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Review

Application and Implementation Gaps in the Conical Model for Older Adults' Mobility: A Scoping Review

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Abstract: Background: The 2010 Conical Model of Theoretical Framework for Mobility in Older Adults examines how various factors impact elderly mobility. A decade later, describing the model's application in research, clinical practice, and policy is crucial. Objective: This scoping review aims to identify studies utilizing the Conical Model in older adult research, clinical practice, and policy while pinpointing implementation gaps. Methods: Seven databases (MEDLINE (PubMed), Embase, CINAHL, PsycINFO, Scopus, Web of Science, GooogleScholar) from 2010 to April 2025 with a well-defined search strategy. Pairs of reviewers independently conducted title/abstract and full-text screening, extracted data, and assessed study quality using modified Downs and Black Checklist (quantitative), Consolidated Criteria for Reporting Qualitative Research (qualitative), and Mixed Methods Appraisal Tool (mixed methods). Results: Twenty-four studies (20 cross-sectional quantitative studies, 2 mixed methods, one concept and one e-Delphi study) were included, with one advancing the Conical Model, eleven testing it, and twelve incorporating it into study development. Findings showed a consistent association between physical and social factors with mobility, although the assessment of mobility factors varied among studies. The quality of articles ranged from good (23%) to excellent (77%). Conclusion: No evidence was found on the Conical Model's application in clinical practice or policy, despite its theoretical relevance; therefore, there is a need for further validation of the model in real-world applications.

Keywords: clinical practice; framework; mobility; older adults; research; public policy

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1. Introduction

The global population is aging more rapidly than previously anticipated, with projections indicating that the number of individuals aged 60 and over will increase from 1 billion in 2020 to 2.1 billion in 2050 [1]. Moreover, the population aged 80 and older is expected to more than triple within this period [1]. This demographic shift is accompanied by age-related conditions such as declines in muscle power and the accumulation of chronic illnesses, which can lead to mobility limitations, reduced social participation, and further reinforce societal stereotypes of aging—ultimately hindering principles of active and healthy aging [2].

Mobility, defined as movement from point A to B by self, use of an assistive device, transportation, and driving, is crucial for healthy aging as it supports social participation within the community and independence in daily activities [3]. Conversely, declines in mobility can lead to increased pain, morbidity, mortality, and institutionalization among older adults [4,5], contributing to high annual healthcare costs. Hardy, Kang, Studenski, and Degenholtz [6] found that older individuals facing difficulty walking a quarter of a mile incurred an additional $2773 in yearly healthcare expenses in the United States. The increasing prevalence of mobility disability among older adults, rising from 22.6% in 2005 to 47.6% in 2015, emphasizes the urgent need to address mobility as a significant public health concern in the aging population [7].

Mobility is a complex phenomenon, and potential frameworks to explain the complexity have been advancing. Early mobility researchers used the Person-Environment-Fit Model to explain mobility, highlighting that an older adult's capacity should match the environmental demand to enable such an individual to perform mobility-related functions adequately [8,9]. Previous mobility frameworks have primarily focused on either the measurement of mobility [10], the influence of environmental factors such as land use and accessibility on transportation [11,12], or the application of geolocation technologies to enhance mobility [13]. Beauchamp and colleagues [10] delineate three distinct aspects of mobility: perceived mobility ability (what individuals believe they can do), actual mobility ability (what they actually do), and locomotor capacity (what they are capable of doing). Conversely, Anderson and colleagues [12], through concept mapping and e-Delphi methods, identify nine domains essential for promoting mobility among older adults, including research-to-practice, independence and engagement, the built environment and safety, transportation, policy, housing and accessibility, community supports, training, and coordinated action. While these frameworks have advanced understanding in the field, they do not fully capture the multifactorial and multidisciplinary nature of mobility. The Conical Model of Theoretical Framework for Mobility in Older Adults, henceforth termed the Conical Model, developed by Webber and colleagues [5], aims to address this gap by describing the multifactorial and multifaceted explanations of mobility complexity, creating an avenue for interdisciplinary collaborations, accumulating into a more comprehensive framework that previous mobility frameworks.

The Conical Model stipulates that mobility factors, including cognitive, environmental, financial, personal, physical, psychological, and social factors, influence older adults' mobility across the life space, including the room, home, outdoor areas around the home, neighborhood, area in community, country, and the world [5], see Figure 1. The authors highlighted that these factors directly or indirectly interact to influence older adults' mobility and that these interactions are more evident when older adults move away from their surrounding environment into an unfamiliar one. For instance, an older adult with cognitive impairment may be able to move around in their home; however, they may struggle to do that outside their home because of competing interactions between cognitive (cognitive impairment) and/or environmental (noise and traffic in the neighborhood) factors.

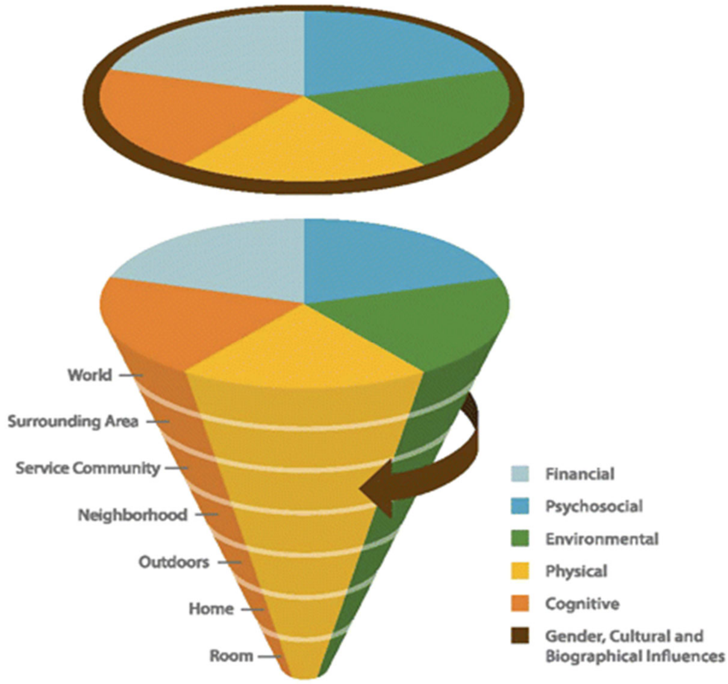

Figure 1. Conical Model of the Theoretical Framework for Mobility in Older Adults illustrating seven life spaces. Reprinted with permission from Webber et al., Oxford University Press and the Gerontological Society of America [5], Licence Number: 6036800687201.

Webber and colleagues [5] redefined mobility to include mobility achieved through various means such as assistive devices, transportation, and driving, expanding beyond walking ability. This inclusive definition challenges disciplines to consider mobility from diverse perspectives, fostering interdisciplinary collaborations and generating novel research concepts. The authors propose that their model could improve diagnostic and treatment approaches for addressing mobility decline among older adults in community and clinical settings. Additionally, the comprehensiveness of the model could inform policy to enhance mobility in older adults. For instance, policymakers can use the factors within each mobility determinant to inform decisions regarding the mobility abilities and capacities of older adults residing in different settings, such as naturally occurring older adult settlements, independent living, community, and long-term care living.

However, the definitive use of the Conical Model in policy development, clinical practice, and research has not been explored since it was published. Examining and identifying gaps in how this framework has been and is currently applied is essential to highlight the practicality of this well-theorized framework, as it promises to promote interdisciplinarity among professionals to further explore the complexity of mobility. Therefore, this scoping review aims to identify and describe studies that have utilized the Conical Model of Theoretical Framework for Mobility in older adults in research, clinical practice and policy, highlighting existing gaps in its implementation.

2. Methods

We utilized the Arksey and O'Malley scoping review framework [14]. This framework is appropriate compared to advanced frameworks such as Levac et al. [15] and Peters et al. [16] as it is suited for broad mapping, identifying gaps, and exploratory research when evidence is emerging or diverse. A scoping review methodology is more appropriate than a systematic review because it enables a comprehensive description of how the Conical Model of the Theoretical Framework has been applied. It provides a basis for an in-depth analysis of the findings from each study that utilized the framework. We adhered to the

Preferred Reporting Items for Systematic Reviews and Meta-analysis extension for scoping reviews (PRISMA-Scr) [17]. The protocol was registered with the Open Science Framework: https://doi.org/10.17605/OSF.IO/BMGEV (accessed on 12 March 2025).

2.1. Search Strategy

In consultation with an expert health sciences research librarian, we systematically searched MEDLINE (PubMed), Embase, CINAHL, PsycINFO, Scopus, Web of Science, and Google Scholar from 2010 to 31 December 2023, and updated until 22 April 2024 for relevant studies. Additionally, we searched ProQuest Dissertations and Theses A&I for gray literature. Studies published after August 2010 were considered, as that was the year and month that the Conical Model was published [5]. Furthermore, we reviewed all publications that cited the original Conical Model paper [5] and hand-searched the references of included studies for additional relevant articles. Appendix A presents the full search strategies for all databases searched.

