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Utilizing Educational Technology for Formative Assessment in Nursing Education: A Scoping Review

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Purpose: This review presents a comprehensive overview of the utilization of educational technology for formative assessment in nursing education and proposes directions for its future application. **Methods:** Arksey and O'Malley's scoping review design was adopted. A total of 509 articles were retrieved in February 2025 from the Cumulative Index to Nursing and Allied Health Literature, the Cochrane Library, Embase, Education Resources Information Center, Scopus, PubMed, PsycINFO, and Web of Science databases. **Results:** Twenty-five articles that conducted formative assessments utilizing educational technology among nursing students and nurses were analyzed. The analysis identified three key themes: educational technology, formative assessment, and educational feedback. Online platforms were the most frequently employed educational technology, while mobile applications have gained prominence since 2020. Formative assessment primarily evaluated knowledge in theoretical courses but has increasingly been used to evaluate skills in practicum settings since 2020. Immediate constructive feedback was provided by educators, peer learners, and non-human agents. Since 2020, feedback delivery has increasingly been automated through non-human agents, including artificial intelligence-based non-human agents. **Conclusion:** This review, which focused on the implementation of educational technology-based formative assessment in nursing education, highlights the increasing adoption of non-human agents for delivering educational feedback in practicum courses. To strengthen educators' competency in providing immediate and constructive educational feedback, sustained support from policymakers and educational institutions is required.

Key Words: Education, nursing; Educational measurement; Feedback; Information technology; Review

INTRODUCTION

The advent of the Fourth Industrial Revolution, together with advances in information and communication technology (ICT) and the circumstances created by the coronavirus disease 2019 (COVID-19) pandemic, has accelerated digital transformation across multiple sectors [1]. The widespread proliferation of ICT established the foundation for significant changes in various fields [2], particularly in education, where it has contributed to the emergence of a new educational paradigm. Consistent with this trend, the number of educational technology-related publications in-

creased from 77 before 2000 to 148 in the 2000s and 441 in the 2010s [3]. The rapid expansion of educational technology use during the COVID-19 pandemic underscored the importance of digital pedagogy and fundamentally transformed instructional approaches [4]. The suspension of in-person classes and clinical practice compelled nurse educators to adopt blended learning, flipped learning, game-based learning, and virtual simulation [5]. Educational technology has enabled interaction and collaboration among nursing students, enhanced problem-solving abilities, and promoted self-directed learning [6]. Furthermore, it offers an effective means of strengthening nursing students' critical thinking and clinical decision-making by linking theoretical knowledge with practical application [7]. Collectively, these developments contribute to a more effective teaching and learning environment in nursing education.

To systematically evaluate students' learning processes and improve learning outcomes, nurse educators have employed formative assessment. Formative assessment refers to assessment for learning and involves the use of processes and tools that generate meaningful feedback about learning to guide subsequent instructional decisions [8]. Specific and timely feedback fosters self-directed learning skills and contributes to improved learning outcomes [9]. For example, Mackintosh-Franklin [10] reported that nursing students who participated in formative assessment developed a deeper understanding of the learning process through feedback and demonstrated higher summative performance. Continuous formative assessment and feedback not only enabled nursing students to refine their learning approaches and deepen their understanding of subject matter [11], but also enhanced their preparation for clinical nursing skills [12]. Nursing education extends beyond the simple transmission of knowledge and instead emphasizes a continuum integrating theoretical instruction, practical application, and clinical experience [13]. Students first acquire foundational knowledge, subsequently apply these concepts in skills laboratories and simulation settings, and ultimately transfer their competencies to patient care during clinical practicums. This continuous learning process cannot be adequately captured by a single assessment; rather, it is strengthened through ongoing and iterative feedback, which allows learners to integrate knowledge into future learning contexts [14]. Consequently, formative assessment supports self-regulated learning by enabling students to monitor their progress and adjust learning strategies, thereby sustaining continuity in nursing education.

In summary, formative assessment functions as a foundational framework for educational evaluation, with feedback serving as a key mechanism for promoting self-directed learning and improving learning outcomes. Educational technology facilitates the effective implementation of formative assessment and feedback. The application of educational technology to formative assessment has been shown to enhance nursing students' motivation, promote self-directed learning, and improve learning outcomes [15]. These findings indicate that educational technology-based formative assessment can be considered an effective assessment strategy in nursing education. Despite this potential, research on educational technology-based formative assessment remains limited. Many existing studies focus on higher education broadly or on health professions education in general [16], rather than specifically addressing nursing education. In addition, related research often examines a single type of ICT, without considering the broader implementation of formative assessment across multiple digital platforms [15]. Accordingly, a focused review of educational technology-based formative assessment in nursing education is needed to clarify current research trends, identify gaps, and establish best practices. The findings of this review offer guidance for nursing educators regarding the effective integration of technology-enhanced formative assessment. By identifying evidence-based strategies, these findings support the development of adaptive learning environments that foster self-directed learning in nursing education. Therefore, this study aimed to systematically examine current applications and research trends in educational technology-based formative assessment in nursing education and to provide evidence and guidance for its effective integration into future practice.

