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MOBILITY ASSESSMENT AND NURSING THEORY: HUNGARIAN VALIDATION OF DEMMI AND CONCEPTUAL FRAMEWORK DEVELOPMENT WITHIN OREM'S THEORY

PhD Thesis

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List of Abbreviations

Abbreviation	Full Form
2MST	2-Minute Step Test
30CST	30-second sit-to-stand test
5CRT	five-repetition chair stand test
5STS	Five Times Sit to Stand Test
ADL	Activities of Daily Living
ASAS-R	Appraisal of Self-Care Agency Scale-Revised
BBS	Berg Balance Scale
BMAT	Banner Mobility Assessment Tool
BMI	Body Mass Index
BT	Back Translation
CCI	Charlson Comorbidity Index
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CI	Confidence Interval
COSMIN	COnsensus-based Standards for the selection of health Measurement INstruments
DEMMI	de Morton Mobility Index
df	degrees of freedom
ESCA	Exercise of Self-Care Agency
FAC	Functional Ambulation Category
FES-I	Falls Efficacy Scale-International

Abbreviation	Full Form
HU-DEMMI	Hungarian de Morton Mobility Index
IADL	Instrumental Activities of Daily Living
ICC	Intraclass Correlation Coefficient
ICF	International Classification of Functioning, Disability and Health
MDC	Minimal Detectable Change
MMSE	Mini Mental State Examination
RMSEA	Root Mean Square Error of Approximation
SCAS	Self-Care Agency Scale
SCDNT	Self-Care Deficit Nursing Theory
SD	Standard Deviation
SEM	Standard Error of Measurement / Structural Equation Modeling
SPPB	Short Physical Performance Battery
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TLI	Tucker-Lewis Index
TUG	Timed Up and Go
WHO	World Health Organization
WLSMV	Weighted Least Squares Mean and Variance

1. Introduction

1.1 Background and Literature Review

1.1.1 Mobility in Geriatric Care (Gyombolai, Simon, et al., 2025)

[Note: Portions of this section (1.1.1) are adapted from the author's work published in Hungarian (Gyombolai, Simon, et al., 2025), with permission from the publisher.]

Mobility is a key component of health-related quality of life and functional capacity (Jung et al., 2021), especially for older adults in long-term care facilities. According to the World Health Organization's International Classification of Functioning, Disability and Health, mobility is the ability to change the position or location of the body (World Health Organization, 2001). This includes the basic positional and location changes from bed mobility through ambulation and dynamic balance tasks. The decline in the mobility of institutionalized elderly is not only about their physical function. Mobility in itself, and through activities of daily living (ADLs), is an important aspect of the psychological well-being and social participation along with life satisfaction and quality of life (Brown & Flood, 2013; Jung et al., 2021), while also having a predictive value in adverse health-related events (Cesari et al., 2009).

The impacts of mobility impairment affect multiple body systems, and add up in effect. Rapid muscle atrophy occurs (Dittmer & Teasell, 1993a), especially in the lower extremities and trunk stabilizers involved in maintaining a vertical posture (Kortebein et al., 2007). Bone density is also greatly affected in immobility, causing pathological fractures (Dittmer & Teasell, 1993a). As the range of motion decreases in joints, the potential for mobility recovery becomes more difficult, or even impossible (Lam et al., 2022). Immobility not only impacts the musculoskeletal system, but it also reduces cardiovascular fitness, causes orthostatic hypotension and increases the risk of thromboembolic complications (Dittmer & Teasell, 1993a). In the supine position, the respiratory muscles are unable to expand the chest sufficiently, which can cause complications such as hypostatic pneumonia (Dittmer & Teasell, 1993b).

It is the responsibility of all professionals working in the elderly care to improve and/or maintain the capacity for basic mobility of residents. Physiotherapists and nurses who work in long-term care settings should aim to preserve bed mobility, seated mobility, standing balance, and ambulation in the institutional environment (Narsakka et al., 2023; Brett et al., 2019; Yang et al., 2021). Planning care for people with declining mobility, optimally using limited staff and material resources, and preparing actions to maintain or improve mobility capacity must be based on a proper assessment of expected mobility potential.

1.1.2 Mobility Assessment Tools for the Elderly

In elderly care a detailed assessment of mobility is necessary to determine the care plan, resource allocation and outcome monitoring. Standard measures of mobility, while credible in specific settings and for specific uses, generally possess significant limitations when applied to heterogeneous populations of institutionalized elderly.

There are many different mobility assessment tools available that are used in long-term care. Each tool assesses a specific aspect of physical function and mobility capacity. The Timed Up and Go (TUG) test is widely regarded as the best tool for assessing functional capacity in nursing homes, for further details see Methods section 3.2.3 (Podsiadlo & Richardson, 1991). The Berg Balance Scale (BBS) is a performance-based rating scale with 14 items. It assesses static and dynamic balance abilities under changing task conditions (Berg et al., 1989). Chair rise tests include the five-repetition chair stand test (5CRT, or Five Times Sit to Stand Test = 5STS) and the 30-second sit-to-stand test (30CST), both tests assess lower extremity strength and functional power (for further details on 30CST see Methods section 3.2.3). Inability to perform the five-chair stand test means a doubled risk of sarcopenia in nursing home residents (Šporin & Zerbo Šporin, 2023). According to Middleton et al. (2015), the four-metre gait speed assessment is the "sixth vital sign" for older adults, where speed that is less than 0.8 m/s denotes increased fall risk and mortality. Additional tools include the Short Physical Performance Battery (SPPB) – which combines gait speed, chair stand and balance assessments – and the 2-Minute Step Test (2MST), that

are both effective measures of physical fitness and endurance capacity in long-term care settings (Guralnik et al., 1994; Rikli & Jones, 1999).

With many of these conventional tools, there are reports of floor and ceiling effects. Floor effect refers to the tool being unable to detect a difference in people who have got severe mobility impairments, while ceiling effect refers to the tool not being able to differentiate between people who function at a higher level (Braun et al., 2022; de Morton, Berlowitz, et al., 2008).

DEMMI was created with the intention of resolving these issues in assessing mobility (de Morton, Davidson, et al., 2008). DEMMI is made up of 15 items which progressively become more difficult ranging from bed mobility to dynamic balance tests. According to various health care settings such as acute care, rehabilitation as well as the community setting, this tool has shown sound psychometric properties (Braun et al. 2015; de Morton & Lane 2010; Sommers et al., 2016). The hierarchical design and interval-level scoring of the DEMMI make it a sensitive measure of change across the entire range of mobility. This feature makes it particularly suitable for people with varying mobility capacities such as those who are older than 65 years.

Several studies involving cross-cultural adaptation have shown validity and reliability of DEMMI. So far, Dutch, German, Danish, Turkish, Slovenian, Brazilian Portuguese and Thai versions have been developed. This confirms the widespread cross-cultural applicability of the instrument (Braun et al., 2015; Jans et al., 2011; Jezek et al., 2024; Jitpanya et al., 2025; Tavares et al., 2020; Yürük et al., 2014; Zupanc et al., 2019). The results indicated that these measures often showed strong correlations with other established functional measures, but did not show ceiling or floor effects.

1.1.3 Orem's Theory in Current Application

Dorothea Orem has established the Self-Care Deficit Nursing Theory (SCDNT), which is the comprehensive theory of how people provide for their self-care needs, when nursing is needed, and how nurses should act (Orem, 2001). The three theories of Orem are the self-

care theory, the self-care deficit theory, and the nursing systems theory. To find a systematic approach applied in nursing can be difficult even today. But through the right assessment, planning, and evaluation it would probably assist in the identification of actual needs and capabilities of the patients. Thus, it could help in selecting the right nursing interventions more accurately.

Orem's theory defines self-care as "the practice of activities that individuals initiate and perform on their own behalf in maintaining life, health and well-being" (Orem, 2001, p. 45). Self-care requires three important types of requisites. The universal requisites include important things that are needed for living a healthy life i.e. air, water, food, activity, excretion, solitude, prevention of hazards, and promotion of normalcy. The second is developmental requisites, which usually have to do with life stage (i.e. growth tasks); and third, health deviation requisites, usually because of disease, injury or treatment (Orem, 2001). The self-care deficit theory shows when nursing is needed, when the self-care agency (capability) is not enough to meet the self-care requisites.

The nursing systems theory identifies three nursing approaches based on the patient's self-care deficits. The categories of nursing activities presented in the model include wholly compensatory, partly compensatory, and supportive-educative systems (Orem, 2001). In the wholly compensatory system the nurse takes full responsibility of caring, so "the nurse accomplishes the patient's therapeutic self-care" (Orem, 2001, p. 350). In partly compensatory systems the nurse and patient share the care, as "both nurse and patient perform care measures or other actions involving manipulative tasks or ambulation" (Orem, 2001, p. 351). With the supportive-educative approach the patient carries out self-care with the teaching and supporting of a nurse, so it should be seen as "the patient is able to perform or can and should learn to perform the required measures of therapeutic self-care" (Orem, 2001, p. 352).

Orem's theory is still relevant today for effective care of elderly people (Hartweg, 1991). Supportive-educative systems are important for chronic disease management as they educate patients about self-monitoring and adherence to medication (Nasiri et al., 2023).

Partly compensatory systems in elderly care settings provide assistance with ADLs, but still encourage maximal independence where possible (Sidani & Fox, 2013). Wholly compensatory systems are usually necessary in acute care or in advanced stages of an illness (e.g. dementia), when full nursing support is required (Nasiri et al., 2023). Orem's theory encourages the design of patient-centered care plans, which makes this process and evaluation systematic (Yip, 2021; Sidani & Fox, 2013).