2.2. Study Selection

We included studies if: (a) they included older adults (i.e., a study population mean/median $\geq$60 years as the Conical Model was described using this population), (b) they defined mobility as the ability to move oneself across the life space (at home, outside the home, in the community and globally) by self, using assistive devices, transportation or driving [5] and (c) they incorporated the Conical Model in one of three ways: (1) they used the Conical Model as their theoretical framework; (2) they tested the model; (3) or they expanded the model. Studies that cited the Conical Model in their introduction, methods, or discussion section without explicitly stating that the model informed their study or guided some aspects of their study were excluded. There was no restriction in the study design. However, articles published in other languages rather than English were excluded due to resource and time constraints.

Following the systematic search, all identified records were collated and uploaded into the systematic review management software–Covidence© (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia, 2024, available online www.covidence.org, accessed on 13 May 2024), and duplicates were removed. We screened retrieved studies using two steps—title/abstract and full-text screening. We conducted pilot testing at each stage to test the eligibility criteria and refine the inclusion and exclusion criteria to ensure that they are appropriate and feasible, identify potential issues and challenges that may arise during the screening process, and reduce the risk of reviewer bias. After the pilot testing, pairs of reviewers independently screened the studies at each stage using the predetermined eligibility criteria described above. All disagreements were resolved through discussion to achieve consensus.

2.3. Data Extraction and Quality Assessment of Included Studies

Data were extracted from the included articles by two independent reviewers using a pre-piloted data extraction tool developed by the reviewers (Appendix B). Extracted information included: (a) study meta-data (e.g., author(s), study design, country of study), (b) study population characteristics (e.g., sample size, sex, age), and (c) how the Conical Model was used. A modified Downs and Black checklist was used to assess the quality of included cross-sectional studies [18]. The original checklist is comprised of 27 items over five domains (reporting [n = 10], external validity [n = 3], internal validity-bias [n = 7], internal validity-confounding [n = 6], and power [n = 1]. Each item was rated as 0 (no or unable to determine) or 1 (yes), except for item 5 (are all confounding factors provided), which was rated as 0 (no), 1 (partially), or 2 (yes). Articles received a score of 0 in the power domain if their sample size was <300 or they did not demonstrate sufficient power through sample size calculations [19]. The checklist was modified for cross-sectional studies (maximum score of 21). Scores of 17 to 21 were considered 'Excellent', 11 to 16 were 'Good', 6 to 10 'Fair', and <6 were considered 'Poor'. The modified checklist can be found in Appendix C. The Mixed Methods Appraisal Tool (MMAT) was used to evaluate the methodological quality of mixed-method studies [20], and the Consolidated Criteria for Reporting Qualitative Research (COREQ) tool was used to evaluate qualitative studies [21]. Identified e-Delphi studies were compared to the Guidance on Conducting and REporting DElphi Studies (CREDES) statement [22]. Two reviewers independently conducted the quality assessment of the identified studies. All disagreements were resolved through discussion to achieve consensus.

2.4. Data Synthesis

We extracted, analyzed, and presented the meta-data of the included articles, such as the countries in which each study was conducted the study design, study settings, sampling method and recruitment strategies, participants' characteristics (sample size, sex, age), and data analysis methods. The continuous extracted data were analyzed using descriptive statistics, such as mean, standard deviation, median, interquartile range, and frequencies and percentages for categorical variables. Details of the included studies were presented in a table and summarized narratively–studies were grouped and discussed based on how they used the model.

3. Results

We retrieved 10,512 studies from the database searches. After removing duplicates, 10,195 citations underwent title and abstract screening, leading to 1396 potentially relevant full texts. Ultimately, 24 studies were included in the final review. Figure 2 shows the PRISMA flow diagram of the search results and the study selection process.

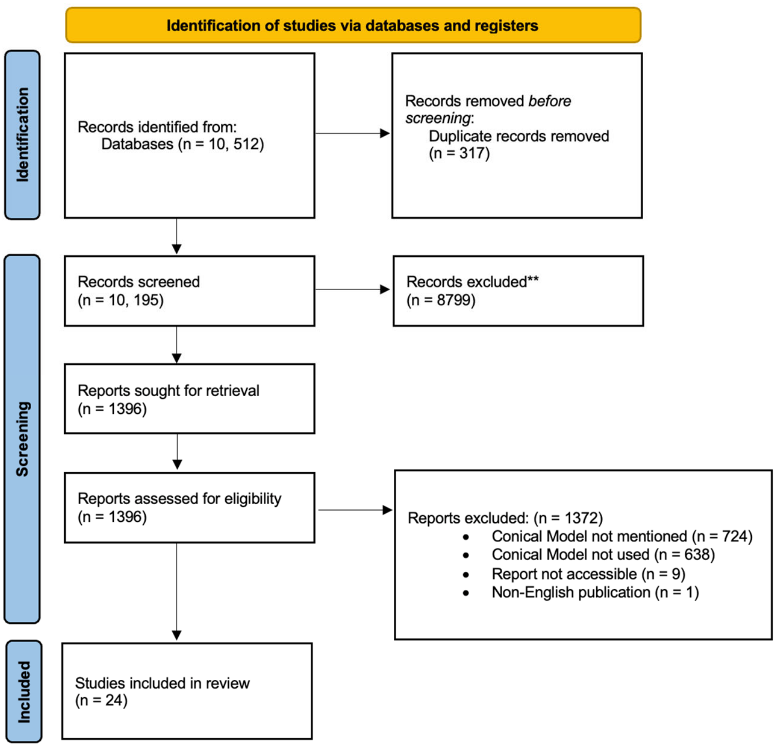

Figure 2. Search results and study selection and inclusion process. Note: **—excluded at title and abstract screening.

3.1. Characteristics of the Included Studies

One study [23] advanced the Conical Model, eleven studies [24–34] tested the framework, and twelve studies [35–46] used the framework to develop a questionnaire, interview guide or domains of a new measurement tool. Of the 24 included articles, 20 (83%) were cross-sectional studies, two (8%) were mixed-method studies, one (4%) was a concept paper, and one (4%) was an e-Delphi study. Studies were conducted in eight countries (Australia, Austria, Canada, China, Germany, Iran, Nigeria, and the United States). Most studies were conducted in Canada (n = 10, 42%), followed by Germany (n = 6, 25%) and the United States (n = 2, 8%).

3.2. Advancing the Conical Model

One study advanced the framework by reframing mobility in older adults to offer a physiological, subjective, contextual, and temporal approach to understanding mobility (see Figure 3). Franke and colleagues [23] adapted the Conical Model using evidence from studies that explored constructivist grounded theory to assess the mobility experiences of low-income older adults in Canada. The authors presented the determinants to cut across physiological, subjective, and context on a sliding scale. These physiological factors include physical and cognitive factors, emphasizing the number and type of chronic conditions. Meanwhile, the subjective factors comprise psychological factors, attitudes, and perceptions, and contextual factors include the financial, built, social and natural environment, sociocultural background, and gender roles. The authors stated that using the sliding scale in their framework reveals the dynamic and fluid nature of mobility, and their framework recognizes that factors influencing mobility are individual and context-dependent.

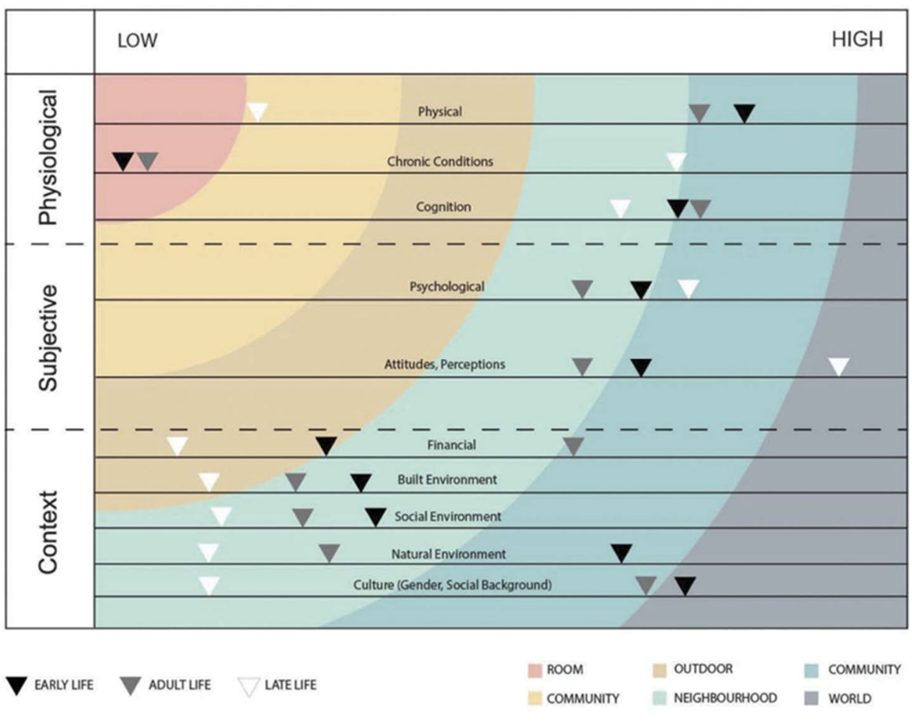

Figure 3. Adapted Mobility Framework. Reprint with permission from Franke et al. and Taylor and Francis Journals [23], Licence number: 6036811161764.

