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FLOOR-RECOVERY TRAINING IN GERIATRIC CARE: CLINICAL EVALUATION OF THE BACKWARD CHAINING METHOD AND DEVELOPMENT OF A PROFESSIONAL READINESS ASSESSMENT TOOL AMONG HUNGARIAN PHYSIOTHERAPISTS

PhD thesis

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List of Abbreviations

Abbreviation	Full form
2PL IRT	Two-parameter Logistic Item Response Theory
30CST	30-second Chair Stand Test
***a* par (SE)**	Discrimination parameter (Standard Error)
ANCOVA	Analysis of Covariance
***b* par (SE)**	Difficulty parameter (Standard Error)
BCM	Backward Chaining Method
BMI	Body Mass Index
CG	Control Group
CONSORT	Consolidated Standards of Reporting Trials
CVR	Content Validity Ratio
df	Degrees of Freedom
EFA	Exploratory Factor Analysis
FES-I	Falls Efficacy Scale - International
FRT	Floor-Recovery Training
I-CVI	Item-level Content Validity Index
I-NHLSD	Independent Nursing Home Life-Space Diameter
ICC	Intraclass Correlation Coefficient
IG	Intervention Group
KAP	Knowledge-, Attitude-, and Practice model
KAP-FALL-HU	Knowledge, Attitude and Practice – Fall – Hungarian
KMO	Kaiser-Meyer-Olkin measure
KR-20	Kuder-Richardson-20 coefficient
LoA	Limits of Agreement
LSA	Life-Space Assessment
MMSE	Mini Mental State Examination
NHLSD	Nursing Home Life-Space Diameter
S-CVI/Ave	Scale-level Content Validity Index, Averaging method
S-X^2	Orlando-Thiessen S-Khi^2
SD	Standard Deviation
SPPB	Short Physical Performance Battery
TUG	Timed Up and Go test

1. Introduction

1.1. Demographic challenges and falls

As life expectancy increases worldwide, the concept of "successful aging" becomes particularly important. A critical aspect of successful aging is the maintenance of high physical functions which is negatively affected by the frequent occurrence of falls in later life (Wang et al., 2024). It is well-established that approximately one-third of individuals aged 65 and older experience at least one fall annually (Salari et al., 2022).

In Hungary, the proportion of adults in this demographic is steadily increasing in alignment with global trends. According to recent data, approximately 20% of the Hungarian population is aged 65 and older, highlighting an urgent need for interventions that support functional independence and healthy aging (Hungarian Central Statistical Office, 2023).

The clinical consequences of falls are often severe. Beyond immediate traumatic injuries, such as hip fractures or head trauma, falls frequently lead to a significant decline in quality of life and high mortality rates (Marcinkowski et al., 2025; Rodrigues et al., 2022; Vaishya & Vaish, 2020).

Even in the absence of major trauma, a fall can lead to the so-called "long lie". This term is used to describe a period of prolonged immobilization on the floor due to an individual's inability to rise independently (Kubitza et al., 2023).

A long lie can cause serious medical complications, including hypothermia, dehydration, pneumonia, or pressure ulcers (Blackburn et al., 2022). Furthermore, experiencing the inability to stand up from the floor following a fall can cause severe psychological distress which will lead to an increased fear of falling (Cox & Williams, 2016; Kovács et al., 2019).

Due to this fear, older adults may avoid activities they perceive potentially dangerous, thereby limiting their own physical activity. Over time, this will lead to restricted mobility, decreased functional capacity, and ultimately, an increased risk of future falls (Dhar et al., 2022; dos Santos et al., 2023; Kaynat et al., 2025; Samant et al., 2019).

1.2. Physiotherapy and fall prevention

To mitigate these risks, the latest global fall prevention guideline by Monter-Odasso et al. explicitly recommends floor-recovery training. While the guideline highlights the need for regaining the ability to rise from the floor, it considers floor-recovery training (FRT) as part of a broader multi-component exercise intervention incorporating balance, strength and functional exercises (Montero-Odasso et al., 2022).

Despite the recommendation, FRT has not become a standard component of the daily practice of physiotherapists (Vandervelde et al., 2024).

Although physiotherapists play a critical role in both primary and secondary fall prevention by improving balance, muscle strength, and functional movement, while also addressing environmental risk factors through patient education (Gumber et al., 2022; Sherrington & Tiedemann, 2015; van der Velde et al., 2025), implementing FRT presents challenges.

Obstacles include the lack of knowledge regarding current guidelines, or the perception, held either by the therapists or the patients, that practicing the movement sequence is too difficult or dangerous. This concern may stem from the patient's deteriorating physical abilities, the presence of chronic illnesses or low self-efficacy (Swancutt et al., 2020).

This thesis focuses on this neglected but vital element of fall prevention: teaching older adults how to stand up from the floor safely and effectively and to assess the professional readiness amongst physiotherapists to carry out such an intervention.

1.3. Floor-recovery training via the Backward Chaining Method

Originating in behavioural psychology and motor learning pedagogy, backward-chaining is a task-specific teaching technique that breaks a complex activity down into separate sub-tasks, commonly utilized to help individuals systematically achieve proficiency in functional daily tasks (Woods & Teng, 2002)

In the context of floor recovery, the Backward Chaining Method (BCM) is a structured, standardized approach developed specifically for the older population for the safe practice

of the movement sequence required to get down to the floor, thereby learning, how to stand up from it. The core principle of BCM is to introduce the sequence starting from the easiest, standing position, and systematically progressing through intermediate stages (half-kneeling, kneeling, prone kneeling, side-sitting, side-lying) until reaching a supine position on the floor. Progression to a next step only happens when the individual can perform the preceding one confidently and securely (Reece & Simpson, 1996).

By starting from a standing position, BCM minimizes psychological stress and fosters self-confidence by not requiring the individual to assume a vulnerable position, namely, lying on the floor, in the initial stages of learning. Furthermore, the method serves as a therapeutic exercise that enhances lower-limb strength and functional mobility, therefore, practicing the movement sequence remains beneficial even if the individual is eventually unable to learn how to rise from the floor (Bohannon & Lusardi, 2004; Kinn & Galloway, 2000; Swancutt et al., 2020).

Comparative studies have indicated that BCM is more effective for teaching and practicing floor recovery than conventional training methods. Based on a recent review, FRT generally has positive effects on physical functionality and can reduce the time needed to get up from the floor for those, who are able to do it to begin with. However, traditional FRT may fail to improve the actual ability to rise from the floor because it frequently focuses on resistance training rather than teaching the "skill" of getting up (Leonhardt et al., 2020).

The Backward Chaining Method addresses this problem by teaching the specific movement sequence to get down to and up from the floor, while strengthening the exact muscles required for the execution.

1.4. Evaluating professional readiness

For floor-recovery training (via the BCM or other methods) to become a routine part of geriatric physiotherapy, it is essential to evaluate the current professional knowledge, attitudes and daily practice of physiotherapists regarding fall prevention.

In health sciences, knowledge, professional beliefs, and behaviours related to a specific intervention are assessed using surveys based on the so-called Knowledge, Attitude, and Practice (KAP) model. This model is a theoretical framework that examines the level of knowledge regarding, and the attitude towards a given topic and their manifestation in daily practice. The KAP model includes 3 elements:

- Knowledge: The facts, information, and level of understanding an individual has regarding a topic.
- Attitude: An individual's opinions, beliefs, and emotional responses toward the subject.
- Practice: The actual behaviours and daily activities performed, which are influenced by both knowledge and attitude.

Figure 1, which includes the elements of the model, clearly illustrates that although knowledge and attitude influence clinical practice, the relationship is dynamic, meaning, that professional behaviour can also reinforce or alter a therapist's knowledge and beliefs (Andrade et al., 2020).

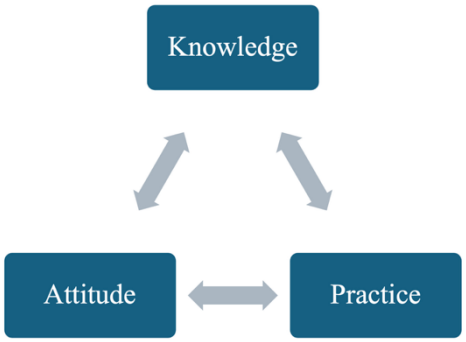

Figure 1: The interconnected elements of the KAP-model

While a number of studies have applied the KAP framework to geriatric fall prevention, these instruments were designed primarily for nursing staff and in some cases lacked rigorous validation (Alsaad et al., 2024; Boros & Balogh, 2024a; Boros & Balogh, 2024b; Cho & Jang, 2020; Ganabathi et al., 2017). Consequently, no validated, physiotherapy-specific instrument was previously available in either a domestic or international context to evaluate professional readiness regarding fall prevention and floor-recovery training.

Identifying the gaps in the Knowledge, Attitude and Practice domains is necessary to provide direction for the education and targeted training of physiotherapists in fall prevention and floor-recovery training.

1.5. Barriers between clinical evidence and professional implementation

While the Backward Chaining Method (BCM) offers a clinically proven strategy to mitigate the risks of falls and the long lie, its effectiveness in geriatric settings depends on whether the healthcare professionals are ready to implement it.

Currently, significant barriers exist between international fall prevention guidelines and their daily clinical application.

Individual barriers (e.g. professionals being unaware of guidelines, low self-efficacy of the patients, safety concerns) are frequently compounded by institutional factors, such as various workplace protocols and severe imbalance between clinical workloads and available workforce capacity, which severely limits the time and resources staff can allocate to implementing intensive training protocols like BCM (Sterke et al., 2025).

By evaluating the clinical effects of the BCM on older adults and assessing physiotherapists' current knowledge, attitudes, and practices, this thesis seeks to align clinical evidence with daily professional practice, thereby contributing to the field of geriatric physiotherapy.

2. Objectives

This dissertation aims to enhance the safety and independence of older adults by addressing the gap between the scientific evidence and the daily clinical practice regarding floor-recovery training in geriatric care. To achieve this, the research was divided into two separate but interconnected studies: a clinical intervention trial of the Backward Chaining Method and the development of a professional assessment tool using the KAP-model.

Parts of this thesis detailing the first study (Study1 – S1) are adapted from the author's work titled *Backward Chaining Method for Teaching Long-Term Care Residents to Stand Up from the Floor: A Pilot Randomized Trial* published in the Journal of Clinical Medicine in 2025 under the terms of the Creative Commons Attribution (CC BY) license.

Parts of this thesis detailing the second study (Study2 – S2) are adapted and translated from the author's co-authored work titled *Development and validation of a questionnaire assessing physiotherapists' knowledge, attitudes, and practices regarding falls among older adults* [Gyógytornász-fizioterapeuták időskori eleséssel kapcsolatos tudásának, attitűdjének és gyakorlatának felmérésére szolgáló kérdőív kifejlesztése és validálása] published in Hungarian language in the journal Orvosi Hetilap in 2026 under the terms of the Creative Commons Attribution (CC BY) license.

2.1. Clinical evaluation of the Backward Chaining Method

The objective of the first study (S1) was to evaluate the clinical effects and acceptability of a structured, standardized floor-recovery training method, the Backward Chaining Method (BCM), designed specifically for the elderly to safely practice the movement sequence required to get down to, and stand up from the floor.

The relevance of this study originates from the connection between declining daily mobility and increased mortality. Fear of falling and of the inability to rise from the floor independently may result in the reduction of "life-space" – the spatial area in which a person moves in their daily life – which is associated with declining physical capabilities,

an elevated risk of future falls, diminished quality of life, and increased mortality rates (Jadczak et al., 2022).

While a substantial body of literature addresses interventions aimed at reducing fall risk (Arkkukangas et al., 2024; Gusi et al., 2012; Sherrington et al., 2020; Skelton et al., 2005; Wei et al., 2023), research focused specifically on improving the ability to rise from the floor remains limited (Leonhardt et al., 2020).

Despite the clinical importance of floor-recovery training, very few intervention studies have utilized a randomized controlled design (Hofmeyer et al., 2002; Zak, 2006), and at the time of writing this thesis, no such trials have examined the impact of the BCM on the physical and psychological well-being of institutionalized older adults.

To address these research gaps, this pilot randomized controlled trial had two primary objectives:

- First, to evaluate the clinical effects of floor-recovery training via the BCM on functional mobility, muscle strength, fear of falling, and life-space mobility among long-term care residents.
- Second, to assess the acceptability of this structured intervention within an institutionalized elderly population to determine its feasibility for broader clinical implementation.

2.2. Development and validation of the KAP-FALL-HU questionnaire

While S1 evaluates the intervention itself, the second study (S2) addresses the barriers in the clinical implementation, because regardless of its effectiveness, no intervention can benefit the population if healthcare providers are not utilizing it.

Therefore, S2 aimed to develop and validate a specialized measurement tool named the KAP-FALL-HU (Knowledge, Attitude and Practice – Fall – Hungarian) questionnaire, tailored for Hungarian physiotherapists. It is designed to assess the level of knowledge regarding fall prevention and floor-recovery training among professionals,

to identify their attitudes towards these interventions, and to examine their daily clinical practices.

In the context of this thesis, the KAP model is used to identify the barriers between clinical evidence and its translation to healthcare, to determine whether the neglect of floor-recovery training is due to gaps in up-to-date professional knowledge, negative attitudes toward the feasibility of the task, or systemic obstacles in daily practice.

Together, S1 and S2 aim to provide a holistic view: confirming a viable solution for falls and the long lie while simultaneously identifying the professional requirements and barriers to making the floor-transfer training a standard part of geriatric physiotherapy.

3. Methods

Both studies were conducted in accordance with the Declaration of Helsinki and the General Data Protection Regulation (GDPR).

Prior to participation, all individuals received a detailed explanation regarding the study's objectives and procedures, then, a written informed consent was obtained from each participant. All subjects were informed about their right to withdraw from the trial at any stage.

The study protocol of S1 was approved by the Regional and Institutional Committee of Science and Research Ethics of Semmelweis University under the identification number SE RKEB: 24/2025 and was also registered on ClinicalTrials.gov under the identifier NCT06908317.

The study protocol of S2 was approved by the Regional and Institutional Committee of Science and Research Ethics of Semmelweis University under the identification number SE RKEB: 364/2025.