The contemporary evaluation tools measure the self-care agency and dependency levels according to areas as per Orem's theory. The Exercise of Self-Care Agency (ESCA), also known as Self-Care Agency Scale (SCAS) measures the perceived ability to self-care. The scale has reliability of r=0.77-0.81 (Kearney & Fleischer, 1979). The Appraisal of Self-Care Agency Scale-Revised (ASAS-R) measures the capacity for self-care, has an overall Cronbach's alpha of 0.89, and shows a strong correlation with quality-of-life variables (Sousa et al., 2010). Both use Likert-scales, and are self-administered. Although not explicitly derived from Orem's theory, dependence can be assessed using the Barthel Index, or the Lawton-Brody Instrumental Activities of Daily Living Scale (Lawton & Brody, 1969; Mahoney & Barthel, 1965). Both tools are related to universal self-care requisites.

1.1.4 The Gap Between Mobility Assessments and Nursing Theory

Despite the availability of advanced tools like the DEMMI, and comprehensive nursing theories like Orem's SCDNT, a gap remains between assessment opportunities and their systematic integration in nursing theoretical frameworks in clinical practice. Most nursing theories do not specifically include mobility assessment instruments as a main source of information, and in turn, mobility-specific assessments are not usually designed to be used primarily in nursing theory applications (Boynton et al., 2014; Fessele & Syrkin, 2024; Luna-Aleixos et al., 2023). This gap limits the integration potential of assessment data into nursing care planning (Boynton et al., 2014). Orem's theory has particular relevance as it identifies mobility as a universal self-care requisite, but still lacks an operational-level integration of mobility assessment tools (Hartweg, 1991).

This hiatus leads to a number of problems. Healthcare professionals (e.g. physiotherapists) often have extensive mobility assessment data, yet, there is a lack of standards for fitting this information into nursing and selecting intensity of care and interventions accordingly. In many cases, decisions about assigning resources are made on the basis of broad functional assessments, rather than mobility-informed, theory-driven care planning. The relationship between the mobility capabilities and the self-care capacity on both theoretical and operational levels is not established sufficiently in clinical situations, which should be a growing concern to nursing practice (Boynton et al., 2014; Luna-Aleixos et al., 2023).

1.1.5 Reasons for DEMMI integration

The idea to use the DEMMI rather than existing Orem-related tools has both methodological and theoretical reasons. The Exercise of Self-Care Agency (ESCA) and Appraisal of Self-Care Agency Scale-Revised (ASAS-R) are self-report measures that require intact cognitive function for valid assessment (Kolanowski, 2019). Long-term care populations usually show cognitive impairment. As a result, the validity of self-report measures can be questionable as participants may be unable to judge their own abilities (Wientzek et al., 2023). According to research, around 60-80% of residents in nursing homes have some form of cognitive impairment (Alzheimer's Association, 2023) with an overall prevalence of dementia of 53% (Fagundes et al., 2021), which makes self-assessment tools unreliable by themselves (Kolanowski, 2019). One potential solution offered by Kolanowski et al. (2019), however, is the use of objective, performance-based assessments alongside the self-report measure in use.

The existing scales of self-care agency may have ceiling effects on high-functioning individuals (and/or floor effects on the severely impaired) (Schönenberg et al., 2022). This indicates the scale's incomplete capacity for measuring self-care agency at all levels of functioning present in geriatric settings (Wientzek et al., 2023). The DEMMI was designed to overcome these measurement limitations and to output interval data. This level of measurement is more precise than the ordinal Likert scales usually used in Orem instruments (de Morton, Davidson, et al., 2008).

Mobility is a basic universal self-care demand of humanity, which enables further self-care demands (Orem, 2001). Previous validation research has shown a strong correlation between assessments of mobility and measures of functional independence (Braun et al., 2015; de Morton, Davidson, et al., 2008). This suggests that objective measurement of mobility provides relevant information about self-care.

1.2 Research Plan and Structure

1.2.1 Central Problem

Through this thesis, I attempt to explore, and then to some extent, bridge the gap between mobility assessment and nursing practice. The DEMMI gives detailed information on the mobility status of the elderly, but it is not utilized either in nursing theory, or in clinical nursing practice. Having this kind of scientifically sound and elaborate measurement, the failure of making use of it is a lost opportunity for improving nursing care quality.

There should be an established way in healthcare settings to be able to fit mobility assessment findings into nursing frameworks. Without the guided collection and interpretation of such data, both the assessment and intervention selection can become subjective, which may result in inadequate care planning. Moreover, allocation of usually limited resources could also benefit from the knowledge that systematically gathered and analyzed data could provide on patients' functions and needs.

1.2.2. Research Timeline

Over the course of the research program, the psychometric properties and clinical utility of DEMMI in Hungary were examined. This was intended to provide HU-DEMMI the necessary theoretical basis to conduct further analyses.

In the second phase, clinical patterns and relationships were identified through detailed assessments of mobility in long-term care settings. The study explored correlations between mobility categories and other, wider indicators of functional capacities of the elderly.

This thesis contains the third step of the theory-building research program. Rather than attempting to create a complete framework that would require extensive further validation, this work presents a conceptualization of how mobility assessment with DEMMI could integrate into Orem's nursing theory from a theoretical perspective. This approach builds directly on the solid ground of the empirical findings, while maintaining appropriate scope for a doctoral thesis.

1.2.3 Thesis Structure

This work follows a structure that attempts to balance the presentation of original empirical contributions with the theoretical efforts. The primary objective of the thesis is to create a theoretical synthesis demonstrating how DEMMI could be systematically integrated into Orem's Self-Care Deficit Nursing Theory to improve the quality and effectiveness of geriatric nursing care. The integration would be built on our empirical findings from completed studies. A conceptual framework would be proposed, which could serve as a guide for further studies or clinical applications. In the following chapters, the objectives of the thesis, the methods and results, and the related implications of empirical research and theoretical synthesis will be discussed in detail.

2. Research Objectives

The aim of this dissertation emerged during the research on mobility assessment in the Hungarian long-term care context, where the potential for theoretical integration was discovered. In light of the literature gap identified in the introduction, the following objectives have been established that provide structure to the presentation of the completed research and theoretical proposals.

2.1 Primary Research Aim

The aim of this thesis is to develop a conceptual framework which shows how DEMMI could be integrated into Orem's Self-Care Deficit Nursing Theory, in order to improve the quality and effectiveness of geriatric nursing care.

This work builds upon completed empirical studies, and should fill the described gap between sophisticated assessment tools and nursing theories (Fessele & Syrkin, 2024; Luna-Aleixos et al., 2023). The suggested integration (based on theoretical similarities) is presented through a conceptual framework that relies on findings from our validation and clinical use studies, and which could give rise to potential further studies and clinical applications.

There are three components to the aim of this thesis: (1) to present our evidence and clinical studies to demonstrate psychometric properties and clinical utility; (2) to make theoretical propositions connecting DEMMI mobility categories to Orem's nursing system classification; (3) and to highlight implications for nursing practice and possibilities for future research.

2.2 Research Objectives

This thesis has three key objectives for the two empirical studies and the theoretical work, with each step building on the previous ones.

2.2.1 Adaptation and Validation of HU-DEMMI

Objective 1: To validate the Hungarian adaptation of the de Morton Mobility Index (HU-DEMMI) for institutionalized older adults, establishing a reliable and valid tool that meets international standards.

This is considered an essential requirement for the integration work: DEMMI shall act the same way for the Hungarian population as internationally. Measurement properties that are not validated would then have no empirical basis for theoretical integration.

2.2.2 Relationship of Mobility and Functional Capacity

Objective 2: To examine the systematic links between DEMMI-based mobility categories and functional indicators relevant to self-care capacity.

This objective provides the empirical patterns that should inform theoretical integration. By examining the ways mobility categories relate to other indicators of self-care capacity, it can be decided whether mobility assessment can capture aspects which are relevant to Orem's self-care agency construct.

2.2.3 Developing Conceptual Integration Framework

Objective 3: To develop a conceptual framework that proposes theoretical alignments between the DEMMI mobility categories and the Orem nursing system classifications through the analysis of empirical patterns in relation to theoretical constructs.

With the use of conceptual framework methodology, it is examined how patterns from the empirical findings of Objective 1 and 2 correlate to Orem's nursing system requirements (i.e. wholly compensatory, partly compensatory, supportive-educative). This results in propositions guiding healthcare teams translate DEMMI assessment findings into theoretically-grounded care planning decisions (Boynton et al, 2014; de Foubert et al., 2021).

2.3 Scientific Relevance

This work can contribute to nursing science in two major areas.

Empirical foundation: The HU-DEMMI validation contributes to the international evidence base of mobility assessment in older adults, while findings from clinical applications provide new insights into the functional patterns of Hungarian long-term care residents. These findings also serve as the basis for the conceptual framework development.

Theoretical development: The thesis shows how validated instruments can be integrated with established nursing theories to operationalize a nursing theory (Nasiri et al, 2023; Yip, 2021). This work also demonstrates how objective mobility assessment could help theory-based care planning by proposing the conceptual connections between DEMMI mobility categories and Orem's nursing systems (Hartweg, 1991).

We further hope to improve upon the understanding of mobility not only by itself, but also as a self-care requisite that is needed in various functions and for quality of life (Jung et al, 2021).

3. Methods

This section describes the methodology of the two different, but complementary phases. Phase one involves the empirical investigation which covers the studies of DEMMI validation and the clinical application. The second phase uses conceptual framework development. All empirical work process followed standard procedures for cross-cultural adaptation and psychometric assessment (Beaton et al., 2000; Mokkink et al., 2010).

[Note: The validation study methods described in sections 3.2 and 3.4 were published in Gyombolai, Zimonyi-Bakó, et al. (2025). The clinical application study methods described in sections 3.3 and 3.4 were published in Hungarian language, in Gyombolai, Simon, et al. (2025). This section discusses them for thesis purposes, permission was acquired from the copyright owners.]