3.3. Testing the Conical Model

Eleven articles tested the Conical Model and explored the association between mobility determinants and various aspects of mobility among older adults [24–34]. Table 1 presents the studies' detailed descriptions, including each mobility determinant's mobility measures.

Table 1. Studies show how the Conical Model of the Theoretical Framework for Mobility in Older Adults has been tested across the literature.

Authors, Year, and Country	Study Design Sample	Sample Size Mean Age (SD), Range	Study Analysis Method	Mobility Outcome Measures	Factors for Each Determinant	How Each Factor Was Measured	Plain Language Key Findings
Dunlap et al., 2021, USA [24]	Cross-sectional Community-dwelling	249 77.4 (6.6), NR	Backward elimination multivariate linear regression	Life-space mobility (LSA)	Cognitive: Mental status, executive function Environmental: Neighborhood walkability (land-use mix, traffic-related safety, sidewalk characteristics) Financial: Neighborhood socioeconomic status (household income, education, occupation) Personal: Age, gender, race, education, current employment, living situation Physical: Muscle power, muscle strength, balance, gait speed, muscle endurance, coordination, oxygen consumption, gait efficiency, functional impairments, comorbidities, BMI, fall history Psychosocial: Self-efficacy, depression	Cognitive: 3MS, Trail Making Tests A and B Environmental: Active Neighborhood Checklist Financial: 2018 US Census data Personal: All were Self-reported Physical: Electronic, pneumatic leg press machine, SPPB, trials of self-selected walking speed, 6MWT, Figure of 8 walk test, the energy cost of walking, self-selected walk on the treadmill, LLDFI Psychosocial: Modified Gait Efficacy Scale, Geriatric Depression Scale, self-reported fear of falling using yes or no.	Age and energy cost of walking negatively predicted life space. Lower extremity power and gait efficacy positively predicted life space.
Kuspinar et al., 2020, Canada [28]	Cross-sectional Community-dwelling	12,646 73.1 (5.7), 65–86	Multivariable regression	Self-reported life-space mobility (Life-Space Index)	Cognitive: Executive function, verbal learning and memory Environmental: Residential location (rural vs. urban) Financial: Income Personal: Age, sex, education, marital/partner status Physical: Gait speed, grip strength, balance, pain, fatigue, vision, BMI, smoking, number of chronic conditions Psychosocial: Depression, Social Support	Cognitive: Mental Alternation test, Rey's Auditory Verbal Learning test Environmental: Not Reported (NR) Financial: NR Personal: NR Physical: Timed 4-metre walk test, electronic handgrip dynamometer, single leg stance test, self-reported, self-reported, measured weight and height, self-reported, self-reported Psychosocial: CESD-10, Medical Outcomes Study Social Support Survey	Underweight BMI, smoking, pain, fatigue, poor vision, and depression negatively predicted life space. Gait speed, grip strength, social support, and executive function positively predicted life space.
Ullrich et al., 2019, Germany [33]	Cross-sectional Community-dwelling	118 82.3 (6.0), NR	Linear regression	Self-reported life-space mobility (Life-Space Assessment in Persons with Cognitive Impairment)	Cognitive: Global cognition Environmental: Temperature, weather Financial: Did not included in the study Personal: Age, gender, education, marital status Physical: Motor performance, comorbidities, BMI, physical activity Psychosocial: Self-efficacy, fear of falling, depression, apathy, care from friends and family, social situation	Cognitive: MMSE Environmental: mean temperature, precipitation height and snow depth Financial: Did not included in the study Personal: all personal factors were self-reported Physical: SPPB, patient charts, measured height and weight, accelerometer Psychosocial: FES-I, FFABQ, GDS, AES-C, questionnaire for health-related resource use, Erhebungsbogen SOziale Situation survey	SPPB scores, social activities, gender, and number of steps/physical activity positively predicted life space.
Giannouli et al., 2019, Germany [25]	Cross-sectional Community-dwelling	154 Wave 1: 72.3 (5.9), NR Wave 2: 69.5 (4.9), NR	Stepwise multiple regression	Performance-based real-life mobility is defined as: Life-space area (GPS data from smartphones) Active and Gait Time (motion data from smartphones) Number of Steps (motion data from smartphones) AR-max (GPS data from smartphones)	Cognitive: Planning ability, visuospatial attention Environmental: Temperature Financial: Did not included in the study Personal: Age, gender, education Physical: Gait speed, muscle strength Psychological: Self-efficacy Social: Sociableness, perceived help availability	Cognitive: HOTAP.A test Attention Window test Environmental: Recorded maximum temperature Financial: Did not included in the study Personal: all personal factors were self-reported Physical: iTUG, Grip and leg strength Psychological: Falls efficacy scale Social: MPTE3, ISEL-TSS	Age negatively predicted AGT and AR-max. Leg strength positively predicted AGT and the number of steps. Grip strength positively predicted life space area and AR-max.

Table 1. *Cont.*

Authors, Year, and Country	Study Design Sample	Sample Size Mean Age (SD), Range	Study Analysis Method	Mobility Outcome Measures	Factors for Each Determinant	How Each Factor Was Measured	Plain Language Key Findings
Meyer et al., 2014, USA [30]	Cross-sectional Community-dwelling	6112 74.7 (7.1), 65–100	Structural equation modeling	Self-reported personal mobility Self-reported community mobility (See note below on how personal mobility and community mobility were measured)	Cognitive: Global cognition, episodic memory Environmental: Neighborhood safety, geographic location Financial: Total household income Personal: Gender, race, age, marital status, education Physical: Chronic conditions, number of falls, participation in physical activities Psychosocial: Depression, social activity	Cognitive: Telephone Interview for Cognitive Status, immediate and delayed recall tests Environmental: all environmental factors were self-reported Financial: the financial factor was self-reported Personal: all personal factors were self-reported Physical: all physical factors were self-reported Psychosocial: CES-D, self-reported time spent with family and friends at home and in the community	Geographical location, neighborhood safety, chronic conditions, physical activity, history of falls, social activity, depression, memory, and global cognition were all retained in the model. Age and marital status also predicted personal and community mobility.
Jansen et al., 2017, Germany [27]	Cross-sectional Nursing home residents	65 82.9 (9.6), 53–98	Linear regression	Performance-based life-space mobility, defined as time spent away from their private room, frequency of life-space zone changes (wireless sensor network).	Cognitive: Cognitive status Environmental: Institutional routines (movement during scheduled mealtimes) Financial: Did not included in the study Personal: Age, sex, length of stay Physical: Ambulation without aid, ambulation with aid, self-propelled wheelchair use, fully immobile wheelchair use Psychosocial: Depression, apathy, fall-related self-efficacy	Cognitive: MMSE Environmental: Timing during institutionally scheduled mealtimes Personal: Extracted from participants' care documentation note Physical: All personal factors were from observations by staff Psychosocial: GDS-12R, AES-D, Short FES-I	Sex was a positive predictor of life-space zone changes. Gait speed was a negative predictor of life-space zone changes. Gait speed was a positive predictor of time spent away from their private room. MMSE and GDS-12R scores were negative predictors of time spent away from their private room.
Jafari et al., 2020, Iran [26]	Cross-sectional Community-dwelling	1201 59.2 (8.0), 51–97	Structural equation modeling	Self-reported mobility limitations (Medical Outcomes Study—Physical Functioning Scale)	Cognitive: Global cognition Environmental: Did not include in their study Financial: Income Personal: Age, gender, marital status, education Physical: Physical activity, BMI Psychological: Depression Social: Social support	Cognitive: MMSE Environmental: Did not include in their study Financial: Self-reported Personal: all personal factors were self-reported Physical: Physical Activity Scale for the Elderly, measured weight and height Psychological: CES-D Social: Duke Social Support Index	Age, female gender, poor economic status, poor physical activity, and sociopsychological activity negatively predicted mobility limitation. Educational level, marital status, cognitive function, and living environment being on the ground floor positively predicted mobility limitation.
Nwachuwku et al., 2023, Nigeria [31]	Cross-sectional Community-dwelling	277 66.6 (6.8), 60+	Stepwise linear and logistic regression	SPPB (gait speed, balance, lower extremity strength) Mänty Preclinical Mobility Limitation scale (limitations walking 2 km, 0.5 km, and climbing 1 flight of stairs)	Cognitive: Global cognition Environmental: Environmental obstacles Financial: Income Personal: Age, sex, occupation, education Physical: Physical activity, BMI, mean arterial pressure, number of comorbidities Psychological: Extraversion, agreeableness, conscientiousness, neuroticism, openness to new experience Social: Living arrangement	Cognitive: MoCA Environmental: Adapted question from the Lower Extremity Functional Scale Financial: the financial factor was self-reported Personal: all personal factors were self-reported Physical: Self-reported, measured height and weight, measured blood pressure, self-reported Psychological: all personal factors were assessed using the 50-item International Personality Item Pool Social: the social factor was self-reported	Age negatively predicted gait speed, balance, and lower extremity strength. A history of no exercise positively predicted an inability to walk 0.5 km and 2 km. Living arrangement was the only factor that consistently interacted with other variables to improve the regression model for all mobility outcomes, except balance and self-reported inability to walk 2 km.
Ma et al., 2023, Australia [29]	Cross-sectional Community-dwelling	6685 NR (NR), 65+	Logistic regression	Self-reported unmet mobility needs (yes vs. no—whether older adult leaves home as often as would like)	Cognitive: Did not include in their study Environmental: Residential location Financial: Weekly income Personal: Age, sex, marital status, main language at home Physical: Self-rated health, long-term conditions, limitations in everyday physical activities Psychological: Level of distress Social: Did not include in their study	Cognitive: Did not include in their study Environmental: the environmental factor was self-reported Financial: the financial factor was self-reported Personal: All personal factors were self-reported Physical: All physical factors were self-reported Psychological: the psychological factor was self-reported Social: Did not include in their study	Older age and residing in inner regional residential locations predicted fewer unmet mobility needs. Lower-income, poorer self-rated health, long-term conditions, limitations in everyday physical activities, and higher levels of distress positively predicted unmet mobility limitations.