3.1. Design of S1

This research utilized a single-blinded, double-arm randomized controlled trial design, and was conducted among residents of a long-term care facility in Budapest, Hungary. The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines to ensure transparent and comprehensive reporting. To minimize bias, a single-blinded approach was employed: while participants and the physiotherapists administering the BCM were necessarily unblinded due to the nature of the intervention, all outcome assessors remained blinded to group allocations

3.1.1. Participants

Participation in the intervention program was offered to all residents who met the eligibility criteria. Residents were included if they were at least 65 years old, had been a resident of the long-term care facility for at least two months, and maintained the ability to walk independently or with the use of an assistive device.

Potential participants were excluded from the study if they were deemed unfit for floor-recovery training due to severe pain (Visual Analog Scale >7/10), lower limb endoprosthesis surgery within the preceding six months, other significant physical constraints, uncontrolled hypertension (>160/90 mmHg), cognitive impairment preventing cooperation (determined by psychological assessment) or planned relocation from the facility during the study period.

The enrolment procedure of the study is detailed in the CONSORT flow diagram presented in Figure 2.

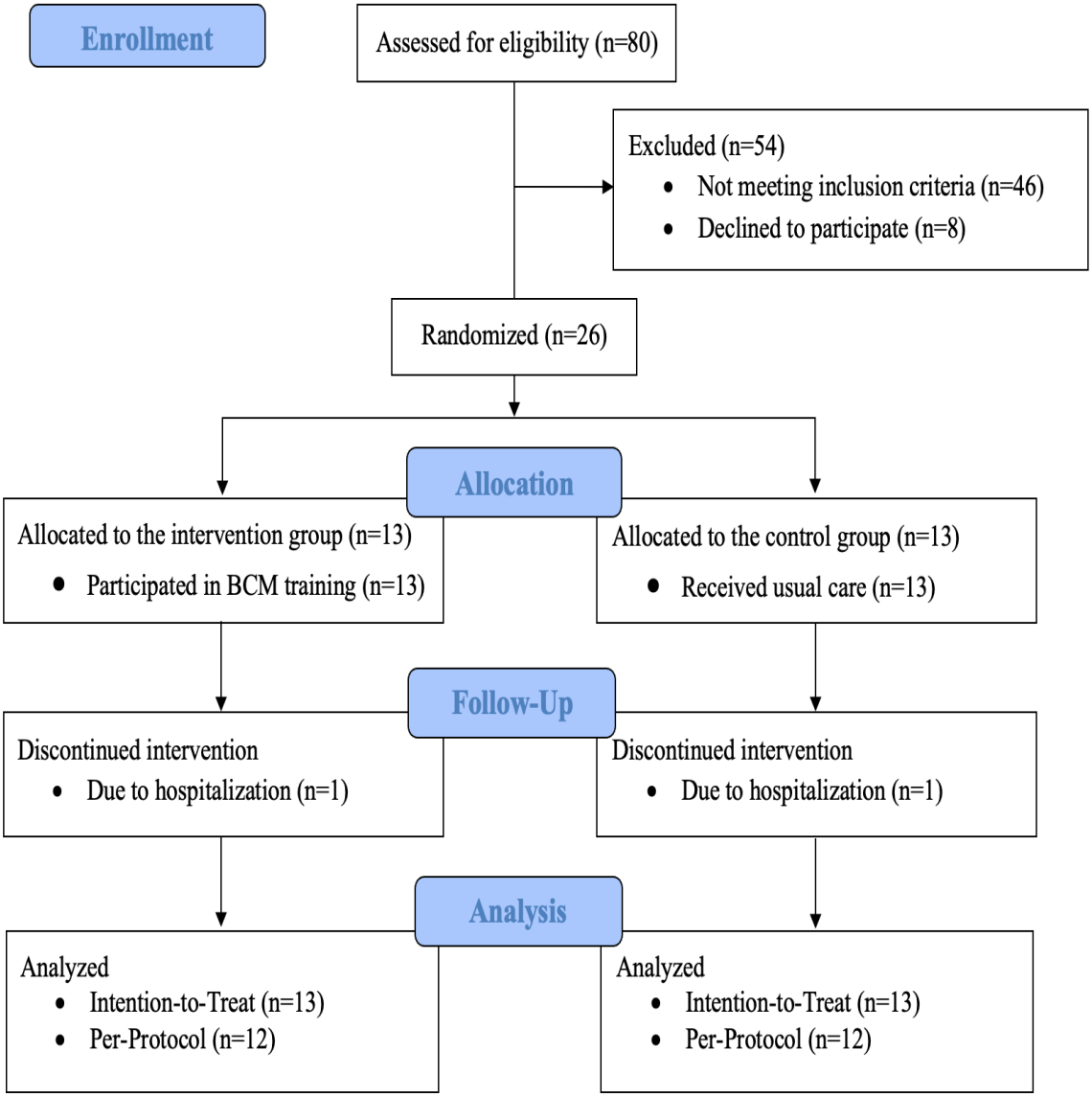

Figure 2: CONSORT flow diagram detailing the enrolment process of the study

3.1.2. Measures

Participant demographics and health-related characteristics, including weight, height, Mini Mental State Examination (MMSE) scores, use of assistive devices, fall history within the previous six months, and existing chronic conditions were obtained from nursing records.

Outcome assessments were performed at baseline and following the intervention period by a trained physiotherapist. The physiotherapist was blinded to group allocation and was not involved in the administration of the training programs. Participants were instructed not to disclose details of their treatment to the outcome assessor.

The primary outcome measure was functional mobility assessed using the Timed Up and Go (TUG) test which is a standard measurement in geriatric rehabilitation worldwide as well as in Hungarian clinical practice (Zöllei et al., 2021). The test measures the time (in seconds) required for a participant to stand up from a standard armchair (seat height: approximately 46 cm, arm height: approximately 65 cm) walk three meters ahead to a marker, then turn around, walk back to the chair, and sit down again. To ensure safety and consistency, participants were permitted to wear their usual footwear, use their usual assistive devices, and use the arms of the chair for support when standing up. Following an introductory trial, two performances were recorded with an optional 30-second rest interval between attempts. The mean of the two attempts was used for analysis. (Podsiadlo & Richardson, 1991).

Secondary outcome measures included functional lower limb strength, grip strength, fear of falling and life-space mobility.

Functional lower limb strength was assessed using the 30-second Chair Stand Test (30CST), which records the total number of sit-to-stand repetitions completed through a full range of motion within 30 seconds. The test starts in a seated position on a standard chair (seat height: approximately 46 cm), with arms crossed over the chest. To ensure safety and consistency, all participants wore their regular footwear and performed a single practice trial prior to formal assessment. On the command "go," the assessor activated a digital stopwatch, and participants started the sit-to-stand transitions. They were

encouraged to do as many repetitions as possible in the given timeframe. Throughout the test, the assessor silently counted each correctly executed stand. Any incorrectly performed repetitions were excluded from the final results. At the end of the 30-second period, any attempt completed more than halfway toward a full stand was counted as a successful repetition. Participants unable to perform at least one repetition using the standard technique received a score of zero (Jones et al., 1999).

Grip strength, a measure highly correlated with overall muscle strength, was quantified in kilograms using a Kern MAP 40K1 digital dynamometer. During the assessment, participants remained in a seated position with elbows bent in 90 degrees and griped the handles of the device as hard as possible. The test was performed with the dominant hand, and the mean value of two consecutive measurements were recorded (Benton et al., 2022).

Fear of falling was assessed using the Hungarian version of short Falls Efficacy Scale International (FES-I) which consists of seven items designed to evaluate an older adult's level of concern about falling during the performance of routine daily activities. Responses are recorded on a four-point scale where 1 indicates "not at all concerned," 2 "somewhat concerned," 3 "fairly concerned," and 4 "very concerned". The total score ranges from 7 to 28 points, with higher scores representing a greater fear of falling. The Hungarian version of the FES-I is recognized as a valid and reliable measurement tool for Hungarian-speaking older populations and is a standard metric in both clinical practice and geriatric research (Kovács et al., 2018).

The extent and frequency of the resident's mobility, also known as life-space mobility, was assessed using the Nursing Home Life-Space Diameter (NHLSD). As part of the standard documentation of the long-term care facility, this measure was completed with the assistance of the staff and reflected the resident's movement patterns over the two weeks preceding the evaluation. The NHLSD evaluates the resident's mobility across four domains: (1) within the resident's room, (2) within the unit, (3) outside the unit, and (4) beyond the facility.

Movement frequency within these domains is rated on a six-point scale: 0 = never, 1 = less than weekly, 2 = at least weekly, 3 = more than twice per week, 4 = one to three times per day, and 5 = more than three times per day. The total NHLSD score is calculated

using the formula: *1(diameter1 × frequency1) + 2(diameter2 × frequency2) + 3(diameter3 × frequency3) + 4(diameter4 × frequency4).*

Beyond distance and frequency, the NHLSD also accounts for the independence: if a resident moves through a domain without human assistance, the score for that item is doubled, resulting in the independent NHLSD scores (I-NHLSD).

Ultimately, two types of total scores were calculated for analysis. The first score (NHLSD) represents the spatial range of movement, with scores ranging from 0 to 50 where 0 means the resident is bedbound, while 50 indicates multiple daily movements outside the facility. (Tinetti & Ginter, 1990). The second score (I-NHLSD) integrates independence into the calculation, by doubling the scores achieved for any domains completed without human assistance. Using this scoring system, participants who are able to move outside the facility daily and independently can reach 100 points in total (Bergland et al., 2010).

3.1.3. Randomization

Following the baseline assessment, eligible participants were assigned to the intervention group (IG) or the control group (CG) using stratified randomization. This process accounted for baseline FES-I scores and the use of walking aids, to ensure balanced groups.

The random allocation sequence was generated using GraphPad software by an independent researcher who held no role in either the assessment or the intervention, thereby ensuring allocation concealment

3.1.4. Sample-size estimation

To determine the required sample size, findings regarding functional mobility improvements from previous publications were used. Zak et al. reported a 5.3-second improvement in the TUG test performance among older adults following a training program based on the BCM (Zak, 2006). This degree of change is considered as clinically significant and is particularly relevant for elderly populations with chronic conditions such as knee osteoarthritis (Alghadir et al., 2015), Parkinson's disease (Hayakawa et al.,

2020; Huang et al., 2011), Alzheimer's disease (Ries et al., 2009), or stroke (Lexell et al., 2005).

To detect this between-group difference with a significance level of alpha=0.05 and a statistical power of 80%, while also accounting for a 30% of dropout rate, a minimum of 13 participants in each group was necessary to conduct this study. The sample size calculation was performed using the OpenEpi online statistical tool: (https://www.openepi.com/SampleSize/SSMean.htm).

3.1.5. Control Group activity

Participants assigned to the control group (CG) received the standard of care typically provided in long-term care facilities. This consisted of 40-minute chair-based, low-intensity exercise sessions, combined with communicative social activities. To ensure equal care for all residents, participants in the CG were offered to participate in a subsequent training program focusing on floor-recovery after the end of the trial period.

3.1.6. Intervention Group activity

In addition to the standard of care typically provided in long-term care facilities, residents in the intervention group (IG), participated in a structured, seven-week training program, which focused on floor-recovery techniques using the Backward Chaining Method (BCM). These sessions were conducted three times per week with each 40-minute session beginning with a 5-minute warm-up consisting of low intensity flexibility exercises, followed by a 30-minute period to practice the various steps of floor-to-stand transitions and ended with a 5-minute period of stretching and breathing exercises as cool-down. The structured instruction and practice of floor-to-stand transitions were following the seven steps of BCM based on Reece and Simpson (Reece & Simpson, 1996) as detailed below and illustrated in Figure 3:

- Step 1: The participant descends from standing one foot forward into a half-kneeling position on a wedge pillow then returns to the standing position.
- Step 2: The participant descends from standing one foot forward into a half-kneeling position directly on the floor then returns to the standing position.

- Step 3: Following the half-kneeling position of Step 2, the participant lowers the other knee into a high kneeling position then returns to standing through Step 2.
- Step 4: Following the high kneeling position of Step 3, the participant places both hands on the floor one at a time to reach a prone kneeling position then returns to standing through Steps 3 and 2.
- Step 5: Following the prone kneeling position of Step 4, the participant lowers the body into a half-sitting position (a pillow may be used for comfort) then returns to standing through Steps 4, 3 and 2.
- Step 6: Following the half-sitting position of Step 5, the participant descends into a side-lying position then returns to standing through Steps 5,4,3 and 2.
- Step 7: Following the side-lying position of Step 6, the participant turns into a supine position then returns to standing through Steps 6,5,4,3 and 2 therefore reversing the entire sequence: supine, side-lying, half-sitting, prone kneeling, high kneeling, half-kneeling, and finally standing.