3.1 Study Design and Ethics

This study was conducted in three phases, each built on the previous one(s). Our work began with the psychometric validation and cross-cultural adaptation, followed by the next phase that was a clinical application analysis of HU-DEMMI. Lastly, this thesis contains the proposal of a theoretical synthesis. All empirical studies used a cross-sectional design and involved institutionalized elderly people in long-term care facilities in Hungary.

Semmelweis University Regional and Institutional Committee of Science and Research Ethics (SE RKEB 132/2023) gave ethical approval for our study. All procedures were in accordance with the Helsinki Declaration and the Hungarian healthcare research regulations. We informed all participants about the aim and procedure of the study, and obtained written informed consent from them. The adaptation process has been approved by DEMMI's initial developer, Professor Jenny Keating (de Morton, Davidson, et al., 2008).

We conducted our research program following accepted reporting guidelines (Gagnier et al., 2021). The observational studies were conducted according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al.,

2007). Psychometric evaluation procedures were guided by the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guidelines (Mokkink et al., 2010).

3.2 Phase 1: Cross-Cultural Adaptation and Validation Study (Gyombolai, Zimonyi-Bakó, et al., 2025)

3.2.1 Translation and Cultural Adaptation

The Hungarian DEMMI (HU-DEMMI) was developed in line with Beaton et al.'s (2000) established procedure, so this is the guideline referred later in this section. This process ensures the tool's language and cultural similarity with the target population. It also preserves the psychometric and measurement qualities of the instrument itself, while ensuring semantic, idiomatic, experiential, and conceptual equivalence during the whole process of translation.

Forward Translation: Two independent professional Hungarian translators who specialize in English-Hungarian medical translations produced the first Hungarian editions (T1 and T2). According to the cross-cultural adaptation guideline, the two translators were experienced bilinguals and health professionals, both native Hungarian speakers.

Consensus Development: A group of Hungarian physiotherapists, nurses and a language specialist compared the Hungarian translations. Two physiotherapists with between 10 and 15 years of experience in geriatrics, and a nurse from the same field with 5-year experience, took part in its preparation to ensure a clinically adequate Hungarian version (T-12).

Back Translation: According to Beaton et al.'s framework, two translators who have attained a C2 level of proficiency in English were commissioned to perform an independent back translation into English of the preliminary version, which had previously been translated into Hungarian (BT1 and BT2). The aim of this procedure was making sure that there would be detection of all the possible errors that might occur in translation, and semantic equivalence must be maintained.

Expert Review: The same multidisciplinary team compared the original DEMMI with back-translated versions to arrive at the pre-final Hungarian version.

Pilot Testing: Healthcare professionals from home care, acute hospital, chronic hospital, and long-term care settings assessed 33 Hungarian-speaking older adults. Professionals rated the comprehensibility of the tasks, scoring, item instructions and administration protocol on 5-point scales. They used the think-aloud method to identify potential problems in understanding or cultural appropriateness.

The final Hungarian version of DEMMI is attached to the thesis.

3.2.2 Participants and Settings

The validation study had residents from three long-term care institutions in Hungary. The three institutions differed in their organization: a state-run, a church-run (urban), and a church-run small-town one near Budapest. This diversity was advantageous in enhancing representativeness.

Inclusion Criteria:

- Over the age of 60 years
- Minimum 4-week residence in the institution
- Ability to understand and follow test instructions
- Written informed consent

Exclusion Criteria:

- Sensory aphasia
- Medical contraindications to mobilization
- Severe dementia (impairing the understanding of instructions)
- A terminal illness with imminent death
- Refusal to participate

Since we had been planning to use confirmatory factor analysis, the adequate sample size was 10 subjects per item. With 15 items and calculating for a 10% dropout rate, 170 of the 457 eligible residents were randomly selected of three institutions, based on computer-generated random numbers.

3.2.3 Data Collection

Sociodemographic and health data: Information including age, sex, length of stay in the institution, body weight, height, chronic diseases, and Mini Mental State Examination was extracted from the care records according to a standardized protocol.

Mobility Assessment: The HU-DEMMI was administered by trained physiotherapists, who followed protocols set by the original developers (de Morton, Davidson, et al., 2008). The instrument consists of 15 mobility items with increasing level of difficulty, which are divided into 5 categories: bed mobility, chair-based mobility, static balance, walking, and dynamic balance. The items are scored either on a two-point (0, 1) scale, or a three-point (0, 1, 2) scale. The raw score (which ranges from 0-19) is then converted into interval scores ranging from 0-100 using the provided conversion table. On the backside of the scoring sheet, there is an exhaustive description on details of the assessment protocol.

Concurrent Measures:

- The **Barthel Index** was used to assess the degree of assistance needed by the participant for ten activities of daily living (ADLs) (Mahoney & Barthel, 1965). This was done through interviews of the participant and/or caregiver.
- The **Timed Up and Go** (TUG) measures the time it takes an individual to rise from a chair, walk three metres, then turn around, walk back, and finally sit down (Podsiadlo and Richardson, 1991). The average time of two trials was used for analysis, with 30 seconds between tries.
- The **30-Second Sit-to-Stand** test counted the number of complete sit-to-stand movements performed in 30 seconds, from an armless chair with the arms crossed over the chest (Jones et al., 1999).

- The **Functional Ambulation Category** (FAC) is a 6-point scale that assesses the personal assistance level required to walk (Mehrholtz et al., 2007).
- The **Falls Efficacy Scale-International Short** (FES-I) measures the individual's concern about falling during seven daily activities using a 4-point scale (Kempen et al., 2008, Kovács et al., 2018).

3.2.4 Reliability Testing

Inter-rater Reliability: A randomly selected group of 55 participants were used for inter-rater reliability testing. Two physiotherapists with 5 and 7 years' of geriatric experience assessed the participants independently, 2 hours apart.

Intra-rater Reliability: To evaluate temporal stability, the same 55 participants were tested with the same (first) physiotherapist after seven days. In line with recommendations (and common practice) for testing reliability of a mobility assessment, a 7-day time interval was chosen (Braun et al., 2015; Mokkink et al., 2010).

3.3 Phase 2: Clinical Application Study (Gyombolai, Simon, et al., 2025)

3.3.1 Participants

The clinical application study involved 209 residents from the same three long-term care institutions, with the same inclusion and exclusion criteria as the validation study. All participants underwent the same comprehensive assessment including HU-DEMMI, and concurrent measures described above.

3.3.2 Mobility Categorization

DEMMI scores were categorized using cut-off values proposed by Thorsted et al. (2024), which provide a clinically meaningful stratification:

- **Very low mobility:** 0-26 points
- **Low mobility:** 27-40 points
- **Moderately reduced mobility:** 41-61 points

- **Independent mobility:** 62-100 points

Through previous research, these categories were developed to provide a clinically relevant classification for care planning, and help in resource allocation decisions. These are also shown to be associated with readmission rates, mortality, and discharge destinations in older adults (Melgaard et al., 2019; Thorsted et al., 2024).

3.4 Statistical Analysis (Gyombolai, Zimonyi-Bakó, et al., 2025; Gyombolai, Simon, et al., 2025)

3.4.1 Validation Study Analysis

Kolmogorov-Smirnov tests were used to check normality of data distribution. Descriptive statistics included means, standard deviations, medians, interquartile range and frequency distributions, as appropriate for each variable and distribution.

Construct validity: Based on previous research on the DEMMI, seven hypotheses were specified a priori, and constructed according to COSMIN guidelines for hypothesis testing (Terwee et al., 2018).

1. Strong positive correlation with Barthel Index ($\rho \geq 0.70$).
2. Strong negative correlation with TUG test ($\rho \leq -0.70$).
3. Strong positive correlation with 30-second sit-to-stand ($\rho \geq 0.70$).
4. Strong positive correlation with FAC ($\rho \geq 0.70$).
5. Moderate negative correlation with FES-I ($-0.70 \leq \rho \leq -0.40$).
6. Weak negative correlation with Charlson Comorbidity Index ($\rho \leq -0.30$).
7. Significant differences between mobility aid usage groups.

Due to non-normal data distribution Spearman coefficients were calculated. Then known-groups validity was analyzed with Kruskal-Wallis ANOVA and Mann-Whitney U test, and because of the multiple comparisons we applied the Bonferroni correction ($\alpha = 0.008$).

Structural validity: Structural equation modeling (SEM) using confirmatory factor analysis (CFA) was performed with Weighted Least Squares Mean and Variance

(WLSMV) estimator. Unidimensional, three-dimensional, and five-dimensional models were examined. The χ^2, Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) were used to evaluate model fit. We set our cut-off criteria as per Hu & Bentler (1999).

Reliability: We used Cronbach's alpha to assess reliability, with an acceptance range of 0.70 to 0.95, following the COSMIN guidelines (Terwee et al., 2007). The test-retest reliability used intraclass correlation coefficients (ICC) from the two-way random effects ANOVA. The measurement error of the instrument was calculated using standard error of measurement (SEM = SD$\sqrt{1}$-ICC) and minimally detectable change at a 90% confidence level (MDC90 = 2.363 × SEM). The agreement between raters and test-retest measures was visualized using Bland-Altman plots.

3.4.2 Clinical Application Study Analysis

Due to the non-normal data distribution, analysis was done using non-parametric statistics. Differences between the four mobility groups were tested using Kruskal-Wallis ANOVA for:

- Lower limb muscle strength (30-second sit-to-stand),
- Dynamic postural control (TUG test),
- Cognitive function (MMSE scores),
- Fear of falling (FES-I scores), and
- Self-care independence (Barthel Index scores).

We used Mann-Whitney U tests with Bonferroni correction ($\alpha = 0.0167$) for post-hoc comparisons between the adjacent mobility groups to identify differences between the categories. To quantify the effect size of the differences, we used $r = Z/\sqrt{N}$ (Cohen, 1988).

