.

2.3. Quantitative Survey Instruments and Variables

Trained enumerators administered face-to-face, structured interviews in either Malay or English using a multi-domain questionnaire. The primary quantitative outcome (dependent variable) was trip frequency, defined as the self-reported total number of out-of-home trips made by the participant per week.

Meanwhile, the independent variables and covariates are as follows:

1. Personal characteristics: This variable assessed age, gender, marital status, educational attainment, employment status, residential typology, and living arrangements. Monthly household income was adjusted to Malaysia's regional strata cut-offs for

Bottom 40% (B40), Middle 40% (M40), and Top 20% (T20) specific to Kuala Lumpur and broader Selangor domains.

2. Health and Functional Status: Chronic morbidity was assessed through self-reported physician diagnoses of 17 diseases (e.g., hypertension, diabetes mellitus, heart disease, hypercholesterolaemia, cancer, bronchial asthma, cataract, gastritis, chronic kidney disease, joint pain/gout/arthritis, stroke, tuberculosis, incontinence, constipation, hearing problems, vision problems, and other chronic conditions). Functional impairment was assessed using the Washington Group on Disability Statistics Short Set on Functioning [39], while musculoskeletal pain was measured using the Nordic Musculoskeletal Questionnaire [40]. The use of mobility aids (wheelchairs, canes, or walkers) was also recorded. All variables were coded as binary (yes/no) indicators.
3. Transport and Mobility Characteristics: Variables included mode of transport used (private, public, or active transport), driving status (active, ceased, or non-licensed), vehicle ownership, use of transit concession fares, and perceived affordability of public transport (4-point Likert scale). Spatial availability of transit nodes near the home was measured using a binary item asking participants, "Is there a bus stop within a 10-min walk/400 m from your home?" (1 = Yes, 0 = No), capturing the presence of an active public transport node within a distance threshold widely recognized in transport planning as the standard walkable catchment area for older adults.
4. Mobility Behaviours and Transport Difficulties: Trip characteristics included trip destinations (workplaces, neighbourhood shops, shopping malls or markets, service centres, healthcare facilities, places of worship, sports, leisure or recreational facilities, community centres, educational centres, and visits to relatives or friends), travel times, and trip durations. Transport difficulties and unmet community mobility needs were assessed using indicators adapted from the WHO's Global Age-Friendly Cities: A Guide [41] and Checklist of Essential Features of Age-Friendly Cities [24].
5. Perceived mobility satisfaction: This variable was assessed using the Older Adults' Community Mobility Satisfaction Index (OACMSI), developed for this study.

Psychometric Index Development and Pilot Testing

Perceived mobility satisfaction was evaluated via the OACMSI, a 10-item instrument developed for this study. The index captures multidimensional mobility satisfaction across four conceptual domains (physical, mental, social, and economic well-being), drawing from Musselwhite's travel needs framework, Webber's life-space framework, and Lee and Sener's Transportation-Related Quality of Life guidelines [42–44]. The instrument assessed satisfaction with: (1) ability to move around the community; (2) ability to move independently without relying on others; (3) ability to cope with long-duration trips; (4) choice of transport modes available; (5) ability of available transport to reach intended destinations; (6) distance from home to public facilities (e.g., shops, places of worship, parks, clinics); (7) sense of safety when on roads, at stations, or on public transport; (8) traffic-related air pollution; (9) traffic-related noise; and (10) affordability of transport used. Items were scored on a 5-point Likert scale and summed to generate a continuous composite score ranging from 10 to 50, with higher scores indicating greater mobility satisfaction.

Face and content validity were assessed by six specialists in public health and gerontology, yielding a Content Validity Ratio of 0.714. Bilingual experts further assessed conceptual and semantic equivalence between the English and Malay versions. A pilot study involving 35 independent older adults (approximately 10% of the main study sample) from a non-study area was conducted to assess questionnaire feasibility, clarity, and the preliminary psychometric performance of the newly developed instrument. The pilot sample was pri-

marily intended for preliminary instrument assessment rather than definitive psychometric validation. Completion of the questionnaire required approximately 45 min on average.

The OACMSI demonstrated excellent internal reliability (overall Cronbach's alpha = 0.930). Exploratory Factor Analysis was conducted as a preliminary assessment of the underlying dimensional structure. The data demonstrated acceptable factorability (Kaiser–Meyer–Olkin = 0.815; Bartlett's Test χ^2 = 185.28, $p < 0.001$) and the analysis identified a two-factor solution accounting for 73.0% of the total variance. Factor 1 (Physical Mobility, Autonomy, and Safety; six items) and Factor 2 (Environmental Accessibility and Comfort; four items) demonstrated good internal consistency, with Cronbach's alpha coefficients of 0.855 and 0.822, respectively. No substantial floor or ceiling effects were observed.

To validate the psychometric structure of the 10-item OACMSI, Confirmatory Factor Analysis (CFA) using Maximum Likelihood estimation was conducted on the full study dataset (N = 374). The hypothesized two-factor model demonstrated empirical non-identification, with the estimated correlation between latent factors exceeding unity (r = 1.009), suggesting a lack of empirical distinction between factors. Therefore, a one-factor model was subsequently examined, consistent with the use of an overall composite 10-item satisfaction score in the present study. The initial one-factor model exhibited modest fit. Based on modification indices and substantive content overlap, residual covariances were specified between two pairs of conceptually related items: mobility capacity (Item 1: ability to move around the community and Item 3: ability to cope with long-duration trips) and environmental nuisances (Item 8: traffic-related air pollution and Item 9: traffic-related noise). The refined one-factor model demonstrated acceptable fit (χ^2/df = 4.843, CFI = 0.912, TLI = 0.880, RMSEA = 0.103, GFI = 0.920, AGFI = 0.867). Standardized factor loadings across the 10 items ranged from 0.327 to 0.819 (all $p < 0.001$), confirming moderate to strong item-construct convergence. All items were retained despite lower loadings on select items, as each item captures a theoretically essential facet of mobility satisfaction among older adults with chronic morbidity, and item deletion would have reduced the instrument's domain coverage and content validity.

2.4. Quantitative Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality and summarised as means ± standard deviations or medians with interquartile ranges, as appropriate, while categorical variables were summarised using frequencies and percentages. Missing data were assessed for all study variables before statistical analysis. The number and proportion of missing observations were examined for each variable. Missing data were present for some study variables, with socioeconomic status having the highest proportion of missing observations (40/374, 10.7%), while other variables had less than 2.0% missingness. Missing values were handled using complete-case analysis, whereby participants with missing values for variables included in a particular analysis were excluded from that analysis. The final multivariable regression model included 374 participants.

Differences in trip frequency across independent variables were examined using independent-samples t-tests or analysis of variance for parametric data, and Mann–Whitney U or Kruskal–Wallis tests for non-parametric data. Variables demonstrating an association with trip frequency in the bivariate analyses ($p < 0.05$), together with variables considered conceptually or clinically relevant based on previous literature, were included in the multivariable linear regression model to identify factors independently associated with trip frequency. The final model was developed using the specified variable-selection procedure,

while consideration was also given to the conceptual relevance of potential factors to avoid relying solely on statistical significance.

Prior to fitting the final model, the assumptions of linear regression were assessed, including linearity, normality of residuals, homoscedasticity, and the presence of influential observations or outliers. Linearity was assessed using scatterplots, while the distribution of residuals was examined using histograms and normal P–P plots (probability–probability). Homoscedasticity was assessed using a scatterplot of standardised residuals against standardised predicted values. Potential influential observations and outliers were assessed using standardised residuals, leverage, and Cook's distance. The diagnostic assessments indicated that the assumptions were reasonably satisfied.

Although weekly trip frequency represents a non-negative count outcome, multivariable linear regression was retained as the primary analytical approach because the regression diagnostics supported the adequacy of the linear model for these data. In addition, the unstandardized regression coefficient (β) provides an interpretable estimate of the adjusted absolute difference in the expected number of weekly trips associated with each factor.

Then, multicollinearity among independent variables was assessed using tolerance and variance inflation factor (VIF). A VIF < 5.0 and tolerance > 0.10 were considered indicative of no serious multicollinearity. Then, a sensitivity analysis was conducted using simultaneous entry of the primary factors and additional theoretically relevant covariates identified a priori from the study conceptual framework and previous literature. The direction and magnitude of the regression coefficients were compared between the primary and sensitivity models.

Additionally, given the multi-stage cluster sampling design, a sensitivity analysis was conducted to assess the potential influence of clustering on the multivariable regression estimates. A linear mixed-effects model with a random intercept for residential cluster was fitted using the same fixed effects as the primary multivariable linear regression model, namely age, gender, educational attainment, driving status, bus-stop availability near home, and mobility satisfaction. Restricted maximum likelihood (REML) estimation was used. Sampling weights were not applied because individual-level sampling probabilities were not available.