This study aimed to identify trends in published articles on educational technology-based formative assessment and to explore effective strategies for implementing educational technology-based formative assessment in nursing education.

METHODS

1. Study Design

This study is a scoping review conducted in accordance with the five-stage framework of scoping review methodol-

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ogy proposed by Arksey and O'Malley [17]. A scoping review is used to identify key concepts, sources of information, and types of available evidence that collectively define a research domain.

2. Identifying the Research Question (Stage 1)

The research questions are as follows: 1) What are the publication and research characteristics of articles related to educational technology-based formative assessment for nursing students and nurses? 2) How has the utilization of educational technology for formative assessment changed over time? 3) What strategies can enhance the implementation of educational technology-based formative assessment in nursing education?

3. Identifying Relevant Studies (Stage 2)

The literature search was conducted in February 2025, with no restrictions on publication date. Three authors independently searched for relevant peer-reviewed journal articles using a comprehensive electronic literature search strategy. The literature review included publications from database inception through February 2025. A thorough search was conducted across multiple databases, including the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, Embase, Education Resources Information Center (ERIC), Scopus, PubMed, PsycINFO, and Web of Science. The search strategy employed a combination of keywords designed to capture articles relevant to the topic: (nurse* OR "student nurse*" OR "nursing student*") AND ("information communication technology" OR computer* OR web OR internet OR "artificial intelligence" OR "big data" OR "neural network" OR "natural language processing" OR "machine learning" OR "deep learning" OR mobile OR smartphone OR digital* OR simulation OR virtual OR "augmented reality" OR "mixed reality" OR "extended reality" OR e-learning OR "blended learning" OR "online learning" OR gam*) AND ("formative assessment" OR "formative evaluation" OR "formative test" OR "formative exam").

4. Study Selection (Stage 3)

The processes of literature searching and study selection were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist (Figure 1). A total of 509 articles were identified: 90 from CINAHL, 20 from the Cochrane Library, 87 from Embase, nine from ERIC, 127 from Scopus, 76 from PubMed, 16 from PsycINFO, and 84 from Web of Science. After removing 262 duplicate records, 247 articles remained for screening. Three researchers independently reviewed the titles and abstracts of these 247 articles. Discrepancies in study selection were resolved through research meetings until consensus was reached. The inclusion criteria were studies published in academic journals that addressed formative assessment utilizing educational technology for nursing students or nurses. The exclusion criteria were as follows: (1) dissertations, conference posters or abstracts, and books, and (2) studies published in languages other than Korean or English. As a result, the full texts of 126 articles were assessed for eligibility. Of these, 11 studies did not focus on nurses or nursing students, 79 did not implement formative assessment utilizing educational technology, nine were not journal articles, and one was published in a language other than Korean or English. Ultimately, 25 articles met all inclusion criteria and were included in the final analysis.

5. Charting the Data (Stage 4)

Data from the 25 included articles were charted using a standardized data charting form developed for this review. The form captured the following information: (1) characteristics of the selected studies, including author, year, study design, and participants; (2) educational technology, including the type and sub-type used for formative assessment; (3) formative assessment characteristics, including course, content, and assessment method; and (4) educational feedback characteristics, including provider, timing, and specificity. Three researchers independently extracted and recorded relevant data using this charting form. To enhance transparency, an example of the coding framework applied to one included study is presented in Supplementary Table 1.

6. Collating, Summarizing, and Reporting the Results (Stage 5)

The study followed the PRISMA-ScR checklist to ensure comprehensive and transparent reporting of the scoping review process. The three researchers compared their analysis results and identified studies with discrepant evalua-