Table 1. *Cont.*

Authors, Year, and Country	Study Design Sample	Sample Size Mean Age (SD), Range	Study Analysis Method	Mobility Outcome Measures	Factors for Each Determinant	How Each Factor Was Measured	Plain Language Key Findings
Saunders et al., 2023, Canada [32]	Cross-sectional Community-dwelling	247 78 (7.3), 65+	Linear regression	Late Life Function Instrument (LLFI)	Cognitive: Did not include in their study Environmental: Neighbourhood safety, extent of unpleasantness to walking in the neighborhood Financial: Household income Personal: Age, sex, education Physical: Musculoskeletal pain, number of comorbidities, self-reported health, history of falls, volume of walking, nutrition risk, BMI Psychological: Distress (fear of falls), resilience from stress, quality of life Social: Loneliness, health assistance from the community	Cognitive: Did not include in their study Environmental: All environmental factors were self-reported Financial: the financial factor was self-reported Personal: All personal factors were self-reported Physical: Self-reported, self-reported, self-reported, Physical Activity Scale for the Elderly, Seniors in the Community: Risk Evaluation of Eating and Nutrition Abbreviated, measured height and weight Psychological: Impact of Events Scale-Revised, Brief Resilience Scale, EuroQol 5D-5L Social: A single question from the CES-D, self-reported	Age, musculoskeletal pain, number of comorbidities, receiving health assistance from the community, history of falls, fear of falling, and having an unpleasant walk throughout the neighborhood were negative predictors of LLFI scores. Being male, having better self-reported health, and having a higher volume of walking were positive predictors of LLFI scores.
Webber et al., 2023, Canada [34]	Cross-sectional Community-dwelling	11667 NR (NR), 65+	Structural equation modeling	Life Space Index	Cognitive: Immediate and delayed recall of words, consecutive numeric and alphabetical alternations Environmental: Rural/urban status, fear of walking alone after dark in their local area Financial: Total household income, how well income satisfied basic needs Personal: Age, sex, education Physical: Frequency and average hours per day spent walking, engaging in resistance exercises, and participating in light and moderate-intensity physical activities, types and numbers of comorbidities, number of falls, the intensity of pain experienced, whether pain influenced participation in activities, physical capacity, gait speed, chair rise, balance, grip strength Psychological: Anxiety, frequency of feeling depressed, frequency of feeling lonely Social: Availability of social supports, frequency of community-based activity participation, whether fear of injury contributed to lack of participation	Cognitive: Rey Auditory Verbal Learning test, Mental Alternation Test Environmental: All environmental factors were self-reported Financial: All financial factors were self-reported Personal: All personal factors were self-reported Physical: Self-reported, self-reported, self-reported, self-reported, self-reported, self-reported, self-reported, self-reported, Timed Get Up and Go test, 4-m walk, chair rise tests (5 repetitions), single leg stance for balance, grip strength Psychological: All psychological factors were self-reported Social: All social factors were self-reported	Cognitive, psychological, social, physical, and environmental factors were directly associated with life-space mobility. Financial and personal factors were indirect influences. Older adults with greater cognitive, psychosocial, and/or physical health had greater life-space mobility. Older adults who were less afraid to walk after dark in their local area had greater life-space mobility.

Note: 3MS = Modified Mini-Mental State; 6MWT = Six Minute Walk Test; AES-C = Apathy Evaluation Scale; AES-D = Apathy Evaluation Scale; BMI = Body Mass Index; CES-D = Center for Epidemiologic Studies Depression Scale; CESD-10 = Center of Epidemiologic Studies Depression Scale, 10-item version; FES-I = Falls Efficacy Scale International; FFABQ = Fear of Falling Avoidance Behavior Questionnaire; GDS = Geriatric Depression Scale; GDS-12R = 12-item Geriatric Depression Scale—Residential; HOTAP.A = Action- and Daily planning test; ISEL-TSS = Interpersonal Support Evaluation List-Tangible Support Subscale; iTUG = Instrumented Timed Up and Go Test; LLDFI = Late-Life Function and Disability Instrument; LLFI = Late Life Function Instrument; LSA = Life-Space Assessment; MMSE = Mini-Mental State Examination; MoCA = Montreal Cognitive Assessment; MPTE3 = Multidimensional Personality Test for Adults; SPPB = Short Physical Performance Battery. Personal mobility was assessed using the following questions: (a) ability to walk several blocks, (b) ability to jog one mile, (c) ability to walk one block, (d) ability to sit for 2hr, (e) ability to get up from a chair, (f) ability to climb stairs, (g) ability to climb one flight of stairs, (h) ability to stoop, (i) ability to reach arms, and (j) ability to pull/push objects. Higher scores indicated greater mobility (range: 0–10). Community mobility was assessed using the following questions: (a) Are you able to drive? (b) Have you driven in the past month? (c) Do you have a car available? and (d) Do you limit your driving to nearby places, or do you also drive on longer trips? A composite score was then created with higher values indicating greater community mobility (range: 0–5).

Six of the eleven studies focused on the association of mobility determinants with self-reported or performance-based life-space mobility. In a cross-sectional analysis of 12,446 older adults, Kuspinar and colleagues [28] reported that all physical, psychological, social, environmental, financial, and cognitive factors were significantly associated with life-space mobility and that social support and walking speed explained the most variation in the life space index score. However, among 114 German community-dwelling older adults with mild to moderate cognitive impairment, only physical, social, and personal factors were predictors of life-space mobility [33]. Similar findings were noted in Dunlap et al.'s [24] and Giannouli et al.'s [25] studies; both reported that physical, personal, and psychosocial or psychological factors were associated with life-space mobility. Dunlap and colleagues [24] included a baseline sample of 249 community-dwelling older adults who participated in a randomized control trial in the USA, while Giannouli and colleagues [25] recruited 154 community-dwelling older adults in Germany. A study by Jansen and colleagues [27] explored the association between several factors and the life-space mobility measured using a sensor-based assessment of 65 residents in a German nursing home and found that personal, cognitive, and psychological factors were associated with life-space mobility. In addition, Nwachuwku and colleagues [31] assessed the predictors of mobility among 227 older Nigerians in a cross-sectional study and found that physical and personal factors consistently predicted self-reported and performance-based mobility measures.

Across all articles, physical factors consistently predict mobility; however, living arrangements (social factors) consistently interacted with other mobility factors to improve the regression model predicting mobility outcomes. Notably, the variance explained by the significant predictors in the life-space mobility score varied across the studies: 43.0%, 42.4%, 28.3%, and 13.5% in Jansen et al. [27] Ullrich et al. [33], Dunlap et al. [24], and Kuspinar et al. [28], respectively. Giannouli and colleagues [25] reported that the predictors explained 5 to 30% of the variance in real-life space mobility, and Nwachuwku and colleagues [31] found that predictors explained 23.0 to 31.3% and 25.8 to 39.5% of performance-based and self-reported measures of mobility, respectively. These findings highlight that the percentage variance explained by mobility determinants in life space measures is low to moderate.

