International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 3, 572-590, 2026
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: Kajian Pendidikan Dan Kesejahteraan Komuniti

Environmental Barriers and Mobility Dependency among Older Adults in Urban Malaysia: An Ordered Logistic Regression Analysis

Mohamad Sidik Mahir[1*], Nurhafizul Abu Seri[2]

[1] School of Social Sciences, Universiti Sains Malaysia, Penang, Malaysia.
[2] School of Geography, Universiti Sains Malaysia, Penang, Malaysia.

*Corresponding Author: muhdsidik@yahoo.com

Received: 3 January 2026 | Accepted: 1 April 2026 | Published: 15 May 2026

DOI: https://doi.org/10.55057/ijares.2026.8.3.42

Abstract: *Population ageing raises growing concerns over mobility and independence, particularly in rapidly urbanising contexts. While existing studies often emphasise health factors, limited attention has been given to the role of environmental barriers in shaping mobility dependency. This study examines how built environment constraints and health-related limitations influence mobility dependency among older adults in urban Malaysia. Using survey data from 450 respondents, an ordered logistic regression model is applied to analyse three levels of dependency. Environmental barriers are measured through composite indices of pedestrian walkways, crossings, building accessibility, and public space quality, while health factors include walking difficulty, visual impairment, chronic illness, and use of mobility aids. The results indicate that pedestrian walkway barriers significantly increase the likelihood of higher mobility dependency. Walking difficulty and use of mobility aids also show strong positive effects. In contrast, other environmental and general health factors are not statistically significant. Overall, the findings highlight the critical role of pedestrian-level environments in shaping mobility outcomes, underscoring the need for age-friendly urban planning that prioritises safe and accessible walking infrastructure.*

Keywords: Older adults, Mobility dependency, Pedestrian barriers, Pedestrian environment, Age-friendly cities, Ordered logistic regression

---

1. Introduction

Population ageing represents one of the most profound demographic transformations of the twenty-first century, carrying significant implications for urban mobility, social inclusion, and overall quality of life. As the proportion of older adults continues to increase—particularly in rapidly urbanising countries—maintaining mobility and independence in later life has emerged as a critical policy and planning concern (Jopp et al., 2016; Ahacic et al., 2007). For older adults, mobility extends beyond physical movement; it underpins access to healthcare services, participation in social and community activities, fulfilment of daily needs, and engagement in active ageing. Consequently, declining mobility or increasing dependency on others for movement is frequently associated with heightened risks of social isolation, deteriorating physical and mental health, and reduced well-being (Plummer & Findley, 2012; von Renteln-Kruse et al., 2011).

International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 3, 572-590, 2026
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: Kajian Pendidikan Dan Kesejahteraan Komuniti

In urban environments, the relationship between ageing and mobility is particularly complex. While cities often offer closer proximity to essential services and amenities, they are simultaneously characterised by dense development patterns, high traffic volumes, and infrastructure predominantly designed to serve economically active populations. Such urban characteristics may generate physical and perceptual barriers for older adults, especially those experiencing age-related functional decline (Dzisi et al., 2025; Torabi Kachousangi et al., 2025). Features such as uneven or poorly maintained sidewalks, unsafe pedestrian crossings, inadequate signage, and inaccessible public spaces can transform routine trips into challenging and stressful experiences, even over short distances. As a result, older adults may increasingly rely on family members, caregivers, or companions for mobility, despite residing in environments that are ostensibly well served by urban infrastructure.

A substantial body of literature has documented the influence of health-related factors on mobility outcomes among older adults. Functional limitations—including difficulty walking, visual impairment, and chronic illness—are consistently associated with reduced travel activity, mobility restriction, and increased reliance on assistance (Bahrmann et al., 2010; von Renteln-Kruse et al., 2011). Difficulty walking, in particular, has been identified as a key constraint affecting both pedestrian mobility and access to other transport modes, thereby limiting independent travel. However, growing evidence suggests that health status alone does not fully explain mobility dependency in later life. Rather, mobility outcomes are shaped by the interaction between individual physical capabilities and the characteristics of the surrounding built environment (Jopp et al., 2016). Older adults with mild functional limitations may remain largely independent in environments that are supportive and accessible, yet become highly dependent in settings characterised by pedestrian-level and accessibility barriers.

Despite increasing recognition of environmental influences, empirical research explicitly examining environmental barriers as determinants of mobility dependency remains limited, particularly in developing and middle-income countries. Existing studies have predominantly focused on travel frequency, mode choice, or overall mobility levels, with considerably less attention given to dependency as an outcome in its own right (Ahacic et al., 2007; Plummer & Findley, 2012). Moreover, research that incorporates environmental factors often relies on broad neighbourhood-level indicators, overlooking pedestrian-scale barriers—such as sidewalk quality, crossing safety, and micro-level accessibility features—that directly shape older adults' everyday mobility experiences. Recent studies emphasise that these pedestrian-level barriers may exert a more immediate and decisive influence on mobility dependency than broader neighbourhood characteristics (Kordrostami et al., 2025).

This gap is particularly evident in the Malaysian context. Malaysia is approaching the status of an ageing nation, with the proportion of older adults projected to rise substantially in the coming decades. While national policies increasingly emphasise active ageing, social participation, and inclusive urban development, empirical evidence on how urban environments facilitate or constrain independent mobility among older adults remains limited. Rapid urban development in Malaysia has not always been accompanied by systematic integration of age-sensitive design and accessibility considerations, potentially exacerbating mobility challenges for older adults residing in urban areas (Dzisi et al., 2025; Torabi Kachousangi et al., 2025). Understanding the determinants of mobility dependency is therefore essential to ensure that urban and transport policies are responsive to the needs of an ageing population.

Against this backdrop, the present study examines how environmental barriers and health-related limitations influence older adults' mobility dependency in urban Malaysia. Mobility dependency is conceptualised as an ordered outcome reflecting increasing levels of reliance on external assistance, allowing for a more nuanced assessment than conventional binary mobility measures. By employing an ordered logistic regression model, the analysis captures graded variations in dependency levels and facilitates systematic comparison of the relative influence of pedestrian-level environmental barriers and health-related factors.

This study contributes to the literature in three important ways. First, it advances understanding of later-life mobility by explicitly examining mobility dependency as a primary outcome rather than a secondary consequence of reduced travel. Second, it highlights the importance of pedestrian-level environmental barriers by providing empirical evidence on how micro-scale built environment features shape mobility dependency among older adults (Kordrostami et al., 2025). Third, it offers context-specific insights from urban Malaysia, addressing a notable gap in a literature that has been dominated by studies from high-income countries. Collectively, these contributions support the development of evidence-based, age-friendly urban policies aimed at promoting independent mobility, social inclusion, and quality of life among older adults.

2. Literature Review

Mobility constitutes a core dimension of active ageing, underpinning older adults' ability to live independently, participate in social life, and access essential services. As individuals age, maintaining independent mobility becomes increasingly critical, yet progressively more vulnerable to the combined effects of physical decline and environmental constraints (Jopp et al., 2016; World Health Organization, 2002). Mobility dependency—commonly defined as reliance on others for movement and travel—has therefore emerged as an important indicator of well-being in later life. Empirical studies consistently associate higher levels of dependency with reduced autonomy, social exclusion, and adverse physical and mental health outcomes, highlighting the need to identify the determinants of mobility dependency among older adults (Plummer & Findley, 2012; von Renteln-Kruse et al., 2011).