3.4.3 Statistical Software

Statistical analyses were performed with SPSS 18.0 for descriptive statistics, correlation analyses, and group comparisons. Mplus software was used to conduct the structural

equation modeling of the psychometric assessment (Muthén & Muthén, 2017), and the software used to carry out Rasch modeling and to assess differential item functioning was ConQuest (Wu et al., 2007). Statistical significance was set at $p < 0.05$ for all analyses.

3.5 Conceptual Framework Development

3.5.1 Methodology

The method used for examining the potential integration of DEMMI in Orem's framework was conceptual framework development. Fawcett (1984) describes this method as a reference point that structures nursing knowledge by organizing interrelated concepts and relationships. Using this approach the focus could be on the identification of overlapping theories between DEMMI and Orem's work, without the specific need for performing a systematic review.

This conceptual development included the thorough examination of fundamental works on Orem's Self-Care Deficit Nursing Theory (e.g. Hartweg, 1991; Orem, 2001) and the development and validation of DEMMI (e.g. de Morton, Davidson, et al., 2008). It also included the contemporary geriatric applications of Orem's theory (e.g. Nasiri et al., 2023; Yip, 2021), and the key literature on the relationship between functional mobility and independence (e.g. Braun et al., 2022; Jung et al. 2021).

The selection was based on the works' relevance for the thesis research objectives, namely the integration conceptualization. The results from our validation and clinical application studies were also examined for potential alignment with Orem's nursing systems (based on the literature mentioned above).

3.5.2 Conceptual Mapping Process

The conceptual connection was examined between the mobility categories of DEMMI and Orem's nursing system classifications. The steps were the following:

1. Pattern recognition: Identifying relationships between mobility levels and care dependency indicators in the acquired data.

2. Theoretical alignment: Matching the identified patterns to Orem's three nursing systems (using the self-care deficit characteristics).
3. Proposition creation: Making specific theoretical propositions to use in clinical practice, which links mobility categories to nursing systems.
4. Framework for integration: A systematic way to (potentially) use assessment results for care decisions.

3.5.3 Validation Using Existing Evidence

While the first two steps were mainly based on our data, the latter two needed confirmations through comparisons to existing literature. The coherence of the theoretical propositions was assessed by comparing them to the literature on mobility assessment outcomes, and on nursing theory (Braun et al., 2022; Hartweg, 1991). The framework's consistency with research on care dependency of the elderly, resource allocation, and selection of interventions was also examined (Boynton et al., 2014; de Foubert et al, 2021). This way, the theoretical development was based on empirical evidence, and speculations or unsupported claims regarding clinical effectiveness could be prevented (Gagnier et al., 2021).

4. Results

This chapter presents the findings of the two empirical studies that serve as the foundation for the theoretical integration of this thesis. The results are divided in three main sections: the results from the validation study of HU-DEMMI, the results from the clinical application study, and the evidence for theoretical integration with Orem's Self-Care Deficit Nursing Theory.

4.1 Validation Study Results (Gyombolai, Zimonyi-Bakó, et al., 2025)

[Note: The study results presented in this section were published in detail in Gyombolai, Zimonyi-Bakó, et al. (2025). This section presents them for thesis purposes.]

4.1.1 Sample Characteristics

The validation study involved 170 participants, recruited from three long-term care institutions in Budapest, Hungary. After dropouts and exclusions were taken into account, 158 participants completed the whole assessment protocol, which equals a 93% completion rate.

The sample involved 135 women (85.4%) and 23 men (14.6%), with the mean age of 84.14 years (SD = 8.93, range 60-98 years). Participants had lived in the institutions for 42 months on average (SD = 33.88), with a median of 32 months. The average score of Mini Mental State Examination (MMSE) was 21.89 (SD = 5.41), which indicated mild to moderate cognitive impairment. This is considered typical of institutionalized older adults (Fagundes et al., 2021).

As noted in the previous chapter, the three participating institutions represented different model organizations: a state-run facility, a church-run (urban) facility, and a church-run facility in a small town in the vicinity of Budapest. This diversity allowed the sample to be more representative of the Hungarian long-term care environment.

Participants had high rates of chronic conditions, as the Charlson Comorbidity Index had a mean score of 5.93 (SD = 1.69, median = 6). Almost quarter of the participants were

capable of walking without an aid (24.1%), while most of them used a mobility aid including walking frames or rollators (43.7%) and walking canes (15.8%), and the rest (16.5%) were unable to ambulate.

4.1.2 Psychometric Properties

Reliability

HU-DEMMI was evaluated for three aspects of reliability: internal consistency, test-retest reliability, and measurement error.

The HU-DEMMI had an excellent **internal consistency** score with a Cronbach's alpha value of 0.906, well in the ideal range of 0.70-0.95 (Terwee et al., 2007). This demonstrates that the 15 items of HU-DEMMI measure a single mobility construct.

Reliability testing started by measuring 55 individuals, of them, 52 completed all 3 assessments. The inter-rater reliability was excellent, with the intraclass correlation coefficient (ICC) of 0.981 (95% CI: 0.966-0.989). The test-retest reliability was considered stable over a 7-day period, with an ICC of 0.989 (95% CI: 0.980–0.993).

Pooled standard deviation was 21.21, as a result, the **standard error of measurement** (SEM) for inter-rater reliability was 2.924 points (on the 100-point scale). The value of minimal detectable change at 90% confidence level (MDC90) was 6.803 points (95% CI: 0.897-12.709), so clinicians presented with a 7 points change in the DEMMI score can be 90% confident that real change has occurred in mobility.

The Bland-Altman plot showed that the mean inter-rater difference was 0.2115, with 95% limits of agreement of -11.252–11.675. Four outliers (7.69%) were identified. The mean intra-rater difference was -1.0577, with 95% limits of agreement range of -9.809–7.694. Similarly, four data points (7.69%) fell outside these limits.

Construct Validity

All seven a priori hypotheses for construct validity were confirmed. The HU-DEMMI showed strong correlations with four established measures of functional capacity:

- Barthel Index: $\rho = 0.764$ (95% CI: 0.69-0.822, $p < 0.001$)
- Functional Ambulation Category: $\rho = 0.850$ (95% CI: 0.8-0.888, $p < 0.001$)
- 30-second sit-to-stand test: $\rho = 0.715$ (95% CI: 0.589-0.806, $p < 0.001$, $n = 82$)
- Timed Up and Go test: $\rho = -0.711$ (95% CI: -0.786 to -0.614, $p < 0.001$, $n = 130$)

There were moderate correlations with fear of falling measured with short FES-I: $\rho=-0.504$ ($p < 0.001$), and weak but significant correlations with the Charlson Comorbidity Index (CCI): $\rho = 0.232$ ($p < 0.003$).

Known-groups Validity

There was a significant difference in the HU-DEMMI scores among the four groups based on the use of mobility aids (Kruskal-Wallis test: $\chi^2 = 112.89$, df = 3, N = 158, $p < 0.001$), confirming the remaining seventh hypothesis. Participants who used no mobility aid had significantly higher DEMMI scores (median = 74) compared to those who used walking canes (median = 57), walking frames or rollators (median = 48), or were unable to walk (median = 22). After Bonferroni correction ($p < 0.008$), 5 out of 6 pairwise comparisons with Mann-Whitney U tests were found to be significant, with the exception of comparing people using canes vs. walking frames or rollators.

4.1.3 Structural Validity

The unidimensional structure of the HU-DEMMI was further supported by confirmatory factor analysis (CFA). The single-factor model provided a good fit for the data: $\chi^2 = 153.819$ (df = 90, $p = 0.001$), RMSEA = 0.067 (90% CI: 0.048-0.085), CFI = 0.987, and TLI = 0.985.

The factor loadings of the items were substantial and statistically significant, confirming that all items measure mobility. There were no floor or ceiling effects, as only 4

participants (2.5%) scored the maximum total score of 100, while also 4 participants (2.5%) scored the lowest, null score.

The mean HU-DEMMI score was 49.43 (SD = 20.27), indicating good distribution across the measurement range, further confirming the absence of meaningful floor or ceiling effects.

4.2 Clinical Application Study Results (Gyombolai, Simon, et al., 2025)

[Note: The study results presented in this section were published in detail in Gyombolai, Simon, et al. (2025). This section presents them for thesis purposes, permission was acquired from the copyright owners.]

4.2.1 Sample Characteristics

The study of clinical application of HU-DEMMI involved 209 residents from the same three long-term care facilities. The study included 149 women (71.3%) and 60 men (28.7%), who had an average age of 81.34 years (SD = 8.92).

On average, participants had been living in the institutions for 50.1 months (SD = 39.1). Mean body mass index (BMI) was 24.68 kg/m² (SD = 5.7), and mean Charlson Comorbidity Index score was 5.81 (SD = 2.7). This indicates a moderate level of comorbidities, typical of long-term care population.

Regarding the pattern of mobility aid use, 21.1% could walk without mobility aids, 11.9% used a walking cane, 34.9% used a walking frame or rollator, and 32.1% were unable to walk.

4.2.2 Mobility Categories

The 209 participants were categorized into four mobility groups using established cut off values based on their scores of HU-DEMMI (Thorsted et al., 2024).

- **Very low mobility** (DEMMI 0-26): n = 53 (25.4%)
- **Low mobility** (DEMMI 27-40): n = 41 (19.6%)

- **Moderately reduced mobility** (DEMMI 41-61): n = 64 (30.6%)
- **Independent mobility** (DEMMI 62-100): n = 51 (24.4%)

When splitting the sample categorization in halves, the distribution indicates that 45% of the residents have very low or low mobility, while 55% have moderately reduced or independent mobility. This finding is in line with past international studies on similar populations (Maresova et al., 2023; Melgaard et al., 2019; Thorsted et al., 2024).