2.5. Qualitative Phase: Design, Sampling, and Analysis

The qualitative phase followed the quantitative analysis to contextualise and explain the factors associated with trip frequency. Purposive sampling was used to recruit a demographically and functionally diverse subset of participants who completed the quantitative phase and provided written consent for follow-up interviews. Recruitment concluded upon reaching data saturation, as successive interviews yielded no new themes. Semi-structured, face-to-face in-depth interviews lasting 30–45 min were conducted at participants' homes or community centres using a standardised field guide. The guide focused on daily mobility patterns, travel barriers, and coping strategies. Digital audio recordings were transcribed verbatim and audited for accuracy. Data were analysed thematically following Braun and Clarke's six-phase framework, with NVivo version 10.0 (QSR International Pty Ltd, Melbourne, VIC, Australia) used for data organisation. Coding protocols combined deductive approaches, anchored by key factors identified in the quantitative analysis as associated with trip frequency, with inductive open coding to capture unanticipated emerging themes and lived experiences.

2.6. Mixed-Methods Integration

Integration was undertaken at the interpretation stage using an explanatory joint-display approach. Qualitative themes were mapped to the multivariable quantitative findings, allowing participants' experiences and contextual factors to explain and contextualise the factors associated with trip frequency.

2.7. Ethics Approval

Ethical approval was obtained from the Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia (JKEUPM-2021-909). All participants were given detailed information about the study objectives and confidentiality of the information, and written consent was obtained from each participant before the study started.

3. Results

3.1. Quantitative Findings

The required minimum sample size for this study was 345. A total of 522 eligible individuals were approached, of whom 25 either declined to participate or did not complete the questionnaire, yielding a response rate of 95.2% (n = 497). Among them, 374 participants met the inclusion criterion for chronic morbidity and were included in the final analysis.

The analytical sample (N = 374) had a mean age of 64.5 ± 7.2 years, with 59.4% being female. The most prevalent self-reported morbidities were hypertension (68.7%) and diabetes mellitus (58.3%). Additionally, 65.8% reported at least one functional impairment, 69.1% had musculoskeletal pain, and 6.0% used walking aids.

3.1.1. Trip Behaviour

Participants averaged 5.20 ± 3.59 trips per week. Trips were most common in the morning on both weekdays (77.8%) and weekends (61.8%), with fewer participants travelling in the afternoon (29.9% weekdays; 31.3% weekends) and evening/night (36.1% for both).

The most common trip destinations were places of worship (39.8%), neighbourhood shops (35.5%), workplaces (21.9%), malls or markets (13.1%), and healthcare facilities (12.8%). Other destinations included sports, leisure, or recreational facilities (9.8%), visits to relatives or friends (8.6%), community centres (8.3%), educational centres (5.1%), and service centres such as banks or post offices (4.9%).

Average trip duration varied by destination. Trips to places of worship required an average of 11.62 ± 12.80 min, neighbourhood shops 11.82 ± 2.26 min, and community centres 12.73 ± 1.83 min. Travel to service centres averaged 15.00 ± 2.02 min, while trips to healthcare facilities and sports or recreational facilities required 15.45 ± 0.81 min and 15.45 ± 2.18 min, respectively. Longer travel times were reported for malls or markets (18.18 ± 2.55 min) and educational centres (18.18 ± 3.11 min). Trips to the workplace averaged 28.64 ± 5.56 min, while visits to relatives' or friends' homes had the longest travel time, at 31.36 ± 5.40 min.

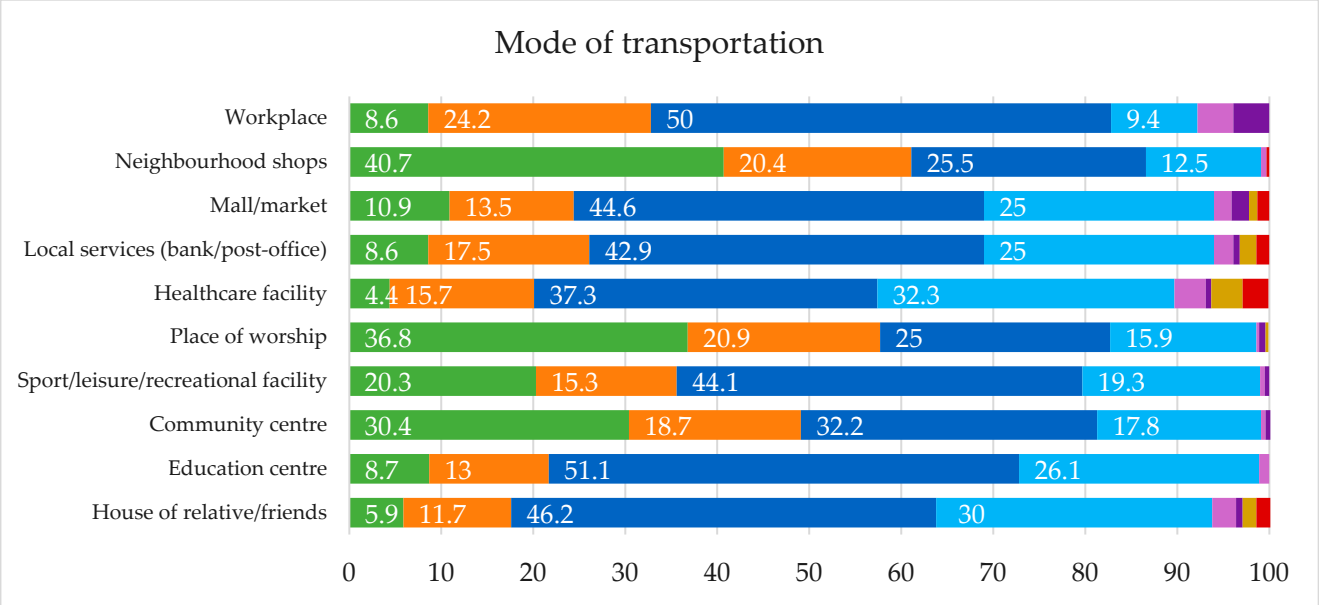
3.1.2. Transport Mode and Expenditure

Private car use dominated travel across most destinations, particularly for workplace (50.0%), educational centres (51.1%), malls or markets (44.6%), sports or recreational facilities (44.1%), and visits to relatives' or friends' homes (46.2%). Conversely, travelling as a car passenger was common for healthcare facilities (32.3%) and visits to relatives or friends (30.0%), suggesting reliance on family or social support for health-related or longer trips.

Walking was most prevalent for neighbourhood-based trips, particularly to neighbourhood shops (40.7%), places of worship (36.8%), and community centres (30.4%), indicating the importance of proximity and local accessibility for active mobility. Motorcycle use was

less common, ranging from approximately 11.7% to 24.2%, while public transport modes accounted for less than 5% of trips across destinations.

Mean monthly transportation expenditure was RM 720.22 ± 1046.72. Figure 1 summarises transport modes used among participants across different trip destinations.



	House of relative/friends	Education centre	Community centre	Sport/leisure/recreational facility	Place of worship	Healthcare facility	Local services (bank/post-office)	Mall/market	Neighbourhood shops	Workplace
Walking	5.9	8.7	30.4	20.3	36.8	4.4	8.6	10.9	40.7	8.6
Motorcycle	11.7	13	18.7	15.3	20.9	15.7	17.5	13.5	20.4	24.2
Driving car	46.2	51.1	32.2	44.1	25	37.3	42.9	44.6	25.5	50
Send by car	30	26.1	17.8	19.3	15.9	32.3	25	25	12.5	9.4
Bus	2.6	1.1	0.5	0.5	0.3	3.4	2.1	1.9	0.6	3.9
Train	0.7	0	0.5	0.5	0.7	0.6	0.7	1.9	0	3.9
Taxi	1.5	0	0	0	0.3	3.4	1.8	0.9	0	0
E-hailin	1.5	0	0	0	0	2.8	1.4	1.3	0.3	0

Figure 1. Modes of transportation by trip destination among older adults with chronic morbidity.

3.1.3. Trip Frequency Stratified by Participants' Personal, Health, and Transport Characteristics

Bivariate analyses showed that trip frequency differed significantly across age groups ($p = 0.006$), with participants aged 55–59 years reporting the highest mean trip frequency (5.79 ± 3.90 trips/week), followed by those aged 60–69 years (5.09 ± 3.51 trips/week), 70–79 years (4.11 ± 2.53 trips/week), and ≥80 years (3.33 ± 2.09 trips/week). Men reported a higher mean trip frequency than women participants (6.11 ± 2.89 vs. 4.34 ± 4.01 trips/week, respectively; $p < 0.001$). Trip frequency also differed significantly by marital status ($p = 0.015$), with married participants reporting a mean of 5.39 ± 3.73 trips/week, followed by divorced/separated participants (5.38 ± 2.60 trips/week), widowed participants (4.00 ± 2.44 trips/week), and never-married participants (3.88 ± 3.54 trips/week).