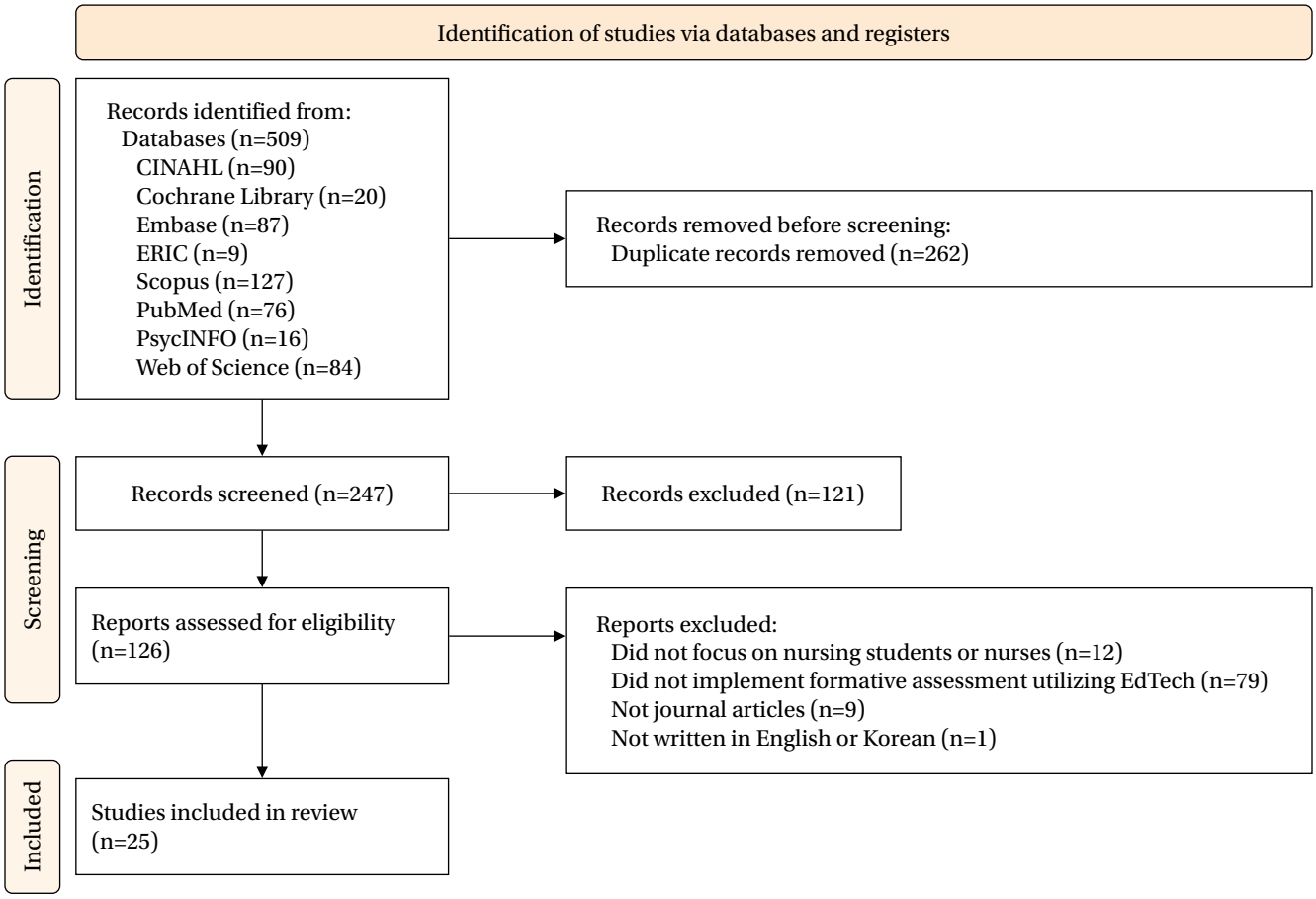

Figure 1. Article selection process. CINAHL = Cumulative Index to Nursing and Allied Health Literature; EdTech = educational technology; ERIC = Education Resources Information Center.

tions. These studies were subsequently re-examined and discussed until full consensus was achieved, after which the extracted data were finalized. Several included studies exhibited methodological limitations, such as insufficient reporting of the reliability or validity of measurement instruments, the use of single-group designs without control groups that limited causal inference, and small sample sizes or reliance on descriptive statistical analyses, which reduced the generalizability of findings. However, all studies clearly articulated their research questions, and the data collected were consistently judged by the three reviewers to be adequate for addressing those questions. Because a scoping review emphasizes comprehensive mapping of the literature rather than study exclusion based on quality, all studies that met the inclusion criteria were retained. Following both independent and consensus-based review, all included studies were considered to meet minimum methodological standards and were included in the final synthesis. The results describe the general characteristics of the studies, the educational technologies employed, the formative assessment approaches used, and the characteristics of educational feedback. After completion of the search and review process, the literature was collated, and a summary of article characteristics was presented in Table 1.

7. Ethical Considerations

Ethical approval was exempted by the Institutional Review Board of Ewha Womans University (IRB No. ewha-202311-0007-01), as this study was a scoping review of published literature.

RESULTS

1. Characteristics of Selected Studies

A total of 25 articles published between 2006 and 2025 were analyzed (Supplementary Data 1). Of these, nine arti-

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Table 1. Characteristics of the Studies Included