Three studies used structural equation modeling analysis to test the mobility framework. Among 6122 respondents from the Health and Retirement Study in the USA, all, except financial determinants, were predictors of community and personal mobility [30]. Jafari and colleagues [26] reported that all determinants, cognitive, environmental, financial, personal, physical, psychological, and social factors, are significant predictors of mobility limitation, as assessed using the Medical Outcomes Study-Physical Functioning Scale among 1201 older adults in Iran. Using the Canadian Longitudinal Study on Aging study (n = 11,667), Webber and colleagues [34] reported that all seven determinants directly or indirectly influenced life-space mobility. The remaining two studies evaluated predictors informed by the Conical Model on self-reported mobility measures. In a cohort of 6685 community-dwelling older adults, Ma and colleagues [29] found that environmental, financial, personal, physical, and psychological factors predicted self-reported unmet mobility needs. Likewise, Saunders and colleagues [32] found that environmental, personal, physical, psychological, and social factors predicted extremity function in a sample of 247 community-dwelling older adults.

Details of the quality assessment for the eleven studies that tested the conventional model can be found in Table 2. Five studies were classified as 'Good', and six studies were classified as 'Excellent'. Less than half (n = 5, 45%) of studies were sufficiently powered to detect a clinically meaningful effect. Detailed quality assessments for each study can be found in Appendix C.

Table 2. Quality assessment of studies that assessed the Conical Model of the Theoretical Framework for Mobility in Older Adults using a modified version of the Down and Black checklist.

Authors, Year, and Country	Reporting (/11)	External Validity (/3)	Internal Validity-Bias (/3)	Internal Validity—Confounding (/3)	Sufficient Power to Detect a Clinically Important Effect (/1)	Overall Score (/21)	Overall Quality
Dunlap et al., 2021, USA [24]	9	1	3	2	0	15	Good
Kuspinar et al., 2020, Canada [28]	9	3	3	2	1	18	Excellent
Ullrich et al., 2019, Germany [33]	8	3	3	2	0	16	Good
Giannouli et al., 2019, Germany [25]	10	3	3	2	0	18	Excellent
Meyer et al., 2014, USA [30]	10	3	2	3	1	19	Excellent
Jansen et al., 2017, Germany [27]	9	3	3	2	0	17	Excellent
Jafari et al., 2020, Iran [26]	8	1	2	2	1	14	Good
Nwachukwu et al., 2023, Nigeria [31]	11	2	3	2	0	18	Excellent
Ma et al., 2023, Australia [29]	8	2	3	3	1	16	Good
Saunders et al., 2023, Canada [32]	8	2	3	3	0	17	Excellent
Webber et al., 2023, Canada [34]	9	2	3	3	1	18	Excellent

3.4. Using the Conical Model in Study Development

Table 3 showcases the 12 studies that used the Conical Model in their study development [35–46]. Of the 12 studies, only 8 (66%) explicitly described how they used the framework: guiding interview questions and questionnaire development [37,40,43], guiding mobility definitions [35], selecting independent variables to assess [36,38,44], and developing a driving-focused mobility framework [39]. The remaining four articles referenced the Conical Model in passing or mentioned that the framework was used to guide their methods. However, they either did not specify how the model was used or cited it alongside other papers, leading to ambiguity regarding the model's exact purpose [41,42,45,46]. Details of the quality assessment for the 12 studies that used the Conical Model in their study development can be found in Appendix D.

Tong and colleagues' [43] qualitative study used the Conical Model to develop their research question—how do gender, culture and personal biography affect a participant's mobility? Furthermore, the domains from the Conical Model were used to guide the development of their interview guide. For example, based on the environmental domain of the model, the authors developed the question, "Do you think that your neighborhood is walkable?" [43]. Similarly, Franke and colleagues [37] used the framework to inform the questions in their qualitative interview guide to explore 24 participants' perceptions of how the physical and social environments influence physical activity and mobility. Likewise, the Conical Model guided the development of mobility-related questions in Bechtold and colleagues' [35] study assessing how older adults perceive their own and others' life-course and aging.

Chudyk and colleagues [36] used the Conical Model to comprehensively measure participants' demographics across multiple levels including environmental, cognitive, physical and psychosocial) in their cross-sectional study of 161 older adults exploring the influence of low socioeconomic status on mobility. Similarly, the Conical Model guided the selection and classification of some personal factors (age, gender), physical (number of medications, pain intensity, frailty level), cognitive factors (mental status) and psychosocial factors (fall efficacy) in Hauer and colleagues [38] longitudinal cohort study. Using a sample of 94 hospitalized older adults, the authors compared the Life-Space Assessment for Institutionalized Settings by proxy informants to the aforementioned mobility factors.

Hirsch and colleagues [39] developed a mobility framework called MOVES (Mobility Over Varied Environments Scale) by identifying items related to the model from the Canadian Community Health Survey-Health Aging. Meanwhile, Kalu and colleagues [40] used the Conical Model to determine the mobility factors to include in their modified e-Delphi study to assess which factors should be included in a comprehensive mobility discharge assessment framework. Finally, Ullrich and colleagues [33] applied the Conical Model to determine which mobility factors to test against their telephone-based life-space assessment questionnaire to assess its construct validity.

Table 3. Studies using the Conical Model of the Theoretical Framework for Mobility in Older Adults in their study development.

Authors, Year, and Country	Study Design Sample	Sample Size Mean Age (SD), Range	How Was the Framework Used to Guide Study Development?
Wettstein et al., 2015, Germany [45]	Cross-sectional Community-dwelling	257 72.9 (6.4), 59–91	The framework is cited as findings and reasonings their work builds upon, but the Conical Model is cited alongside two other sources, leading to ambiguity.
Yu et al., 2020, China [46]	Cross-sectional Community-dwelling	64 72.50 (7.68), Not Reported (NR)	Brief mention of the Conical Model in the introduction as a reference to the different aspects of the framework.
Tong et al., 2020, Canada [43]	Mixed-method Community-dwelling	18 72.56 (4.81), 66–81	The framework was used to guide one of the two research questions in the study. The question looked at how gender, culture and personal biography affect participant's mobility.
Koppel et al., 2016, Australia [41]	Cross-sectional Community-dwelling	227 81.5 (3.37), 76–96	The Conical Model is cited twice in the study, once alongside a list of 3 other studies, so how the Conical Model is used is unclear. The authors also cite it again, stating that their driving habits and intentions questionnaire was adapted from Webber's short questionnaire regarding driving-related thoughts, beliefs and actions.
Franke et al., 2019, Canada [37]	Mixed-method Community-dwelling	6 NR, NR	Use the framework to inform interview questions used to explore participant perception of how physical and social environment influences their physical activity and mobility.
Patterson et al., 2019, Canada [42]	Cross-sectional Community-dwelling	114 65.8 (15.5), NR	Brief mention of using the mobility domain within the self-report questionnaire. The Conical Model is cited, but how the framework is used is not made clear.
Bechtold et al., 2021, Austria [35]	Cross-sectional Community-dwelling	245 NR, 61–93	This study makes use of the Conical Model to develop their definition of mobility and framework for the determinants of mobility
Chudyk et al., 2016, Canada [36]	Cross-sectional Community-dwelling	161 74.3 (6.3), NR	The framework used to select the independent variables in the study.
Hauer et al., 2021, Germany [38]	Cross-sectional Hospital	84 83.3 (6.1), NR	The Conical Model influenced their definition of mobility, which impacted their selection and classification of variables.
Hirsch et al., 2017, Canada [39]	Cross-sectional Community-dwelling	NR (NR), ≥45 years	Used Webber's model to help guide the development of their own mobility framework called MOVES (Mobility Over Varied Environments Scale).
Kalu et al., 2023a, Canada [40]	e-Delphi study	NA	The Conical Model guided their selection of mobility factors to assess as part of a comprehensive mobility discharge framework for older adults using an e-Delphi study.
Ullrich et al., 2023, Germany [33]	Cross-sectional Community-dwelling	50 79.3 (5.3), NR	The Conical Model influenced which mobility factors they tested against their telephone-based life space questionnaire to assess construct validity.

Note: NA—not applicable, as participants comprised of healthcare workers, family members, researchers and older adults.

4. Discussion

This scoping review aimed to map and describe the available studies that have used the Conical Model in clinical practice and research concerning older adults. We grouped the studies into three headings: modified the framework (n = 1), tested the framework (n = 11), and used the framework in study development (n = 12), highlighting the varied use of the framework in research practice. We did not find any documents describing the use of the Conical Model in clinical practice. We discussed the findings from this review in light of the new direction proposed in the original Conical Model publication [5], noting that the included articles are of good or excellent quality, which further enhances the credibility of using the Conical Model.