A substantial body of research has examined the role of the built environment in shaping mobility outcomes in later life, particularly within urban contexts. While cities often provide closer proximity to services and amenities, they may simultaneously expose older adults to physical and perceptual barriers that undermine independent mobility (Kordrostami et al., 2025; Clarke & Gallagher, 2013). Pedestrian infrastructure has been shown to be especially influential, given that walking remains the dominant mode of everyday travel among older adults. Features such as sidewalk continuity, surface quality, curb ramps, and pedestrian crossings are repeatedly identified as critical determinants of mobility. Poorly maintained walkways, uneven surfaces, inadequate crossing times, and obstructed paths increase fall risk and perceptions of insecurity, prompting older adults to curtail travel or depend on assistance (Torabi Kachousangi et al., 2025; Herrmann-Lunecke et al., 2022).

Beyond pedestrian infrastructure, the design and accessibility of public spaces and neighbourhood environments further shape mobility behaviour in later life. Public spaces that lack barrier-free access, seating, legible signage, or safe entry points may discourage independent travel even when destinations are geographically proximate (Curl et al., 2020; Cauwenberg et al., 2018; Cerin et al., 2017). Neighbourhood-level conditions—including

International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 3, 572-590, 2026
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: Kajian Pendidikan Dan Kesejahteraan Komuniti

traffic intensity, environmental upkeep, and perceived safety—also influence older adults' confidence in navigating their surroundings. In dense urban environments, high traffic volumes and complex spatial layouts can impose additional physical and cognitive demands, exacerbating mobility challenges and increasing reliance on others (Dzisi et al., 2025; Clarke & Gallagher, 2013).

Health-related factors remain central to understanding mobility outcomes among older adults. Functional limitations—particularly difficulty walking—are consistently identified as among the strongest predictors of reduced mobility and increased dependency (von Renteln-Kruse et al., 2011; Bahrmann et al., 2010). Walking difficulty not only constrains pedestrian movement but also limits access to other transport modes by complicating first- and last-mile connections. Consequently, even well-developed transport systems may fail to support independent mobility when functional capacity is compromised, underscoring the interdependence between individual physical capability and environmental conditions (Jopp et al., 2016).

Sensory limitations, especially visual impairment, have also been examined in relation to mobility in later life, although empirical findings remain mixed. Visual impairment may affect hazard detection, spatial orientation, and confidence in unfamiliar environments, potentially increasing reliance on companions or caregivers (Plummer & Findley, 2012). However, several studies suggest that the impact of visual limitations on mobility dependency is contingent upon environmental accommodation. Supportive features such as adequate lighting, high-contrast signage, and intuitive spatial design may mitigate the effects of sensory decline, enabling some older adults to maintain independence despite visual impairments (Clarke & Gallagher, 2013).

The use of assistive mobility devices represents another important dimension of mobility in later life. Devices such as canes, walkers, and wheelchairs are intended to compensate for functional decline and enhance independent movement. Nevertheless, their effectiveness is closely tied to environmental compatibility. In environments characterised by narrow sidewalks, uneven surfaces, or inadequate curb ramps, mobility aids may become difficult or unsafe to use, potentially increasing rather than reducing dependency (Kordrostami et al., 2025). Empirical evidence indicates that older adults who rely on mobility aids often experience higher mobility restriction in poorly designed environments, highlighting the need to consider both individual adaptations and environmental context when assessing mobility dependency.

Chronic illness is frequently associated with reduced mobility in older age, yet its direct relationship with mobility dependency appears less straightforward. While conditions such as arthritis, cardiovascular disease, and diabetes may constrain physical capacity, several studies suggest that chronic illness primarily influences mobility through functional impairment rather than diagnosis alone (Che Had et al., 2023; Bahrmann et al., 2010). Older adults with well-managed chronic conditions may remain mobile and independent, whereas those experiencing functional decline are more likely to become dependent regardless of specific medical diagnoses. This distinction reinforces the importance of focusing on functional outcomes when examining mobility dependency.

Despite growing recognition of environmental influences, much of the existing literature remains concentrated in high-income countries, with limited empirical evidence from rapidly urbanising, middle-income contexts. In countries such as Malaysia, urban development has progressed rapidly, yet age-sensitive design principles have not always been systematically integrated into planning and transport policies. Moreover, many previous studies rely on binary or continuous measures of mobility, overlooking the ordered nature of dependency that reflects varying degrees of reliance on others (Plummer & Findley, 2012; Ahacic et al., 2007).

In response to these gaps, the present study examines mobility dependency among older adults in urban Malaysia by explicitly incorporating pedestrian-level environmental barriers, neighbourhood conditions, and health-related functional limitations. By conceptualising mobility dependency as an ordered outcome, the study provides a more nuanced understanding of how environmental and health-related factors contribute to escalating levels of reliance on others. This approach offers empirically grounded insights that are directly relevant to the development of age-friendly urban environments and policies aimed at supporting independent mobility in later life.

3. Methodology

3.1 Research design

This study adopts a quantitative cross-sectional research design to examine the factors influencing older adults' mobility dependency in their daily activities. The analysis focuses on how environmental barriers within the built environment, conditions of public spaces, and health-related functional limitations jointly shape mobility dependency among older adults.

Given the ordinal nature of the dependent variable, mobility dependency was classified into three ordered categories—low, moderate, and high dependency. Accordingly, an ordered logistic regression model was employed as the primary analytical technique. This modelling approach is methodologically appropriate as it preserves the inherent ranking of the dependent variable while allowing the simultaneous estimation of multiple explanatory factors influencing increasing levels of mobility dependency (Hayawi et al., 2025; Kleinbaum & Klein, 2010).

The study is guided by a conceptual framework (Figure 1) that integrates environmental barriers, health-related limitations, and residential location. The framework reflects the interaction between individual functional capability and the surrounding built environment in shaping older adults' reliance on others for mobility.

3.2 Data collection

Primary data were collected through a structured questionnaire survey involving 450 older adults residing in urban, suburban, and rural areas. The sample size is adequate for multivariate statistical analysis and ordered regression modelling.

The questionnaire consisted of several sections. The first section captured the frequency of mobility dependency on others, which serves as the dependent variable in this study. Respondents were asked how often they relied on assistance from family members, friends, or others to conduct daily mobility-related activities, such as travelling to shops, healthcare facilities, or social destinations.

Subsequent sections focused on perceived environmental barriers within the built environment. These barriers were operationalised into four composite indices: pedestrian walkway barriers, pedestrian crossing barriers, building accessibility barriers, and public space quality. Each index was constructed using multiple indicators, including uneven or slippery walkways, inadequate pedestrian crossing time, absence of ramps or handrails, poor lighting, open drains, and lack of seating or resting facilities.

3.3 Measurement of environmental barriers

Perceived environmental barriers were measured using a frequency-based response scale designed to capture older adults' regular exposure to mobility-related obstacles in their daily environments. For each indicator related to pedestrian walkways, pedestrian crossings, building accessibility, and public space quality, respondents were asked how often they encountered specific barriers during routine mobility activities.

Response options were categorised into five ordered levels: never encountered barriers, rarely encountered barriers, frequently encountered barriers, very frequently encountered barriers, and not applicable. This scale reflects varying intensities of environmental exposure rather than subjective agreement alone. The inclusion of a "not applicable" category allowed respondents to indicate situations where particular environmental features were not relevant to their daily mobility context.