Furthermore, trip frequency also differed significantly by educational attainment ($p = 0.013$), with participants with no formal education reporting the highest mean trip frequency (6.50 ± 5.89 trips/week), followed by those with secondary education (5.51 ± 3.50 trips/week), tertiary education (4.73 ± 2.37 trips/week), primary education

(4.36 ± 3.19 trips/week), and other educational backgrounds (3.25 ± 2.63 trips/week). Employment status was also significantly associated with trip frequency ($p < 0.001$). Participants who were currently working reported a mean of 6.21 ± 4.09 trips/week, compared with 5.08 ± 3.00 trips/week among retired participants and 3.48 ± 3.07 trips/week among those who had never worked or were homemakers. A summary of participants' characteristics and mean trip frequency is presented in Table 1.

Table 1. Average trip frequency stratified by personal characteristics ($N = 374$).

Variables	*n* (%)	Average Trip Frequency (s.d.)	*p*-Value
Age			**0.006** *
55–59 years old	101 (27.0)	5.79 (3.90)	
60–69 years old	191 (51.1)	5.09 (3.51)	
70–79 years old	65 (17.4)	4.11 (2.53)	
80 years old and above	17 (4.5)	3.33 (2.09)	
Gender			**<0.001** *
Male	152 (40.6)	6.11 (2.89)	
Female	222 (59.4)	4.34 (4.01)	
Marital status			**0.015** *
Married	261 (69.8)	5.39 (3.73)	
Divorced/separated	22 (5.9)	5.38 (2.60)	
Widowed	72 (19.3)	4.00 (2.44)	
Never married	17 (4.5)	3.88 (3.54)	
Missing data	2 (0.5)		
Education Level			**0.013** *
No education	25 (6.7)	6.50 (5.89)	
Primary school	116 (31.0)	4.36 (3.19)	
Secondary school	168 (44.9)	5.51 (3.50)	
Tertiary education	60 (16.0)	4.73 (2.37)	
Others	4 (1.1)	3.25 (2.63)	
Missing data	1 (0.3)		
Employment status			**<0.001** *
Still working	111 (29.7)	6.21 (4.09)	
Retired	155 (41.4)	5.08 (3.00)	
Never worked/housewife	103 (27.5)	3.84 (3.07)	
Missing data	5 (1.33)		
Socioeconomic status			0.352
B40	314 (84.0)	5.15 (3.63)	
M40	16 (4.3)	6.21 (1.72)	
T20	4 (1.1)	3.50 (1.00)	
Missing data	40 (10.7)		
Residence area			0.862
Urban	338 (90.4)	5.04 (3.56)	
Suburban/Rural	36 (9.6)	5.14 (2.76)	
Living arrangement			0.519
Alone	28 (7.5)	4.50 (3.09)	
With spouse only	51 (13.6)	5.04 (4.26)	
With children	278 (74.3)	5.16 (3.42)	
Others	16 (4.3)	4.00 (2.59)	
Missing data	1 (0.3)		

* A *p*-value of <0.05 was considered statistically significant. Statistically significant *p*-values are presented in bold.

Among health-related factors, no significant differences in trip frequency were observed by number of chronic morbidities, most types of functional impairment, musculoskeletal pain, or use of walking aids (Table 2). Only walking impairment was significantly associated with lower trip frequency compared with participants without walking impairment (4.46 ± 2.91 vs. 5.43 ± 3.77 trips/week, $p = 0.012$).

Table 2. Average trip frequency stratified by self-reported health and functional status ($N = 374$).

Variables	*n* (%)	Average Trip Frequency (s.d.)	*p*-Value
Number of chronic morbidity(ies)			0.708
Has 1 morbidity	117 (31.3)	5.26 (3.40)	
Has 2 morbidities	115 (30.7)	4.88 (2.85)	
Has ≥3 morbidities	142 (38.0)	5.00 (4.00)	
Type of functional impairment			
Vision impairment	171 (45.7)	5.09 (3.41)	0.881 *
Hearing impairment	71 (19.0)	5.06 (4.56)	0.986 *
Walking impairment	142 (38.0)	4.46 (2.91)	**0.012 ***
Cognitive impairment	91 (24.3)	4.88 (4.04)	0.526 *
Self-care impairment	12 (3.2)	3.91 (2.30)	0.271 *
Communication impairment	17 (4.5)	3.88 (2.15)	0.160 *
Musculoskeletal pain (by region)			
Neck pain	78 (20.9)	5.25 (4.07)	0.580 *
Upper limb pain	124 (33.2)	4.87 (3.06)	0.508 *
Back pain	172 (46.0)	5.30 (3.79)	0.202 *
Lower limb pain	197 (52.7)	5.09 (3.13)	0.795 *
Use of walking aid(s)			
Wheelchair	4 (1.2)	2.00 (0.82)	0.078 *
Cane/walker	17 (4.9)	5.12 (3.90)	0.931 *

* Statistical significance was assessed by comparing participants with each specified condition to those without the condition. A *p*-value of <0.05 was considered statistically significant. Statistically significant *p*-values are presented in bold.

Participants with a bus stop or taxi station near their home had lower mean weekly trip frequencies than those without these facilities near their home (4.60 ± 2.93 vs. 5.60 ± 4.01 and 4.30 ± 2.71 vs. 5.32 ± 3.69 trips/week, respectively; $p = 0.007$ and $p = 0.016$, respectively). Similarly, participants who used train concession fares had a lower mean weekly trip frequency than those who did not use them (4.14 ± 2.44 vs. 5.25 ± 3.65 trips/week, $p < 0.001$).

In contrast, participants who were still driving had a higher mean weekly trip frequency (5.81 ± 3.57 trips/week) than those who had ceased driving (3.87 ± 3.36 trips/week) or were not driving (4.09 ± 2.99 trips/week) ($p < 0.001$). Additionally, participants who held a car or motorcycle driving licence and those who owned a car/van/SUV/MPV had higher mean weekly trip frequencies than their respective comparison groups (5.53 ± 3.53 vs. 4.40 ± 3.32, $p = 0.003$; 5.77 vs. 4.66, $p = 0.004$, 5.79 ± 3.71 vs. 4.45 ± 3.17, $p < 0.001$, respectively) (Table 3).

Table 3. Average trip frequency stratified by transport and mobility characteristics (N = 374).

Variables	*n* (%)	Average Trip Frequency (s.d.)	*p*-Value
Availability of public transport infrastructure near home			
Bus stop	208 (55.6)	4.60 (2.93)	**0.007** *
Bus station	94 (25.1)	4.67 (2.76)	0.266 *
Taxi station	99 (26.5)	4.30 (2.71)	**0.016** *
Train station	214 (57.2)	4.99 (3.62)	0.730 *
Driving status			**<0.001**
Still driving	216 (57.8)	5.81 (3.57)	
Had ceased driving	42 (11.2)	3.87 (3.36)	
No driving licence	114 (30.5)	4.09 (2.99)	
Type of licence			
Car licence	212 (56.7)	5.53 (3.53)	**0.003** *
Motorcycle licence	130 (34.8)	5.77 (3.53)	**0.004** *
Other licence	8 (2.1)	5.71 (2.22)	0.609 *
Vehicle ownership			
Bicycle	56 (15.0)	5.69 (4.61)	0.135 *
Motorcycle	108 (28.9)	5.37 (3.88)	0.264 *
Car/van/SUV/MPV	166 (44.4)	5.79 (3.71)	**<0.001** *
Others	0		
Use of concession fare			
Town bus concession fare	91 (24.3)	5.07 (3.22)	0.942 *
Train concession fare	68 (18.2)	4.14 (2.44)	**0.020** *
Express bus concession fare	40 (10.7)	4.72 (3.43)	0.536 *
Perceived public transport affordability			0.154
Very reasonable	45 (12.0)	5.07 (4.37)	
Somewhat reasonable	124 (33.2)	4.76 (3.00)	
Somewhat unreasonable	26 (7.0)	3.92 (4.09)	
Very unreasonable	5 (1.3)	3.00 (2.83)	

* Statistical significance was assessed by comparing participants with each transport condition to those without it. A p-value of <0.05 was considered statistically significant. Statistically significant p-values are presented in bold.

3.1.4. Most Frequently Encountered Transport Barriers

Across transport modes, older adults reported barriers related to infrastructure quality, distance to destinations, and facility accessibility. Percentages were calculated using the number of active users of each transport mode as the denominator (walking: n = 333; car driver/passenger: n = 223; motorcycle: n = 103; bicycle: n = 19; bus: n = 99; train: n = 69; taxi: n = 43; e-hailing: n = 38).