4.2.3 Comparisons Across Categories

For all (five) measured variables, significant differences across the four categories of mobility were found (Kruskal-Wallis ANOVA, all $p < 0.001$). Adjacent mobility categories' post-hoc comparison showed a systematic pattern, supporting the integration theory. This held up after the Bonferroni correction of the significance value ($p < 0.0167$).

Summary of the physical, cognitive, and self-care indicators of people across the different levels of mobility are presented in Table 1.

Table 1: Physical, Cognitive, and Self-Care Indicators Across Mobility Levels. [a]Q1: first quartile; [b]Q3: third quartile; [c]30sSTS: 30-Second Sit-to-Stand test; [d]MMSE: Mini Mental State Examination; [e]FES-I: Falls Efficacy Scale-International (Gyombolai, Simon, et al., 2025)

	Very low mobility (n=53)	Low mobility (n=41)	Moderately reduced mobility (n=64)	Independent mobility (n=51)
Barthel Index (score)				
Participant count (n)	53	41	64	51
Median	20	60	80	95
Q1[a]; Q3[b]	17; 70	30; 80	72,5; 90	90; 100

30sSTS[c] (repetitions)				
Participant count (n)	0	4	33	50
Median		2,5	4	9
Q1[a]; Q3[b]		1,5; 5,5	3; 6	7; 11
Timed Up and Go (sec)				
Participant count (n)	2	23	63	51
Median	25,5	34,5	29	14
Q1[a]; Q3[b]	23,5; 27,5	25,8; 45,7	21,12; 36,5	10,5; 20,02
MMSE[d] (score)				
Participant count (n)	51	41	61	48
Median	16	20	24	25,5
Q1[a]; Q3[b]	15; 20	14; 24	17; 26	23; 27,5
FES-I[e] (score)				
Participant count (n)	46	39	63	51
Median	25	17	13	8
Q1[a]; Q3[b]	22; 26	11; 22	10; 18	7; 11

Self-care Independence (Barthel Index)

The Barthel Index showed significant differences in all mobility categories ($\chi^2 = 120.526$, df = 3, N = 209, $p < 0.001$). I would like to highlight the median Barthel Index scores of the four groups: very low mobility (20 points), low mobility (60 points), moderately reduced mobility (80 points), and independent mobility (90 points). All adjacent group comparisons were statistically significant (Figure 1):

- Very low vs. low mobility: U = 654, Z = -3.318, $p < 0.001$, r = 0.34

- Low vs. moderately reduced mobility: U = 571, Z = -4.894, p < 0.001, r = 0.48
- Moderately reduced vs. independent mobility: U = 758, Z = -4.982, p < 0.001, r = 0.46

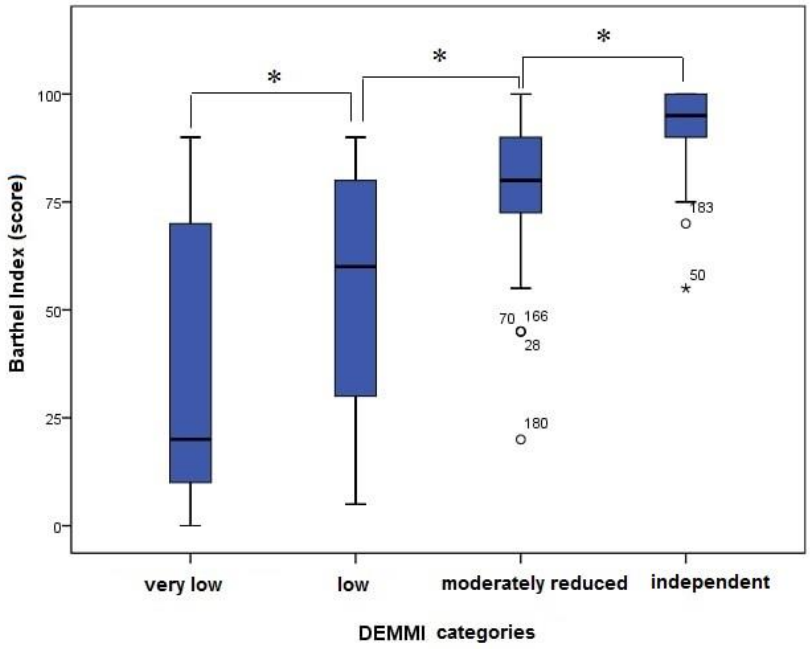

Figure 1: Barthel Index scores by mobility categories. The box plot displays median values (horizontal line), interquartile ranges (box), and minimum and maximum values (whiskers). ○ = mild outlier (case number); * = extreme outlier (case number); * = statistically significant difference between adjacent groups (p < 0.0167). DEMMI: de Morton Mobility Index. (Gyombolai, Simon, et al., 2025)

Lower Limb Strength (30-second Sit-to-Stand)

The 30-second sit-to-stand test results showed significant differences among the mobility categories ($\chi^2 = 35.844$, df = 2, N = 87, p < 0.001). As none of the subjects in the very low mobility group were able to do standard sit-to-stand movements, the statistical comparison included only the low, moderately reduced and independent mobility group (n = 87 total). (Although the comparison between the very low and low mobility categories were not tested for significance, that difference can still be considered remarkable.)

There was no statistically significant difference between the low and moderately reduced mobility groups (U = 36, Z = -1.497, p = 0.134, r = 0.24). However, the moderately reduced and independent mobility groups did differ significantly (U = 216.5, Z = -5.691, p < 0.001, r = 0.80) (Figure 2).

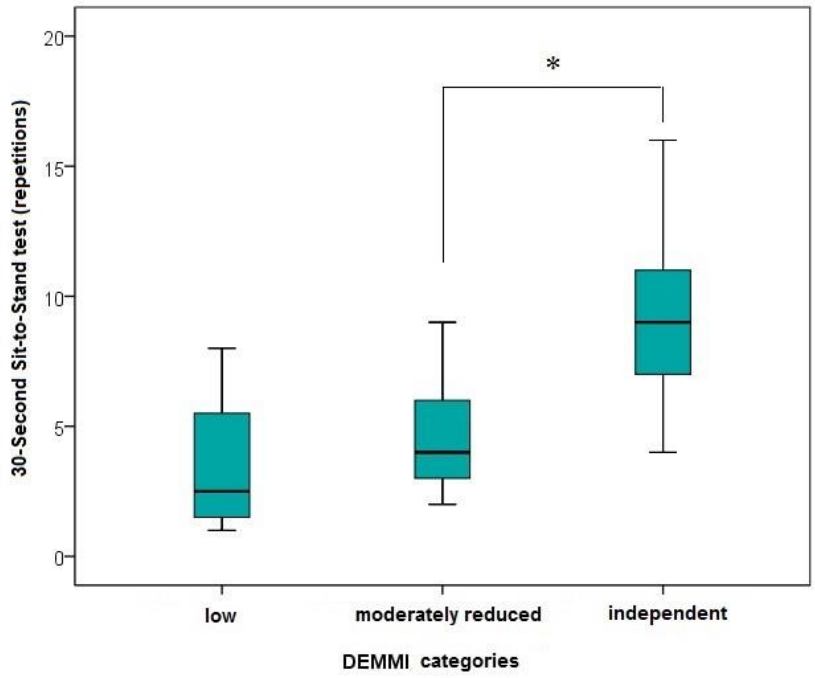

Figure 2: 30-second sit-to-stand test results by mobility categories. The box plot displays median values (horizontal line), interquartile ranges (box), and minimum and maximum values (whiskers). * = statistically significant difference between adjacent groups (p < 0.0167). DEMMI: de Morton Mobility Index. (Gyombolai, Simon, et al., 2025)

Dynamic Postural Control (Timed Up and Go)

The results of the TUG test showed significant differences among the DEMMI-based categories (χ^2 = 50.619, df = 3, N = 139, p < 0.001). The difference remained significant even when we excluded results of the very low mobility group, as only 2 individuals completed the test successfully in that category (χ^2 = 49.9, df = 2, N = 137, p < 0.001).

The difference between low and moderately reduced mobility groups was not significant (U = 530.5, Z = -1.893, p = 0.058, r = 0.20). On the other hand, difference between the

moderately reduced and independent mobility groups was found significant (U = 49.5, Z = -6.361, p < 0.001, r = 0.60) (Figure 3).

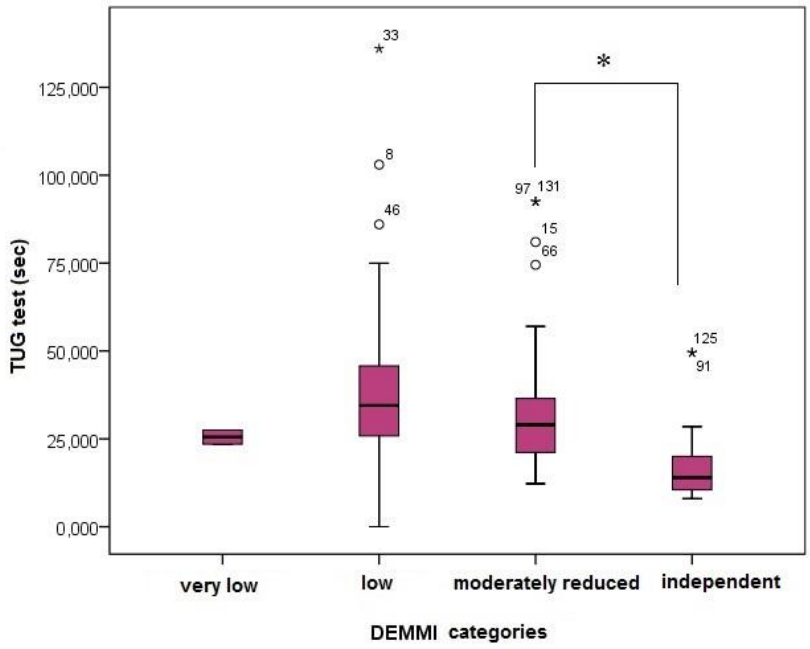

Figure 3: TUG test results by mobility categories. The box plot displays median values (horizontal line), interquartile ranges (box), and minimum and maximum values (whiskers). ○ = mild outlier (case number); * = extreme outlier (case number); * = statistically significant difference between adjacent groups (p < 0.0167). TUG: Timed Up and Go test. DEMMI: de Morton Mobility Index. (Gyombolai, Simon, et al., 2025)

Cognitive Function (Mini Mental State Examination)

Cognitive function was assessed using MMSE scores. They differed significantly across groups (χ^2 = 38.757, df = 3, N = 201, p < 0.001), with one major step between adjacent group comparisons.