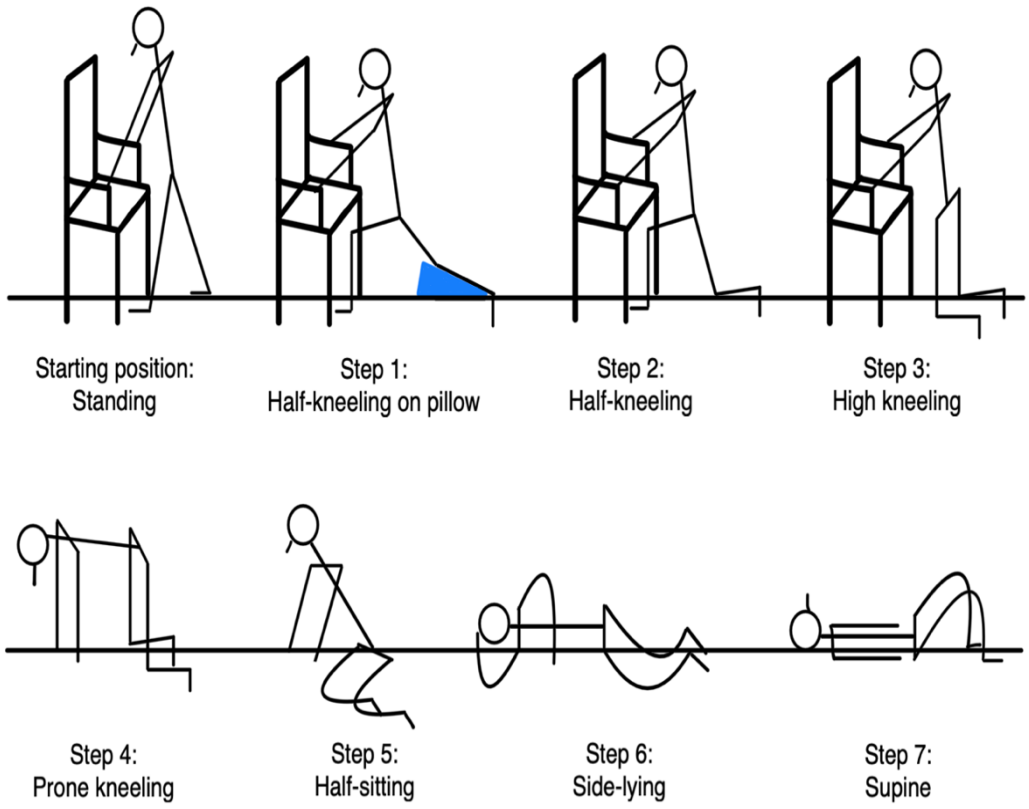

Figure 3: Steps of the Backward Chaining Method

The BCM sessions were conducted in a designated community room within the facility and were led by a physiotherapist with extensive expertise in geriatric rehabilitation. To ensure participant safety and to provide adequate support during the exercises, additional supervision was provided by two physiotherapy students and one staff member.

As a further safety precaution, arterial blood pressure was measured prior to each session. Participants with a systolic blood pressure above 160 mmHg or a diastolic blood pressure above 90 mmHg were excluded from the specific session. The training sessions utilized minimal equipment, requiring only stable chairs, wedge pillows, and standard training mats.

3.1.7. Acceptability

Acceptability of the intervention was evaluated based on participant adherence rates and the occurrence of any adverse events. Adherence was quantified by the number of sessions completed by each participant, with a threshold of 80% attendance required for inclusion in the per-protocol analysis.

To encourage consistent participation, the clinical significance of the study was clearly articulated to the residents, and the safety of the exercise sessions was continuously emphasized. Participants received reminders for upcoming sessions, and their individual progress in mastering the movement sequence was highlighted, to support confidence and motivation. Furthermore, participants were encouraged to share both positive and negative experiences with their peers or staff members.

Detailed records of attendance, individual progress, and participant feedback were documented in a pre-designed attendance-sheet by the physiotherapist leading the sessions. Throughout the intervention period, facility staff members monitored and recorded all adverse events, with specific focus on falls, using a pre-designed diary for this purpose, which were collected weekly by the blinded assessor physiotherapists.

A fall was defined as an „unexpected event in which a participant comes to rest on the ground, floor, or a lower level" (Montero-Odasso et al., 2022). This definition may include various incidents, such as falling backward onto a bed or a chair while attempting to stand up or losing balance and making contact with a wall or piece of furniture.

3.1.8. Data analyses

Descriptive statistics were used to summarize participant characteristics, with discrete variables reported as numbers and percentages and continuous variables presented as means with standard deviations or medians with interquartile ranges depending on the normality of the distribution. The Kolmogorov-Smirnov test was used to assess the distribution of all continuous data.

Baseline comparisons between the intervention and control groups were conducted using chi-square tests for discrete variables, while independent-sample t-tests or Mann Whitney U tests were applied for continuous variables, as appropriate.

Primary and secondary outcome analysis followed an Intention-to-Treat approach, in which all participants were analyzed within their original, randomly assigned groups. This was followed by a Per-Protocol analysis, which included only those participants who maintained at least 80% adherence to their assigned group.

To evaluate treatment effects while accounting for the baseline differences between groups, Analysis of Covariance (ANCOVA) was applied for grip-strength, the FES-I, NHLSD and I-NHLSD scores. In these models, the baseline scores were used as covariates to adjust the final results for any initial differences between the CG and IG. Prior to analysis, all statistical assumptions for ANCOVA, including linearity, homogeneity of regression slopes, and homogeneity of variance (Levene's test) were verified.

For the TUG and 30CST, which exhibited non-normal distributions, between-group comparisons were conducted using the non-parametric Mann-Whitney U test.

Within-group changes over the seven-week period were evaluated using paired-samples t-tests or Wilcoxon signed-rank tests, depending on the data distribution. In case of significant differences, effect sizes were calculated using the eta-square ($\eta 2$) for between-groups comparisons and Cohen's d for within-groups effect sizes (Cohen, 2013). Statistical analyses were performed using IBM SPSS Statistics version 18.0 (IBM Corp., Armonk, NY, USA) software, with statistical significance set at $p < 0.05$.

3.2. Design of S2

This research focused on the development and validation of a questionnaire regarding the knowledge, attitude, and practice of Hungarian physiotherapists in the topic of fall prevention and floor recovery training.

The study was conducted in two phases: Phase I involved the development of the questionnaire, while Phase II consisted of its psychometric evaluation. Figure 4 represents the development and evaluation process of KAP-FALL-HU.

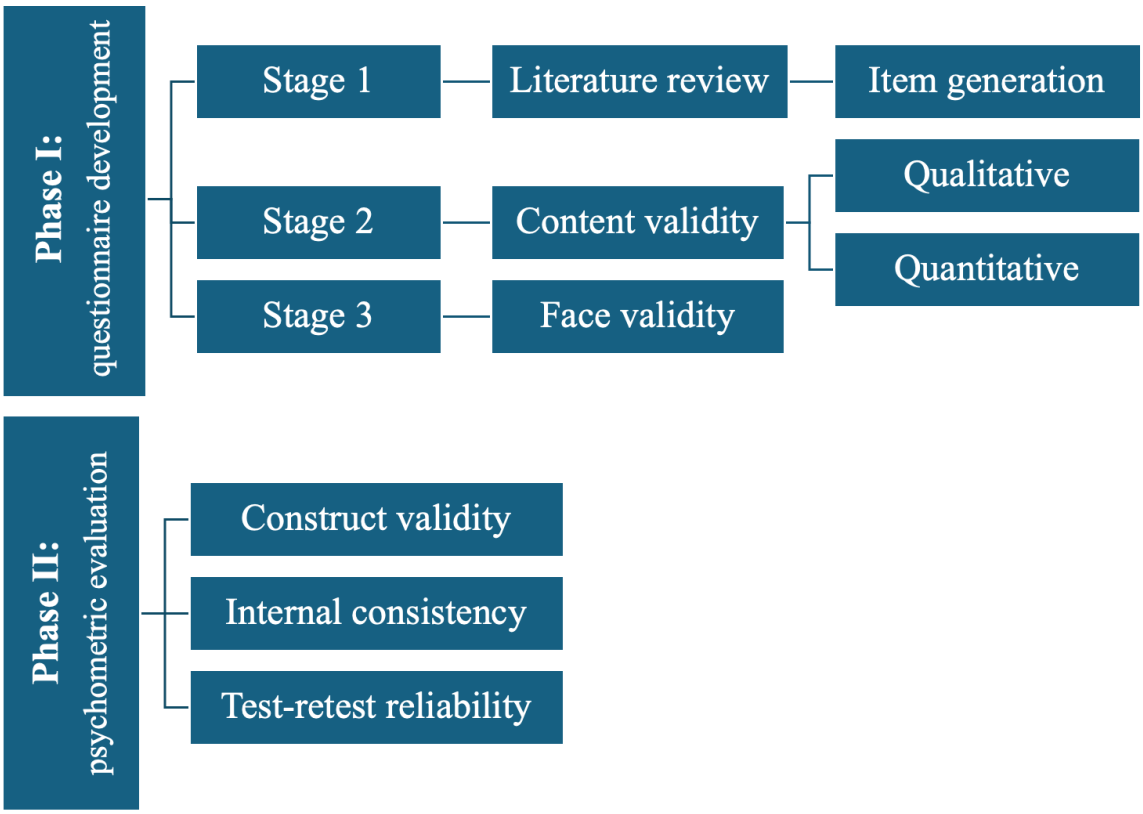

Figure 4: Development and evaluation process of KAP-FALL-HU

3.2.1. Phase I: Questionnaire development

The development phase of KAP-FALL-HU was structured into three consecutive stages:

1. Item generation and construction of the questionnaire
2. Assessment of content validity
3. Assessment of face validity

Phase I, Stage 1: Item generation and construction of the questionnaire

The initial stage involved formulating the individual items, establishing appropriate response options and defining the scoring system. To ensure the scientific basis of the items, a literature review was conducted across the MEDLINE, CINAHL, and Web of Science databases. The search focused on English-language studies published up to July 2025 focusing on the professional knowledge, attitude, and practice regarding fall prevention and floor recovery.

Keywords for the search included: "knowledge," "attitude," "practice," "fall," "fall prevention," "floor-transfer training," "floor-recovery training," "older people," and "physiotherapist".

Corresponding Hungarian terms were used to search Hungarian databases, including the Hungarian Medical Bibliography (Magyar Orvosi Bibliográfia – MOB), the Hungarian Periodicals Table of Contents Database (Magyar folyóiratok tartalomjegyzékeinek kereshető adatbázisa – MATARKA), and the Hungarian Science Bibliography (Magyar Tudományos Művek Tára – MTMT).

The search initially yielded 16,517 results, which were screened by title. Following the exclusion of duplicates and papers unrelated to the KAP-model, falls, fall prevention or floor-recovery training, 34 potentially relevant publications were identified.

After thorough review of the abstracts and full texts 14 publications were selected as basis for item generation. The items were either adapted from previously published studies assessing nursing fall prevention behaviours (Albasha et al., 2023; Alsaad et al., 2024; Boros & Balogh, 2024a; Boros & Balogh, 2024b; Cho & Jang, 2020; Ganabathi et al., 2017), or developed based on current clinical fall prevention guidelines (Montero-Odasso et al., 2022) and research related to long lies (Blackburn et al., 2022; Kubitza et al., 2023) or floor-transfer training (Kinn & Galloway, 2000; Simpson & Mandelstam, 1995; Simpson & Salkin, 1993; Swancutt et al., 2020; van der Velde et al., 2025).

Finally, a total of 126 items related to fall prevention were drafted and categorized into the three domains (Knowledge: 37, Attitude: 35, Practice: 54 items) of the KAP-model.

Phase I, Stage 2: Assessment of content validity

Content validity was examined using both qualitative and quantitative evaluation to ensure the instrument accurately represented the intended domains. During the qualitative evaluation, a panel of 5 experts conducted a comprehensive review of the items. The expert panel was consisting of the following professionals:

- one physician with 10 years of geriatric experience
- three physiotherapists with 20, 18, and 7 years of geriatric experience respectively
- one nurse with 26 years of geriatric experience

To ensure an unbiased evaluation process, no superior-subordinate professional relationship existed between the members of the expert panel.

During the qualitative evaluation the expert panel identified and removed duplicates, overlapping content, or items irrelevant to physiotherapy. Additionally, ten new items were formulated regarding sociodemographic data and work experience. This process resulted in an initial 68-item questionnaire prepared for quantitative evaluation.

In the subsequent quantitative evaluation, 10 independent physiotherapists were recruited to assess the 68 items based on essentiality, professional relevance, clarity, and simplicity of response. Ratings were collected using binary and four-point scales. Furthermore, respondents were encouraged to provide qualitative feedback and specific suggestions for item modification. Table 1 represents the methodology for assessing content validity.

Table 1: Methodology of evaluating content validity

	Essentiality		**Relevance**
1	Not necessary	1	Not relevant
2	Essential	2	Slightly relevant
		3	Relevant
		4	Very relevant
	Clarity		**Simplicity**
1	Not clear	1	Not simple
2	Slightly clear	2	Slightly simple
3	Clear	3	Simple
4	Very clear	4	Very simple

Following the assessment by the 10 physiotherapists, the quantitative evaluation of content validity was performed using two metrics: the Content Validity Ratio (CVR) and Item-level Content Validity Index (I-CVI). CVR quantifies the essentiality of each item using the following formula:

$$\mathbf{CVR = (N_e - N/2) / (N/2)}$$

Where:
N_e: the number of respondents who considered a given item essential
N: the total number of respondents

CVR values range from -1 to 1, where a value of 1 indicates a perfect consensus on an item's necessity. In accordance with Lawshe's criteria, a threshold value above 0.800 was considered acceptable CVR value (Ayre & Scally, 2014).

I-CVI quantifies the relevance, comprehensibility, and ease of response for each item using the following formula (Lynn, 1986):

$$\mathbf{I\text{-}CVI = N_{e3\text{-}4} / N}$$

Where:
$N_{e3\text{-}4}$: the number of respondents who rated a given item as 3 or 4
N: the total number of respondents

I-CVI values range from 0 to 1, where values > 0.79 indicate that the item is relevant, clear and simple to respond. Values between 0.70 and 0.79 indicate a need for the modification of the item. Items with values below 0.70 are considered to be removed based on expert consensus (Polit et al., 2007).

In addition, the Scale-level Content Validity Index (S-CVI/Ave) was calculated to determine the average validity of the entire instrument, using the following equation:

$$\mathbf{S\text{-}CVI/Ave = \Sigma I\text{-}CVI / n}$$

Where:
$\Sigma I\text{-}CVI$: sum of the item-level content validity indices of each item
n: the total number of items in the questionnaire

The quantitative evaluation of content validity was conducted in two rounds with the 10 physiotherapists. Following revisions from the first round, the final version consisted of 67 items. The second round was performed to confirm that the final instrument achieved an S-CVI/Ave index of 1.0, indicating perfect expert consensus on the final item pool.

Phase I, Stage 3: Assessment of face validity

After completion of the content validity calculations, the final 67-item questionnaire was structured into four domains (as represented in Table 2) for online distribution using the Google platform.