Study no.	Authors (year)	Country	Methodology and research design	Sample
A1	Little (2006)	UK	Quantitative	Undergraduate nursing students (n=177)
A2	DeBourgh (2008)	USA	Mixed methods	Undergraduate nursing students (n=65)
A3	Rangel et al. (2010)	Brazil	Quantitative	Undergraduate nursing students (n=44)
A4	Efstathiou and Bailey (2012)	UK	Quantitative	Undergraduate nursing students (n=195)
A5	Adwan (2016)	USA	Quantitative	Undergraduate nursing students (n=279)
A6	Forsberg et al. (2016)	Sweden	Qualitative	Graduate nursing students (n=14)
A7	Gabriele et al. (2016)	USA	Quantitative	Undergraduate nursing students (n=70)
A8	Mackavey and Cron (2019)	USA	Quantitative	Graduate nursing students (n=522)
A9	Sheng et al. (2019)	Canada	Mixed methods	Undergraduate nursing students (n=236)
A10	Ahlstrom and Holmberg (2021)	Sweden	Mixed methods	Undergraduate nursing students (n=246)
A11	Darnell et al. (2021)	USA	Mixed methods	Nurses (n=30)
A12	Fernandez-Nieto et al. (2021)	Australia	Mixed methods	Undergraduate nursing students (n=39)
A13	Lin (2022)	Taiwan	Mixed methods	Graduate nursing students (n=74)
A14	Oz and Ordu (2021)	Turkey	Quantitative	Undergraduate nursing students (n=110)
A15	Coveney et al. (2022)	Ireland and Italy	Quantitative	Nursing students (n=83)
A16	Lin et al. (2021)	Taiwan	Quantitative	Undergraduate nursing students (n=52)
A17	Zhang et al. (2022)	China	Quantitative	Intern nursing students (n=144); Junior college (n=13); Undergraduate (n=26); Postgraduate and above (n=2)
A18	Cadet (2023)	N/I	Quantitative	Undergraduate nursing students (n=37)
A19	Lajane et al. (2023)	Morocco	Methodological	N/A
A20	Ma et al. (2023)	China	Quantitative	Undergraduate nursing students (n=185)
A21	Nilsson et al. (2023)	Sweden	Qualitative	Undergraduate nursing students and nurses (n=27)
A22	Say et al. (2023)	Austria	Mixed methods	Undergraduate nursing students (n=802)
A23	Darnell et al. (2024)	USA	Quantitative	Nurses (n=18)
A24	Say et al. (2024)	Australia	Mixed methods	Undergraduate nursing students (n=1,082)
A25	Khalafi et al. (2025)	Iran	Quantitative	Graduate nursing students (n=62)

N/A=not applicable; N/I=no information.

cles were published between 2006 and 2019 [A1-9], and 16 were published between 2020 and 2025 [A10-25]. Articles published in the last five years accounted for more than half of the included studies (n=16), indicating growing interest in educational technology-based formative assessment in nursing education. Geographically, among the 25 articles, one study [A18] did not report identifiable geographic information, while the remaining 24 articles were conducted in the following locations: six in the USA [A2,A5,A7,A8,A11,A23]; three in Sweden [A6,A10,A21]; two each in Australia [A12,A24], China [A17,A20], Taiwan [A13,A16], and the UK [A1,A4]; and one each in Austria [A22], Brazil [A3], Canada [A9], Iran [A25], Morocco [A19], and Turkey [A14]. In addition, one study was conducted jointly in Ireland and Italy [A15]. Quantitative studies were the most common (n=14) [A1,A3-5,A7,A8,A14-18,A20,A23, A25], followed by mixed-methods studies (n=8) [A2,A9-13,A22,A24], qualitative studies (n=2) [A6,A21], and one methodological study (n=1) [A19]. Among the 25 reviewed articles, excluding the methodological study, participant characteristics in the remaining 24 articles showed that 21 studies involved nursing students [A1-10,A12-18,A20, A22,A24,A25], two involved nurses [A11,A23], and one included both nursing students and nurses [A21].

2. Key Themes

The analysis identified three key themes: educational technology, formative assessment, and educational feedback (Table 2, Figure 2).

Table 2. Classification of Formative Assessment and Feedback Utilizing Educational Technology

Study no.	Educational technology		Formative assessment			Educational feedback		
	Type	Sub-type	Course	Content	Method	Provider	Timing	Specificity
A1	Online	Web browser	Practicum	Skill	Formal	Educator	Immediate	Empirical
A2	Electronic	Web browser	Theory	Knowledge	Formal	Educator	Immediate	Constructive
A3	Online	Web browser	Theory	Knowledge	Formal and informal	Educator	Immediate	N/I
A4	Electronic	N/I	Theory	Knowledge	Formal	Educator	Immediate	N/I
A5	Online	Web browser	Theory	Knowledge	Informal	Educator and peer learner	Immediate	Constructive
A6	Online	Web simulation	Practicum	Knowledge	Formal	Non-human agents	Immediate	N/I
A7	Electronic	Video	Practicum	Skill	Informal	Peer learner	Immediate	N/I
A8	Online	Web browser	Theory	Knowledge	Formal	Educator	Delayed	Constructive
A9	Online and mobile	N/I	Theory	Knowledge	N/I	N/I	N/I	N/I
A10	Electronic and online	N/I	Theory	Knowledge	Formal	N/I	N/I	N/I
A11	Online	Web browser	Practicum	Knowledge	Formal	AI-based non-human agents	Immediate	Constructive
A12	Online	Web simulation	Practicum	Skill	Formal	Non-human agents	Immediate	Constructive
A13	Online	Web browser	Practicum	Skill	Informal	Peer learner	Immediate	Constructive
A14	Online and mobile	Web game	Practicum	Knowledge and skill	Formal	Non-human agents	Immediate	Constructive
A15	Online and mobile	Web game	Practicum	Knowledge	Formal	Non-human agents	Immediate	Constructive
A16	Online and mobile	N/I	N/I	Knowledge	Formal	Educator and peer learner	N/I	N/I
A17	Online	Web simulation	Practicum	N/I	Formal	N/I	N/I	N/I
A18	Online and mobile	Web game	Theory	Knowledge	Formal	N/I	Immediate	Constructive
A19	Mobile	Web game	N/I	N/I	Formal	Non-human agents	Immediate	Constructive
A20	Online	Web browser	Theory	Knowledge	Formal and informal	Educator	Immediate	N/I
A21	Mobile	N/I	Practicum	Skill	Formal	N/I	N/I	N/I
A22	Online	N/I	Practicum	Knowledge and skill	Formal	Non-human agents	Immediate	Constructive
A23	Online	Web browser	Practicum	Skill	Informal	AI-based non-human agents	Immediate	Constructive
A24	Online	N/I	N/I	Knowledge and skill	Formal	N/I	Immediate	Constructive
A25	Online	Web browser	Practicum	Skill	Formal	Educator	Immediate	Constructive

AI = artificial intelligence; N/I = no information.