For walking, the most common issues were lack of public toilets, insufficient seating, and exposure to noise and odour. Cyclists and motorcyclists most frequently reported long distances to essential destinations and poorly maintained or unsafe roads, while car users reported insufficient or distant parking areas and high parking fees.

Among public transport users, buses were commonly associated with long waiting times, limited parking, and poor punctuality, whereas trains were characterised by lack of shelters, limited parking at stations, and multiple interchanges. Taxi users most frequently reported high or inconsistent fares and lack of toilets at taxi stands, while e-hailing users highlighted high and variable pricing and limited availability at night or weekends. Figure 2 presents the three most frequently reported transport difficulties for each mode.

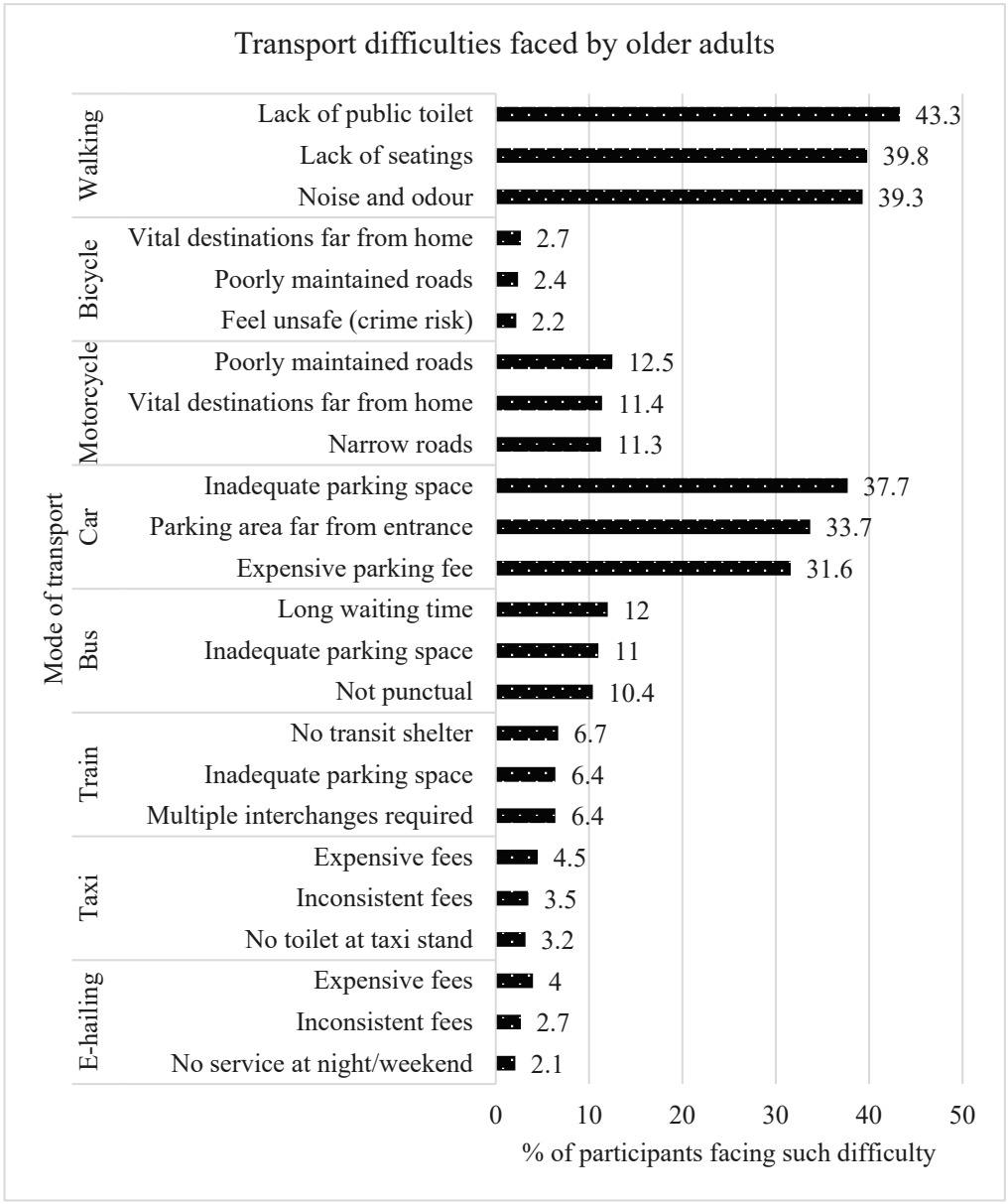


Figure 2. Transport barriers experienced by older adults across different modes of transportation. Percentages were calculated within each transport mode using the number of participants who reported using that mode as the denominator; therefore, the denominator varies across transport modes.

3.1.5. Unmet Mobility Needs

About 11.0% of participants reported difficulty finding transport when needed, while 20.0% relied on others for trips. Additionally, 7.8% were unable to reach their intended destinations due to transport problems.

3.1.6. Perceived Mobility Satisfaction

The mean OACMSI score was 36.5 ± 5.87 (range: 19.0–50.0), indicating moderate overall mobility satisfaction. Participants were most satisfied with their ability to move around the community and to travel independently (both 4.07 ± 0.798 and 4.07 ± 0.720, respectively), as well as with the choice of transport modes available (3.96 ± 0.797). The lowest satisfaction scores were reported for traffic-related noise (2.95 ± 1.054), traffic-related air pollution (3.01 ± 1.092), and affordability of transport used (3.35 ± 1.043).

3.1.7. Factors Associated with Trip Frequency

Increasing age was associated with lower trip frequency, with each additional year corresponding to a 0.103-unit decrease in trips (β = –0.103, $p = 0.001$). Male was associated with higher trip frequency compared with female gender (β = 1.056, $p = 0.020$). Participants with formal education at the school or university level exhibited lower trip frequency than those without formal education (β = –2.888, $p < 0.001$). Current driving status was positively associated with trip frequency (β = 1.059, $p = 0.023$). Among built environment factors, the presence of a bus stop near home was associated with lower trip frequency (β = –1.040, $p = 0.007$). Higher mobility satisfaction was also positively associated with trip frequency (β = 0.714, $p = 0.043$). Multicollinearity was not considered problematic, with tolerance values ranging from 0.420 to 0.956 and VIF values ranging from 1.046 to 2.380.

As a sensitivity analysis, a linear mixed-effects model incorporating residential cluster as a random intercept was fitted to account for the multi-stage sampling structure. The estimated between-cluster variance was 0.000, indicating no detectable residual variation in weekly trip frequency attributable to residential clustering after adjustment for the individual-level covariates. The fixed-effect estimates were broadly comparable with those from the primary multivariable linear regression. These findings indicate that consideration of residential clustering did not materially alter the principal associations.

Table 4 presents the multivariable factors associated with trip frequency among the participants.

Table 4. Factors associated with trip frequency among the participants ($N = 374$).

	β Coeff (95% CI)	*p*-Value	Adjusted β Coeff (95% CI)	*p*-Value
Age	−0.107 (−0.158, −0.056)	<0.001	−0.103 (−0.161, −0.045)	0.001
Gender	1.765 (1.039, 2.491)	<0.001	1.056 (0.170, 1.941)	0.020
Formal education	−1.552 (−3.053, −0.051)	0.043	−2.888 (−4.428, −1.348)	<0.001
Driving status	1.772 (1.050–2.495)	<0.001	1.059 (0.149, 1.969)	0.023
Presence of bus stop near home	−1.007 (−1.737, −0.276)	0.007	−1.040 (−1.787, −0.293)	0.007
Mobility satisfaction	0.918 (0.246, 1.591)	0.008	0.714 (0.023, 1.406)	0.043

3.2. Qualitative Findings

Twenty respondents participated in the qualitative phase of the study. The mean age of participants was 63.35 years. The sample comprised 12 male and eight female older adults. Sixteen participants were Malay, three were Chinese, and one was Indian. Twelve participants were retired, while six were still employed and two were housewives. Eight participants lived with their spouses only, 10 lived with their children and/or other family members (e.g., spouse, grandchildren), one lived with a sibling, and one lived alone. In terms of driving status, 16 participants were still actively driving, three had ceased driving, and one did not possess a driving licence. Table 5 summarises the sociodemographic and health characteristics of respondents participating in the qualitative phase.

Table 5. Sociodemographic and health characteristics of respondents.