Table 2: The final structure of the KAP-FALL-HU questionnaire

Domain	Items	Focus Areas	Response Format
General Information	10	Sociodemographic data, education level, occupational field and work experience.	Open-ended and multiple-choice questions.
Knowledge	21	Definitions of long lies, falls and risk factors, information regarding preventive interventions and floor-recovery training	True False I don't know
Attitude	20	Beliefs regarding fall prevention and floor-recovery training.	Strongly disagree Disagree Neutral Agree Strongly agree
Practice	16	Daily activities directed to fall prevention and floor-recovery training in clinical practice.	Never Rarely Usually Always

The first, general information domain consisted of 10 questions focusing on sociodemographic data, education level (BSc, MSc, PhD), occupational field (healthcare or social care), and work experience (years).

The Knowledge domain consisted of 21 items evaluating the knowledge regarding falls, its risk factors, the concept of long lie, and information about various preventive interventions including floor-recovery training. Respondents provided their answers on a three-point scale (“True”, “False”, or “I don’t know”) where each correct answer was scored one point, while an incorrect answer or “I don’t know” was scored zero. A higher total score in this section indicated a higher level of knowledge.

The Attitude domain consisted of 20 items addressing professional attitudes toward falls, fall prevention and floor-recovery training. These questions were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Items 2, 4, 5, 6, 9,

12, 14, 16, 17, and 20 were inversely scored. A higher total score indicated a more positive attitude.

The Practice domain consisted of 16 items, assessing the frequency of physiotherapy activities aimed at fall prevention and floor-recovery training. Respondents provided their answers on a four-point Likert scale ranging from 1 (never) to 4 (always) where a higher total score indicated a higher frequency of evidence-based clinical practice.

To evaluate face validity, a pretest was conducted with a pilot sample of 25 physiotherapists (Perneger et al., 2015). Participants were required to complete the questionnaire and rate the clarity of each item. Additionally, they were required to measure and indicate the time needed to complete the questionnaire.

3.2.2. Phase II: Psychometric evaluation

After the development of the questionnaire, its psychometric properties were evaluated. This phase focused on examining construct validity, internal consistency and test-retest reliability to ensure that the instrument provides accurate and reliable measurement.

Construct Validity of the dichotomous responses (correct or incorrect) in the Knowledge domain was examined with a 2-Parameter Logistic Item Response Theory (2PL IRT) model, using the jMetrik 4.1.1 software.

During analysis, discrimination *(a)* and difficulty *(b)* parameters for each individual items were estimated and the item-fit test (S-X^2: Orlando-Thiessen S-Khi^2) was performed. The discrimination parameter indicates how effectively an item differentiates between respondents with high or low levels of knowledge while the difficulty parameter indicates the level of knowledge required to have a 50% probability of answering the item correctly.

For discrimination parameters, values between 0.30 and 2.5 were used as the threshold for inclusion as is widely supported in the psychometric literature (Alzaben et al., 2024; Baker, 2001) while difficulty parameters between the range of −3 and +3 were considered acceptable.

To examine the construct validity of the Attitude and Practice domains, Exploratory Factor Analysis (EFA) was performed using principal component analysis and varimax rotation.

The factorability of the data was determined based on the Kaiser-Meyer-Olkin (KMO) measure (>0.6) and the Bartlett's test result (<0.001). The number of factors was determined based on the eigenvalue (>1) and the scree plot. Items with factor loadings greater than 0.3 were considered significant for factor retention (Polit & Beck, 2016; Williams et al., 2010).

Internal Consistency was assessed by calculating the Kuder-Richardson-20 (KR-20) coefficient for the dichotomous responses of the Knowledge domain, while the Cronbach-alpha coefficient was used for the Likert scales of the Attitude and Practice domains. A KR-20 coefficient value of ≥0.50 indicates satisfactory internal consistency. While a Cronbach-alpha coefficient value between 0.6 and 0.7 is generally considered acceptable in exploratory questionnaire validation, values above 0.7 indicate good reliability (Bonett & Wright, 2015).

Reproducibility of the instrument was evaluated via test-retest reliability: 55 physiotherapists completed the questionnaire twice within ten days. For the binary data within the Knowledge domain, Kappa coefficients were calculated to measure agreement: values between 0.41-0.60 indicate moderate, values between 0.61-0.80 indicate substantial, and values above 0.80 indicate almost perfect agreement (Altman, 1990; Landis & Koch, 1977; McHugh, 2012; Sim & Wright, 2005).

For the continuous data of the Attitude and Practice domains, reliability was assessed using Intraclass Correlation Coefficients (ICC). ICC values between 0.50-0.75 are acceptable, values between 0.76-0.90 are good, and values above 0.90 indicate excellent reproducibility (Koo & Li, 2016).

Furthermore, Bland-Altman analysis was performed to visualize the agreement between the two measurements. The results were illustrated via scatterplots, where the x-axis represented the mean of the two measurements, and the y-axis represented the difference between the two measurements.

3.2.3. Participants

The participants for this study were recruited through non-random sampling. For the quantitative content validity (n=10) and the face validity pilot test (n=25) a convenience sample was used, recruiting respondents from the researchers' professional network, aiming to include physiotherapists from all education levels (BSc, MSc, PhD) and both occupational field (healthcare and social care) in the sample.

For evaluating the instrument's construct validity and internal consistency and assessing the test-retest reliability, a quota sampling technique was used. In the absence of available databases, recruitment quotas were established based on the professional experience of the researchers to mirror the supposed distribution of Hungarian physiotherapists, with the following proportions: 70-80% BSc, 20-25% MSc, 2-4% PhD, and 80% healthcare, 20% social care.

For the construct validity and internal consistency evaluation (n=209) the questionnaire was distributed through the Hungarian Association of Physiotherapists and professional social networking platforms (Facebook, Instagram, and LinkedIn).

For the assessment of test-retest reliability (n=55) the sample were recruited through the researchers' professional network.

Potential participants were contacted via email with a cover letter detailing the study's purpose and a link to the questionnaire. Informed consent was obtained digitally at the beginning of the survey. Inclusion criteria required participants to hold at least a BSc degree in physiotherapy and provide active consent. A total of 210 responses were received which is an 18% response rate considering the 1200-member registry of the Hungarian Association of Physiotherapists. Following data cleaning, 209 responses were deemed valid for final analysis.

3.2.4. Sample-size estimation

The sample size was determined in accordance with international validation procedures. For the EFA, a ratio of at least 10 participants per item is considered ideal (Boateng et al., 2018; Williams et al., 2010), however, there is no standard requirement for the sample

size required for 2PL IRT analysis. Literature suggests a range between 100 and 500 subjects. The sample examined in this study (n=209) provides a stable foundation for both the 2PL IRT parameter estimations and the EFA, ensuring the statistical reliability of the results.

3.2.5. Data analyses

Statistical analyses were performed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). To fit the 2PL IRT model, the jMetrik software (University of Virginia, Charlottesville, VA, USA) was used. Microsoft Excel was used for the calculation of the content validity indices.

Descriptive statistics were used to summarize the data: continuous data were presented as means and standard deviations, while categorical data were reported as absolute and relative frequencies. Results were considered statistically significant at a p-value below 0.05.

4. Results

This chapter presents the findings of the two research components of this thesis. The first section presents the results of the randomized controlled trial which evaluated the effects and acceptability of the Backward Chaining Method (BCM) in institutionalized older adults as an intervention for fall prevention and floor-recovery.

The second section details the outcome of the development and psychometric evaluation of the KAP-FALL-HU questionnaire, which was designed to assess the knowledge, attitude, and practice of Hungarian physiotherapists regarding fall prevention and floor-recovery training.

Together, these results provide a comprehensive evaluation of both the clinical intervention itself, and the current professional standpoint regarding that intervention.

4.1. Results of S1

Following the initial screening of the residents, 26 of them were randomly assigned to participate in the study in either the intervention group (IG, n=13) or the control group (CG, n=13). The selection process is illustrated on page 12 in the CONSORT flow-chart in subsection 3.1.1. Participants (Figure 2).

A total of 24 participants (92%) adhered to the study protocol. During the 7 weeks of the intervention, two participants experienced one fall each; however, since neither incident resulted in an injury, both individuals continued to participate in the program. No other adverse events were reported during the study period, suggesting the intervention was safe for this demographic.

4.1.1. Baseline characteristics

Statistical analysis confirmed that there were no significant differences between the IG and CG across any baseline parameters, ensuring the groups were well-matched for comparison. The demographic and clinical characteristics of the study participants, including age, Body Mass Index (BMI), cognitive status (measured by the MMSE), fall history and chronic diseases are summarized in Table 3.

Table 3: Demographic and clinical characteristics of study participants.

Participants' characteristics	IG (n=13)	CG (n=13)	p-value
Age (years), mean (SD)	82.7 (7.8)	87.7 (7.1)	0.110
BMI (kg/m2), mean (SD)	25.93 (4.3)	25.39 (3.8)	0.735
MMSE (points), mean (SD)	23.54 (5.7)	21.92 (6.4)	0.505
Barthel index (points), mean (SD)	94.62 (6.9)	91.15 (9.4)	0.295
Persons who fell in last year, n (%)	10 (76.9)	8 (61.5)	0.395
Chronic diseases			
Cardiological disease, n (%)	3 (23.1)	4 (30.8)	0.658
Pulmonological disease, n (%)	1 (7.7)	4 (30.8)	0.320
Diabetes mellitus, n (%)	2 (15.4)	1 (7.7)	0.539
Hypertension, n (%)	9 (69)	12 (93)	0.320
Lower limb arthritis, n (%)	2 (15.4)	2 (15.4)	1.000
Osteoporosis, n (%)	4 (30.8)	3 (23.1)	0.658
Persons with hearing aids, n (%)	3 (23.1)	5 (38.5)	0.671

IG: Intervention Group; CG: Control Group; SD: Standard Deviation; BMI: Body Mass Index; MMSE: Mini Mental State Examination

The use of assistive devices showed a balanced distribution between the groups, with the majority of the participants either ambulating independently, or using rollators. Table 4. details the assistive device usage among participants including the within-group percentages.

Table 4: Assistive device usage among participants.

	Rollator	Walking frame	Walking stick	No walking aid
IG	n = 5 (38.5%)	n = 2 (15.4%)	n = 0 (0%)	n = 6 (46%)
CG	n = 5 (38.5%)	n = 2 (15.4%)	n = 1 (7.7%)	n = 5 (38.5%)

IG: Intervention Group; CG: Control Group

4.1.2. Outcomes

The outcome measures at baseline and after the seven-week intervention period are presented in Table 5.

Table 5: Outcome measures at baseline and after the intervention period per groups

	IG		CG	
	at baseline	**after 7 weeks**	**at baseline**	**after 7 weeks**
TUG [a] (sec)	13 (10.8-30.8)	14.5 (10.8-28.1)	13 (10.8-30.8)	20.8 (16.4-30.1)
30CST [a] (number)	9 (4.5-10.5)	7 (2.75-10.5)	4.5 (0-9.25)	4 (0-7.5)
Grip-strength [b] (kg)	12.65 (5.7)	12.95 (5.5)	12.1 (3.6)	11.9 (3.6)
FES-I [b] (score)	12.92 (4.13)	10.69 (3.75)	13.38 (4.99)	14.92 (5.45)
NHLSD [b] (score)	30.54 (5.7)	32.77 (4.8)	29.15 (3.7)	24.77 (7.04)
I-NHLSD [b] (score)	58.23 (14.8)	61.62 (14.02)	56.08 (9.4)	47.46 (17.08)

IG: Intervention Group; CG: Control Group; TUG: Timed Up and Go; 30CST: 30-second Chair Stand Test; FES-I: Fall Efficacy Scale International; NHLSD: Nursing Home Life-Space Diameter; I-NHLSD: Independent Nursing Home Life-Space Diameter; [a] values are median (Q1-Q3); [b] values are mean (SD)

Functional mobility (TUG)

The TUG test results showed no significant difference between groups after the seven-week intervention period ($z = -1.410$, $p = 0.158$). There was no significant change in the TUG performance within the IG between baseline and post-intervention according to the Wilcoxon signed-rank tests ($z = -0.471$, $p = 0.638$). There was no significant difference in the TUG test results of the CG between baseline and post-intervention either ($z = -0.089$, $p = 0.929$).

Functional lower limb muscle strength (30CST)

The 30CST test results showed no significant difference between groups after the seven-week intervention period ($z = -1.291$, $p = 0.197$). There was no significant change in the 30CST performance within the IG between baseline and post-intervention according to the Wilcoxon signed-rank tests ($z = -1.472$, $p = 0.141$). There was no significant difference in the 30CST test results of the CG between baseline and post-intervention either ($z = -0.135$, $p = 0.893$).

Grip strength

The grip strength showed no significant difference between groups after the seven-week intervention period ($F(1, 23) = 0.265$, $p = 0.612$). There was no significant change in the grip strength performance of the IG between baseline and post-intervention ($t(12) = -0.239$, $p = 0.815$). There was no significant difference in grip strength performance of the CG between baseline and post-intervention either ($t(12) = 0.256$, $p = 0.802$).

Fear of falling (FES-I)

FES-I scores showed a significant difference between groups following the intervention period after adjusting for baseline values, $F(1, 23) = 13.16$, $p = 0.001$ with a large effect size ($\eta^2 = 0.364$). FES-I scores decreased significantly within the IG from baseline to post-intervention as indicated by paired t-tests ($t(12) = 3.371$, $p = 0.006$, Cohen's d=0.63 representing medium effect) while no significant change was observed in the CG ($t(12) = -1.822$, $p = 0.093$). FES-I score results are illustrated in Figure 5.

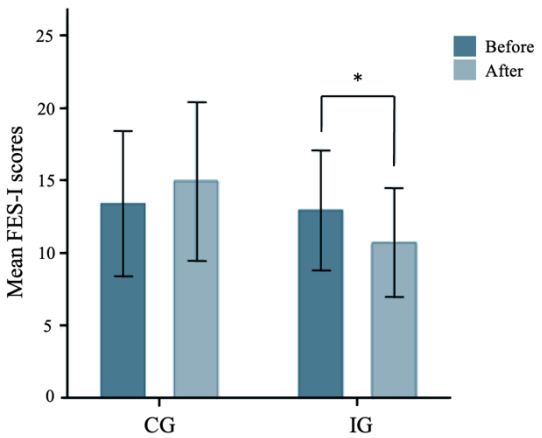

Figure 5: Post-intervention changes in FES-I scores. * p-value < 0.05

Life-space mobility (NHLSD)

NHLSD scores showed a significant difference between groups following the intervention period after adjusting for baseline values, ($F(1, 23) = 10.46$, $p = 0.004$), with a large effect size ($\eta^2 = 0.313$). NHLSD scores increased significantly within the IG from baseline to post-intervention as indicated by paired t-tests ($t(12) = -2.441$, $p = 0.031$, Cohen's d=0.44 representing medium effect) while no significant change was observed in the CG ($t(12) = 1.94$, $p = 0.076$). NHLSD score results are illustrated in Figure 6.