The analysis showed no significant differences between very low and low mobility groups (U = 845, Z = -1.581, p = 0.114, r = 0.16), or between low and moderately reduced mobility groups (U = 1013, Z = -1.622, p = 0.105, r = 0.16). However, the difference

between moderately reduced and independent mobility groups was significant (U = 1045, Z = -2.563, p = 0.01, r = 0.25) (Figure 4).

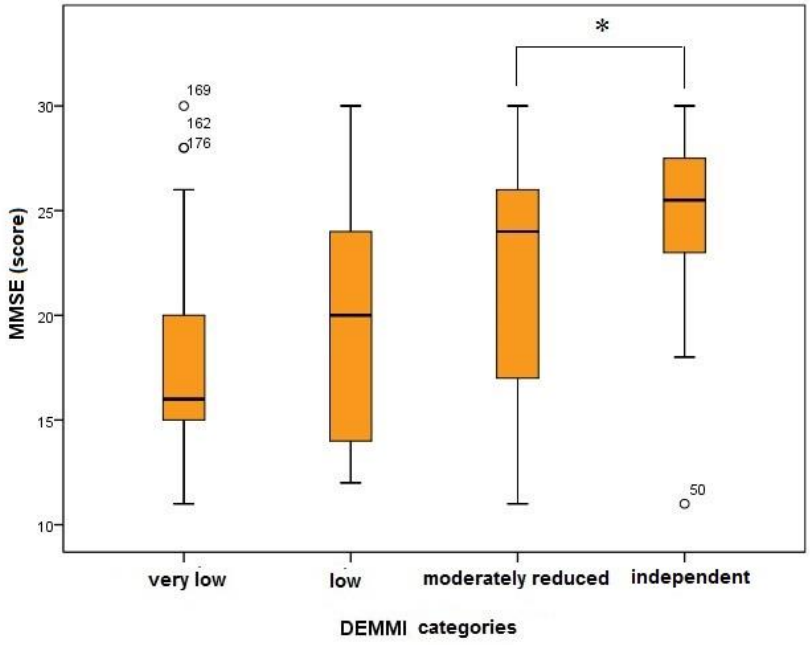

Figure 4: MMSE scores by mobility categories. The box plot displays median values (horizontal line), interquartile ranges (box), and minimum and maximum values (whiskers). ○ = mild outlier (case number); * = statistically significant difference between adjacent groups ($p < 0.0167$). MMSE: Mini Mental State Examination. DEMMI: de Morton Mobility Index. (Gyombolai, Simon, et al., 2025)

Fear of Falling (Falls Efficacy Scale-International)

The FES-I scores were significantly different among the categories ($\chi^2 = 82.377$, df = 3, N = 199, $p < 0.001$), with higher scores indicating greater fear. This time there were two major differences between adjacent groups.

Significant differences were found between the very low and low mobility groups (U = 421, Z = -4.215, $p < 0.001$, r = 0.457), and between the moderately reduced and independent mobility groups alike (U = 787.5, Z = -4.698, $p < 0.001$, r = 0.44). The

difference between low and moderately reduced groups, however, was not significant (U = 950, Z = -1.921, p = 0.055, r = 0.19) (Figure 5).

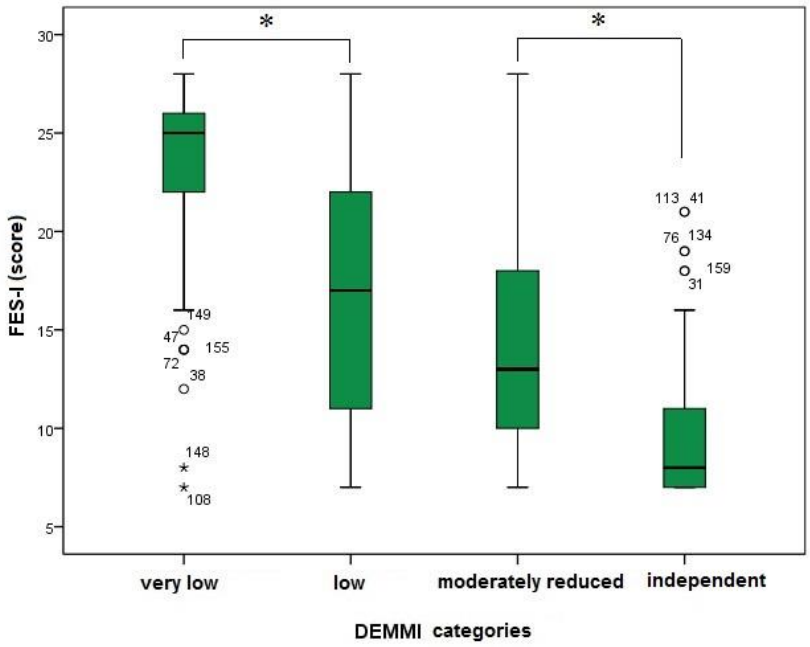

Figure 5: FES-I scores by mobility categories. The box plot displays median values (horizontal line), interquartile ranges (box), and minimum and maximum values (whiskers). ○ = mild outlier (case number); * = extreme outlier (case number); * = statistically significant difference between adjacent groups ($p < 0.0167$). FES-I: Falls Efficacy Scale-International. DEMMI: de Morton Mobility Index. (Gyombolai, Simon, et al., 2025)

4.3 Empirical Patterns for Integration

The validation and clinical application study results revealed systematic patterns, which support the theoretical integration with empirical data. This section tries to bridge results to the discussion, as it gathers facts and trends that could be considered results in a theoretical work, however are implementations of our raw statistical data to a small degree.

4.3.1 Systematic Relationships

The validation study proved that HU-DEMMI scores are strongly correlated with other functional measures, like Barthel index, Functional Ambulation Category, 30-second sit-to-stand test, and Timed Up and Go test. This indicated that mobility assessment with DEMMI likely captures several aspects of functional capabilities.

In every measured variable, systematic differences could be seen throughout mobility categories in the clinical application study. Barthel Index, that shows the independence in self-care, had a clear trend across mobility groups as all adjacent groups were significantly different. The measures of cognitive function, fear of falling, and physical performance also showed systematic patterns that corresponded well with mobility categories.

4.3.2 Patterns Across Mobility Categories

The even distribution of participants across the DEMMI mobility categories provided insight into the characteristics of each group. Those with very low mobility always showed the most severe impairments in all areas, while those with independent mobility showed substantially better (comparatively the best) functional abilities. The two middle categories were usually between the two extremes.

The degree of differences in scores between adjacent mobility categories was greater than the measurement error thresholds (i.e. established in the validation study), suggesting that the measured differences could be clinically meaningful. The consistent nature of differences in various (e.g. physical, cognitive, or even psychological) domains shows that the DEMMI-based classification, even in itself, could reflect important aspects of the functional status of older adults.

4.3.3 Evidence for Integration Potential

The empirical trends show a systematic connection between mobility performance and care dependency indicators for various functions. Because these associations are strong and regular, mobility assessment might provide an important perspective for the clinical decision-making processes.

The continuous changes through the degrees of dependence seem consistent with Orem's theory on self-care deficits. These empirical outcomes provide the evidence to further examine the theoretical integration potential with this nursing framework in the discussion chapter.

5. Discussion

In this Discussion chapter I interpret the findings of our two HU-DEMMI studies, and introduce a proposal of the theoretical integration. The structure is kept the same as previously: first, the cross-cultural adaptation study is discussed, then the clinical application one, and lastly, I present the details on the potential integration of DEMMI to Orem's framework, with the implications for future practice and research.

5.1 Validation of Hungarian DEMMI and International Context (Gyombolai, Zimonyi-Bakó, et al., 2025)

[Note: The study results discussed in this section were published in detail in Gyombolai, Zimonyi-Bakó, et al. (2025). This section discusses them for thesis purposes.]

5.1.1 Psychometric Performance

The validation of the Hungarian DEMMI showed psychometric properties that meet, or even exceed international standards. The internal consistency was examined through Cronbach's alpha, and was found that $\alpha = 0.906$, which was comparable to other validated DEMMI adaptations, including the German ($\alpha = 0.93$) (Braun et al., 2015), Dutch ($\alpha = 0.94$) (Jans et al., 2011), and Slovenian ($\alpha = 0.90$) (Zupanc et al., 2019) versions. The theoretical work behind DEMMI is a strong foundation, which allows it to function the same across a variety of cultures (Braun et al. 2015; Soares Menezes et al., 2017).

The reliability coefficients achieved were exceptional. Both the inter-rater reliability (ICC = 0.981) and internal consistency (ICC = 0.989) indicators exceeded the values documented in most of the international validation studies (Braun et al., 2015; Jans et al., 2011; Jezek et al., 2024; Tavares et al., 2020; Yürük et al., 2014; Zupanc et al., 2019). It can be stated, based on the results, that the Hungarian version has sufficient measurement precision for clinical or research purposes (Fessele & Syrkin, 2024).