ID	Age	Gender	Ethnicity	Employment Status	Living Arrangement	Driving Status
1	68	Male	Malay	Retired	With children	Still driving
2	55	Female	Malay	Still working	With children	Still driving
3	64	Male	Chinese	Retired	Alone	Had ceased driving
4	71	Female	Chinese	Still working	With children	Still driving
5	65	Male	Chinese	Retired	With children	Still driving
6	69	Male	Indian	Still working	With children	Had ceased driving
7	61	Male	Malay	Retired	With spouse	Still driving
8	84	Female	Malay	Housewife	With children	No driving license
9	62	Female	Malay	Retired	With spouse	Still driving
10	61	Male	Malay	Retired	With spouse	Still driving
11	56	Female	Malay	Still working	With spouse	Still driving
12	56	Female	Malay	Housewife	With children	Still driving
13	68	Female	Malay	Retired	With spouse	Had ceased driving
14	63	Female	Malay	Retired	With spouse	Still driving
15	62	Male	Malay	Retired	With spouse	Still driving
16	58	Male	Malay	Still working	With children	Still driving
17	63	Male	Malay	Retired	With spouse	Still driving
18	64	Male	Malay	Still working	With children	Still driving
19	61	Male	Malay	Retired	With children	Still driving
20	56	Male	Malay	Retired	With other	Still driving

The thematic analysis identified three overarching themes: (1) Personal and Functional Mobility Challenges; (2) Transport and Environmental Mobility Barriers; and (3) Social Support and Dependency in Mobility. Together, these themes provide contextual insights into the individual, environmental, and social factors underlying community mobility among participants. Table 6 presents the thematic framework derived from the qualitative analysis.

Table 6. Thematic framework derived from qualitative analysis.

Theme	Sub-Theme
Personal and Functional Mobility Challenges	• Clinical Pathologies and Health-Mediated Travel Reduction • Underlying Ageing-Related Pathology and Weariness • Ageing-Related Physical Exertion and Post-Transit Fatigue • Retirement and the Reshaping of Daily Mobility Routines
Transport and Environmental Mobility Barriers	• Road Infrastructure: Road Conditions, Configurations, and Parking Deficits • Traffic Conditions and Spatial Constraints • Erratic Behaviour of Other Road Users and Safety Vulnerability • Transportation Costs and Post-Retirement Economic Readjustment • Transport Accessibility: The Urban–Suburban/Rural Transit Divide • Subjective Acceptability and Behavioural Familiarity
Social Support and Dependency in Mobility	• Intergenerational and Peer Mobility Support • The Caregiver Mobility Burden and Asset Reallocation

3.2.1. Theme 1: Personal and Functional Mobility Challenges

Intrinsic health-related factors, including chronic health conditions, age-related physiological changes, and musculoskeletal pain, were important factors influencing out-of-home travel frequency. Participants described a reduction in the extent of their life space as they reduced their trip frequency in response to pain, sensory difficulties, and fatigue.

(a) Clinical Pathologies and Health-Mediated Travel Reduction

Chronic health conditions and the side effects of medical treatments were described as factors that may reduce discretionary trip frequency. Many participants described limiting out-of-home travel and remaining at home because of concerns about becoming unwell while travelling.

> *I don't want to travel far-distance. I think I am more comfortable at home than in a vehicle. I am afraid I get sick there.* (P08)

Specific clinical conditions, such as obstructive sleep apnoea, were described as affecting driving safety through daytime drowsiness, resulting in medical advice to limit long-distance driving.

I have sleep apnoea. I was advised not to drive long-distance. The doctor is worried I might fall asleep behind the wheels. (P12)

Furthermore, age-related health conditions, including cardiovascular symptoms, dizziness, and medication side effects, were described as contributing to decisions to stop driving based on medical advice, resulting in reduced independent mobility.

I can't drive anymore. My doctor advised me to stop driving due to the medicine that I take. The medicine caused dizziness… Besides, because of my heart condition, I always feel lethargic. (P13)

(b) Underlying Ageing-Related Pathology and Weariness

Musculoskeletal conditions, including chronic arthritic conditions, introduced physical difficulties that were associated with reduced travel frequency. Participants described pain and joint stiffness that affected their ability to tolerate prolonged driving or maintain comfortable postures when riding a motorcycle. On long-distance routes, the physical exertion required to operate foot pedals or maintain posture on a motorcycle was associated with pain and discomfort, leading some participants to change their travel habits or take more frequent rest breaks.

My leg would start to have some discomfort when driving for long hours. When you had to press the pedal for hours, it surely will cause discomfort in the limb. (P05)

I felt body ache and weary when traveling far. (P14)

I am getting old. Sometimes I got pain in my back and waist when driving the motorcycle for too long. I have to stop and rest a while and then continue my trip back. (P20)

Visual conditions, particularly cataracts and refractive errors such as astigmatism, affected participants' driving experiences. Participants noted that reduced visual clarity made it more difficult to read overhead road signs and affected their ability to drive.

After I got cataract, my driving was disturbed because I couldn't react fast as I couldn't see clearly. Besides, I can't see the road signboard. (P01)

Furthermore, changes in lighting conditions were described as affecting participants' travel and driving patterns. Night lighting and headlights contributed to glare, particularly among participants experiencing age-related visual changes. This glare appeared to be more noticeable during wet-weather conditions, further limiting the times at which participants felt comfortable driving.

I can't drive much at night anymore. There's glare. (P05)

I'd prefer not to drive on rainy days. I can't see as clearly as before. (P09)

Usually, I would avoid driving at night because of my astigmatism. I also would not drive in rain. (P10)

In tandem with sensory changes, age-related cognitive changes were also described as affecting spatial navigation. Participants reported occasional episodes of spatial disorientation or difficulty recalling routes, including in familiar areas, which reduced their confidence in travelling independently.

We always go there, so I knew the road. Then suddenly I realised, 'Where am I?' But I couldn't remember. (P03)

Age-related sensory and cognitive changes were also associated with reduced confidence in driving. Built-environment features that require greater cognitive processing, such as dense traffic, complex multi-junction interchanges, and frequent traffic signals, were described as increasing the demands of driving and contributing to self-imposed travel restrictions.

I would avoid driving to places where I am not familiar with the road. (P02)

I don't drive much anymore. I can't stand anymore with the traffic jammed, traffic light, and junctions here and there. (P15)

This reduction in travel extended beyond transport limitations and affected opportunities for social and family interactions. Concerns about navigating complex road infrastructure, such as multi-level flyovers, contributed to reduced independent travel to participants' hometowns, thus limiting their opportunities for family visits.

I became terrified to drive far or pass the flyover. I didn't even go back to my hometown for two years now unless someone brings me there. (P14)

(c) Ageing-Related Physical Exertion and Post-Transit Fatigue

Beyond localised musculoskeletal pain, reduced stamina and increased susceptibility to fatigue were also described as affecting participants' travel frequency. The physical effects of travel sometimes extended beyond the journey itself, with some participants requiring periods of rest and recovery that contributed to reduced trip frequency.

I also easily get tired and sleepy. Before this, I don't have such a problem. Nowadays, I don't drive far distances at night because I easily got sleepy. (P10)

I easily get tired nowadays. After 30 min of doing things, I have to take a break. I don't want to travel much anymore. . . I would feel tired for two days after a long trip. (P12)

This fatigue was also associated with changes in travel mode to maintain out-of-home mobility. When long-distance driving became physically difficult, some older adults described using public transport services to maintain contact with family and other distant social networks.

I no longer want to drive long distance much anymore. I can't stand the driving; I feel tired and sleepy. Last month, instead of driving, we took a bus to Johor Bahru. (P09)

(d) Retirement and the Reshaping of Daily Mobility Routines

The transition from active employment to retirement represented an important change in participants' daily mobility routines. For some participants, leaving the workforce was associated with a reduction in mandatory travel frequency. Their travel became more concentrated around local community and religious activities.

I spent my time mostly at home. I rarely go out. If I ever go out, it is for surau or grocery shopping. (P10)

However, this transition was also associated with reduced interest in discretionary activities such as shopping and leisure trips. Participants expressed limited interest in additional travel activities and a preference for a more localised life space, suggesting that the availability of additional transport options may not necessarily increase their travel frequency.

I rarely want to go out anymore, like to the shopping mall, as I don't feel the need to go there. . . Even if there are new trains, buses, or e-hailing services here, I don't think I'd travel any more than now. (P12)

Usually, I just stay at home. I just go to the surau, masjid, religious class, and community activities. (P13)

3.2.2. Theme 2: Transport and Environmental Mobility Barriers

While intrinsic factors related to chronic health conditions may influence an individual's physical capacity, extrinsic features of the urban built environment and transport networks also affect the feasibility of travel. Infrastructure design, traffic congestion, public transport accessibility, and behavioural factors were described as influencing participants' travel frequency.

(a) Road Infrastructure: Road Conditions, Configurations, and Parking Deficits

Road infrastructure and localised maintenance issues were frequently identified as environmental factors affecting participants' mobility and driving confidence. Participants described how poorly configured intersections, ongoing roadwork, and degraded road surfaces affected their travel experience and contributed to decisions to avoid certain trips.