In the original Conical Model paper [5], the authors reported that the framework was not developed using extensive empirical evidence but rather conceptually using the biopsychosocial model. Our review found that eleven studies have tested the model. Across these eleven studies, regardless of how mobility was measured, physical and social factors were the only factors that consistently predicted mobility in older adults. This finding aligns with reviews that have reported physical or social factors as a consistent determinant of mobility decline in older adults [47–50]. The interaction between social factors and other determinants of mobility has significant clinical implications. Recognizing that social support, isolation, and community engagement interact with physical, environmental, and psychological factors underscores the need for healthcare providers to assess and address these social determinants alongside traditional clinical factors. Implementing tailored, culturally sensitive, and community-based interventions can more effectively improve mobility and outcomes in older adults [51].

Findings differed among studies that tested the Conical Model. While Kuspinar and colleagues [28] reported that all determinants predicted life-space mobility, in Jansen and colleagues' [27] study, only personal and physical determinants predicted life-space mobility. The remaining studies reported that only physical, personal, and psychosocial determinants predicted life-space mobility [24,25,33]. The differences in the findings across these studies could be because most selected different factors within each determinant—for example, environmental factors were measured using residential location [28], weather temperature [33], and neighborhood walkability—a composite of the land-use mix, traffic-related safety, and sidewalk characteristics [28]. Where the same factors were selected for each determinant, each study measured it using a different measure; for example, Kuspinar et al. [28] and Dunlap et al. [24] measured executive functioning using the Mental Alternation Test [52] and Trail Making Test A and B [53], respectively. While these studies highlighted the determinants that influence and predict mobility, research to date also underscores the lack of clarity regarding what factors clinicians and researchers should evaluate for each mobility determinant. It is not surprising that Reijnerse and colleagues [54] reported low to moderate agreement on the definition of mobility and the identification of constructs and measures, emphasizing the need to develop a core set of mobility factors tailored to different hospital settings. Interestingly, a comprehensive list of factors within each determinant and their associations with mobility outcomes [55–57] provides a foundation for the creation of a core outcome set for mobility—a recommended minimum set of outcomes or outcome measures for a particular health construct, condition, or population, which should be reported for all trials on that issue [58]. Having core outcome sets for mobility factors in a specific context, such as hospital-to-home transition, increases outcome consistency across studies, resulting in a reduction in selective reporting to ensure the potential of a study to contribute to meta-analyses of the key outcomes, ultimately increasing the use of study findings in clinical and research practice [58].

Furthermore, the proposed comprehensive list of mobility factors can advance the utilization of the studies guided by Webber's framework. For instance, Franke and colleagues [23] reframed the Conical Model into a sliding scale, revealing that older adults and their caregivers can rate each physiological, subjective, and contextual factor influencing their mobility across the sliding scale in a continuum scale ranging from high to low. Similar to the limitations of the Conical Model, Franke and colleagues' [37] study did not provide specific examples of physiological, subjective, and contextual factors. Older adults and their family caregivers can use mobility factors in the comprehensive list developed through scoping reviews [55–57] for example, physiological factors (e.g., muscle strength and muscle power) or contextual factors (e.g., street, residential and sidewalk characteristics) to identify which mobility factors they believe most influence their mobility.

This approach could guide clinicians to focus interventions on specific factors that could maximize therapeutic benefit.

Webber and colleagues [5] recommended developing a tool (or a set of interrelated tools) capable of measuring factors influencing mobility in different contexts, for example, in the community or hospital settings. We found two studies that aimed to develop a tool. Hirsch and colleagues [39] developed the MOVES framework—a mobility measurement tool consisting of three mobility determinants: physical, cognitive and social, and transportation as a form of mobility. Kalu and colleagues developed a Comprehensive Discharge Assessment Framework (COMDAF) by asking experts to prioritize factors within mobility determinants that are crucial to be part of COMDAF to be used to assess older adults' mobility during the hospital-to-home transition [40]. While these studies have attempted to establish the relative importance of mobility determinants in a different mobility context, the use of the model has not transferred to clinical practice. We did not find any studies that reported the clinical use of the Conical Model. It is plausible that the Conical Model may have been used in the clinical setting and to develop forms as part of a clinical evaluation document (grey document), which is challenging to retrieve for inclusion. Therefore, studies that explore the use of the Conical Model in the clinical setting are needed.

The Conical Model is highly comprehensive and interdisciplinary and subsequently demands a significant degree of rigor from those seeking to implement it in developing study designs or clinical interventions. As a result, the model may have suffered from low implementation fidelity. A systematic review of the usage of various multidimensional theoretical models in the development of physical activity intervention plans found theoretical implementation weaknesses in most included interventions [59]. Low implementation fidelity restricts the extent to which patient outcomes in research indicate a framework's usefulness, impairing decision-making in clinical settings [59]. It is possible that clinicians are unaware of the model's breadth and its practical utility, highlighting the need for further studies to explore clinicians' knowledge and perspectives on the Conical Model. Such research could inform the co-creation of training programs and guide their integration into clinical practice and policy, particularly regarding mobility as a form of transport.

Strengths and Limitations

This scoping review has several strengths. First, we consulted an experienced health sciences librarian who helped develop a comprehensive and rigorous search strategy to capture several articles. We also thoroughly reviewed sources of grey literature, including thesis databases, to ensure we captured all relevant articles and documents.

Three major limitations of this scoping review should be noted. Our search was restricted to those published in English. There are likely studies published in other languages that have been missed. A potential limitation is publication bias, as studies with negative or inconclusive findings may not have been published, whether in peer-reviewed journals or grey literature. Additionally, not all the articles that used the Conical Model outlined clearly how the model was used; many cited the framework in passing and failed to state how it was used explicitly. Moreover, we could not identify any studies using the Conical Model in clinical practice. Even though we searched some well-established interdisciplinary mobility teams, such as those in John Hopkins and Cleveland Clinic, we did not see evidence of the Conical Model's use in these settings [60].

5. Conclusions

We described how the Conical Model had been used in research and clinics. We found a varied use of the Conical Model in research, including one article advancing the model, eight articles testing the model, and eleven articles using it to inform their study development. We did not find any clinical or policy use of the Conical Model, highlighting the need for further validation of the Conical Model in clinical and policy contexts. For instance, research should comprehensively create factors within each mobility determinant that would allow for a core outcome set development that can be used for a specific context. A clear definition of each determinant is needed to ensure consistent use of factors within each determinant to allow for comparison and practical synthesis of factors that most predict mobility in older adults and different settings. Establishing this core-mobility factor set would enable longitudinal comparisons over time, facilitating continuous assessment of how each factor evolves across various settings and regions globally.

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Appendix A. Search Strategies for Bibliographic Databases to 10 February 2025

MEDLINE (via PubMed):

Search	Query	Records Retrieved
#1	((older adults OR seniors OR elderly OR aged adults OR geriatric individuals OR retiring adults OR aging OR older persons) AND (Conical Model of Theoretical Framework for Mobility OR Theoretical Model OR Conceptual Model)) AND (mobility OR physical mobility OR movement OR motility OR maneuverability OR mobility determinants OR life-space mobility OR mobility performance OR capacity)	8877
Filters: 80 and over: 80+ years; Aged: 65+ years; From 2010 to 2025.		

EMBASE (via OVID):

Search	Query	Records Retrieved
#1	(older adult* OR senior* OR elderly OR aged adult* OR geriatric individual* OR retiring adult* OR aging OR older person*).mp [mp = title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	1,480,378
#2	(Conical Model of Theoretical Framework for Mobility OR Theoretical Model* OR Conceptual Model*).mp [mp = title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	125,391
#3	(mobility OR physical mobility OR movement OR motility OR maneuverability OR mobility determinant* OR life-space mobility OR mobility performance OR capacity).mp [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	1,850,282
#4	#1 AND #2 AND #3	291
From 2010 to 2025.		

CINAHL (via EBSCO):

Search	Query	Records Retrieved
#1	"older adults OR seniors OR elderly OR aged adults OR geriatric individuals OR retiring adults OR older persons" OR (MH "Aged")	931,774
#2	(MH "Models, Theoretical") OR (MH "Conceptual Framework") OR "Conical Model of Theoretical Framework for Mobility"	100,931
#3	(MH "Physical Mobility") OR "mobility OR physical mobility OR motility OR maneuverability OR mobility determinants OR life-space mobility OR mobility performance OR capacity"	7678
#4	#1 AND #2 AND #3	88
From 2010 to 2025.		

Scopus:

Search	Query	Records Retrieved
#1	(ALL (older AND adults OR seniors OR elderly OR aged AND adults OR geriatric AND individuals OR retiring AND adults OR aging OR older AND persons) AND ALL (conical AND model AND of AND theoretical AND framework AND for AND mobility OR theoretical AND model OR conceptual AND model) AND ALL (mobility OR physical AND mobility OR movement OR motility OR maneuverability OR mobility AND determinants OR life-space AND mobility OR mobility AND performance OR capacity))	6
From 2010 to 2025.		