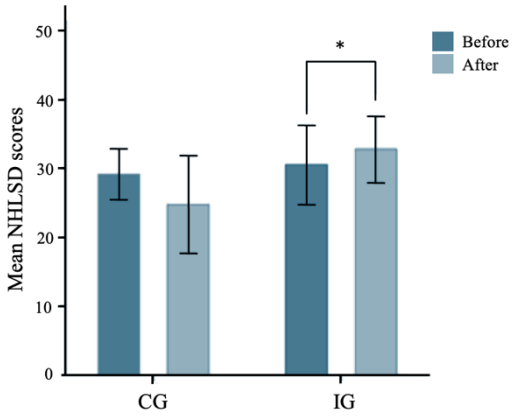

Figure 6: Post-intervention changes in NHLSD scores. * p-value < 0.05

Independent life-space mobility (I-NHLSD)

I-NHLSD scores showed a significant difference between groups following the intervention period after adjusting for baseline values, ($F(1, 23) = 6.975$, $p = 0.015$), with a large effect size ($\eta^2 = 0.233$). I-NHLSD scores increased significantly within the IG from baseline to post-intervention as indicated by paired t-tests ($t(12) = -2.757$, $p = 0.017$, Cohen's d=0.24 representing small effect), while no significant change was observed in the CG ($t(12) = -1.935$, $p = 0.077$). Results are illustrated in Figure 7.

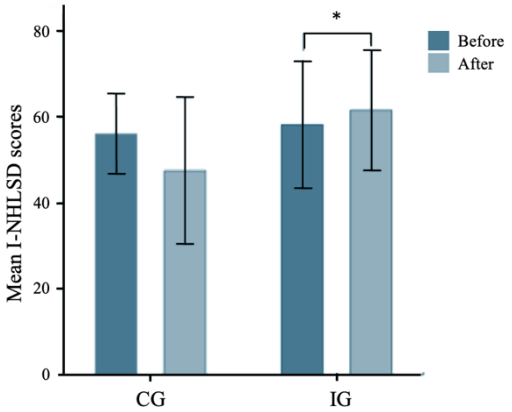

Figure 7: Post-intervention changes in I-NHLSD scores. * p-value < 0.05

4.2. Results of S2

The construction of the KAP-FALL-HU followed a systematic process where items were removed or refined as necessary. The process of the development phase and the resulting item numbers in each stage are summarized in Figure 8.

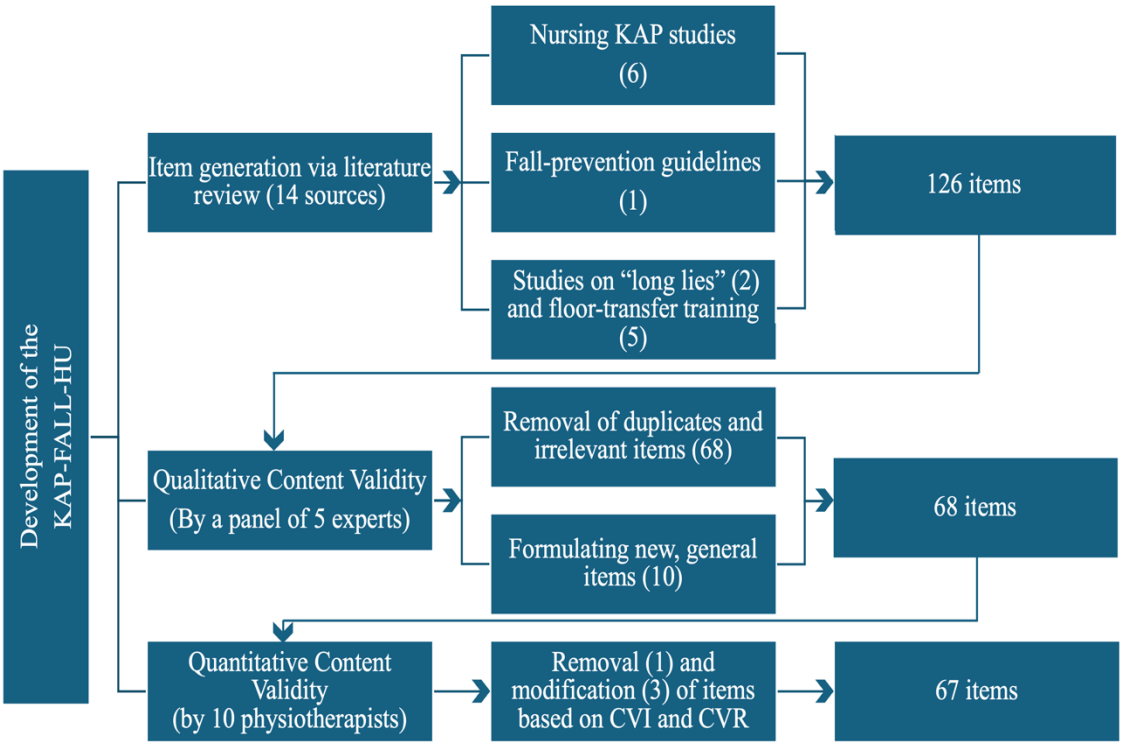

Figure 8: Construction of the KAP-FALL-HU

The initial item pool was generated through a literature review and consisted of 126 items. This was reduced to 58 and complemented with 10 general questions during the qualitative evaluation of content validity, thus creating the first 68-item version of the questionnaire by a panel of 5 experts.

During the first round of the quantitative evaluation of content validity by 10 independent physiotherapists, 1 item with an I-CVI value below 0.70 was excluded, and 3 items with I-CVI values between 0.70 and 0.79 were modified.

During the second round, the I-CVI value of each item and the S-CVI/Ave for the entire 67-item questionnaire were both 1.0, thus this became the final version. The items of the Knowledge-, Attitude-, and Practice domains are presented in Table 6.

Table 6: Items of the Knowledge, Attitude, and Practice domains

Item ID	Knowledge Items (Translated from Hungarian)
K1	The recurrence rate of falls is high among those who have already fallen.
K2	Falls in old age may increase the risk of mortality.
K3	Fear of the consequences of falls increases fall risk in old age.
K4	Falling back onto a sitting surface is not considered a fall.
K5	The more medication someone takes, the lower the risk of falling.
K6	Those who are afraid of not being able to get up from the ground are more afraid of falling.
K7	Only getting on the ground is considered as a fall.
K8	Older adults who are able to get up from the ground ambulate in a larger life-space (e.g., room, living space, outdoors, etc.).
K9	Stumbling against a furniture or a wall is considered a fall.
K10	Floor-transfer training is a necessary element of fall prevention.
K11	Different strategies exist for teaching how to rise from the floor.
K12	Older adults are more willing to practice/learn the movement sequence starting from a standing position than from lying on the floor.
K13	Falls in old age should be paid attention to, even if it they do not require hospital care.
K14	The more illnesses someone has, the higher the risk of falling.
K15	Declining physical strength makes it difficult or impossible to get up from a lying position.
K16	A fall can result in a prolong period of lying on the floor.
K17	It is expedient to assess and teach the technique of getting up from the floor for all older adults, regardless of previous falls.
K18	Performing a fall risk assessment helps identify patients/clients at risk of falling.
K19	A prolonged period of lying on the floor increases the risk of hypothermia, pneumonia, and pressure ulcers.
K20	Those who feel capable of getting up from the floor are less afraid of falling.
K21	Teaching how to get up from the floor requires a lot of equipment.
Item ID	**Attitude Items (Translated from Hungarian)**
A1	I am concerned about falls or the risk of falls in elderly patients/clients.
A2	I believe that falls among elderly patients/clients are inevitable. **(Inverse)**
A3	I believe that fall prevention has a high priority in physiotherapy.
A4	I have doubts regarding the effectiveness of fall prevention interventions used by physiotherapists. **(Inverse)**
Removed	I feel guilty if my patient/client falls.
A5	It has never occurred to me to teach my patient or client how to get up from the floor. **(Inverse)**
A6	I avoid teaching floor-transfer techniques because I believe my patient/client would be unable to stand up, or only with great difficulty. **(Inverse)**
A7	I believe that it is essential that my patient or client masters the skill to stand up from the floor.
A8	I am confident that I can effectively reduce the fall risk of my patients/clients.

A9	I believe most older adults no longer have the cognitive abilities to learn how to get up from the floor. **(Inverse)**
A10	Institutional fall prevention protocols contribute to increasing the safety of patients/clients.
A11	I believe that my patient or client would be afraid of getting down to the floor from where they would have to stand up.
A12	I avoid teaching floor-transfer techniques because if my patient/client could not stand up, I could not physically help them up from the floor. **(Inverse)**
A13	If I had more time available, I would put greater emphasis on teaching floor-transfer techniques.
A14	I believe that patients/clients have emergency call systems, so it is unnecessary to teach them how to get up from the floor. **(Inverse)**
A15	I believe the ability to stand up from the floor should be assessed in every older adult.
A16	I believe my patient/client would be reluctant to practice floor-transfer techniques. **(Inverse)**
A17	I consider teaching floor-transfer techniques mostly justified for those older adults who live at home or are expected to return there. **(Inverse)**
A18	In my opinion, there are older adults who are in adequate physical and cognitive condition to safely learn how to stand up from the floor.
A19	Professionals involved in care must work together with the patient/client and their caregiver to ensure the success of fall prevention.
A20	I believe that most older adults no longer have the physical abilities necessary for mastering floor-transfer techniques. **(Inverse)**
Item ID	**Practice Items (Translated from Hungarian)**
P1	I inform patients/clients and their caregivers about the risk factors of falls.
P2	I use fall risk assessment scales.
P3	I perform muscle-strengthening exercises with the patient/client.
P4	I perform balance-improving exercises with the patient/client.
P5	I perform range-of-motion improving exercises with the patient/client.
P6	I practice the movement sequence to stand up starting from a lying position.
P7	I practice the movement sequence to stand up starting from standing.
P8	I search for educational materials related to fall prevention in the professional literature or on the internet.
P9	I provide educational materials about movement techniques to the patient/client.
P10	I use functional fall risk assessments (e.g., TUG, 30CST, gait speed, SPPB).
P11	I assess the patient's/client's fear of falling.
P12	I ask if there has been a fall in the past year.
P13	I ask if there has been a time when the patient was unable to stand up independently after a fall.
P14	If necessary, I check and correct the use of walking aids.
P15	I ask about the ability to stand up from the floor or observe its execution.
P16	I perform the safe execution of functional movements (e.g., stair climbing, rising from a chair, using the toilet) with the patient/client.

TUG: Timed Up and Go; 30CST: 30-second Chair Stand Test; SPPB: Short Physical Performance Battery

4.2.1. Sample

The face validity pilot test was conducted on a sample of 25 participants. They reported that on average, 10 minutes were needed to complete the questionnaire (M=10.28±2.30 minutes). For the construct validity analysis, a total of 209 respondents were included, after the removal of one response from the original dataset of 210 due to unrealistic age data. The majority of the respondents were women. Most of them were employed within the healthcare sector, with an average of approximately 10 years of professional work experience. Nearly two-thirds of the sample held a BSc degree. The detailed demographic and professional characteristics of the samples are presented in Table 7.

Table 7: Sample characteristics

Characteristics	Face Validity Sample (n=25)	Construct Validity Sample (n=209)
Age (years), mean ± SD	33.3 ± 7.7	37.2 ± 10.6
Women, n (%)	23 (92)	190 (91)
Men, n (%)	2 (8)	19 (9)
Education level		
BSc, n (%)	17 (68)	151 (72)
MSc, n (%)	7 (28)	52 (25)
PhD, n (%)	1 (4)	6 (3)
Occupational field		
Healthcare, n (%)	20 (80)	176 (84)
Social care, n (%)	5 (20)	33 (16)
Work experience (years), mean ± SD	8.7 ± 7.5	10.1 ± 8.2

SD: Standard Deviation; BSc: Bachelor of Science; MSc: Master of Science; PhD: Doctor of Philosophy

4.2.2. Analysis of construct validity and internal consistency

The construct validity for the Knowledge domain was evaluated using 2 Parameter Logistic Item Response Theory (2PL IRT). Most discrimination (*a*) parameters fell between 0.5 and 2.6, with the lowest *a* value observed for item K5 (0.06), and the highest *a* values observed for items K4, K7 and K9 (in the range of 2.34–2.61). The difficulty (*b*)

parameters showed a wide range: several items showed extremely low *b* values, specifically items K5 and K15, with values of -31.68 and 14.40, while items K4 and K9 were closest to the center of the scale with *b* values of -0.48 and -0.47 respectively.

Based on the item-fit statistics, most items demonstrated an adequate fit. The S-X^2 tests demonstrated a significant difference for items K5, K7, and K11 ($p < 0.05$), while the fit proved to be adequate for all other items. The calculated *a* and *b* parameters and fit indices of all 21 items in the Knowledge domain are presented in detail in Table 8.