> *When there are a lot of junctions, I feel uncomfortable driving around.* (P02)

> *Here, they complete construction; they dig a hole there. Then, they complete construction there and dig a hole here. They have no clear plan for construction work.* (P05)

> *The road here is not smooth and has potholes. It is a one-lane road. Because of its narrowness, the motorcyclists tend to drive a bit to the middle of road.* (P14)

These conditions were further compounded by limitations in road maintenance, such as insufficient or widely spaced street lighting. Poor night-time visibility raised safety concerns and limited participants' willingness to travel after dark.

> *The street lights are insufficient. They are placed too far apart. It's quite dark there at night, so I don't really go out at night.* (P10)

(b) Traffic Conditions and Spatial Constraints

Traffic congestion was described as a source of stress, leading some participants to cancel medical appointments or postpone discretionary trips, particularly during holiday periods.

> *Once, I need to go to Hospital Kuala Lumpur. But because of the very bad traffic at the time, I cancel the plan.* (P01)

> *I cancel my plan and choose to stay at home because of stress from traffic congestion, especially during the holiday and festive seasons.* (P09)

Furthermore, participants described increased traffic volume associated with urbanisation as affecting their confidence when driving. This contributed to more localised travel patterns and reluctance to travel to more distant destinations.

> *Sometimes I feel reluctant to go to my child's house because of the distance and traffic jams.* (P10)

> *I don't go back during Eid but only afterward. I am concerned about the heavy traffic, risk of car breakdowns and accidents.* (P19)

> *The number of cars has increased tremendously. The roads are congested from morning until night. I'm not as confident about driving as I used to be.* (P20)

(c) Erratic Behaviour of External Road Users and Safety Vulnerability

The behaviour of other road users was described as contributing to feelings of vulnerability while driving. Participants highlighted driving behaviours among commercial logistics and food delivery motorcyclists that they perceived as unsafe or inconsiderate. Participants attributed some of these behaviours to delivery time pressures and reported that riders sometimes occupied narrow lanes, followed closely behind slower vehicles, or

used their horns against slower elderly drivers. These experiences contributed to feelings of stress while driving, causing immense psychological stress.

> *The Grab food delivery motorcyclists have to meet delivery time targets, so they sometimes ride very dangerously. When you drive a bit slowly, they honk at you because the road is narrow and they want to move faster.* (P05)

(d) Transportation Costs and Post-Retirement Economic Readjustment

Financing transport on a fixed, post-retirement income introduces financial constraints that may limit trip frequency. Participants described needing to consider the costs of fuel, toll fees, and vehicle maintenance when planning trips, which contributed to reduced long-distance travel and discretionary social visits.

> *I have to think carefully before making any trips, mainly because of transportation costs. I face more financial constraints now compared to when I was still working.* (P07)

(e) Transport Accessibility: The Urban–Suburban/Rural Transit Divide

Participants frequently described long distances between residential areas and essential healthcare or commercial services, which made non-motorised travel difficult or impractical.

> *I always use my car to get around. All places are too far to reach on foot from my home.* (P09)

When age-related declines lead to driving cessation, the lack of accessible transport options was associated with reduced out-of-home trip frequency. Participants who could no longer drive described emotional distress and reduced opportunities to participate in religious and community activities, particularly when alternative transport options were limited.

> *Since I stopped driving, I can't go to the masjid as often as before. . . I have to rely on others to get around. It is stressful not being able to move around as freely as before.* (P13)

The impact of driving cessation was influenced by the availability and geographic distribution of public transport options. Participants in urban areas described greater access to multimodal transport infrastructure.

> *I am really satisfied with public transport. . . I like using the commuter or LRT.* (P01)

Yet, some participants still described physical challenges that limited the frequency with which they used public transit.

> *I had to change trains twice and walk quite a bit between stations, so the journey took a while. Besides, it was tiring because I had to climb the stairs. The lifts and escalators were always crowded, especially during peak hours.* (P09)

> *The train service is not elderly-friendly. The system uses coins and is highly computerised, and the multi-level stations make it difficult for us to use the service.* (P14)

Conversely, participants in suburban and rural areas described more limited public transport infrastructure. Buses, taxis, and e-hailing services were reported to have limited availability in these areas. These transport and infrastructure limitations contributed to greater reliance on private vehicles for accessing essential destinations, which may present challenges when vehicles were unavailable or when participants' ability to drive declined.

> *This area lacks public transport, and I think it is much needed. I can feel my driving ability declining. If my car were to break down, the only option I would have is to call Grab for transport, as taxis and buses don't come into this area.* (P15)

(f) Public Transit Acceptability and Behavioural Familiarity

Beyond physical access, participants also described practical challenges associated with using public transit. Fixed-route bus services may require passengers to walk some distance from drop-off points to their final destinations, making them less convenient than the point-to-point travel offered by private cars or motorcycles.

> *If I take the bus, the drop-off point might be far from my destination, so I would have to walk a long distance. But that isn't an issue when I ride a motorcycle.* (P07)

Finally, some participants described limited familiarity with public transit systems after many years of relying primarily on private vehicles. This unfamiliarity was associated with concerns about navigating public transit and may have discouraged some participants from using public transport even when it was available.

> *After I bought my car, I no longer take public transport. I used to have to wait for hours for a bus to get to the city.* (P11)

> *I don't take buses, trains, taxis, or e-hailing services. I don't know how to take the bus. I don't know where it stops. . . I'm afraid I might get lost, or end up at the wrong bus stop, or have to walk far to reach my destination. I prefer to drive myself around.* (P19)

3.2.3. Theme 3: Social Support and Dependency in Mobility

The social environment also influenced participants' mobility. Informal networks of family members, friends, and neighbours provided support for accessing healthcare and maintaining participation in social activities. At the same time, caregiving responsibilities and household asset constraints were described as factors that could limit participants' mobility.

(a) Intergenerational and Peer Mobility Support

When physical environments presented mobility challenges and participants experienced reduced confidence in driving, informal family support became an important source of transportation assistance. Multi-linked road systems, complex highway flyovers, and intricate junctions were described as challenging to navigate, leading some participants to rely on their children for regional trips.

> *If I want to go to KL, my child will drive me there. . . There are so many junctions, and I'm terrified of driving there even though I've been there numerous times before.* (P11)

At the destination level, limited parking availability at medical facilities and commercial centres was described as a barrier to access. Participants noted that the lack of designated parking for older adults sometimes required them to rely on family members for drop-off, particularly for healthcare visits.

> *Parking is a major issue [at the hospital]. For convenience, I asked my child to drive me there.* (P01)

Furthermore, family members provided navigational support during travel. For participants who experienced difficulties with spatial memory or were less familiar with digital navigation applications (e.g., Waze), having a family member accompany them during travel provided additional support for navigating unfamiliar or complex routes.

> *I can't remember the routes to distant places. I don't know the directions there [to Hospital Putrajaya], and I don't know how to use Waze. So, I need someone beside me to guide me.* (P12)

This familial support varied according to the distance and complexity of travel. Spouses were more commonly involved in local and short-distance trips within familiar areas, while adult children provided support for more complex or longer-distance journeys across the region.

If I need to go to the market, my husband will drive me there. I only drive short distances around the village. (P12)

Usually, my kids would drive me if we want to go back to our hometown. (P15)

Beyond immediate family, friends and neighbourhood networks also provided social support for maintaining community participation. Travelling with friends enabled participants to remain involved in religious activities and community events.

If I really need to go to the city, I would tag along with others. For example, I will be going to an event there with my friends later today. (P14)

(b) The Caregiver Mobility Burden and Asset Reallocation

Conversely, social relationships could also constrain mobility when participants were responsible for providing care rather than receiving support. Participants who cared for highly dependent family members described reduced travel frequency and fewer opportunities to participate in discretionary community activities.

My wife is on dialysis, so whenever we have to travel, I have to carry a lot of things, including dialysis fluid. As a result, we barely go out anymore. (P07)

Participants' independent mobility was also influenced by the sharing and reallocation of household assets among family members. In some cases, participants shared their vehicles with their children, reducing their access to independent travel and contributing to lower travel frequency as household transport needs were accommodated.

He [son] has just finished his studies and started working, so he uses my car a lot. It's harder for me to get around these days. (P12)

Collectively, the findings indicate that late-life mobility was influenced by interconnected personal, environmental, and social factors. Functional limitations, chronic health conditions, transport barriers, and challenging traffic environments were reported to reduce travel frequency and independent mobility among older adults with chronic morbidity. At the same time, informal social support networks helped address some of these mobility challenges by facilitating access to essential destinations and supporting continued participation in community activities.

3.3. Integration of Quantitative and Qualitative Findings

The joint display (Table 7) integrates the quantitative and qualitative findings. Qualitative data provided contextual explanations for most significant factors identified in the regression model, particularly age, gender, driving status, bus stop proximity, and mobility satisfaction.

Overall, the integrated findings suggest that community mobility is shaped by the interaction between functional capacity, transport environments, and social support systems.