PsycINFO (via OVID):

Search	Query	Records Retrieved
#1	(seniors OR elderly OR aged adults OR geriatric individuals OR retiring adults OR aging OR older persons).mp [mp = title, abstract, heading word, table of contents, key concepts, original title, tests and measures, mesh word]	170,838
#2	(Conical Model of Theoretical Framework for Mobility OR theoretical framework OR conceptual model).mp [mp = title, abstract, heading word, table of contents, key concepts, original title, tests and measures, mesh word]	38,474
#3	(physical mobility OR movement OR motility OR maneuverability OR mobility determinants OR life-space mobility OR mobility performance OR capacity).mp [mp = title, abstract, heading word, table of contents, key concepts, original title, tests and measures, mesh word]	207,384
#4	#1 AND #2 AND #3	42
From 2010 to 2025.		

Web of Science (Core Collection):

Search	Query	Records Retrieved
#1	seniors OR elderly OR aged adults OR geriatric individuals OR retiring adults OR aging OR older persons (All Fields) AND Conical Model of Theoretical Framework for Mobility OR theoretical framework OR conceptual model (All Fields) AND physical mobility OR movement OR motility OR maneuverability OR mobility determinants OR life-space mobility OR mobility performance OR capacity (All Fields)	1056
From 2010 to 2025; Original language of publication—English.		

ProQuest Dissertations and Theses A&I:

Search	Query	Records Retrieved
#1	noft(older adults OR elderly OR aged adults OR geriatric individuals OR retiring adults OR aging OR older persons) AND noft(Conical Model of Theoretical Framework for Mobility OR theoretical framework OR conceptual model) AND noft(physical mobility OR movement OR motility OR maneuverability OR mobility determinants OR life-space mobility OR mobility performance OR capacity)	152
From 2010 to 2025, English only.		

Note = * Booleans used in the search strategy

Appendix B. Data Extraction Instrument

Study Details	
Evidence Sources—Details and Characteristics	
Citation details (e.g., author(s), date, title, journal, volume, issue, pages)	
Country	
Context	
Participants (details, e.g., age, sex, and number)	
Details/Results Extracted from Source of Evidence	
How was the Conical Model of Theoretical Framework for Mobility in Older Adults used?	
(a)	Expanded the model
(b)	Tested the model
(c)	Used the model for study development (e.g., questionnaire or mobility assessment tool development)
(d)	Overall study findings

Appendix C. Modified Down and Black Checklist for Cross-Sectional Studies

Category	Item	Criteria	Scoring
Reporting	1	Is the hypothesis/aim/objective of the study clearly described?	Yes = 1 No = 0
	2	Are the main outcomes to be measured clearly described in the Introduction or Methods section? If the main outcomes are first mentioned in the Results section, the question should be answered no.	Yes = 1 No = 0
	3	Are the characteristics of the patients included in the study clearly described? In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case definition and the source for controls should be given.	Yes = 1 No = 0
	4	Are the interventions of interest clearly described? Treatments and placebo (where relevant) that are to be compared should be clearly described.	Yes = 1 No = 0
	5	Are the distributions of principal confounders in each group of subjects to be compared clearly described? A list of principal confounders is provided.	Yes = 2 Partially = 1 No = 0
	6	Are the main findings of the study clearly described? Simple outcome data (including denominators and numerators) should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests, which are considered below).	Yes = 1 No = 0
	7	Does the study provide estimates of the random variability in the data for the main outcomes? In non-normally distributed data, the interquartile range of results should be reported. In normally distributed data, the standard error, standard deviation or confidence intervals should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.	Yes = 1 No = 0
	8	Have all important adverse events that may be a consequence of the intervention been reported? This should be answered yes if the study demonstrates that there was a comprehensive attempt to measure adverse events. (A list of possible adverse events is provided).	Yes = 1 No = 0
	9	Have the characteristics of patients lost to follow-up been described? This should be answered yes, where there were no losses to follow-up or where losses to follow-up were so small that findings would be unaffected by their inclusion. This should be answered nowhere a study does not report the number of patients lost to follow-up.	Yes = 1 No = 0
	10	Have actual probability values been reported (e.g., 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?	Yes = 1 No = 0

Category	Item	Criteria	Scoring
External Validity	11	Were the subjects asked to participate in the study representative of the entire population from which they were recruited? The study must identify the source population for patients and describe how the patients were selected. Patients would be representative if they comprised the entire source population, an unselected sample of consecutive patients, or a random sample. Random sampling is only feasible where a list of all members of the relevant population exists. Where a study does not report the proportion of the source population from which the patients are derived, the question should be answered as unable to determine.	Yes = 1 No = 0 Unable to determine = 0
	12	Were those subjects who were prepared to participate representative of the entire population from which they were recruited? The proportion of those asked who agreed should be stated. Validation that the sample was representative would include demonstrating that the distribution of the main confounding factors was the same in the study sample and the source population.	Yes = 1 No = 0 Unable to determine = 0
	13	Were the staff, places, and facilities where the patients were treated representative of the treatment the majority of patients receive? For the question to be answered yes, the study should demonstrate that the intervention was representative of that in use in the source population. The question should be answered no if, for example, the intervention was undertaken in a specialist center unrepresentative of the hospitals most of the source population would attend.	Yes = 1 No = 0 Unable to determine = 0
Internal Validity—Bias	14	If any of the results of the study were based on "data dredging", was this made clear? Any analyses that had not been planned at the outset of the study should be clearly indicated. If no retrospective unplanned subgroup analyses were reported, then answer yes.	Yes = 1 No = 0 Unable to determine = 0
	15	Were the statistical tests used to assess the main outcomes appropriate? The statistical techniques used must be appropriate to the data. For example, nonparametric methods should be used for small sample sizes. Where little statistical analysis has been undertaken but where there is no evidence of bias, the question should be answered yes. If the distribution of the data (normal or not) is not described, it must be assumed that the estimates used were appropriate, and the question should be answered yes.	Yes = 1 No = 0 Unable to determine = 0
	16	Were the main outcome measures used accurate (valid and reliable)? For studies where the outcome measures are clearly described, the question should be answered yes. For studies that refer to other work or that demonstrate the outcome measures are accurate, the question should be answered as yes.	Yes = 1 No = 0 Unable to determine = 0
Internal Validity—Confounding	17	Were the patients in different intervention groups (trials and cohort studies), or were the cases and controls (case-control studies) recruited from the same population? For example, patients for all comparison groups should be selected from the same hospital. The question should be answered, unable to determine for cohort and case-control studies where there is no information concerning the source of patients included in the study.	Yes = 1 No = 0 Unable to determine = 0
	18	Were study subjects in different intervention groups (trials and cohort studies), or were the cases and controls (case-control studies) recruited over the same period of time? For a study that does not specify the time period over which patients were recruited, the question should be answered as unable to determine.	Yes = 1 No = 0 Unable to determine = 0
	19	Was there adequate adjustment for confounding in the analyses from which the main findings were drawn? This question should be answered no for trials if the main conclusions of the study were based on analyses of treatment rather than an intention to treat, the distribution of known confounders in the different treatment groups was not described, or the distribution of known confounders differed between the treatment groups but was not taken into account in the analyses. In non-randomized studies, if the effect of the main confounders was not investigated or confounding was demonstrated but no adjustment was made in the final analyses, the question should be answered as no.	Yes = 1 No = 0 Unable to determine = 0
Power	20	Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%? Sample sizes have been calculated to detect a difference of x% and y%. Did the study have a sample size > 300?	Yes = 1 No = 0 Unable to determine = 0

Appendix D. Quality Assessments of Studies Testing the Conical Model

Category	Item	Dunlap 2021 [24]	Kuspinar 2020 [28]	Ullrich 2019 [33]	Giannouli 2019 [25]	Meyer 2014 [30]	Jansen 2017 [27]	Jafari 2020 [26]	Nwachuwku 2023 [31]	Ma 2023 [29]	Saunders 2023 [32]	Webber 2023 [34]
Reporting	1	1	1	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1	1	1
	4	1	1	1	1	1	1	0	1	1	1	1
	5	1	2	1	1	2	1	1	2	1	1	0
	6	1	1	1	1	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1	1	1	1	1
	9	0	0	0	1	0	1	0	1	0	0	1
	10	1	0	0	1	1	0	1	1	0	0	1
External Validity	11	0	1	1	1	1	1	0	1	1	1	1
	12	0	1	1	1	1	1	0	0	0	0	0
	13	1	1	1	1	1	1	1	1	1	1	1
Internal Validity—Bias	14	1	1	1	1	1	1	1	1	1	1	1
	15	1	1	1	1	1	1	1	1	1	1	1
	16	1	1	1	1	0	1	0	1	1	1	1
Internal Validity—Confounding	17	1	1	1	1	1	1	1	1	1	1	1
	18	1	1	1	1	1	1	1	1	1	1	1
	19	0	0	0	0	1	0	0	0	1	1	1
Power	20	0	1	0	0	1	0	1	0	1	0	1
Total (/21)		**15**	**18**	**16**	**18**	**19**	**17**	**14**	**18**	**16**	**17**	**18**