For analytical purposes, responses were coded to reflect increasing levels of environmental constraint, with higher values indicating more frequent exposure to mobility barriers. Items marked as "not applicable" were treated as missing values during index construction to avoid biasing the measurement of environmental exposure (Reckien, 2018). Composite indices for pedestrian walkway barriers, pedestrian crossing barriers, building accessibility barriers, and public space quality were subsequently generated by aggregating the relevant items, with higher index values representing greater environmental impediments to independent mobility (Broby & Smyth, 2025).

Health-related variables were collected as standalone measures and include difficulty walking, visual impairment, use of mobility aids, and presence of chronic illness. In addition, respondents were categorised by residential location (urban, suburban, or rural) to capture spatial variation in mobility dependency. All responses were coded and prepared for analysis using STATA statistical software.

3.4 Ethical consideration

Ethical standards for social science research involving older populations were strictly observed throughout the study. Participation was entirely voluntary, and respondents were informed of the study objectives, the confidentiality of their responses, and their right to withdraw at any stage without consequence (Rubio, 2022). No personally identifiable information was collected, and all data were used solely for academic research purposes.

3.5 Data analysis

Data analysis was conducted using STATA statistical software. The dependent variable—frequency of mobility dependency on others—was specified as an ordinal outcome reflecting increasing levels of reliance on external assistance, categorised into low, moderate, and high dependency. Given the ordinal nature of this outcome, modelling approaches appropriate for ordered response data were required. Accordingly, both ordered logit regression and ordered probit regression models were initially considered as potential analytical specifications (Reynolds, 2023).

To determine the most suitable model, a formal comparison of model fit was undertaken using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). These information criteria are widely used for model selection in discrete choice and ordinal response models, as they balance model goodness-of-fit against model complexity, with lower values indicating a preferable specification (Sihombing, 2022; Cakmakyapan & Goktas, 2013). The comparison results indicated that the ordered logit model (AIC = 1245.3, BIC = 1310.6) yielded lower AIC and BIC values than the ordered probit model (AIC = 1258.7, BIC = 1324.9), suggesting a superior overall fit. Based on these criteria, the ordered logit model was retained as the primary analytical framework.

Beyond model fit considerations, the ordered logit specification was also preferred due to its interpretability and its widespread application in ageing and mobility research involving graded dependency outcomes. The model preserves the inherent ranking of mobility dependency levels while allowing systematic examination of how explanatory variables shift individuals across ordered categories of reliance.

To enhance interpretability and policy relevance, average marginal effects were estimated for all explanatory variables. Marginal effects quantify the change in the probability of belonging to each mobility dependency category associated with variations in the independent variables, allowing regression results to be translated into substantively meaningful probability changes rather than abstract coefficient estimates (Nguyen, 2025).

The Brant test was then conducted to assess the proportional odds assumption underlying the ordered logistic regression model was assessed using standard diagnostic procedures. The results indicate no substantive violation of this assumption, supporting the appropriateness of the ordered logit specification for analysing graded levels of mobility dependency among older adults (Liu et al., 2023).

Overall, Figure 1 shows the conceptual framework and Table 1 shows a summary of the data on older adults respondents used in this study.

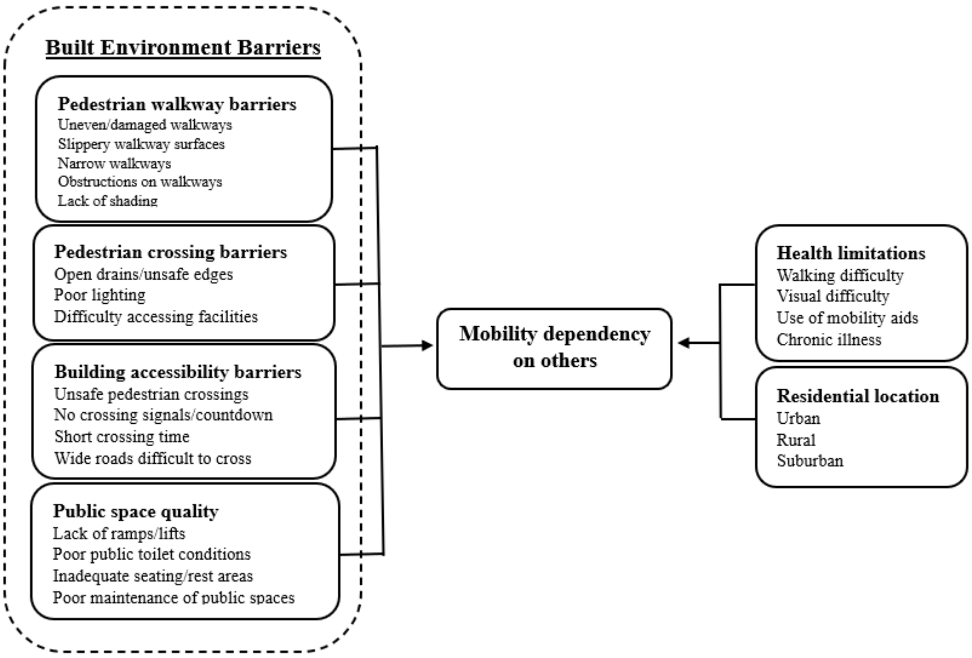

Figure 1: Conceptual framework

Table 1: Summary of data on older adults respondents

Variable description	% per category				
	0	1	2	3	4
Individual attributes					
Age group (1 = 60–64 years, 2 = 65–75 years, 3 = >75 years)		61.78	32.22	6.00	
Sex (1 = female, 2 = male)		56.67	43.33		
Marital status (1 = never married, 2 = married, 3 = others)		3.78	72.00	24.22	
Education level (1 = no education, 2 = primary, 3 = secondary, 4 = tertiary)		5.11	32.44	44.89	17.56
Household attributes					
Household income (1 = no income, 2 = < RM1000, 3 = RM1000–RM4000, 4 = > RM4000)		13.11	22.67	50.00	14.22
Employment status (1 = retired/not working, 2 = working)		66.00	34.00		
Household size (1 = 1–2 persons, 2 = 3–4 persons, 3 = >5 persons)		24.61	31.54	43.85	
Car ownership (1 = no, 2 = yes)		47.11	52.89		
Motorcycle ownership (1 = no, 2 = yes)		61.56	38.44		
Public transport discount card (1 = no, 2 = yes)		70.89	29.11		
Residential location (1 = urban, 2 = rural, 3 = suburban)		88.44	4.22	7.33	
Health condition					
Walking difficulty (1 = no, 2 = yes)		66.67	33.33		
Visual difficulty (1 = no, 2 = yes)		60.44	39.56		
Use of mobility aids (1 = no, 2 = yes)		95.78	4.22		
Chronic illness (1 = no, 2 = yes)		3.78	96.22		
Pedestrian walkway barriers					
Uneven/damaged walkways	44.89	15.78	18.89	11.11	9.33
Slippery walkway surfaces	46.89	18.44	17.78	10.67	6.22
Narrow walkways	52.00	17.56	12.22	8.22	10.00
Obstructions on walkways	45.56	18.00	20.67	7.78	8.00
Lack of shading	46.67	14.89	17.78	11.56	9.11
Pedestrian crossing barriers					
Open drains/unsafe edges	46.44	17.56	14.44	10.89	10.67
Poor lighting	47.56	18.22	15.78	7.56	10.89
Difficulty accessing facilities	46.22	15.56	17.11	10.00	11.11
Building accessibility barriers					
Unsafe pedestrian crossings	15.11	21.11	37.33	16.89	9.56
No crossing signals/countdown	15.33	25.33	32.22	18.44	8.67
Short crossing time	15.11	24.00	34.44	20.00	6.44
Wide roads difficult to cross	15.33	24.22	33.56	20.00	6.89
Public space quality					
Lack of ramps/lifts	14.89	19.11	24.44	25.56	16.00
Poor public toilet conditions	14.22	21.33	28.44	22.89	13.11
Inadequate seating/rest areas	14.44	20.44	20.00	23.11	22.00
Poor maintenance of public spaces	15.33	22.00	27.78	18.67	16.22