Table 8: 2PL IRT model of the Knowledge domain

Item	2PL IRT results		Item fit statistics		
	a par (SE)	b par (SE)	S-X^2	df	p-value
K1	0.59 (0.11)	-5.92 (0.78)	7.615	7.000	0.367
K2	0.52 (0.09)	-5.93 (0.70)	6.730	7.000	0.457
K3	0.57 (0.21)	-3.98 (1.33)	7.756	7.000	0.354
K4	2.61 (0.22)	-0.48 (0.08)	8.502	7.000	0.290
K5	0.06 (0.06)	-31.68 (34.28)	22.255	7.000	0.002
K6	0.62 (0.22)	-3.90 (1.25)	5.268	7.000	0.627
K7	2.34 (0.29)	-1.21 (0.11)	20.856	7.000	0.004
K8	0.95 (0.22)	-2.33 (0.45)	3.457	7.000	0.839
K9	2.60 (0.22)	-0.47 (0.08)	4.229	7.000	0.753
K10	0.66 (0.13)	-5.92 (0.80)	7.649	7.000	0.364
K11	1.68 (0.31)	-1.89 (0.22)	15.579	7.000	0.029
K12	1.58 (0.23)	-0.95 (0.14)	9.670	7.000	0.208
K13	1.36 (0.59)	-4.13 (1.31)	9.615	7.000	0.211
K14	0.55 (0.17)	-3.01 (0.90)	13.783	7.000	0.055
K15	0.33 (0.32)	-14.40 (14.04)	5.224	7.000	0.632
K16	1.02 (0.37)	-3.80 (1.08)	9.041	7.000	0.249
K17	1.17 (0.47)	-3.97 (1.19)	5.517	7.000	0.597
K18	0.83 (0.27)	-3.58 (0.98)	4.169	7.000	0.760
K19	0.62 (0.27)	-5.00 (1.96)	6.092	7.000	0.529
K20	0.67 (0.23)	-3.75 (1.14)	6.710	7.000	0.460
K21	0.93 (0.28)	-3.26 (0.79)	11.308	7.000	0.126

a par (SE): discrimination parameter (Standard Error); b par (SE): difficulty parameter (Standard Error); S-X^2: Orlando-Thiessen S-Khi2; df: degrees of freedom

Regarding internal consistency, the Kuder-Richardson-20 (KR-20) coefficient was 0.702, indicating a satisfactory level of internal consistency across the Knowledge domain

The construct validity of the Attitude domain was evaluated using Exploratory Factor Analysis (EFA). The results of the Kaiser-Meyer-Olkin (KMO) measure (0.804) and the Bartlett test (<0.001) indicated the factorability of the items. The factor loadings for all 20 items exceeded 0.3. Based on the eigenvalue and the scree plot, 3 factors were identified, as presented in Table 9. The 3 factors accounted for 47.2% of the total variance.

Table 9: EFA of the Attitude domain

Factor	Item Code	Factor Loading (λ)
Factor 1: Preventive responsibility and professional conviction	**A2**	0.580
	A3	0.468
	A4	0.524
	A10	0.717
	A13	0.452
	A15	0.612
	A17	0.512
	A19	0.358
Factor 2: Barriers to floor-recovery training	**A6**	0.696
	A9	0.648
	A11	-0.725
	A12	0.623
	A16	0.598
	A20	0.525
Factor 3: Preventive motivation and self- efficacy	**A1**	0.604
	A5	0.571
	A7	0.679
	A8	0.515
	A14	0.660
	A18	0.582

The overall internal consistency for the Attitude domain was good, with a Cronbach's alpha of 0.778. The internal consistency for each factor and the concept of the groupings is as follows:

- Factor 1: Preventive responsibility and professional conviction (Cronbach's alpha=0.715): items assessing the perceived importance of fall prevention, trust in protocols, and the functional preventive approach.
- Factor 2: Barriers to floor-recovery training (Cronbach's alpha=0.506): items related perceived barriers, such as patients' functional or cognitive limitations, fears, concerns regarding physical capacity.
- Factor 3: Preventive motivation and self-efficacy (Cronbach's alpha=0.753): items related to the perceived importance, effectiveness, and necessity of training, and trust in the clients' abilities.

The construct validity of the Practice domain was also evaluated using EFA. The results of the KMO measure (0.847) and the Bartlett test (<0.001) indicated the factorability of the items. The factor loadings for all 16 items exceeded 0.3. Based on the eigenvalue and the scree plot, 3 factors were identified, as presented in Table 10. The 3 factors accounted for 61.32% of the total variance.

Table 10: EFA of the Practice domain

Factor	Item Code	Factor Loading (λ)
Factor 1: Information gathering on fall risk	**P1**	0.565
	P7	0.467
	P11	0.781
	P12	0.788
	P13	0.817
	P15	0.727
Factor 2: Individualized activities based on personal needs	**P2**	0.638
	P6	-0.729
	P8	0.683
	P9	0.659
	P10	0.765
Factor 3: Functional preventive interventions	**P3**	0.829
	P4	0.734
	P5	0.765
	P14	0.594
	P16	0.650

The overall internal consistency for the Practice domain was good, with a Cronbach's alpha of 0.864. The internal consistency for each factor and the concept of the groupings is as follows:

- Factor 1: Information gathering on fall risks (Cronbach's alpha=0.818): items assessing the general interest, anamnesis-type questions, and observation.
- Factor 2: Individualized activities based on personal needs (Cronbach's alpha=0.612): items assessing the use of objective measuring tools that reveal personal needs and determine related educational activities.
- Factor 3: Functional preventive interventions (Cronbach's alpha=0.805): items related to the prescription of strengthening, balance, and functional exercises, and correcting the use of assistive devices.

4.2.3. Analysis of reproducibility

The reproducibility of the KAP-FALL-HU questionnaire was examined using test-retest analysis (n=55). For the Knowledge domain, Kappa Coefficients were calculated, while for the Attitude and Practice domains, Intraclass Correlation Coefficients (ICC) were used. An item is considered reliable with a value above 0.8. In case of this instrument, the values ranged between 0.869 and 1.000 for each item.

Reproducibility of the Attitude domain was further evaluated by Bland-Altman analysis. The average of the test-retest differences was negligible (M = 0.09 points), indicating the absence of systematic bias between the two measurements.

The standard deviation of the differences (SD = 1.04) remained low, with the 95% limits of agreement (LoA) ranging from -1.95 to +2.13 points. This demonstrates that for most respondents, the difference between the two measurements remained within ±2 points, representing strong agreement relative to the range of the Attitude scale.

The distribution of the differences remained uniform, confirming that the magnitude of the discrepancies was independent of the mean scores. Visual inspection of the point

cloud revealed no trends, indicating the lack of heteroscedasticity as represented in Figure 9.

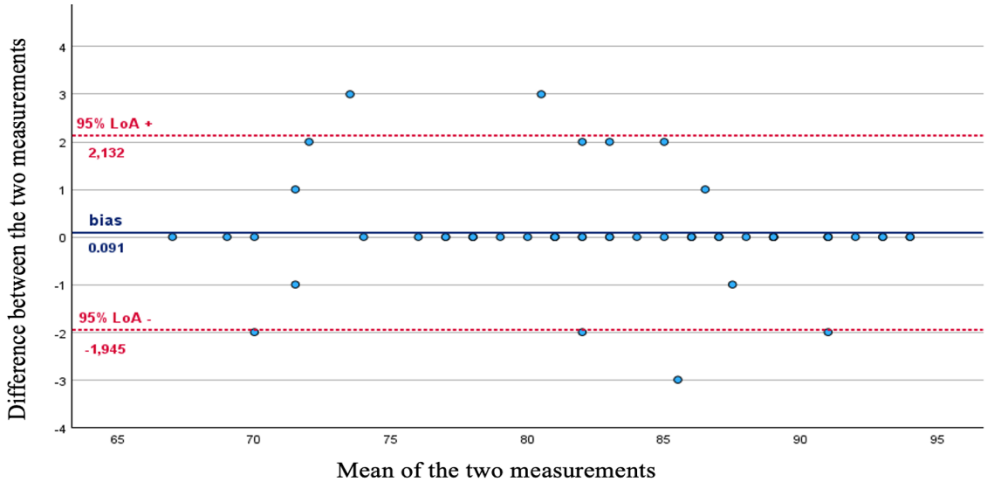

Figure 9: Bland-Altman Analysis of the Attitude domain

Reproducibility of the Practice domain was also evaluated by Bland–Altman analysis and showed a minimal mean difference between the test and retest (M = 0.09 points). The standard deviation of the differences (SD = 0.73) was low as well, and the 95% LoA ranged from −1.33 to +1.52 points. This demonstrates that for most respondents, the difference between the two measurements remained within ±1.5 points representing good measurement stability relative to the range of the Practice scale.

The distribution of the differences showed no trend relative to the mean scores therefore the reliability of the measurement can be considered uniform across the entire range of scores. Visual inspection of the point cloud revealed no trends, indicating the lack of heteroscedasticity as represented in Figure 10.

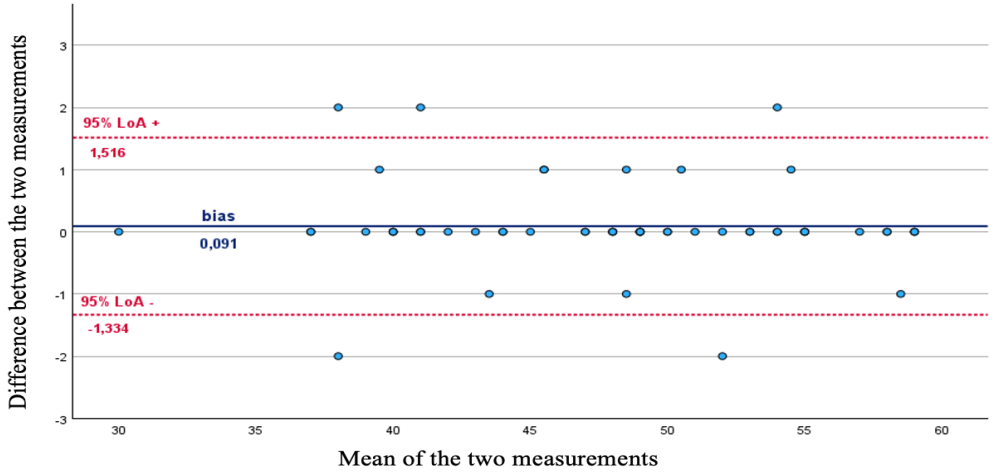

Figure 10: Bland-Altman Analysis of the Practice domain

5. Discussion

The primary aim of this thesis was to enhance the safety and independence of older adults by bridging the gap between recommendations regarding floor-recovery training and the actual clinical implementation of it. To achieve this, two separate, but interconnected studies were carried out:

- First, a randomized controlled trial was conducted to evaluate the clinical effects and acceptability of a floor-recovery training technique, the Backward Chaining Method among institutionalized older adults (S1).
- Second, a professional questionnaire, the KAP-FALL-HU was developed, to assess the knowledge, attitude and practice of physiotherapists in order to investigate the obstacles preventing the clinical adaptation of floor-transfer training in geriatric practice (S2).

The following section will discuss the findings of these two studies in detail, in context of the international literature.

5.1. Discussion of S1

The aim of S1 was to examine the impact of a seven-week floor-transfer training program based on the Backward Chaining Method (BCM) on functional mobility, muscle strength, fear of falling, and life-space mobility among long-term care residents as well as the acceptability of the intervention in this population using a randomized, controlled, assessor-blinded design.

5.1.1. Acceptability

The data suggests, that BCM is an acceptable and effective intervention within the long-term care population: out of the 12 participants who completed the study in the IG, 11 successfully mastered the skill of standing up from the floor, 10 of them entirely without help. Even those, who did not fully learn to stand up independently, experienced a sense of success with every step they managed to achieve. This feeling of accomplishment likely contributed to the high adherence as well:

the IG demonstrated a mean attendance rate of 94%, with four participants attending all 20 training sessions, one participant missing 3 sessions, while the remaining participants missing 1 or 2 sessions only.

5.1.2. Effect of BCM on physical performance

Regrading physical performance, no significant between-group differences were found in functional mobility measured by the TUG test or lower limb strength measured by the 30CST. This finding aligns with the observation published in Leonhardt's review, that while traditional floor-recovery training focuses on improving strength with resistance training, it often fails to improve the physical skill of rising from the floor. In contrast to that, the BCM serves as a therapeutic exercise that may enhance lower-limb strength, but its main value appears to be the practice and improvement of the specific movement sequence rather than a significant increase in muscle strength (Leonhardt et al., 2020).

The lack of significant improvement in functional mobility observed in S1 stands in contrast to the results of Zak et al. who implemented a 12-week rehabilitation program incorporating BCM three times per week among community-dwelling older adults over 80 years of age. Their study found a significant improvement in TUG time, compared to a control group, that received a less intensive regimen and learned floor transfer using the conventional method. These contrasting results suggest that functional mobility outcomes are likely influenced not only by the duration and frequency of training, but also by the specific floor-transfer strategy chosen and the baseline functional status of the population (Zak, 2006).

5.1.3. Effect of BCM on fear of falling and life-space mobility

Results of S1 present a psychological and behavioral shift following the intervention:

- Participants in the IG demonstrated significantly lower fear of falling scores measured by the FES-I compared to the CG who received only usual care.
- The IG also showed significantly higher life space mobility and independent life-space mobility scores measured by the NHLSD and I-NHLSD compared to those in the CG.

These results support the initial theory behind S1: by increasing a resident's confidence in their ability to rise independently after a fall, they became less inclined to restrict their physical activity. The reduction in fear of falling likely acted as a catalyst for expanded life-space mobility. This is a critical clinical outcome, as maintaining life-space mobility is essential for preserving physical function and reducing the risks of disability and premature death in long-term care settings.

The FES-I score, that measures fear of falling is an established predictor of falls (Prieto-Contreras et al., 2023). Consequently, interventions that succeed in reducing FES-I scores may offer benefits for fall prevention, self-efficacy and overall physical function. A number of research already explored several different methods to reduce fear of falling (Arkkukangas et al., 2024; Gerards et al., 2023; Gusi et al., 2012; Wei et al., 2023).

The findings of S1 are in alignment with those of Gusi et al., who conducted a 12-week balance training program in an institutionalized older adult population with fear of falling. Despite differences in the specific nature of the intervention, the similarity in the study population, outcome measures and the overall training load allows for meaningful comparison: both studies demonstrate that a structured exercise program can significantly improve fear of falling among long-term care residents (Gusi et al., 2012).