Table 7. Joint display of quantitative and qualitative findings on factors associated with trip frequency.

Quantitative Finding	Qualitative Explanation
Advancing age ($\beta = -0.103$, $p = 0.001$)	Age-related sensory decline, fatigue, and reduced driving confidence led participants to restrict travel and avoid challenging environments.
Gender (Male) ($\beta = 1.056$, $p = 0.020$)	Women more frequently relied on spouses or adult children for transportation, particularly for healthcare and longer-distance trips.
Formal education ($\beta = -2.888$, $p < 0.001$)	No direct qualitative explanation emerged.

Table 7. *Cont.*

Quantitative Finding	Qualitative Explanation
Driving status (Still driving) ($\beta = 1.059$, $p = 0.023$)	Driving was closely associated with autonomy, healthcare access, and continued social participation.
Presence of bus stop near home ($\beta = -1.040$, $p = 0.007$)	The use of public transport was hindered by poor walkability, extended waiting times, and a lack of familiarity with the system, despite its physical availability.
Mobility satisfaction ($\beta = 0.714$, $p = 0.043$)	Satisfaction reflected perceived independence, transport convenience, environmental safety, and family support.

4. Discussion

4.1. Overview and Structural Adaptive Mobility

Participants averaged five trips per week, indicating that many older adults with chronic morbidity remained engaged in out-of-home activities despite chronic health conditions. Rather than complete mobility withdrawal, the findings suggest a pattern of adaptive mobility in which essential and meaningful trips, particularly to places of worship, neighbourhood shops, markets, community centres, and healthcare facilities, were selectively maintained. Consistent with the WHO ICF framework, mobility in later life appears to reflect the interaction between health status, environmental conditions, and social circumstances rather than disease burden alone.

Particularly, private vehicles were found to be the dominant mode of transportation across most destination types, whereas public transport accounted for less than 5% of trips across all destinations. The strong reliance on private vehicles observed in this study appears to reflect both limitations in public transport usability and adaptive travel preferences among older adults, rather than a single underlying factor. Qualitative findings indicated that participants preferred cars or motorcycles partly because public transport was not practically accessible from their residential areas, particularly among those living in suburban or residential areas with limited access to transit services. Even when public transport was available, participants described long distances to transit nodes, prolonged waiting times, stairs, crowded lifts at stations, and inconvenient walking during transfers as barriers that made public transport less practical for routine travel. These findings suggest that physical proximity to a transport facility does not necessarily translate into effective or convenient accessibility, particularly for older adults with reduced walking capacity or functional limitations.

At the same time, the interviews also indicated that private vehicle use was not driven exclusively by dissatisfaction with public transport. Some participants described adapting their travel behaviour after retirement by reducing their overall travel range and limiting trips to destinations within their immediate life-space. Within this more spatially constrained pattern of mobility, driving or travelling by private vehicle provided a direct and flexible means of reaching necessary destinations without the waiting, transfers, walking, and other operational demands associated with public transport. Thus, the observed car dependence may represent a combination of constrained public transport usability and self-adaptive travel behaviour, whereby older adults retained private vehicle use for the trips they continued to make while simultaneously reducing the need for longer-distance travel after retirement. These findings highlight that improving public transport uptake among older adults may require not only greater spatial availability of services but also attention to the entire journey experience, including access to transit nodes, waiting conditions, vertical circulation, transfers, and pedestrian connectivity.

This pattern is broadly consistent with previous evidence among older adults in Malaysia. A study found that only one-quarter of older adults used flexible transport modes

involving both public and private transportation, and a higher burden of comorbidities was significantly associated with reliance on others for transportation and walking [45]. Similarly, a study of older adults in George Town and Malacca found heavy reliance on private transportation, with differences in public transport use between the two cities suggesting the influence of local transport environments [30]. Furthermore, another local study conducted in Selangor and Kedah reported that over three-quarters of participants were active drivers who engaged in self-regulatory driving practices to adapt to age-related physical, behavioural, and psychological changes [38]. These findings underscore that private vehicles remain an important component of mobility in later life in Malaysia, while the use of alternative modes may depend on both individual circumstances and local environmental and transport conditions. The use of private vehicles offers greater convenience, direct door-to-door access, flexibility, and personal autonomy, particularly for older adults managing chronic morbidity when physical endurance or walking capacity is limited or when access to public transport is difficult [26].

Advancing age was associated with lower trip frequency, which qualitative findings linked to sensory decline, musculoskeletal discomfort, fatigue, and reduced driving confidence. Participants frequently restricted travel to familiar routes and avoided night driving, heavy traffic, adverse weather, and complex road networks. Age-related declines in muscle strength, balance, sensory and cognitive function, compounded by chronic disease and medication effects, are known to increase fatigue, pain, fall risk, and mobility-related anxiety [13,46,47]. These findings strongly align with Lawton's Environmental Docility Hypothesis, which posits that as individual functional capacity declines, older adults become disproportionately vulnerable to the structural friction of their surrounding environment. The self-imposed spatial boundaries observed in this study reflect a protective coping mechanism against physical fatigue, sensory limitations, and perceived accident risks, mirroring global gerontological trends, where shrinking life-space mobility serves as a precursor to declining independence and frailty [48,49].

In addition, gender was also associated with trip frequency. Qualitative findings indicated that mobility remained shaped by traditional household transport roles, with men commonly acting as primary drivers, especially for complex regional or long-distance trips, while women relied more on spouses or children for medical and discretionary travel. This suggests that the lower trip frequencies observed among older women do not merely reflect physical limitations, but also differences in independent mobility and driving opportunities across the life course. Disproportionately greater mobility restrictions experienced by older women with chronic morbidity are partly attributable to the combined effects of post-menopausal osteoporosis, osteoarthritis, and sarcopenia, alongside heightened fall risk and fear of falling [50,51]. Similar findings have been reported in the U.S. and U.K., where older women experience greater transport difficulties and mobility restrictions despite living in settings with more developed transportation systems, highlighting a critical point of vulnerability within patriarchal transport dynamics [52,53].

Moreover, although educational attainment was not explicitly discussed during the qualitative interviews, the significant inverse association between educational attainment and trip frequency observed in the quantitative analysis suggests its potential role in socioeconomic circumstances, health-related behaviours, and daily activity patterns. Several plausible life-course mechanisms may hypothetically explain this quantitative finding. Older adults with higher educational attainment may benefit from greater lifetime financial security and earlier voluntary retirement, enabling them to adopt health-protective behaviours that intentionally reduce unnecessary physical strain or symptom exacerbation when managing chronic morbidity [54–56]. Conversely, individuals without formal education may be compelled to maintain higher trip frequencies out of economic necessity,

such as informal employment, localized trade, or essential caregiving duties, resulting in sustained travel out of obligation despite chronic health constraints [57,58].

Furthermore, driving status emerged as a key factor associated with trip frequency, highlighting the continued reliance on private vehicles in the Klang Valley. Qualitatively, independent driving represents far more than a transport mode. It is a vital psychological tether to autonomy, healthcare access, and community-level social capital. Driving cessation triggers an abrupt shift from self-sufficiency to forced dependency, which is often accompanied by emotional distress and involuntary withdrawal from vital religious and social networks. The impact was particularly pronounced in suburban areas with limited public transport, where driving remained essential for maintaining community mobility. Conversely, older adults living in urban areas could still maintain some degree of mobility through the availability of public transportation. This reinforces the notion that in hyper-automobilized middle-income nations, driving functions as the primary mechanism for enabling older adults to meet routine healthcare, daily living needs, and community participation in later life while buffering the functional limitations imposed by chronic morbidity.

While the presence of a bus stop near the home was inversely associated with trip frequency, the qualitative data revealed a critical caveat: spatial availability does not necessarily equate to transport usability or acceptability. Although public transport infrastructure may be available within a given spatial radius, participants reported long and physically demanding walking distances to final destinations, prolonged waiting times, overcrowding, and multiple transfers, which reduced the practical usability of public transport despite its physical presence. Furthermore, studies of Malaysian pedestrian environments have highlighted that transit nodes frequently lack age-friendly micro-infrastructure, such as continuous shaded walkways, step-free paths, and traffic-calming measures, which may constrain outdoor mobility, particularly under hot daytime conditions [59,60]. The total absence of pedestrian infrastructure, narrow sidewalks, the presence of large vehicles, and higher pedestrian and traffic volumes in the area further contributed to concerns about road safety and fear of falling among older adults [22]. Taken together, these findings suggest that older adults living near bus stops may limit their trip frequency when they face difficulties navigating the surrounding pedestrian and transport environments, particularly when they lack access to private transportation. In contrast, those with access to private vehicles may rely primarily on driving to overcome some of these environmental and service-related barriers [38].