4. Results

4.1 Descriptive analysis

4.1.1 Mobility dependency by age group

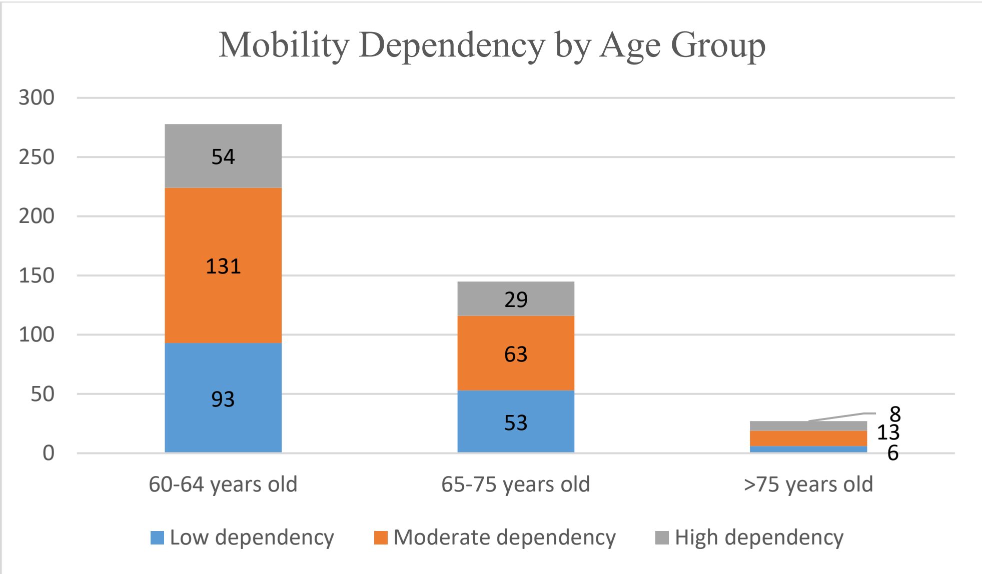

Figure 2: Mobility dependency by age group

Fig. 2 presents the distribution of mobility dependency across age groups. Among respondents aged 60–64 years, the majority fall within the moderate dependency category, followed by low dependency, while only a small proportion report high dependency. A similar distribution is observed among those aged 65–75 years, although the proportion classified under high dependency is slightly higher. In contrast, respondents aged above 75 years exhibit a markedly higher concentration in the high dependency category compared to younger age groups.

4.1.2 Mobility dependency by gender

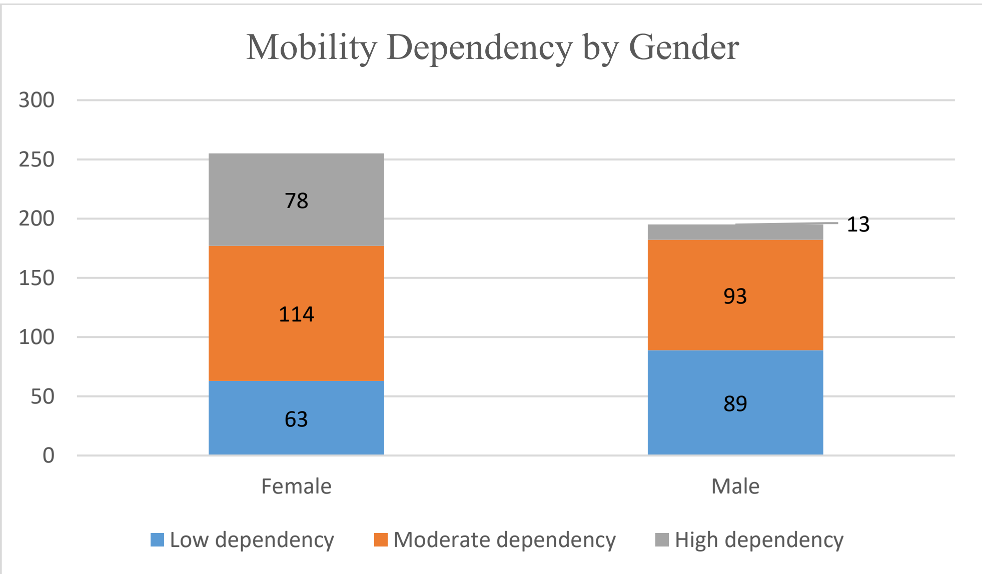

Figure 3: Mobility dependency by gender

Fig. 3 shows the distribution of mobility dependency by gender. Female respondents are more frequently represented in the high dependency category than male respondents. Specifically, a larger number of females report high dependency, while males are more concentrated in the low and moderate dependency categories.

4.1.3 Mobility dependency by household income

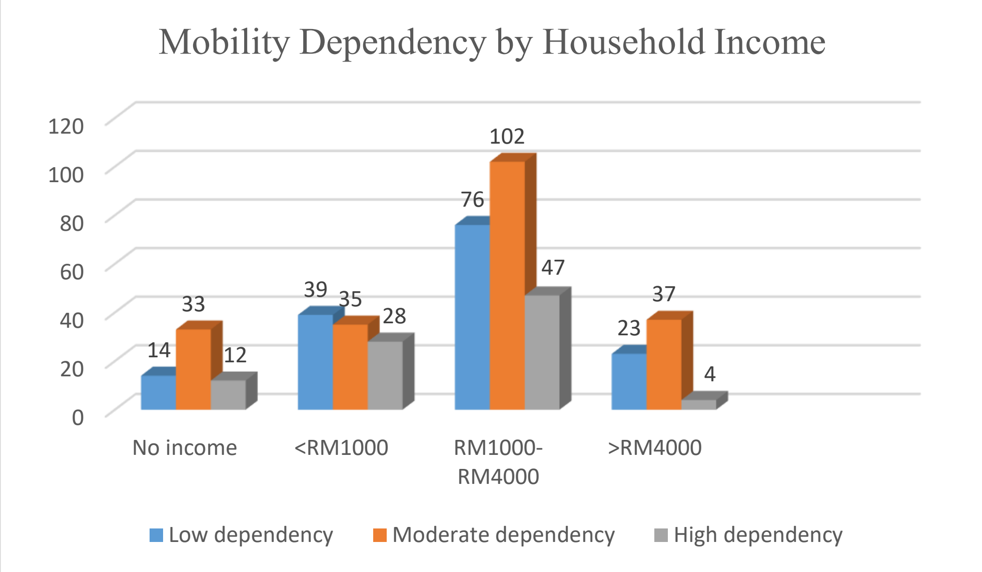

Figure 4: Mobility dependency by household income

Fig. 4 illustrates mobility dependency across household income groups. Respondents in the middle-income category (RM1000–RM4000) constitute the largest share across all dependency levels, reflecting the overall income distribution of the sample. However, respondents in the lowest income category account for a relatively larger proportion of high dependency cases. In contrast, respondents in the highest income category display the smallest proportion of high dependency.