1) Educational technology

Five types of educational technology were identified: online (n = 14) [A1,A3,A5,A6,A8,A11-13,A17,A20,A22-25], mobile (n = 2) [A19,A21], electronic (n = 3) [A2,A4,A7], electronic and online (n = 1) [A10], and online and mobile (n = 5) [A9,A14-16,A18]. Prior to 2020, online (n = 5) [A1,A3, A5,A6,A8] and electronic (n = 3) [A2,A4,A7] technologies were used at similar frequencies, whereas after 2020, the combined use of online and mobile technologies (n = 5) [A9,A14-16,A18] newly emerged.

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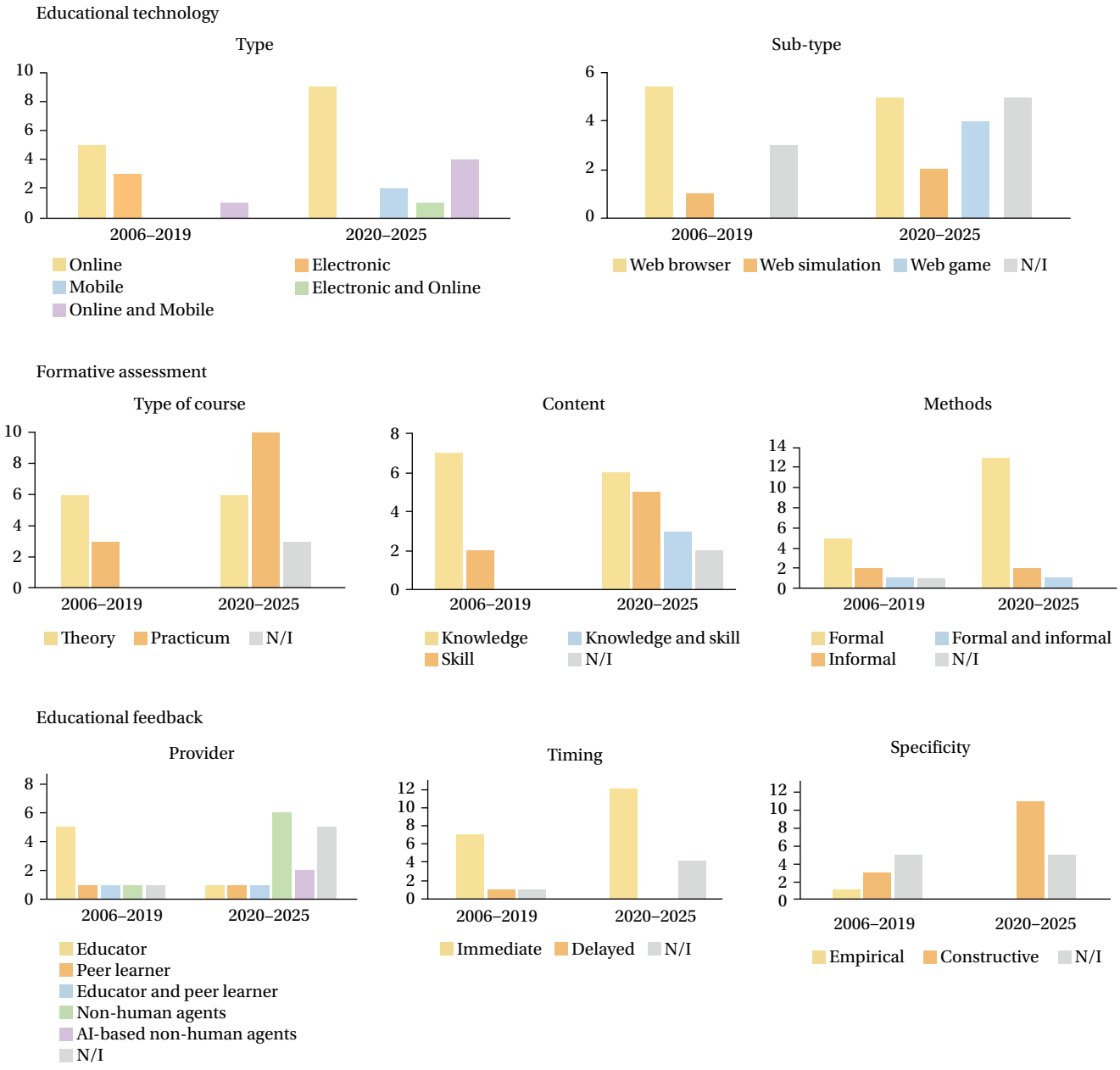

Figure 2. Classification of formative assessment and feedback utilizing educational technology: a comparison between 2006–2019 and 2020–2025. AI = artificial intelligence; N/I = no information.