Appendix E. Quality Assessments of Studies Using the Conical Model in Their Study Development

Cross-Sectional Studies (n = 9)										
Category	**Item**	**Wettstein 2015 [45]**	**Yu 2020 [46]**	**Koppel 2016 [41]**	**Patterson 2019 [42]**	**Bechtold 2021 [35]**	**Chudyk 2017 [36]**	**Hauer 2021 [38]**	**Hirsch 2017 [39]**	**Ullrich 2023 [44]**
Reporting	1	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1
	4	1	1	1	1	1	1	1	1	1
	5	1	2	2	1	0	2	2	0	2
	6	1	1	1	1	0	1	1	1	1
	7	1	1	1	1	1	1	1	1	1
	8	0	0	0	0	0	0	0	1	0
	9	0	1	0	1	1	1	0	0	0
	10	0	1	0	1	1	0	0	1	1
External Validity	11	1	1	1	0	1	1	1	1	1
	12	1	1	1	1	1	1	1	0	1
	13	1	1	1	0	1	1	1	1	1
Internal Validity—Bias	14	1	1	1	1	1	1	1	0	1
	15	1	1	1	1	1	1	1	1	1
	16	1	1	1	1	1	1	1	1	1
Internal Validity—Confounding	17	1	1	1	1	1	1	1	1	1
	18	1	1	0	0	0	1	1	1	1
	19	0	0	0	0	0	0	0	1	0
Power	20	1	1	1	1	1	1	1	1	1
Total (/21)		**16**	**19**	**16**	**15**	**15**	**18**	**17**	**16**	**18**

MMAT Assessment of Tong 2020 [43]		
Domain	**Item**	**Assessment**
Screening	S1	Yes
	S2	Yes
Qualitative	1.1	Yes
	1.2	Yes
	1.3	Yes
	1.4	Yes
	1.5	Yes
Quantitative randomized controlled trials	2.1	Not applicable
	2.2	Not applicable
	2.3	Not applicable
	2.4	Not applicable
	2.5	Not applicable
Quantitative non-randomized	3.1	Not applicable
	3.2	Not applicable
	3.3	Not applicable
	3.4	Not applicable
	3.5	Not applicable
Quantitative descriptive	4.1	Not applicable
	4.2	Not applicable
	4.3	Not applicable
	4.4	Not applicable
	4.5	Not applicable
Mixed methods	5.1	Yes
	5.2	Can't tell
	5.3	Can't tell
	5.4	Can't tell
	5.5	Can't tell

COREQ Assessment of Franke 2019 [23]		
Item	**Questions**	**Reported?**
1	Which author/s conducted the interview or focus group?	No
2	What were the researcher's credentials? E.g., PhD, MD	No
3	What was their occupation at the time of the study?	No
4	Was the researcher male or female?	No
5	What experience or training did the researcher have?	No
6	Was a relationship established prior to study commencement?	No
7	What did the participants know about the researcher? e.g., personal goals, reasons for doing the research	No
8	What characteristics were reported about the interviewer/facilitator? e.g., Bias, assumptions, reasons and interests in the research topic	No
9	What methodological orientation was stated to underpin the study? e.g., grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Yes
10	How were participants selected? e.g., purposive, convenience, consecutive, snowball	Yes
11	How were participants approached? e.g., face-to-face, telephone, mail, email	Yes
12	How many participants were in the study?	Yes
13	How many people refused to participate or dropped out? Reasons?	No
14	Where was the data collected? e.g., home, clinic, workplace	Yes

COREQ Assessment of Franke 2019 [23]		
Item	**Questions**	**Reported?**
15	Was anyone else present besides the participants and researchers?	No
16	What are the important characteristics of the sample? e.g., demographic data, date	Yes
17	Were questions, prompts, and guides provided by the authors? Was it pilot-tested?	Yes
18	Were repeat interviews carried out? If yes, how many?	No
19	Did the research use audio or visual recording to collect the data?	Yes
20	Were field notes made during and/or after the interview or focus group?	Yes
21	What was the duration of the interviews or focus groups?	Yes
22	Was data saturation discussed?	No
23	Were transcripts returned to participants for comment and/or correction?	No
24	How many data coders coded the data?	No
25	Did the authors provide a description of the coding tree?	Yes
26	Were themes identified in advance or derived from the data?	Yes
27	What software, if applicable, was used to manage the data?	No
28	Did participants provide feedback on the findings?	No
29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g., participant number	Yes
30	Was there consistency between the data presented and the findings?	Yes
31	Were major themes clearly presented in the findings?	Yes
32	Is there a description of diverse cases or a discussion of minor themes?	Yes

CREDES Checklist for Kalu 2023 [40]				
Domain	**Item**	**Checklist Item**	**Reported?**	**Location**
Rationale for the choice of the Delphi technique	Justification	The choice of the Delphi technique as a method of systematically collating expert consultation and building consensus needs to be well justified. When selecting the method to answer a particular research question, it is important to keep in mind its constructivist nature	Yes	3
Planning and design	Planning and process	The Delphi technique is a flexible method and can be adjusted to the respective research aims and purposes. Any modifications should be justified by a rationale and be applied systematically and rigorously	Yes	3 to 4
	Definition of consensus	Unless not reasonable due to the explorative nature of the study, an a priori criterion for consensus should be defined. This includes a clear and transparent guide for action on (a) how to proceed with certain items or topics in the next survey round, (b) the required threshold to terminate the Delphi process, and (c) procedures to be followed when consensus is (not) reached after one or more iterations	Yes	4 to 5
Study conduct	Informational input	All material provided to the expert panel at the outset of the project and throughout the Delphi process should be carefully reviewed and piloted in advance in order to examine the effect on experts' judgments and to prevent bias	Yes	4
	Prevention of bias	Researchers need to take measures to avoid directly or indirectly influencing the experts' judgments. If one or more members of the research team have a conflict of interest, entrusting an independent researcher with the main coordination of the Delphi study is advisable	Yes	11
	Interpretation and processing of results	Consensus does not necessarily imply the 'correct' answer or judgment; (non)consensus and stable disagreement provide informative insights and highlight differences in perspectives concerning the topic in question	Yes	3 to 5
	External validation	It is recommended to have the final draft of the resulting guidance on best practice in palliative care (mobility assessment) reviewed and approved by an external board or authority before publication and dissemination	Yes	3 to 4

CREDES Checklist for Kalu 2023 [40]				
Domain	**Item**	**Checklist Item**	**Reported?**	**Location**
Reporting	Purpose and rationale	The purpose of the study should be clearly defined and demonstrate the appropriateness of the use of the Delphi technique as a method to achieve the research aim. A rationale for the choice of the Delphi technique as the most suitable method needs to be provided	Yes	3
	Expert panel	Criteria for the selection of experts and transparent information on recruitment of the expert panel, socio-demographic details including information on expertise regarding the topic in question, (non)response and response rates over the ongoing iterations should be reported	Yes	4 to 5
	Description of the methods	The methods employed need to be comprehensible; this includes information on preparatory steps (How was available evidence on the topic in question synthesized?), piloting of material and survey instruments, design of the survey instrument(s), the number and design of survey rounds, methods of data analysis, processing and synthesis of experts' responses to inform the subsequent survey round and methodological decisions taken by the research team throughout the process	Yes	3 to 5
	Procedure	Flow chart to illustrate the stages of the Delphi process, including a preparatory phase, the actual 'Delphi rounds', interim steps of data processing and analysis, and concluding steps	Yes	3
	Definition and attainment of consensus	It needs to be comprehensible to the reader how consensus was achieved throughout the process, including strategies to deal with non-consensus	Yes	4 to 5
	Results	Reporting of results for each round separately is highly advisable in order to make the evolving of consensus over the rounds transparent. This includes figures showing the average group response, changes between rounds, as well as any modifications of the survey instrument such as deletion, addition or modification of survey items based on previous rounds	Yes	6 to 7
	Discussion of limitations	Reporting should include a critical reflection of potential limitations and their impact on the resulting guidance	Yes	10
	Adequacy of conclusions	The conclusions should adequately reflect the outcomes of the Delphi study with a view to the scope and applicability of the resulting practice guidance	Yes	10
	Publication and dissemination	The resulting guidance on good practice in palliative care mobility assessments should be clearly identifiable from the publication, including recommendations for transfer into practice and implementation. If the publication does not allow for a detailed presentation of either the resulting practice guidance or the methodological features of the applied Delphi technique, or both, reference to a more detailed presentation elsewhere should be made (e.g., availability of the full guideline from the authors or online; publication of a separate paper reporting on methodological details and particularities of the process (e.g., persistent disagreement and controversy on certain issues)). A dissemination plan should include endorsement of the guidance by professional associations and health care authorities to facilitate implementation	Yes	10

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