4.1.4 Mobility dependency by car ownership

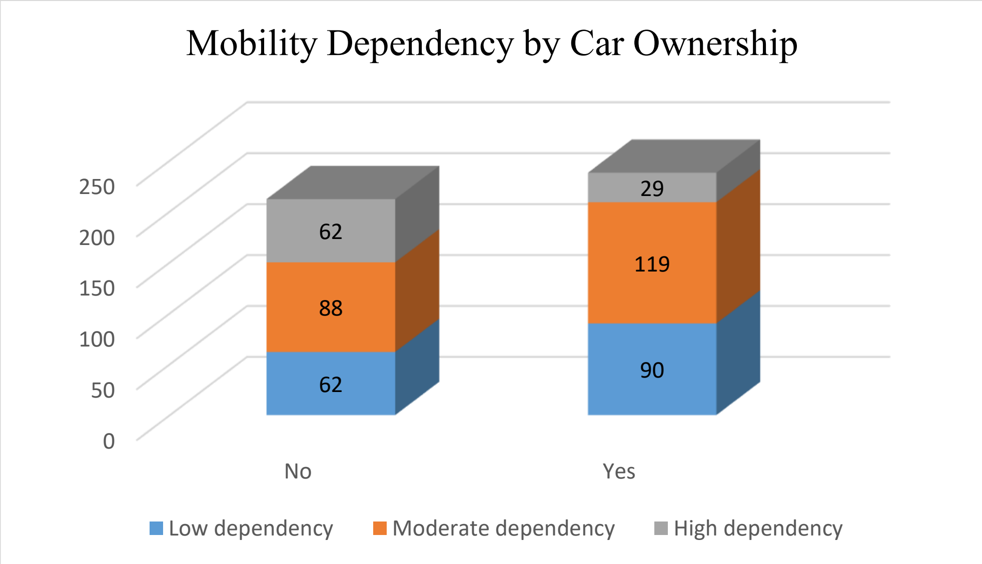

Figure 5: Mobility dependency by car ownership

International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 3, 572-590, 2026
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: Kajian Pendidikan Dan Kesejahteraan Komuniti

Fig. 5 presents mobility dependency by car ownership. Older adults without access to a private car are more frequently classified under the high dependency category compared to those who own a car. Conversely, respondents with car ownership are more heavily represented in the low and moderate dependency categories.

4.1.5 Mobility dependency by motorcycle ownership

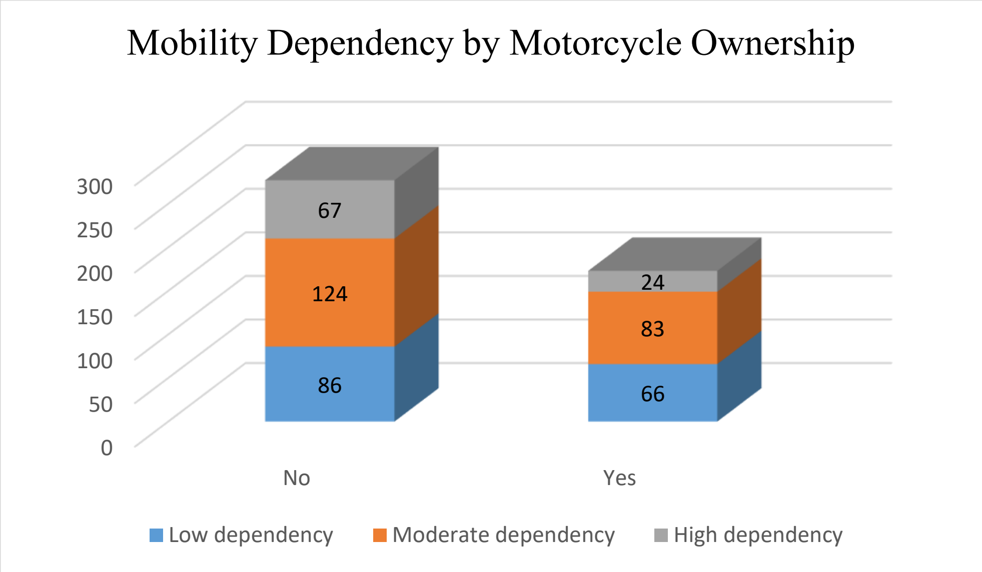

Figure 6: Mobility dependency by motorcycle ownership

Fig. 6 shows mobility dependency by motorcycle ownership. Respondents without motorcycle access exhibit higher levels of mobility dependency than those who own a motorcycle. Motorcycle owners are more commonly observed in the low and moderate dependency categories, while non-owners account for a larger share of high dependency cases.

4.1.6 Mobility dependency by public transport discount card

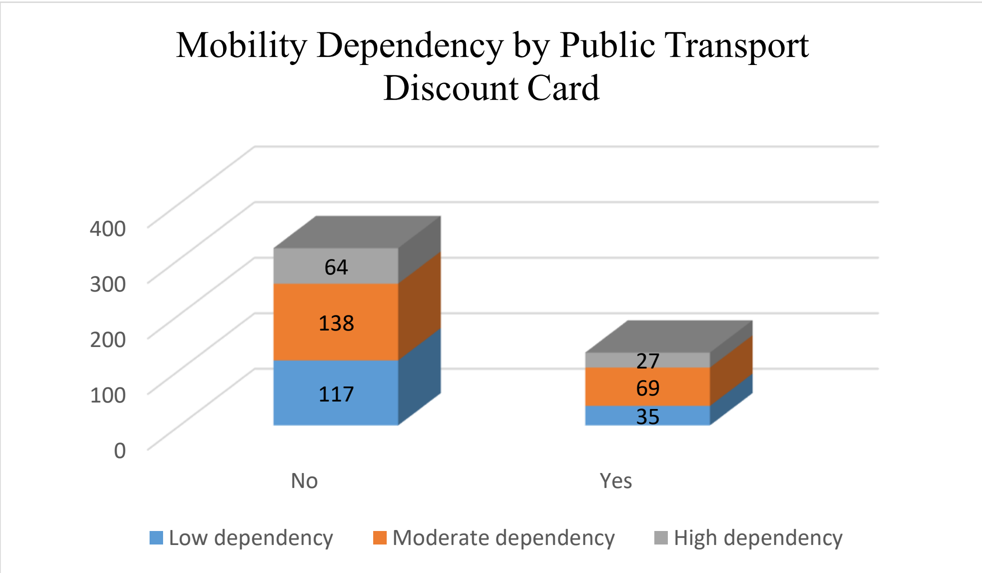

Figure 7: Mobility dependency by motorcycle ownership

Fig. 7 illustrates mobility dependency by ownership of a public transport discount card. Discount card holders and non-holders are present across all dependency categories. However, a larger proportion of respondents classified under high dependency do not possess a discount card.

Overall, the descriptive cross-tabulation analysis reveals clear patterns in mobility dependency across age, gender, household income, and access to mobility resources. Mobility dependency increases with advancing age, with older age groups exhibiting a higher concentration in the high dependency category. Differences are also observed by gender, household income, and ownership of private transport, particularly cars and motorcycles. Respondents without access to personal transport resources and those in lower income groups are more frequently classified under higher dependency levels.

These descriptive patterns provide an empirical overview of mobility dependency among older adults and serve as a foundation for the subsequent ordered logistic regression analysis, which formally examines the relative influence of environmental barriers and functional limitations while controlling for individual and household characteristics.