Three sub-types of educational technology were identified, excluding eight articles in which sub-types were not specified [A4,A7,A9,A10,A16,A21,A22,A24]: web browser (n = 10) [A1-3,A5,A8,A11,A13,A20,A23,A25], web game (n = 4) [A14,A15,A18,A19], and web simulation (n = 3) [A6,A12,A17]. The web browser was the most frequently utilized sub-type across the entire study period. After 2020, web games emerged alongside the expansion of mobile educational technology. Web browsers were consistently reported in studies published between 2006 and 2025. Web simulations were first reported in 2016 and appeared intermittently thereafter. Following 2020, web games were increasingly reported, primarily in studies published between 2021 and 2023.

2) Formative assessment

After excluding three articles in which the course type was not identified [A16,A19,A24], two course types were identified: theory (n = 9) [A2-5,A8-10,A18,A20] and practicum (n = 13) [A1,A6,A7,A11-15,A17,A21-23,A25]. Before

2020, formative assessment was primarily implemented in theoretical courses (n=6) [A2-5,A8,A9]. In these courses, audience response systems were used to facilitate real-time student discussion [A2,A4]. In addition, peer evaluation was conducted using Google Forms [A5], and real-time educational feedback was provided through case-based learning and gamification approaches [A8]. Overall, theoretical courses predominantly employed knowledge-based formal assessments. After 2020, formative assessment was more frequently applied in practicum courses (n=10) [A11-15,A17,A21-23,A25], with practicum-based applications increasing notably from 2021 onward.

After excluding two articles with unidentified formative assessment content [A17,A19], three categories of assessment content were identified: knowledge (n=13) [A2-6,A8-11,A15,A16,A18,A20], skill (n=7) [A1,A7,A12,A13,A21,A23,A25], and combined knowledge and skill (n=3) [A14,A22,A24]. Prior to 2020, assessments primarily focused on knowledge (n=7) [A2-6,A8,A9]. After 2020, there was a shift toward assessing skills (n=4) [A12,A13,A21,A25] or integrating both knowledge and skills (n=3) [A14,A22,A24]. From 2008 to 2021, formative assessment largely emphasized knowledge, whereas after 2021, studies increasingly assessed skills or combined competencies.

After excluding one article with unidentified formative assessment methods, three assessment methods were identified: formal (n=18) [A1,A2,A4,A6,A8,A10-12,A14-19,A21,A22,A24,A25], informal (n=4) [A5,A7,A13,A23], and a combination of formal and informal methods (n=2) [A3,A20]. Formal methods, such as quizzes and classroom tests, were the most commonly used forms of formative assessment, whereas informal methods, including discussion and peer feedback, were used less frequently.

3) Educational feedback

After excluding six articles in which educational feedback providers were not identified [A9,A10,A17,A18,A21,A24], five types of feedback providers were identified: educators (n=7) [A1-4,A8,A20,A25], peer learners (n=2) [A7,A13], a combination of educators and peer learners (n=2) [A5,A16], non-human agents (n=6) [A6,A12,A14,A15,A19,A22], and artificial intelligence (AI)-based non-human agents (n=2) [A11,A23]. Before 2020, educational feedback was primarily delivered by educators (n=5) [A1-4,A8]. Combined educator and peer learner feedback was reported in 2016 [A5] and again in 2022 [A16]. From 2020 onward, educational feedback was most commonly provided by non-human agents (n=5) [A12,A14,A15,A19,A22].

Across the 25 articles, two feedback timing types were identified: immediate (n=19) [A1-7,A11-15,A18-20,A22-25] and delayed (n=1) [A8]. Immediate feedback predominated, while five articles did not specify feedback timing.

In 15 articles, the specificity of educational feedback was reported as empirical (n=1) [A1] or constructive (n=14) [A2,A5,A8,A11-15,A18,A19,A22-25]. Constructive feedback was consistently reported across all publication periods, whereas empirical feedback appeared only once, in 2006. Ten articles did not specify the type of educational feedback provided.

DISCUSSION

This study conducted a scoping review of 25 articles addressing formative assessment utilizing educational technology in nursing education. In addition, the study identified publication trends and sought approaches for developing strategies to enhance educational technology-based formative assessment in nursing education. Because nursing education requires the ongoing integration of theory, skills, and clinical practice, formative assessment holds substantial pedagogical value. It supports learners' continuous monitoring and reflection, helping to bridge classroom learning with clinical application and to sustain meaningful learning progression.