The overall construct validity was confirmed through all 7 pre-specified hypotheses. This firmly demonstrates that mobility assessment through the HU-DEMMI measures the same

fundamental construct as other established functional assessment tools globally. The Barthel Index had a strong correlation with the study findings ($\rho = 0.764$), which supports that assessing mobility can provide useful insights on broader self-care capabilities. The correlation found with the Functional Ambulation Category ($\rho = 0.850$) shows that the DEMMI measures walking ability, but goes beyond simple ambulation and includes bed mobility, transfers and balance tasks.

5.1.2 Methodological Advantages and Clinical Utility

One important benefit of the DEMMI over conventional measures of mobility is the successful avoidance of floor and ceiling effects. This feature overcomes a limitation of traditional mobility tests, which often cannot make distinctions between individuals with better functional levels or between those who are severely impaired (Braun et al., 2022; Soares Menezes et al, 2017). The items in the DEMMI are arranged hierarchically, starting from the basic bed mobility activities and ending at the dynamic balance activities. This arrangement enables a comprehensive assessment of the functionality.

HU-DEMMI with the calculated MDC90 of 6.803 points can be used for the precise detection of clinical changes in order to help guide treatment decisions and outcome assessment. This accuracy allows healthcare providers to monitor changes in mobility over time, and be confident that the changes they observe are real, and not just due to measurement variability (Fessele & Syrkin, 2024).

The cross-cultural adaptation was carried out according to international standards (Beaton et al. 2000). In this way, the measure is culturally and linguistically appropriate and psychometrically sound. The instrument has been pilot tested in diverse elderly care settings, suggesting its broader applicability across the Hungarian healthcare system, and its potential for wider implementation.

5.2 Clinical Application Findings and Population Insights (Gyombolai, Simon, et al., 2025)

[Note: The study results discussed in this section were published in detail in Gyombolai, Simon, et al. (2025). This section discusses them for thesis purposes, permission was acquired from the copyright owners.]

5.2.1 Mobility Distribution Patterns

In our sample, almost half of the long-term care facility residents in Hungary (i.e. very low and low mobility) required long-term mobility support of some intensity. The other half maintained some level of independence. This distribution, as mentioned in section 4.2.2, aligns with results from international studies of similar populations (Maresova et al., 2023; Melgaard et al., 2019; Thorsted et al., 2024), which implies that the mobility category system is likely valid across cultures, and it also indicates similarities in needs of geriatric populations across healthcare systems (de Foubert et al., 2021; Zisberg et al., 2018).

The differences in various functional domains suggest that DEMMI-based categories may prove useful even for comprehensive geriatric assessment in a clinical setting. Through helping evidence-based care planning and resource allocation, this categorization addresses real challenges in healthcare systems.

5.2.2 Multidimensional Functional Relationships

The indicated pattern of changes in the various capabilities across the groups suggests that DEMMI classification may have clinical utility. The link between mobility categories and cognitive function illustrates a strong association between physical and cognitive ability (Kolanowski et al., 2019; Maresova et al., 2023; Sánchez-Sánchez et al., 2024), and supports a more holistic approach to care (Pollak et al., 2023).

Patterns in fear of falling show the psychological dimension of mobility impairment which is likely to trigger functional decline. Low mobility groups had increased fear of falling which could make them avoid certain activities that may further reduce their mobility (Kempen et al., 2008, Maresova et al., 2023). This shows how important it is to overcome the psychological barriers as well as physical ones.

The increasing autonomy seen in self-care over mobility groups is evidence for the association of mobility and overall functional capabilities. The relationship between mobility and self-care activities supports the argument that mobility is the basic ability necessary to perform other self-care activities (Edemekong et al., 2025; Jung et al., 2021), and confirms its integration to nursing theory.

5.3 Theoretical Integration: DEMMI and Orem's Self-Care Deficit Nursing Theory

5.3.1 Empirical Foundation for Theoretical Integration

The research findings show clear patterns across all mobility categories, which may empirically support a potential conceptual fit with Orem's nursing system classifications (Orem, 2001; Yip, 2021). The scale from very low mobility to independent mobility relates well to the concept of what different types of nursing systems would need or presume.

Mobility is a requirement that is universal to self-care (see definition 1.1.3), which allows the individual to meet its basic need for activity and hazard avoidance (Hartweg, 1991). There was a strong correlation between HU-DEMMI score and Barthel Index with $\rho = 0.764$, representing how mobility can be indicative of self-care.

5.3.2 Systematic Mapping of Mobility Categories to Nursing Systems

Aligning Very Low Mobility with a Wholly Compensatory System

Participants with very low mobility (DEMMI 0-26) showed characteristics indicating the need for a wholly compensatory nursing system. With a median score of 20 on the Barthel Index, most people would require maximal support with the ADLs. A majority of them were unable to perform functional mobility tests independently, which suggests total dependence for self-care activities requiring mobility.

This group displays severe mobility restrictions, high care dependency, cognitive impairment (median MMSE = 16.0) with limited self-care agency in most domains. This fits with Orem's description of patients who require wholly compensatory nursing systems (see in 1.1.3).

The increased fear of falling scores in this group further indicate limited confidence in self-care abilities. This further confirms the need for full nursing support in which nurses take primary responsibility for safety and care of mobility, while still facilitating the remaining capabilities where possible.

Aligning Low to Moderately Reduced Mobility with a Partly Compensatory System

Individuals with low and moderately reduced mobility (DEMMI 27-61) showed mixed dependence levels. These represent the typical signs of choosing a partly compensatory nursing system. Even though the median Barthel Index score improved from 60 to 80, showing reduced dependency in self-care, these individuals may still require assistance in some areas.

While they had the ability to do part of the mobility tasks by themselves, they generally could not do the more difficult ones. Improvements in the sit-to-stand and TUG tests show different levels of self-care agency. This aligns with Orem's partly compensatory systems' description (see in 1.1.3).

The clinical utility of distinguishing between low and moderately reduced mobility lies in the fact that these groups can show different support needs. Although both require partly compensatory approach, the interventions required (and the resources allocated) could be tailored to their abilities, allowing for a more precise (i.e. patient-centered) planning (Sidani & Fox, 2013) and optimal use of resources.

Aligning Independent Mobility with a Supportive-Educative System

Participants with independent mobility (DEMMI 62-100) showed properties suggesting that supportive-educative nursing system would be the appropriate choice for them. Subjects in this category had a median Barthel Index score of 90, and were in the best cognitive state (with median MMSE of 25.5). Despite living in long-term care, they still had a considerable capability for self-care.

Participants required institutional support due to age-related needs, but were able to perform most mobility-related activities independently. This level of self-care agency corresponds with Orem's supportive-educative systems (see in 1.1.3).

The low fear of falling scores for this group suggest that they likely have confidence in their ability to care for themselves. Giving them the right support, education, and environmental adjustments, members of this group should be able to carry out most of their own care and maintain their independence.

5.3.3 Supporting Evidence for Integration

Progressive Self-care Capacity

There is a strong correlation between the HU-DEMMI scores and Barthel Index (ρ = 0.764), indicating that mobility assessment also reflects self-care independency to an extent. The clear progression through the categories of mobility indicates that mobility could be a good measure of nursing system needs.

Functional Coherence Across Domains

The regular similarities seen in several functions (strength, balance, cognition, fear of falling) suggest that mobility categories could prove a valid framework for selecting a nursing system. The relationships' coherence indicates that mobility assessment consistently captures important aspects of functional capacity with relevance to self-care agency.

Clinical Meaningfulness

The differences between mobility categories are larger than the value associated with meaningful changes (MDC90 = 6.803 points), so it could be considered potentially clinically significant. Again, the systematic nature of these differences throughout our variables provides evidence regarding the potential for a mobility-based nursing system classification.

Theoretical Consistency

The observed, empirical patterns conceptually align with Orem's theoretical description of nursing system requirements. There is progression from total dependence through partial independence to substantial self-care agency (as illustrated by Barthel Index scores). This progression is parallel to the theoretical continuum of Orem's nursing systems classification.

5.4 Clinical Application Framework and Practice Implications

5.4.1 Systematic Care Planning Approach

With integrating DEMMI into Orem's nursing systems theory, care planning could become systematic, which would use theoretical principles and address functional capabilities. By using DEMMI scores for determining nursing system classification and associated interventions, care planning could then become evidence-based and repeatable, rather than ad hoc and based on subjective impressions (de Foubert et al., 2021; Zisberg et al., 2018).

This method might provide many benefits compared to traditional functional assessments, like a theoretically grounded framework for selecting interventions. It could also allow for systematic, theory based allocation of resources, and aid communication between professionals by a shared language and objective assessment data.

The framework could be operationalized by care planning protocols that correlate DEMMI categories to nursing interventions and resource needs, by which health care institutions would have the option to tailor future protocols to their specific needs and capacities (Zisberg et al., 2018).

5.4.2 Resource Allocation and Quality Improvement

As implied, the mentioned link between mobility categories and care dependency indicators could be used in healthcare facilities for resource allocation, as it would allow for more accurate decisions on staffing and the necessary level of care intensity.

The DEMMI categorization could assist in anticipating both infrastructural and human resource needs, thus having the potential to improve efficiency as well as the quality of

care. The objectivity of this measure could help in monitoring mobility outcomes as quality indicators (Fessele & Syrkin, 2024; Zisberg et al., 2018). Changes in mobility outcomes could measure the effectiveness of chosen interventions, and might indicate the necessity of adjustments in care.

From a different perspective, institutions planning to improve quality of care could use DEMMI categorization (or simply the score) for benchmarking. This way they could set goals to achieve using a tool with repeatable measures, certifying the changes seen in results are generally not artifacts of the process, but real differences in mobility capability, and thus, potentially in self-care agency.