Table 2: Ordered logistic regression and average marginal effects on mobility dependency

Variables	Coef. (β)	Odds Ratio	p-value	Marginal Effect		
				(1) low dependency	(2) moderate dependency	(3) high dependency
Environmental Barriers						
Pedestrian walkway barriers	0.405	1.50	0.013**	−0.084**	0.024**	0.060**
Pedestrian crossing barriers	−0.065	0.94	0.672	0.013	−0.004	−0.010
Building accessibility barriers	0.039	1.04	0.801	−0.008	0.002	0.006
Public space quality	0.016	1.02	0.907	−0.003	0.001	0.002
Health limitations						
Walking difficulty	0.526	1.69	0.013**	−0.109**	0.032**	0.077**
Visual difficulty	0.219	1.24	0.268	−0.045	0.013	0.032
Use of mobility aids	0.936	2.55	0.046**	−0.194**	0.056	0.138**
Chronic illness	0.024	1.02	0.961	−0.005	0.001	0.004
Residential Location (Ref: Rural)						
Urban area	1.434	4.20	0.003***	−0.235***	−0.040	0.274**
Suburban area	0.749	2.11	0.029**	−0.143**	0.016	0.127*

*** $p < 0.01$, ** $p < 0.05$

4.2 Ordered logistic regression analysis

Table 2 presents the results of the ordered logit regression model estimating the determinants of mobility dependency among older adults. Mobility dependency is specified as an ordinal outcome with three ordered categories—low, moderate, and high dependency—reflecting increasing reliance on others for daily mobility. The model is estimated using survey data from 450 older adult respondents.

Overall model diagnostics indicate that the ordered logit regression provides an adequate fit to the data. The likelihood ratio (LR) chi-square statistic is 52.31 and is statistically significant at the 1% level ($p < 0.001$), indicating that the set of explanatory variables jointly improves model fit relative to a null model with no predictors. The pseudo R^2 value is 0.0555, which, although modest, is consistent with values commonly reported in cross-sectional behavioural and mobility studies where outcomes are shaped by complex interactions between individual characteristics, environmental conditions, and contextual factors. Taken together, these indicators suggest that the ordered logistic regression model captures meaningful variation in mobility dependency among older adults and is appropriate for interpreting individual parameter estimates.

Based on the estimated model, the empirical results presented in Table 2 provide insight into the relative influence of environmental barriers, health-related limitations, and residential context on older adults' mobility dependency. The results indicate that pedestrian-level environmental barriers play a critical role in shaping dependency outcomes. Among the environmental variables included, pedestrian walkway barriers emerge as a statistically significant determinant of mobility dependency ($\beta = 0.405$; OR = 1.50; $p < 0.05$). Older adults exposed to higher levels of walkway barriers—such as uneven or slippery surfaces, insufficient walkway width, lack of shading, and exposed drainage—are significantly more likely to be classified into higher dependency categories. This finding underscores the central importance of immediate pedestrian environments in daily mobility, particularly given that walking remains the most frequently used mode for short-distance trips among older adults.

The estimated average marginal effects further clarify the substantive impact of pedestrian walkway conditions. An increase in walkway barriers reduces the probability of remaining in the low-dependency category by 8.4 percentage points, while increasing the likelihood of moderate and high dependency by 2.4 and 6.0 percentage points, respectively. Notably, the largest probability shift is observed for the high-dependency category, suggesting that deteriorating pedestrian conditions may function as a critical tipping point that pushes older adults towards greater reliance on others. This pattern is consistent with previous research demonstrating that micro-scale pedestrian infrastructure exerts a stronger influence on independent mobility than broader urban design features, particularly in the context of age-related declines in balance, strength, and reaction time (Dzisi et al., 2025; Kordrostami et al., 2025; Herrmann-Lunecke et al., 2022).

In contrast, other environmental indices—including pedestrian crossing barriers, building accessibility barriers, and public space quality—do not exhibit statistically significant associations with mobility dependency once pedestrian walkway conditions are controlled for. This suggests that deficiencies in basic pedestrian walkways may outweigh broader infrastructural or public space characteristics in shaping everyday mobility outcomes. Comparable findings have been reported in earlier studies indicating that while older adults may adapt behaviourally to macro-level environmental constraints, they remain particularly vulnerable to routine walking hazards encountered during daily trips, which directly undermine confidence and perceived safety (Dzisi et al., 2025; Cauwenberg et al., 2018).

Health-related factors further reinforce the pivotal role of physical capability in determining mobility dependency. Walking difficulty is positively and significantly associated with higher levels of dependency ($\beta = 0.526$; OR = 1.69; $p < 0.05$). The marginal effects indicate a substantial reduction in the probability of low dependency (−10.9 percentage points), accompanied by corresponding increases in moderate (3.2 percentage points) and high dependency (7.7 percentage points). These results confirm that impairments directly affecting gait and balance exert an immediate and pronounced influence on older adults' ability to remain mobile without assistance, consistent with extensive evidence linking walking ability to independent ageing and ageing in place (von Renteln-Kruse et al., 2011; Bahrmann et al., 2010).

Similarly, the use of assistive mobility devices is significantly associated with increased mobility dependency ($\beta = 0.936$; OR = 2.55; $p < 0.05$). Older adults who rely on mobility aids experience a marked decline in the probability of low dependency and a substantial increase in the probability of high dependency. While assistive devices are intended to support independent movement, their use often reflects more advanced functional limitations. Moreover, existing studies suggest that in environments characterised by narrow or uneven walkways, mobility aids may become difficult to use safely, potentially reinforcing rather than mitigating dependency (Kordrostami et al., 2025; Clarke & Gallagher, 2013).

By contrast, visual difficulty and the presence of chronic illness do not show statistically significant associations with mobility dependency. This indicates that not all health conditions translate equally into reliance on others for mobility. Health limitations that directly constrain physical movement appear to exert a more immediate influence on dependency outcomes than broader health conditions that do not directly impair locomotion, a distinction also noted in prior mobility dependency research (Che Had et al., 2023; Bahrmann et al., 2010).

Finally, residential location introduces an important spatial dimension to the analysis. Relative to older adults residing in rural areas, those living in urban areas are significantly more likely to be classified into higher dependency categories ($\beta = 1.434$; OR = 4.20; $p < 0.01$), with suburban residents also exhibiting elevated dependency risks. These findings are consistent with studies highlighting the paradox of urban ageing, whereby proximity to services is offset by increased environmental complexity, traffic exposure, and pedestrian congestion, all of which may exacerbate mobility challenges for older adults, particularly those with existing functional limitations (Dzisi et al., 2025; Clarke & Gallagher, 2013).

Overall, the ordered logistic regression results demonstrate that pedestrian walkway barriers, walking difficulty, use of mobility aids, and residential location are key determinants of mobility dependency among older adults. By incorporating average marginal effects, the analysis illustrates how these factors systematically shift individuals from lower to higher levels of dependency, reinforcing the importance of age-friendly pedestrian environments and targeted interventions addressing functional mobility limitations, particularly in urban contexts.

5. Discussion

This study investigates how environmental barriers and health-related limitations shape older adults' mobility dependency in an urban Malaysian context. By employing an ordered logistic regression framework, the analysis captures the graded nature of mobility dependency and provides nuanced insights into how environmental constraints and functional limitations jointly influence older adults' capacity for independent mobility. Overall, the findings highlight the dominant role of pedestrian-level environmental conditions and physical capability, while also revealing the structural challenges associated with urban living environments.