The measurement of life-space mobility is considerably more variable in the literature than the measurement of fear of falling. As noted in a recent systematic scoping review by Seinsche et al., studies in this field vary widely in their choice of outcome measures, populations and intervention methods. While several research uses the Life-Space Assessment (LSA), others rely on the Life-Space Questionnaire, GPS or accelerometer-based measurements, or, as S1, the NHLSD (Seinsche et al., 2023).

The positive findings in S1 regarding life-space mobility differ from those of Tanaka et al., who reported no significant improvement in NHLSD scores following an 8-week physical and cognitive group intervention for long-term care residents with dementia. Although the duration of the interventions was similar, their frequency of 2 sessions per week resulted in lower total training load, which may be one possible reason (others being the difference in intervention or the dementia of the study population) behind the lack of significant improvement in NHLSD, in contrast to the results of S1 (Tanaka et al., 2021).

On the other hand, the S1 results are supported by Todo et al., who conducted a 3-month, multicomponent, home-based rehabilitation program for older adults with restricted life-space mobility. Despite differences in study population and the use of the LSA instead of the NHLSD, their findings align with the conclusion of S1, that structured exercise can effectively expand life-space mobility in older adults (Todo et al., 2021).

5.1.4. Barriers for clinical implementation

Based on the available information at the time of writing this thesis, S1 was the first study to examine the effectiveness of BCM on functional mobility, fear of falling, life-space mobility, grip strength and lower limb strength specifically within an institutionalized population. Although a recent world guideline incorporates teaching floor-transfer techniques into fall prevention training programs (Montero-Odasso et al., 2022), these methods are still rarely integrated into the daily practice of long-term care facilities (Vandervelde et al., 2024).

This lack of integration may originate from a lack of up-to-date professional knowledge, but also from systemic factors such as variations in facility structures, heavy workload pressure, and differences in standard treatment protocols. Evidence suggests that while physiotherapists largely agree on their role in fall prevention, strength- and mobility training, pain management and transfer education within nursing homes, there is often no consensus regarding which specific interventions are most effective for addressing these areas (Sterke et al., 2025).

Furthermore, physiotherapy interventions are frequently evaluated using outcome measures that may be irrelevant in a long-term care setting. This misalignment can hinder the adaptation of new protocols by facility management and healthcare professionals. (Sterke et al., 2021).

By measuring the NHLSD score and train older adults using the BCM directly within a long-term care setting, S1 provides a model tailored to the realities of geriatric care. The findings suggest that BCM serves as a practical and effective addition to usual care, as it demonstrates the potential to improve life-space mobility and reduce fear of falling in institutionalized older adults.

5.1.5. Limitations

S1 has several limitations that may account for the lack of statistically significant improvements in functional mobility and muscle strength. First, the small sample size, consisting exclusively of female participants, limits the generalizability of the findings to the broader elderly population.

Second, the 7-week intervention period may have been too short to stimulate measurable changes in physical outcome measures. While some previous studies on the BCM examined even shorter training periods (Adams & Tyson, 2000; Hofmeyer et al., 2002), the most effective interventions in the literature usually last 12 weeks or longer (Gusi et al., 2012; Todo et al., 2021; Zak, 2006).

Finally, the absence of qualitative data also represents a missed opportunity. A systemic approach, such as semi-structured interviews, would have provided a deeper insight into the participants' subjective experiences and perceptions of the training. While the lack of systematic qualitative data collection is a noted limitation, informal feedback gathered throughout the study provides valuable insight into the participants' and staff members' experiences.

Initially, several participants expressed apprehension toward the program, with some doubting their ability to master floor transitions. However, as the program progressed, participants reported increased self-confidence and expressed pride as they learned the various steps of the BCM sequences. Anecdotal evidence of the program's practical effect on their daily life included reports of actual falls, after which participants, using the practiced technique, were able to stand up independently. Furthermore, staff members, who were initially skeptical of the intervention's feasibility, seeing the progress of the participants, expressed interest in learning the instruction of the BCM steps, so they would be able to provide verbal assistance for residents in case of a fall in the future.

These subjective observations suggest that future research incorporating quantitative measures on mental health, such as assessments of depression or self-efficacy, could provide a more comprehensive understanding of the broader psychological and physiological impact of floor recovery training via the BCM.

5.2. Discussion of S2

This study presented the development and validation of the KAP-FALL-HU questionnaire, a tool designed to evaluate the knowledge, attitude and everyday practice of physiotherapists regarding fall prevention. The KAP model provides a comprehensive framework often used to explore the health behaviours of laymen or professional care standards in expert audiences. While various KAP-based instruments exist for different medical conditions or interventions, extensive literature research indicates that a physiotherapy-specific questionnaire focusing on fall prevention in the elderly population had not been previously developed in either domestic or international context.

5.2.1. Item generation and content validity

The questionnaire was developed and refined based on international guidelines, studies conducted on fall prevention and the practical realities of geriatric physiotherapy. After item generation from the literature, the initial 126 items were narrowed down to 68 during the qualitative stage of content validity, by a panel of 5 experts. During the quantitative stage of content validity, 10 physiotherapists evaluated the items, and as a result one item was removed from the Attitude domain because its content validity indicators did not reach the minimal required value (CVR=0.8 and I-CVI=0.7). In addition, three items were rephrased because their I-CVI values were between 0.7 and 0.79. However, in the second round of this stage, the content validity indicators reached the expected value (CVR=1.0; I-CVI=1.0), thus creating the final, 67-item version, with 10 general items, and 21, 20 and 16 items in the Knowledge, Attitude and Practice domains respectively.

5.2.2. Face validity

Examining face validity is a critical stage in the validation process, particularly for instruments developed for specialized populations, as it is vital that the target group correctly interprets the items (Holden, 2010). The data obtained during this phase indicated that all items of the KAP-FALL-HU were well understood by the participating physiotherapists confirming the instrument's linguistic and conceptual clarity for the intended audience. By establishing this initial level of comprehension, the questionnaire provided a reliable foundation for the subsequent, more complex psychometric analyses.

5.2.3. Construct validity

Construct Validity of the Knowledge domain was examined with a 2-Parameter Logistic Item Response Theory (2PL IRT) model, while in case of the Attitude and Practice domains, Exploratory Factor Analysis (EFA) was performed.

The 2PL IRT remains dominant in modern psychometric practice, as confirmed by a recent review (Yiğiter & Boduroğlu, 2024). It allows the exploration of measurement properties by examining the discrimination (*a*) and difficulty (*b*) parameters of the questionnaire items (Birnbaum, 1968; Embretson, 2000; Münnich. 2021).

Based on the item-fit indicators, most items demonstrated an adequate fit to the model. While the S-X^2 statistic revealed significant differences in a limited number of items (K5, K7, and K11), such phenomena are common in international research when items have highly relevant content but prove too easy for the respondents (Goni et al., 2020). These items were not automatically excluded but were assessed from a content-based perspective as is the practice in the literature (Ngah et al., 2022).

The analysis of *a* and *b* parameters revealed three clearly distinguishable content groups, (clusters) each fulfilling a specific role in terms of construct validity.

The first cluster included items with very low difficulty (K1, K2, K5, K10, K15). These items had moderate *a* values and their *b* values were in the lower range of the scale, between -5.92 and -31.68. The particularly extreme parameters of K5 and K15 suggest that factors other than pure knowledge, may also influence response patterns (Hambleton et al., 1991). This phenomenon may be contributed to the professional background of the respondents (most of them working in elderly care, hence are more knowledgeable and experienced in the topic of fall prevention) and is also consistent with the experiences of domestic IRT-based studies (Molnár, 2005; Rajki et al., 2015). While these items are less effective at exploring high-level latent ability, they were retained to identify which fall prevention concepts are self-evident among Hungarian physiotherapists thus can serve as a baseline for future professional training materials.

The second cluster included medium-difficulty items (K3, K6, K13, K14, K16, K17, K18, K19, K20, K21) which had moderate *a* values and their *b* values ranged between −3.01

and −5. The item fit was adequate in all cases. These items stably followed the response pattern assumed by the 2PL IRT model and formed the evaluative core of the questionnaire (Hambleton et al., 1991; Molnár, 2005; Rajki et al., 2015).

The third cluster included items of greater difficulty (K4, K7, K8, K9, K11, K12), with high *a* values and with *b* values close to the upper range of the scale (below -3) indicating the measurement potential for superior levels of knowledge (Yen, 1981). Although the fit indices of items K7 and K11 showed a deviation from the response pattern assumed by the model, their high discrimination values justify their retention as critical clinical indicators. Items K4, K7 and K9 in particular, proved to be both difficult and highly discriminating, thus highlighting the main focus for future professional training material.

The construct validity of the Knowledge domain indicates that the KAP-FALL-HU is primarily informative at an intermediate knowledge level. While several items reflecting basic knowledge are useful for baseline assessment, future development of the instrument should consider the inclusion of more challenging items and the fine-tuning of those showing deviations from the model (K5, K7, and K11). This refinement would further enhance the tool's ability to distinguish between levels of expertise in specialized geriatric care.

5.2.4. Internal consistency

The internal consistency of the Knowledge domain was measured using Kuder-Richardson-20 (KR-20) coefficient while for the Attitude and Practice domains, Cronbach's alpha was used.

The internal consistency of all three domains was good:

- The KR-20 is acceptable above 0.5 and the KR-20 of the Knowledge domain was 0.702, indicating a good internal consistency.
- The Cronbach's alpha values are considered acceptable above 0.6 and good above 0.7. The entirety of the Attitude domain showed a Cronbach's alpha of 0.778 indicating good internal consistency, however the value of the second factor was 0.506. Despite not reaching the acceptable value, the items in this factor were retained, because the overall robustness of the model is of greater significance

than the performance of isolated items and the clinical relevance of the content was also considered to ensure that the questionnaire remained comprehensive.

- The entirety of the Practice domain showed a Cronbach's alpha of 0.864 indicating good internal consistency, with the second factor showing the lowest value of 0.612 which shows acceptable internal consistency of the factor, while the values of the first and third factor were both above 0.8 indicating strong internal consistency.

5.2.5. Reproducibility

The reproducibility of the questionnaire was established through test-retest analysis using the Kappa coefficients and the Intraclass Correlation Coefficients (ICC), both indicating excellent reliability. The reproducibility was further confirmed by Bland–Altman diagrams: most of the values were within the confidence interval limits and the zero-difference line also fell into the 95% confidence interval (Koo & Li, 2016) indicating high consistency in the instrument's performance over time.

These findings collectively demonstrate that the questionnaire is a stable and dependable tool for assessing the professional readiness of physiotherapists in the context of fall prevention.

5.2.6. Limitations

A notable limitation of S2 was the relatively low response rate, which is a common challenge in online survey-based research. Although the study reached an adequate sample size to ensure the validity and reliability of the questionnaire, to analyse complex interdependencies and directional influence between the Knowledge, Attitude, and Practice domains, the application of Structural Equation Modelling is planned in the future, which requires more data.

The sampling technique may also have caused a degree of bias, as the sample was more likely to include professionals with a pre-existing interest or active involvement in geriatric fall prevention.

Furthermore, due to the lack of a comprehensive national database for comparison, the distribution of the sample in terms of education level and occupational field may not represent the actual proportions within the entire Hungarian physiotherapist profession.

5.2.7. Clinical use

The validated KAP-FALL-HU questionnaire presented in S2 provides a reliable mean to determine the specific needs and professional gaps related to fall prevention in the elderly. These findings can serve as a foundation for planning targeted educational measures (aimed not only to improve knowledge, but to shape attitude and enhance daily practice) and clinical interventions, consequently, the questionnaire is designed to be more than just a static assessment: it is intended to function as a dynamic tracking tool, capable of monitoring professional change in a pre- and post-training format and can be utilized to assess the implementation of clinical protocols and guidelines.

This dynamic nature of the tool might require the refinement of items or the addition of new items. These future developments would benefit from an interdisciplinary approach, incorporating expertise from the fields of pedagogy and psychology to better harmonize the training materials with the target professional audience.

While the current version was developed and validated specifically for physiotherapists, it holds potential for further adaptation. In the future, this instrument could be modified for use by other members of the multidisciplinary team, including geriatric nurses, physicians, rehabilitation specialists, and occupational therapists, all of whom play vital roles in fall prevention.

6. Conclusions

This doctoral research addressed the gap between the evidence and recommendations regarding floor-recovery training and its implementation in geriatric care. S1 examined the effectiveness of a training program aimed to teach older adults to stand up from the floor, while S2 aimed to develop a validated professional assessment tool to examine why physiotherapists are not (if so) teaching this skill for their elderly patients.

6.1. Conclusions of S1

S1 demonstrated that the Backward Chaining Method (BCM) is a feasible, well-tolerated intervention in a long-term care setting, evidenced by high adherence and positive participant feedback. The data suggest that incorporating BCM into standard physiotherapy interventions may offer meaningful benefits, particularly in reducing fear of falling and expanding both life-space and independent life-space mobility among institutionalized older adults. Future research should explore longer intervention periods, larger and more diverse samples, while also incorporating additional measures regarding mental health, to address both psychological and physical contributors to fall risk.

6.2. Conclusions of S2

S2 presented the development and validation of the KAP-FALL-HU, a measurement tool specifically designed to assess the knowledge, attitude and everyday practice of Hungarian physiotherapists regarding fall prevention and floor-recovery training.

The instrument demonstrated valid and reliable psychometric indicators, confirming its utility for identifying professional barriers between clinical evidence and daily practice in geriatric care, thus contributing to professional development.

Consequently, the KAP-FALL-HU facilitates the translation of research into daily practice, enabling that evidence-based fall prevention and floor-recovery training becomes a standard component of patient care.

7. Summary

The aging of the global population leads to a high incidence of fall-related injuries and a subsequent decline in functional mobility among older adults. One critical yet often neglected possible consequence of a fall is the so-called long lie, when an older adult remains on the floor after a fall due to the inability to stand up independently. This incident is associated with severe medical complications, a heightened fear of falling and a restriction in life-space diameter which ultimately leads to diminished functional capacity and increased mortality. This thesis investigated a possible solution to this problem by combining a clinical intervention trial and the development of a professional assessment tool.

The first study evaluated the effectiveness and acceptability of the Backward Chaining Method (BCM), a structured approach to teaching floor-recovery, starting from the safe and familiar standing position and progressing systematically toward the floor. Results indicated that the intervention significantly reduced the fear of falling and increased life-space mobility, thereby enhancing the residents' confidence and activity levels.