Crucially, most participants travelled predominantly in the morning, suggesting that the trips were largely necessity-driven and centred around healthcare appointments, market errands, and other essential activities rather than discretionary trips. However, these peak travel periods often coincided with overcrowded buses and transit congestion, which further reduced the perceived convenience and comfort of public transport use among older adults [19]. A similar observation was reported among the broader Malaysian population, where comfort and ease of use were identified as the primary determinants of public transport utilization, superseding spatial availability alone [61]. This finding supports growing evidence that transport accessibility in later life should be conceptualised beyond geographic proximity alone and incorporate perceived usability, convenience, and environmental comfort [62].

Finally, higher mobility satisfaction was associated with greater trip frequency, serving as an affective reflection of an individual's environmental fit. Although not explicitly discussed during qualitative interviews, mobility satisfaction appeared closely related to perceptions of independence, safety, transport convenience, and social support. Participants who retained driving ability or received family support generally reported greater

confidence in travelling and continued participation in healthcare, social, and religious activities. Conversely, participants experiencing driving anxiety, transport barriers, or caregiving burdens described frustration, dependency, and reduced willingness to travel. These results align with prior research establishing that transport satisfaction is heavily shaped by perceived comfort, convenience, safety, and service quality [63]. Moreover, an earlier study indicates that older adults' satisfaction with local transport systems is intrinsically linked to their neighborhood satisfaction and sense of community [64]. When transport infrastructure functions effectively, it fosters social inclusion, prevents isolation, and enhances overall physical and psychological well-being [64]. Viewed through the ICF framework, mobility satisfaction reflects the degree to which older adults can adapt their functional capacities to surrounding environmental demands, underscoring the necessity of age-friendly transport systems and supportive community environments in sustaining later-life mobility.

4.2. Policy Implications

As Malaysia approaches aged-nation status by 2030, these findings provide evidence to support the implementation of the AFC framework within highly motorised urban settings.

The predominance of necessity-driven travel, particularly for healthcare, shopping, and religious activities, highlights the importance of decentralised and age-friendly urban planning. Locating primary healthcare services, community facilities, and essential amenities within residential neighbourhoods may reduce travel burden, improve healthcare accessibility, and support continued community participation among older adults with chronic conditions.

The findings further reveal that the physical presence of public transport infrastructure does not necessarily translate into effective mobility. Age-friendly transport planning should therefore extend beyond geographic accessibility to include walkability, safety, comfort, and usability. Ensuring barrier-free pedestrian networks, sheltered walkways, seating areas, safe road crossings, and accessible transit vehicles may enhance their public transport use. Demand-responsive and community-based transport services may also help address mobility needs, particularly for those with functional limitations or limited access to private vehicles.

Given the importance of driving for maintaining independence and community participation, road and parking environments should be designed to accommodate age-related sensory and physical changes. Enhanced street lighting, use of retroreflective signboards and weather-resilient lane markings, well-maintained road surfaces, and conveniently located priority parking, especially at hospitals, banks, and public facilities, may improve travel confidence and reduce mobility barriers. Collectively, these measures support a more age-friendly mobility system that promotes independence, healthcare access, and social participation in later life.

5. Conclusions

This study examined community mobility and travel behaviour among older adults with chronic morbidity in the Klang Valley. Quantitative findings showed that weekly trip frequency was significantly associated with age, gender, educational attainment, driving status, bus stop availability near home, and mobility satisfaction. Older age was associated with lower trip frequency, whereas being male, actively driving, and reporting higher mobility satisfaction were associated with more frequent trips. The negative association between presence of a bus stop near home and trip frequency suggests that physical proximity to public transport alone may not translate into greater mobility. Qualitative findings complemented these results by illustrating how sensory decline, musculoskeletal

discomfort, fatigue, transport barriers, and reliance on social support shaped participants' everyday mobility experiences.

Taken together, the findings indicate that community mobility among older adults with chronic morbidity is shaped by the interaction of individual characteristics, functional challenges, transport circumstances, and perceived mobility conditions. The findings are consistent with the ICF perspective that mobility reflects the interaction between individual capabilities and environmental factors. The qualitative accounts also suggest that continued access to private transport, particularly driving, can facilitate participants' ability to reach healthcare, social, and other everyday destinations, while transport limitations may increase dependence on others.

These findings highlight the need for mobility planning that considers not only the physical availability of transport infrastructure but also its usability and the functional circumstances of older adults with chronic morbidity. In the Malaysian context, coordination between public health, transport, and urban planning sectors may help address mobility barriers and support continued access to essential destinations and participation in community life among this growing population. As Malaysia moves towards aged-nation status, supporting mobility among older adults with chronic morbidity may help sustain their independence, social participation, and healthy ageing in later life.

Strengths and Limitations

This study has several notable strengths. First, the explanatory sequential mixed-methods design enabled a comprehensive examination of community mobility by integrating quantitative factors with qualitative insights, providing a deeper understanding of the mechanisms underlying travel behaviour. Second, the study addressed an important evidence gap by focusing on older adults with chronic morbidity in an urban Malaysian setting, a population that remains underrepresented in mobility research. Third, the inclusion of personal, health, transport, environmental, and social factors allowed mobility to be examined from a multidimensional perspective consistent with the WHO ICF and AFC frameworks. Finally, the use of the newly developed OACMSI enabled the assessment of subjective mobility experiences alongside objective mobility outcomes.

However, several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inference; therefore, longitudinal studies are needed to examine changes in mobility trajectories over time, particularly during periods of health decline. Second, the inclusion of participants aged 55–59 years should also be considered when interpreting the findings. Individuals in this age group may differ systematically from older participants in terms of health status, functional capacity, employment, access to private vehicles, and transportation needs. Consequently, the mobility characteristics observed in the overall study population may not fully represent those of adults in more advanced old age. Third, while a multi-stage cluster sampling approach was used, the sampling weights were not applied because individual-level selection probabilities were not sufficiently documented. These considerations should be taken into account when interpreting the findings.

Fourth, reliance on self-reported measures of travel behaviour, chronic conditions, and functional status may have introduced recall and social desirability biases. Particularly, the primary mobility measures were based on participants' retrospective reports of their usual travel behaviour before the implementation of COVID-19-related movement restrictions, rather than contemporaneous behaviour during the data-collection period. Given the interval between the reference period and data collection, participants may have had difficulty accurately recalling their usual trip frequency, destinations, and transportation modes. Therefore, the findings should be interpreted with consideration of the retrospective

nature of the measures. Similarly, although data saturation was achieved, the purposive sampling approach may have limited the representation of certain perspectives. Future studies should incorporate objective measures such as GPS tracking, travel diaries, and standardised physical performance assessments.

Fifth, environmental measures focused on spatial availability rather than functional accessibility and therefore did not capture micro-environmental characteristics such as service frequency, overcrowding, seating availability, pedestrian safety, and thermal comfort. Likewise, driving status was measured categorically and did not account for variations in driving frequency, confidence, travel distance, or self-imposed driving restrictions. Sixth, the preliminary EFA was conducted using a relatively small pilot sample of 35 participants, which may limit the stability and generalisability of the identified factor structure. Although the proposed structure was subsequently examined using CFA in the larger main study sample (N = 374), the model demonstrated improved but not uniformly optimal fit, and the standardized factor loadings varied across items. Therefore, the current findings provide preliminary evidence for the use of the overall OACMSI score rather than definitive validation of its underlying factor structure. Further studies using larger and independent samples are warranted to confirm the dimensionality, structural validity, and measurement properties of the OACMSI. Seventh, because the study was conducted in the highly urbanised and car-dependent context of the Klang Valley, the findings may not be generalisable to rural settings or regions with different sociocultural and transport contexts. In addition, the qualitative sample overrepresented active drivers (80.0%) relative to the quantitative survey (57.8%), potentially placing greater emphasis on experiences within Malaysia's transport context, which is characterised by high reliance on private vehicles. This composition provided rich contextual insights into driving self-regulation and barriers to transit adoption among older adult drivers, while non-drivers (20.0%) captured mobility limitations and transport dependence. Finally, psychosocial factors such as fear of falling, perceived safety, and mobility self-efficacy were not assessed. Given their potential influence on mobility behaviour, the omission of these factors may have limited a more comprehensive understanding of the pathways underlying community mobility in later life.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia (Jawatankuasa Etika Universiti untuk Penyelidikan Melibatkan Manusia (JKEUPM)), with reference number JKEUPM–2021-909 and approved on 11 April 2022.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original data presented in the study are openly available at https://drive.google.com/file/d/1GrQCTJHMB0NW3jX3Ng3edOXYK0BebT35/view?usp=drive_link (accessed on 29 July 2026).

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Abbreviations

The following abbreviations are used in this manuscript:

WHO	World Health Organization
ICF	International Classification of Functioning, Disability and Health
AFC	Age-Friendly Cities
OACMSI	Older Adults' Community Mobility Satisfaction Index

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