The results demonstrate that pedestrian walkway barriers significantly increase the likelihood of higher mobility dependency among older adults. This finding reinforces a growing body of literature emphasising that the immediate walking environment constitutes a critical determinant of independent mobility in later life. Previous studies consistently report that micro-scale barriers—such as uneven or slippery surfaces, insufficient walkway width for mobility aids, lack of shading, and exposed drainage systems—undermine both physical safety and perceived confidence among older adults (Dzisi et al., 2025; Kordrostami et al., 2025; Torabi Kachousangi et al., 2025). Even when destinations are geographically proximate, such barriers may render independent travel impractical, thereby increasing reliance on others for daily mobility.

Importantly, the estimated marginal effects reveal a systematic probability shift from low to high mobility dependency as pedestrian walkway barriers increase. This cumulative effect illustrates how repeated exposure to everyday walking obstacles can progressively erode mobility confidence and autonomy. Similar probability shifts have been documented in recent walkability and ageing studies, which show that deteriorating pedestrian environments disproportionately affect older adults due to age-related declines in balance, strength, and reaction time (Torabi Kachousangi et al., 2025; Dzisi et al., 2025).

In contrast, broader environmental features related to pedestrian crossings, building accessibility, and public space quality do not exhibit statistically significant effects once pedestrian walkway conditions are accounted for. This suggests that macro-level infrastructure provision alone may be insufficient to reduce mobility dependency if fundamental pedestrian-scale deficiencies persist. Comparable findings have been reported in studies indicating that older adults may adapt behaviourally to larger-scale environmental constraints but remain particularly vulnerable to immediate walking hazards encountered during routine trips (Dzisi et al., 2025). These results underscore the importance of prioritising fine-grained pedestrian interventions within age-friendly urban planning strategies, rather than relying solely on large-scale infrastructural improvements that may not directly address older adults' everyday mobility challenges.

Health-related factors further elucidate the mechanisms underlying mobility dependency. Functional limitations—particularly difficulty walking—emerge as strong and consistent predictors of higher dependency levels, underscoring the central role of physical capability in shaping everyday mobility outcomes among older adults. This finding aligns closely with previous research identifying walking ability as one of the most critical determinants of independent mobility and ageing in place (Torabi Kachousangi et al., 2025; Kordrostami et al., 2025). The marginal effects indicate that walking difficulty substantially reduces the probability of low dependency while markedly increasing the likelihood of high dependency, reflecting the direct impact of locomotion impairment on mobility autonomy.

Similarly, the use of assistive mobility devices is associated with increased mobility dependency. Although such devices are intended to support independent movement, their use often reflects more severe functional impairments that necessitate external assistance. Prior studies have similarly observed that assistive devices alone are insufficient to ensure independent mobility when environmental conditions remain physically challenging or poorly maintained (Kordrostami et al., 2025; Dzisi et al., 2025). This interaction between individual functional limitations and environmental constraints highlights the need for integrated approaches that simultaneously address personal capability and environmental accessibility.

By contrast, visual difficulties and chronic illness do not exhibit statistically significant effects in the model. This finding suggests that not all health conditions translate equally into mobility dependency. Conditions that directly affect balance, gait, and physical movement appear to exert a more immediate influence on dependency outcomes than broader health conditions that do not directly constrain locomotion. Similar distinctions have been reported in earlier studies, which emphasise the importance of focusing on functional outcomes rather than medical diagnoses alone when assessing mobility dependency in later life (Dzisi et al., 2025).

The inclusion of residential location introduces a critical spatial dimension to the analysis. Older adults residing in urban areas exhibit a significantly higher likelihood of mobility dependency compared to their rural counterparts, with suburban residents also facing elevated risks, albeit to a lesser extent. The marginal effects indicate that urban residence is associated with a substantial increase in the probability of high mobility dependency. Although urban areas typically offer greater service availability and transport connectivity, the findings suggest that the complexity of urban environments—characterised by higher traffic volumes, crowded pedestrian spaces, and cognitively demanding navigation—may outweigh these advantages for older adults, particularly those with physical limitations (Kordrostami et al., 2025; Torabi Kachousangi et al., 2025).

Taken together, the findings align closely with the principles of the World Health Organization's Age-Friendly Cities framework, which emphasises safe, accessible, and walkable environments as foundational to active ageing (World Health Organization, 2002). The evidence from this study indicates that targeted improvements to pedestrian walkway conditions, combined with interventions addressing functional mobility limitations, are likely to be particularly effective in reducing mobility dependency among older adults. In the Malaysian context—where rapid urbanisation coincides with accelerated population ageing—such measures are increasingly critical for sustaining independent mobility, social participation, and quality of life in later life.

This study contributes to the literature in several important ways. First, it provides empirical evidence from an urban setting in a middle-income country, addressing a notable gap in ageing and mobility research dominated by high-income contexts. Second, by conceptualising mobility dependency as an ordered outcome rather than a binary condition, the analysis offers a more refined understanding of how environmental and health-related factors interact to shape varying degrees of reliance on others. Third, the incorporation of marginal effects demonstrates how changes in environmental and health conditions translate into meaningful probability shifts across dependency levels, thereby strengthening the policy relevance of the findings. Finally, the results reaffirm the centrality of pedestrian-scale environments in shaping mobility dependency, extending existing discussions on age-friendly urban design and sustainable urban mobility.

While the findings are robust within the scope of the study, several avenues for future research remain. Longitudinal analyses would enable examination of how mobility dependency evolves over time as health status and urban environments change. Future studies could also explore interaction effects between environmental barriers and socio-demographic characteristics, or apply alternative modelling approaches to capture heterogeneity across dependency levels. Such extensions would further enhance understanding of the complex and dynamic relationships linking ageing, environment, and mobility in rapidly urbanising societies.

International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 8, No. 3, 572-590, 2026
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: Kajian Pendidikan Dan Kesejahteraan Komuniti

6. Future Directions

Future research should further strengthen understanding of mobility dependency among older adults by addressing several key areas. First, heterogeneity among older populations warrants closer attention. Mobility outcomes may vary across socio-demographic characteristics such as age, gender, income, and health status. Future studies should therefore incorporate interaction effects or subgroup analyses to better capture differential vulnerabilities and mobility needs among diverse groups of older adults.

Second, methodological improvements are necessary to enhance the robustness of findings. The use of longitudinal data would allow researchers to examine how mobility dependency evolves over time, particularly in response to changes in health conditions and urban environments. In addition, future studies could incorporate mixed-method approaches, combining quantitative modelling with qualitative insights to better understand lived mobility experiences.

Third, further research should expand the scope of variables examined. Incorporating subjective measures such as perceived safety, walkability, and neighbourhood cohesion would provide a more comprehensive understanding of how both physical and social environments influence mobility outcomes. Finally, the application of alternative modelling approaches—such as generalized ordered logit or mixed-effects models—may help capture unobserved heterogeneity and relax restrictive model assumptions.

7. Limitations

This study is subject to several limitations. First, the analysis is based on cross-sectional data, which limits the ability to infer causal relationships between environmental barriers, health conditions, and mobility dependency. Second, the study relies on self-reported measures of environmental barriers and mobility behaviour, which may be subject to perception bias or recall error.

Third, although the sample size is adequate for statistical analysis, it is geographically limited and may not fully represent all older adult populations in Malaysia, particularly those in rural or less-developed regions. Finally, the study focuses primarily on physical and environmental determinants, while other potentially relevant factors—such as social support networks or psychological factors—are not explicitly examined.