5.4.3 Early Intervention and Prevention Strategies

DEMMI is capable to detect remaining mobility capabilities (Braun et al., 2022), and could identify individuals at risk for functional decline by that (Sánchez-Sánchez et al., 2024). Using this tool it could be possible to establish a proactive form of care planning instead of being merely reactive, as preserving intrinsic (overall) capacity reduces the risk of later impairment (de Foubert et al., 2021; Sánchez-Sánchez et al., 2024). This means that healthcare teams might be able to take effective measures when only DEMMI results started to drop, but otherwise the functional capacities were seemingly intact.

With the categorization, prevention strategies could be targeted, e.g. those who have independent or moderately reduced mobility may benefit from strengthening programs in order to prevent mobility from decreasing to lower categories (Montero-Odasso et al., 2022). For those with low mobility, on the other hand, balance training and fall prevention programs might prove adequate (Montero-Odasso et al., 2022).

5.5 Research Implications and Future Directions

5.5.1 Validation of the Integration Framework

While the conceptual alignment of DEMMI categories and Orem’s nursing systems is supported by statistical data, its clinical effectiveness should still be validated with future

studies. Randomized controlled trials could compare this proposed theory-based care planning with traditional approaches, by which we would gain evidence of how it affects patient outcomes and resource management in a real world setting.

Systematic reviews have suggested the need for studies that assess functional decline and its correlated factors with validated measures over time (Pollak et al., 2023). The predictive validity of DEMMI for care needs could be examined through longitudinal studies regarding how DEMMI scores change by time due to nursing interventions (Sánchez-Sánchez et al., 2024).

5.5.2 Validation Across Cultures and Settings

There are several factors that could affect the relationship between mobility assessment and nursing system needs, e.g. healthcare systems, institutional settings etc. It is essential, for this reason, to test the proposed framework in different contexts to see how universally applicable it is.

Community-dwelling elderly may have different mobility and self-care capabilities (Jung et al., 2021), which would justify modifications in the use of home care or community nursing, but would still retain the theoretical principles and their expected benefits.

5.6 Limitations and Interpretation

5.6.1 Limitations

The cross-sectional design of our studies does not permit to interpret our results as causal evidence for the relationship between mobility and other functional capabilities; we can only acknowledge the theoretical alignment.

We conducted these studies in the Budapest area, which might limit the generalizability in Hungary, and raises the potential need for studies in rural areas.

As implied in the validation plans, the institutional settings where the measurements were taken certainly limit the interpretability for community settings. On a similar note, the

theoretical integration is more of a conceptual development than empirical validation, and that is clearly articulated throughout this work. This, again, would need further validation in various settings for feasibility and effectiveness as suggested before.

Regarding the sample characteristics, though representative of typical long-term care settings, the high proportion of women and people with cognitive decline may limit our results' generalizability. When applying any finding of this thesis, however there do not seem to be imminent threats, caution should be taken in different contexts.

The lack of validation for cut-off values from Thorsted et al.'s work (2024) is another limitation of the study. Though these DEMMI values were derived from data acquired in the Danish elderly population, the DEMMI was rigorously validated among Hungarian older people, and our clinical application study was exploratory in nature. Future research could address this problem by establishing cut-off values for Hungary.

5.6.2 Implications for Interpretation

Even with these limitations, findings from both clinical studies point in the direction that DEMMI is a versatile instrument with clear clinical relevance. The relationships uncovered between mobility and other areas imply that functional capabilities could be effectively and consistently estimated through DEMMI results. Consequently, it has real potential in nursing practice.

The theoretical integration proposed in this work can serve well as a guide for practical implementation, however does not substitute further empirical studies. Ideally, it could be used by healthcare institutions to support decision making about resource allocation and interventions, and while using, may gather further useful data for evidence-based refinements.

6. Conclusions

6.1 Central Idea

This thesis aimed to address the problem that nursing theory (along with practice) does not usually use mobility assessment as a primary tool, or take advantage of even already available data on it. With empirical studies and conceptual framework development the goal was to propose a solution, by using DEMMI integrated in Orem's theory as a potential precursor for expectable care and resource needs of the elderly, all in an evidence-based and theoretically grounded way.

6.2 Research Aims

For this thesis three related objectives had been established. As DEMMI was not yet adapted to Hungary, the first objective was to translate to Hungarian and validate it among institutionalized elderly. After the validation, the second objective was to test DEMMI in a clinical setting, and then compare the results to other indicators of functional capacity – all in order to analyze patterns in the relationship between selected indicators and DEMMI based mobility categories. The third objective was based on the previous two, developing theoretical propositions for the integration of DEMMI results in Orem's framework. It was the conceptual framework development method that helped to achieve this goal, and that helped in demonstrating its implications for nursing practice and future research.

6.3 Key Findings

During the validation HU-DEMMI showed excellent psychometric properties as the inter-rater reliability with an ICC = 0.981, test-retest reliability with ICC = 0.989, and internal consistency with Cronbach's $\alpha = 0.906$ all meet international standards. It also showed strong construct validity through correlations to concurrent measures, and there were no observable ceiling or floor effects.

In the clinical application study systematic patterns were uncovered in the four DEMMI-based mobility categories (very low, low, moderately reduced, and independent), with

significant and progressive differences among them in functional domains related to self-care capacity, such as self-care independence, cognitive function, lower limb strength, dynamic postural control, and fear of falling.

The theoretical contribution was provided with the conceptual framework development for the integration of DEMMI use in Orem's framework, through identifying alignments between DEMMI scores and Orem's nursing system requisites. Characteristics of the very low mobility group corresponded with wholly compensatory nursing system requirements and would need complete nursing support. Individuals in the low to moderately reduced mobility group showed heterogeneity in functional capabilities, but all corresponded to a partially compensatory nursing system. Capabilities of elderly in the independent mobility group suggested their fit for a supportive-educative system, where nurses mainly help in guiding and encourage self-management.

6.4 Main Implications

The proposed integration framework should be understood as a middle-range theory – with further validation it can serve as a guide for establishing specific protocols on a firm theoretical basis. It could offer the general concept of turning available mobility assessment data (from DEMMI) into care decisions: it has the potential to improve the reproducibility, quality, and effectiveness of clinical interventions, while supporting a more optimal resource allocation in healthcare facilities. With a common set of concepts and achievable goals it could also improve and encourage interprofessional communication, mainly between physiotherapists and nurses or other caregivers. Given the strong theoretical basis and worldwide use of both DEMMI and Orem's theory, the framework carries potential value with international standards.

6.5 Limitations and Future Research

Further validation is essential for the appropriate use of the proposed framework, as it is primarily theoretical in nature, and even our empirical studies were conducted in specific settings. This validation should mean comparing framework-guided care planning with

traditional approaches, and include examination of clinical outcomes, resource utilization, and feasibility in various healthcare and cultural contexts. The cross-sectional design of our empirical studies does not permit causal conclusions, which indicates the need for longitudinal studies targeting predictive validity regarding changes in mobility scores and nursing systems. Cut-off values for mobility categories were based on Danish sub-populations, and while consistent with Hungarian findings, the fact necessitates local validation.

6.6 Closing Thought

Through the presentation of the successful cross-cultural validation and clinical application studies of Hungarian DEMMI, and the proposal of theoretical integration with Orem's framework, this thesis contributes to the field of evidence-based and theory driven geriatric care. The proposed framework could be a step in the direction of bridging the gap between detailed mobility assessment and personalized nursing care, an important advancement for healthcare systems in an aging world.

7. Summary

Mobility assessment and nursing theories are established fields in geriatric care, however are not well-integrated, limiting optimal care planning and use of resources. This thesis proposes a conceptual framework to bridge that gap, by using de Morton Mobility Index (DEMMI) as an assessment tool within Orem's Self-Care Deficit Nursing Theory.

The aim was to develop a conceptual framework for potential integration. For this the main objectives were: 1) cross-culturally adapt and validate the DEMMI in Hungary, 2) examine the relationship of DEMMI and other indicators of self-care, and 3) make propositions for integration based on the theoretical alignments with Orem's nursing systems.

The cultural adaptation followed the standard procedure set by Beaton et al. (2000), and the instrument was validated with 158 elderly in long-term care. The clinical application study included 209 participants, and investigated the correlations between DEMMI-based mobility categories and functional indicators relevant to self-care capacity (Barthel Index, MMSE, physical performance, fear of falling). For the theoretical part, the conceptual framework development methodology was utilized.

HU-DEMMI was found to be a reliable instrument with excellent construct validity. Systematic, progressive patterns were uncovered across mobility categories and their relationship to measures of functional capacity. The conceptual framework development revealed that the very low mobility category aligned with a wholly compensatory nursing system, low to moderately reduced mobility corresponded with partially compensatory, and independent mobility with supportive-educative nursing systems.

This thesis presents studies on the Hungarian adaptation and clinical application of DEMMI, and offers empirical foundations for the integration potential of refined mobility assessment to theoretical nursing frameworks, opening up the possibility for more efficient care planning and resource allocation. Further intervention studies are necessary for validation, however, this thesis can serve as a guide for future implementation.

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9. Bibliography of the Candidate's Publications

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Gyombolai, Z., Simon, A., Kubik, A. Z., Jónásné Sztruhár, I., Mayer, R., & Kovács, É. (2025). Tartós ellátást nyújtó intézményben élő idős személyek mobilitási képessége. A de Morton Mobilitási Index (DEMMI) magyar nyelvű verziójának alkalmazása [Mobility of older people in institutions providing long-term care. Applying the Hungarian de Morton Mobility Index (DEMMI)]. *Orvosi Hetilap, 166*(45), 1777–1785. https://doi.org/10.1556/650.2025.33414

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