Analysis of the 25 articles indicated that online technology was the most frequently utilized modality. Online formative assessment can provide immediate and personalized feedback, which enhances learning outcomes and promotes self-directed learning, thereby supporting the development of student autonomy and agency [18]. Similarly, an integrative review reported that online formative assessment in nursing education improves knowledge acquisition, examination performance, and learner confidence and satisfaction [15]. However, in the absence of explicit instructional design guidelines, online formative assessment may not effectively promote learner communication, participation, or self-directed learning [19]. To address these challenges, educators must acquire competencies related to the implementation of well-defined instructional design strategies. Li et al. [20] found that nurse educators' age, teaching experience, and awareness of digital technology were significantly associated with digital literacy. Senior faculty may benefit from targeted training in educational technology, whereas junior faculty may

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require integrated development in both pedagogy and educational technology. Accordingly, institutions should prioritize sustainable support mechanisms, such as tailored faculty development programs, to strengthen nurse educators' assessment design competencies.

After 2020, mobile technology began to be newly utilized as an emerging form of educational technology. However, this shift does not necessarily indicate a heightened interest in mobile technology specifically for formative assessment, but may instead reflect the broader expansion of mobile-based education. This interpretation is supported by Chang et al. [21], who reported an increase in mobile-based learning studies in nursing education from 24 before 2020 to 77 after 2020. Nikou and Economides [22] examined 43 mobile-based assessment studies published in five major journals between 2009 and 2018 and found that 44% effectively incorporated formative assessment. Mobile technology can facilitate continuous and personalized formative assessment, enabling learners in the digital age to engage in learning conveniently anytime and anywhere [23]. Mobile technology is particularly relevant to formative assessment in nursing education because it supports timely, context-aware feedback and facilitates learning continuity across classroom, simulation, and clinical environments, aligning with the situated and practice-oriented nature of nursing learning. Therefore, implementing formative assessment using mobile technology in nursing education may be meaningful.

However, the validity of formative assessment implemented through mobile technology must be carefully examined in light of this educational trend. In this context, country-level variation in ICT utilization represents a critical consideration when implementing mobile-based formative assessment in nursing education. Vargas-Montoya et al. [24] demonstrated that the impact of ICT use for learning varies substantially between developed and developing countries, with high-income settings showing more consistent positive outcomes. These findings suggest that policymakers and educators should exercise caution when transferring technological interventions from developed to developing contexts. The implementation of mobile technology requires careful consideration of technical factors, including accessibility, usability, interface design, and data security, to promote educational equity and sustainability. In low-resource settings, implementation priorities should emphasize technical feasibility and equitable access, including features such as offline functionality, low-bandwidth optimization, multilingual support, and institutional capacity building for educators. In contrast, high-income countries should focus on pedagogical innovation and learner engagement, such as integrating mobile-based formative assessment with adaptive feedback, analytics dashboards, and AI-assisted feedback mechanisms to promote critical thinking and self-regulated learning. In summary, adapting implementation strategies to specific national contexts is essential to fully realize the potential of mobile-based formative assessment in nursing education. Such adaptation helps ensure that technological advancement leads to equitable and effective learning outcomes.

Since 2020, formative assessment has been implemented more frequently in practicum courses, with a greater emphasis on evaluating skills rather than knowledge. This trend suggests an increased focus on practice-oriented subjects in formative assessment utilizing educational technology in nursing education after 2020. The COVID-19 pandemic necessitated physical distancing and coincided with a rapid expansion of online health services and educational programs for healthcare professionals, thereby increasing reliance on technology to maintain continuity of education and clinical training [25]. In this context, both the pandemic and technological advancement appear to have contributed to adaptations in educational technology-based learning environments. As a result, a notable shift toward practicum-based formative assessment has emerged. Educational technology-based formative assessment can effectively support practicum instruction. Practicum courses in nursing education are designed to facilitate adaptation to real clinical settings and emphasize the integrated development of knowledge, skills, and attitudes. In practicum contexts, formative assessment approaches such as clinical and return demonstrations combined with immediate feedback have been shown to enhance students' performance in nursing procedures and support the development of essential competencies [11]. Therefore, incorporating educational technology-based formative assessment into practicum courses is particularly meaningful for the development of nursing skills.

In formative assessment, providing immediate and specific educational feedback after assessment is recommended [26]. Most studies reviewed in this research delivered educational feedback immediately and constructively; however, these findings should be interpreted with caution because many studies did not clearly specify the timing

and specificity of feedback. High-quality feedback is timely, specific, and constructive, providing students with clear guidance regarding strengths, areas for improvement, and strategies for progress [27]. This process may be regarded as essential to achieving the primary objective of formative assessment, namely assessment for learning. The effectiveness of educational feedback, a core element of formative assessment, varies according to timing, specificity, and spacing [9]. Therefore, the absence of explicit information on feedback timing and specificity in several studies represents a significant limitation. Future research in nursing education should incorporate instructional design processes that explicitly address the timing and specificity of feedback to optimize formative assessment outcomes.

The use of AI can effectively facilitate the provision of immediate and specific educational feedback. Automated AI-based feedback systems are capable of delivering real-time diagnostics and tailored responses during the learning process [28]. In a systematic review of AI applications in student assessment, Gonzalez-Calatayud et al. [29] reported that 15 of 22 articles employed AI for formative assessment. In the context of nursing education, however, only two articles examined AI-based non-human agents providing educational feedback, indicating that the current evidence base is insufficient for generalization. Although existing research has primarily focused on the implementation of non-human agents for educational feedback, these initiatives provide a foundation for subsequent investigations into AI-based non-human agents. AI has the potential to reduce educators' workload in simulation-based learning and objective structured clinical examinations, where timely and appropriate feedback is critical. Therefore, in contrast to earlier studies that focused mainly on feasibility and limited acceptability, further research is needed to evaluate the effectiveness of AI-based formative assessment.