Despite these limitations, the study provides valuable empirical insights into the determinants of mobility dependency and offers a strong foundation for future research.

8. Conclusion

This study demonstrates that mobility dependency among older adults in urban Malaysia is shaped by the interaction between environmental barriers and functional health limitations. Pedestrian walkway conditions, walking difficulty, use of mobility aids, and residential location emerge as key determinants of dependency levels.

The findings highlight the critical importance of pedestrian-scale environments in supporting independent mobility. Improvements in walkway quality, accessibility, and safety—combined with interventions addressing physical capability—are essential for reducing reliance on others and promoting active ageing.

Overall, the study contributes empirical evidence from a rapidly urbanising, middle-income context and underscores the need for integrated, age-sensitive urban planning strategies to enhance mobility, independence, and quality of life among older adults.

Acknowledgement
The authors would like to express their sincere appreciation to all respondents who participated in this study. The authors also acknowledge the support provided by Universiti Sains Malaysia in facilitating this research. Appreciation is further extended to individuals who contributed, directly or indirectly, to the completion of this study.

Conflict of Interest Statement
The authors declare that they have no known competing financial or non-financial interests that could have appeared to influence the work reported in this paper.

References

Ahacic, K., Parker, M. G., & Thorslund, M. (2007). Aging in disguise: Age, period and cohort effects in mobility and edentulousness over three decades. European Journal of Ageing, 4(2), 83–91.

Bahrmann, A., Abel, A., Specht-Leible, N., Wörz, E., Hölscher, E., & Zeyfang, A. (2010). Behandlungsqualität bei geriatrischen Patienten mit Diabetes mellitus in verschiedenen häuslichen Versorgungthyvfggsstrukturen. Zeitschrift für Gerontologie und Geriatrie, 43(6), 386–392.

Broby, D., & Smyth, W. (2025). On the use of principal components analysis in index construction. Financial Statistical Journal, 8(1), Article 10858. https://doi.org/10.24294/fsj10858

Caballero Rubio, F. J. (2022). Ethics and empirics: Essence of ethics in social research. In [Book Title] (pp. 471–482). Springer. https://doi.org/10.1007/978-981-19-5441-2_34

Cakmakyapan, S., & Goktas, A. (2013). A comparison of binary logit and probit models with a simulation study. Journal of Social and Economic Statistics, 2(1), 1–17.

Cerin, E., Nathan, A., Van Cauwenberg, J., Barnett, D., & Barnett, A. (2017). The neighbourhood physical environment and active travel in older adults: A systematic review and meta-analysis. Journal of Transport & Health, 5, 55–69. https://doi.org/10.1016/j.jth.2017.05.289

Che Had, N. H., Alavi, K., Md. Akhir, N., Muhammad Nur, I. R., Shuhaimi, M. S. Z., & Foong, H. F. (2023). A scoping review of the factors associated with older adults' mobility barriers. International Journal of Environmental Research and Public Health, 20(5), 4243. https://doi.org/10.3390/ijerph20054243

Clarke, P., & Gallagher, N. A. (2013). Optimizing mobility in later life: The role of the urban built environment for older adults aging in place. Journal of Urban Health, 90(6), 997–1009. https://doi.org/10.1007/s11524-013-9800-4

Curl, A., Fitt, H., & Tomintz, M. (2020). Experiences of the built environment, falls and fear of falling outdoors among older adults: An exploratory study and future directions. International Journal of Environmental Research and Public Health, 17(4), 1224. https://doi.org/10.3390/ijerph17041224

Dzisi, E., Arthur, W., & Nathan, J. (2025). Modeling willingness to pay for park-and-ride systems: Evidence from Kumasi. Urban, Planning and Transport Research, 13(1), 2570928. https://doi.org/10.1080/21650020.2025.2570928

Hayawi, H., Sedeeq, B. S., & Ali, T. H. (2025). A comprehensive overview of ordinal regression in statistical modeling. Preprints. https://doi.org/10.20944/preprints202507.0735.v1

Herrmann-Lunecke, M. G., Figueroa-Martínez, C., Parra Huerta, F., & Mora, R. (2022). The disabling city: Older persons walking in central neighbourhoods of Santiago de Chile. Sustainability, 14(17), 11085. https://doi.org/10.3390/su141711085

Jopp, D. S., Boerner, K., Cimarolli, V., Hicks, S., Mirpuri, S., Paggi, M., & Kennedy, E. (2016). Challenges experienced at age 100: Findings from the Fordham Centenarian Study. Journal of Aging & Social Policy, 28(3), 187–207. https://doi.org/10.1080/08959420.2016.1163652

Kachousangi, F. T., Araghi, Y., van Oort, N., & Hoogendoorn, S. (2025). A latent class approach to explore shared mobility among older people in midsized Dutch inner cities. Transportation Research Interdisciplinary Perspectives, 33, 101592. https://doi.org/10.1016/j.trip.2025.101592

Kleinbaum, D. G., & Klein, M. (2010). Ordinal logistic regression. Springer. https://doi.org/10.1007/978-1-4419-1742-3_13

Kordrostami, A., Esmailpour, J., Aghabayk, K., & Shiwakoti, N. (2025). Promoting social sustainability: Psychological and contextual factors influencing mobility scooter adoption among older adults in a developing country. Sustainable Futures, 100878. https://doi.org/10.1016/j.sftr.2025.100878

Liu, A., He, H., Tu, X. M., & Tang, W. (2023). On testing proportional odds assumptions for proportional odds models. General Psychiatry, 36(3), e101048. https://doi.org/10.1136/gpsych-2023-101048

Muris, C., Raposo, P., & Vandoros, S. (2025). A dynamic ordered logit model with fixed effects. Review of Economics and Statistics, Advance online publication. https://doi.org/10.1162/rest_a_01336

Nguyen, M. (2025). Marginal effects. In Advanced modeling and data challenges (pp. 329–355). Springer.

Plummer, S. B., & Findley, P. A. (2012). Women with disabilities' experience with physical and sexual abuse: Review of the literature and implications for the field. Trauma, Violence, & Abuse, 13(1), 15–29. https://doi.org/10.1177/1524838011426014

Reckien, D. (2018). What is in an index? Construction method, data metric, and weighting scheme determine the outcome of composite social vulnerability indices in New York City. Regional Environmental Change, 18(5), 1439–1451.

Reynolds, P. S. (2023). A guide to sample size for animal-based studies. John Wiley & Sons.

Sihombing, P. R. (2022). Aplikasi pemodelan logit, probit dan clog-log pada regresi binomial. Jurnal Multidisiplin Madani, 2(6), 2599–2610. https://doi.org/10.55927/mudima.v2i6.430

Van Cauwenberg, J., Nathan, A., Deforche, B., Barnett, A., Barnett, D., & Cerin, E. (2018). Physical environments that promote physical activity among older people. In [Book Title] (pp. 447–466). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-71291-8_22

von Renteln-Kruse, W., Dapp, U., Anders, J., Pröfener, F., Schmidt, S., Deneke, C., & Minder, C. (2011). The LUCAS consortium: Objectives of interdisciplinary research on ageing and health care for older people in an urban community. Zeitschrift für Gerontologie und Geriatrie, 44(4), 250–255.

World Health Organization. (2002). Active ageing: A policy framework. https://iris.who.int/handle/10665/67215