The second study addressed the implementation gap, by developing and validating the KAP-FALL-HU questionnaire. Using the Knowledge, Attitude, and Practice (KAP) model the study established a reliable tool for the assessment of professional readiness related to fall prevention and floor-recovery training in a sample of Hungarian physiotherapists. The psychometric analysis confirmed that the questionnaire effectively identifies knowledge levels and professional attitudes, providing a baseline for targeted educational interventions.

Together, these studies aim to address the challenge of falls and long lies. While they provide important and complementary findings, further research is required to demonstrate their direct impact on clinical implementation. The current results are promising in establishing the clinical efficacy of the BCM as a solution for the long lie and providing a validated tool to measure the barriers for professional implementation. As a result, this thesis supports the integration of floor-recovery training into standard geriatric care, ultimately promoting safer and more independent aging.

8. References

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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. http://doi.org/10.1556/650.2025.33414

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10. Appendix

KAP-FALL-HU

Tisztelt Kolléga!

Az alábbi kérdőív kitöltésére invitáljuk, melynek célja, hogy felmérjük a magyar gyógytornászok **esésmegelőzéssel és a földről való felállás tanításával** kapcsolatos tudását, attitűdjét és mindennapi gyakorlatát.

Célunk, hogy feltérképezzük a **szakmában alkalmazott módszereket,** valamint, hogy azonosítsuk azokat a területeket, ahol a jövőben továbbképzési igény merülhet fel.

A részvétel önkéntes és anonim. A kitöltés várhatóan 15 percet vesz majd igénybe. Amennyiben bármilyen kérdése vagy észrevétele merülne fel, kérjük, forduljon hozzánk bizalommal a kérdőív végén feltüntetett elérhetőségen.

Köszönjük együttműködését és idejét!

* Kötelező kérdés

Szociodemográfiai adatok

*1. Neme
☐Nő
☐Férfi

*2. Melyik évben született? _____

*3. Mi az Ön legmagasabb iskolai végzettsége?
☐Főiskolai végzettség (BSc)
☐Egyetemi végzettség (MSc)
☐Doktori végzettség

*4. Milyen jellegű településen dolgozik?
☐Főváros
☐Megyeszékhely
☐Város
☐Község

*5.Melyik ellátói rendszerben dolgozik, ahol közvetlen kapcsolata van 65 év feletti idős betegekkel/kliensekkel?
☐Egészségügyi ellátórendszer - *Ugrás a(z) 6. kérdésre*
☐Szociális ellátórendszer - *Ugrás a(z) 8. kérdésre*

Egészségügyi dolgozókra vonatkozó kérdések

*6. Az ellátási rendszer melyik szintjén dolgozik? (Függetlenül attól, hogy állami vagy magánfinanszírozásban dolgozik. Többet is megjelölhet!)

- ☐ Járóbeteg szakellátás
- ☐ Fekvőbeteg szakellátás
- ☐ Házi betegellátás

*7. Milyen típusú területen (osztályon) dolgozik? (Többet is megjelölhet!)

- ☐ Ápolási osztály/otthon
- ☐ Belgyógyászat
- ☐ Családi és háziorvosi ellátás
- ☐ Geriátria
- ☐ Krónikus belgyógyászati ellátás
- ☐ Neurológia
- ☐ Sebészet
- ☐ Intenzív osztály
- ☐ Mozgásszervi osztály
- ☐ Onkológia
- ☐ Egyéb: _____

Ugrás a(z) 9. kérdésre

Szociális területen dolgozókra vonatkozó kérdés

*8. Milyen típusú területen dolgozik? (Többet is megjelölhet!)

- ☐ Idősek klubja
- ☐ Idősek otthona
- ☐ Szociális rehabilitációs központ
- ☐ Egyéb:

Munkatapasztalat

*9. Nagyjából hány éve dolgozik ezen a szakmaterületen? _____

*10. Azon a területen, ahol dolgozik, Ön a mindennapi munkája során találkozik-e olyan időssel, akinél fennállhat az elesés rizikója?

- ☐ Igen
- ☐ Nem

*11. Hozzávetőlegesen milyen gyakran fordul elő a páciensei körében elesés?

- ☐ Nem fordul elő
- ☐ Évente
- ☐ Félévente
- ☐ Negyedévente (2-3 havonta)
- ☐ Havonta
- ☐ Hetente
- ☐ Napi rendszerességű

Ismereteket felmérő szakasz

A következőkben **21 állítást** fog látni. Kérjük döntse el, hogy az állításokat legjobb tudása szerint **igaznak vagy hamisnak véli.** Erre a későbbi továbbképzési anyag fejlesztése érdekében van szükségünk.

***1. állítás: Az esés ismétlődési aránya magas azok körében, akik már elestek.**
□Igaz
□Hamis
□Nem tudom

***2. állítás: Az időskori esések növelhetik a halálozás kockázatát.**
□Igaz
□Hamis
□Nem tudom

***3. állítás: Az időskori elesések következményeitől való félelem fokozza az esésrizikót.**
□Igaz
□Hamis
□Nem tudom

***4. állítás: Az ülőfelületre történő visszahuppanás nem minősül elesésnek.**
□Igaz
□Hamis
□Nem tudom

***5. állítás: Minél több gyógyszert szed valaki, annál kisebb az elesés kockázata.**
□Igaz
□Hamis
□Nem tudom

***6. állítás: Aki attól fél, hogy nem tud felállni a földről az jobban fél az eleséstől.**
□Igaz
□Hamis
□Nem tudom

***7. állítás: Csak a földre kerülés számít elesésnek.**
□Igaz
□Hamis
□Nem tudom

***8. állítás: Az az idős ember, aki képes felállni a földről, nagyobb életteret (pl. szoba, lakótér, kültér stb...) jár be.**

□Igaz
□Hamis
□Nem tudom

***9. állítás: A bútornak/falnak nekitántorodás elesésnek minősül.**

□Igaz
□Hamis
□Nem tudom

***10. állítás: A földről felállás tanítása az eséprevenció szükséges eleme.**

□Igaz
□Hamis
□Nem tudom

***11. állítás: Különböző stratégiák léteznek a földről felállás mozdulatsorának tanítására.**

□Igaz
□Hamis
□Nem tudom

***12. állítás: A mozdulatsor gyakorlására/tanulására hajlandóbbak az idősek állásból indulva, mint földön fekvésből.**

□Igaz
□Hamis
□Nem tudom

***13. állítás: Az időskori elesésre akkor is figyelmet kell fordítani, ha egyébként nem igényel kórházi ellátást.**

□Igaz
□Hamis
□Nem tudom

***14. állítás: Minél több betegsége van valakinek, annál nagyobb az elesés kockázata.**

□Igaz
□Hamis
□Nem tudom

***15. állítás: A fizikai erő hanyatlása nehezíti vagy akadályozza a fekvő helyzetből való felállást.**

□Igaz
□Hamis
□Nem tudom

*16. állítás: Az elesés következménye lehet a tartós, egy óránál hosszabb földön fekvés.
□Igaz
□Hamis
□Nem tudom

*17. állítás: Minden idős személy esetében célszerű felmérni és tanítani a földről való felállás technikáját, függetlenül korábbi esésektől.
□Igaz
□Hamis
□Nem tudom

*18. állítás: Az eséskockázat-felmérés elvégzése segít az esés szempontjából veszélyeztetett betegek/kliensek azonosításában.
□Igaz
□Hamis
□Nem tudom

*19. állítás: A tartós, egy óránál hosszabb földön fekvés növeli a kihűlés, tüdőgyulladás és felfekvés kockázatát.
□Igaz
□Hamis
□Nem tudom

*20. állítás: Aki képesnek érzi magát arra, hogy felálljon a földről, az kevésbé fél az eleséstől.
□Igaz
□Hamis
□Nem tudom

*21. állítás: A földről felállás tanításának magas az eszközigénye.
□Igaz
□Hamis
□Nem tudom

Személyes véleményt felmérő szakasz

A következőkben **20 állítást** fog látni. Kérjük, döntse el, **mennyire állnak közel az egyes állítások az Ön véleményéhez.**

*1. állítás: Foglalkoztat az idős betegek/kliensek elesése, vagy annak veszélye.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*2. állítás: Úgy gondolom, hogy az idős beteg/kliensek elesése elkerülhetetlen.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*3. állítás: Úgy gondolom, hogy az elesés megelőzése magas prioritású a gyógytornában.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*4. állítás: Kétségeim vannak a gyógytornászok által alkalmazott esésmegelőző beavatkozások hatékonyságát illetően.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*5. állítás: Még soha nem jutott eszembe, hogy megtanítsam a betegemet/kliensemet arra, hogyan álljon fel a földről.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*6. állítás: Azért mellőzöm a földről való felállás tanítását, mert úgy vélem, hogy a betegem/kliensem egyáltalán nem tudna, vagy csak nagy nehézségek árán tudna felállni.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*7. állítás: Lényegesnek tartom, hogy a betegem/kliensem elsajátítsa a földről való felállás képességét.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*8. állítás: Bízom abban, hogy hatékonyan tudom csökkenteni betegeim/klienseim esésrizikóját.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*9. állítás: Úgy gondolom, hogy az idős emberek többsége már nem rendelkezik olyan kognitív képességekkel, amely alkalmassá teszi a földről való felállás elsajátítására.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*10. állítás: Az intézményi esésmegelőzési protokollok hozzájárulnak a betegek/kliensek biztonságának növeléséhez.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*11. állítás: Úgy gondolom, hogy a betegem/kliensem félne attól, hogy lekerüljön a talajra, ahonnan fel kellene állnia.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*12. állítás: Azért kerülöm a földről felállás tanítását, mert ha a betegem/kliensem mégsem tudna felállni, fizikailag magam sem bírnám őt a talajról felállítani.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*13. állítás: Ha több idő állna rendelkezésemre, nagyobb hangsúlyt fektetnék a földről való felállás tanítására.

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***14. állítás: Úgy gondolom, hogy a betegek/kliensek rendelkeznek segélyhívóval, ezért felesleges megtanítani őket arra, hogyan álljanak fel a földről.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***15. állítás: Úgy gondolom, minden idős személy esetében fel kellene mérni a földről való felállás képességét.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***16. állítás: Úgy vélem, hogy a betegem/kliensem nem mutatna hajlandóságot a földről való felállás gyakorlására.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***17. állítás: A földről való felállás tanítását elsősorban azoknál az időseknél tartom indokoltnak, akik otthonukban élnek, vagy várhatóan oda térnek vissza.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***18. állítás: Véleményem szerint vannak olyan idősek, akik megfelelő fizikai és kognitív állapotban vannak ahhoz, hogy biztonságosan megtanulják a földről való felállást.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

***19. állítás: Az ellátásban részt vevő szakembereknek együtt kell működniük a beteggel/klienssel és gondozójával az esésmegelőzés sikeressége érdekében.**

□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

*20. állítás: Úgy gondolom, az idős emberek többsége már nem rendelkezik olyan fizikális képességekkel, amely alkalmassá teszi a földről való felállás elsajátítására.
□Egyáltalán nem értek egyet
□Nem értek egyet
□Egyet is értek és nem is
□Egyetértek
□Teljes mértékben egyetértek

Gyakorlatot felmérő szakasz

A következőkben **16 állítást** fog látni. Kérjük, jelölje be azt a gyakoriságot, amely **legközelebb áll az Ön napi gyakorlatához**.

*1. állítás: Tájékoztatom a betegeket/klienseket és gondozóikat az esés rizikófaktorairól.
□Soha
□Ritkán
□Általában
□Mindig

*2. állítás: Esési kockázat felmérő skálát alkalmazok.
□Soha
□Ritkán
□Általában
□Mindig

*3. állítás: Izomerősítő gyakorlatokat végeztetek a beteggel/klienssel.
□Soha
□Ritkán
□Általában
□Mindig

*4. állítás: Egyensúlyfejlesztő gyakorlatokat végeztetek a beteggel/klienssel.
□Soha
□Ritkán
□Általában
□Mindig

*5. állítás: Mozgásterjedelem növelő gyakorlatokat végeztetek a beteggel/klienssel.
□Soha
□Ritkán
□Általában
□Mindig

***6. állítás: Fekvő helyzetből indítva gyakoroltatom a felállás mozdulatsorát.**
□Soha
□Ritkán
□Általában
□Mindig

***7. állítás: Álló helyzetből indítva gyakoroltatom a felállás mozdulatsorát.**
□Soha
□Ritkán
□Általában
□Mindig

***8. állítás: Eséspreven cióval kapcsolatos oktatóanyagot keresek szakirodalomban vagy interneten.**
□Soha
□Ritkán
□Általában
□Mindig

***9. állítás: A mozgásanyagokról edukációs anyagot adok át a betegnek/kliensnek.**
□Soha
□Ritkán
□Általában
□Mindig

***10. állítás: Funkcionális teszteket alkalmazok az esés rizikójának megítélésére (pl. TUG, felállás teszt, járássebesség, SPPB).**
□Soha
□Ritkán
□Általában
□Mindig

***11. állítás: Felmérem a beteg/kliens eséstől való félelmét.**
□Soha
□Ritkán
□Általában
□Mindig

***12. állítás: Rákérdezek, történt-e esés az elmúlt egy évben.**
□Soha
□Ritkán
□Általában
□Mindig

*13. állítás: Rákérdezek, előfordult-e, hogy esés után nem tudott önállóan felállni.
□Soha
□Ritkán
□Általában
□Mindig

*14. állítás: Szükség esetén ellenőrzöm és korrigálom a járási segédeszköz használatát.
□Soha
□Ritkán
□Általában
□Mindig

*15. állítás: Rákérdezek a földről való felállás képességére, vagy megfigyelés alapján felmérem annak kivitelezését.
□Soha
□Ritkán
□Általában
□Mindig

*16. állítás: Funkcionális mozgások (pl. lépcsőn járás, székről felállás, WC használat) biztonságos kivitelezését gyakoroltatom.
□Soha
□Ritkán
□Általában
□Mindig

Köszönjük a kitöltést!