However, the implementation of AI systems may reduce learner–educator interaction by limiting opportunities for dialogic engagement and personalized mentorship. Seo et al. [30] reported that although AI can improve the scale and timeliness of communication, participants expressed concerns regarding violations of social boundaries, shifts in responsibility, and unclear authority structures when human instructors are less involved. AI-generated feedback systems may also disrupt the natural flow of educator-student interaction and weaken relational bonds in educational contexts [31]. Furthermore, ethical concerns related to data privacy, algorithmic bias, transparency, and accountability become more pronounced with the adoption of AI technologies. Sengul et al. [32], in an integrative review of AI in nursing education, highlighted ethical challenges including bias in training data, inequities in access, cultural sensitivity issues, and concerns regarding accuracy, integrity, and academic responsibility. To mitigate these risks, AI-based formative assessment should incorporate a human-in-the-loop approach, provide clear explanations to help students understand how feedback is generated, and preserve opportunities for educator intervention and override. Institutional policies should mandate robust data governance, regular fairness audits of AI algorithms, and ongoing ethical oversight during implementation.

CONCLUSION

This scoping review analyzed the application of educational technology-based formative assessment in nursing education, identified current practices, and proposed directions for future research. The findings indicate a growing trend toward integrating formative assessment into practicum courses through the use of non-human agents to deliver educational feedback. Given the limited implementation of AI-based non-human agents, further research is needed to evaluate their effectiveness within nursing education contexts. Effective implementation of educational technology-based formative assessment requires strengthening nurse educators' digital literacy and instructional design competence, including the development of systematic formative feedback frameworks and their integration into curricula. National and institutional policies should support sustainable educational systems by enhancing educators' digital literacy and instructional design skills, ensuring equitable access to digital infrastructure, and establishing ethical guidelines for AI-generated feedback to promote fairness and transparency in education.

This study was limited to articles published in English and Korean and lacked complete information on some key themes, which may have affected the comprehensiveness and interpretability of the findings. Despite these limitations, the review provides valuable insights into current trends, identifies important research gaps, and establishes a foundation for the implementation of educational technology-based formative assessment in nursing education.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

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DATA AVAILABILITY STATEMENT

The data can be obtained from the corresponding authors.

SUPPLEMENTARY MATERIAL

Supplementary materials can be found via https://doi.org/10.7475/kjan.2025.0730.

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REVIEW ARTICLE

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The Effect of Non-pharmacological Exposures on Cardiovascular Outcomes in Patients with Metabolic Syndrome: A Systematic Review and Meta-Analysis

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Purpose: Metabolic syndrome (MetS) patients have a higher risk of cardiovascular disease (CVD) incidence and mortality than those without MetS. The effects of non-pharmacological exposures may help improve the management of CVD. This study aimed to assess the long-term effects of non-pharmacological exposures on CVD in MetS patients through a meta-analysis of cohort and case-control studies. **Methods:** Searches were conducted in seven databases (PubMed, Embase, CINAHL, Cochrane, RISS, NDSL, and KoreaMed) between August 7, 2024 and December 1, 2024. The quality of the included studies was assessed using the Newcastle-Ottawa Scale. The meta-analysis was conducted using the RevMan 5.4 program and RStudio 2022.12.0. A total of nine studies were included in the systematic review, with eight studies analyzed in the meta-analysis (PROSPERO CRD42024584658). **Results:** A total of nine studies were included in the systematic review, of which eight were eligible for meta-analysis to evaluate the effects of non-pharmacological exposures. Eight studies were included for meta-analysis to investigate the effect of non-pharmacological exposures. The quality of individual studies was rated "good" for eight studies and "poor" for one. Non-pharmacological exposures in MetS patients were effective in reducing CVD-related mortality (relative risk [RR] = 0.81, 95% confidence interval [CI], 0.73–0.91) and all-cause mortality (RR = 0.80, 95% CI, 0.75–0.85). **Conclusion:** Interventions and education on non-pharmacological exposures in MetS patients are associated with reduced CVD. As evidence continues to emerge, future studies should explore the long-term effects of diet, smoking, and sleep by assessing their individual impacts on CVD outcomes in individuals with MetS.

Key Words: Cardiovascular diseases; Cohort studies; Follow-up studies; Meta-analysis; Metabolic syndrome

INTRODUCTION

Metabolic syndrome (MetS) is a cluster of metabolic risk factors—including abdominal obesity, hypertension, impaired fasting glucose, hypertriglyceridemia, and reduced high-density lipoprotein cholesterol [1]. The global prevalence of MetS ranges from 12.5% to 31.4% [2], with recent Korean data reporting a national prevalence of 24.9% and a marked increase among older adults [3]. Individuals with MetS are at elevated risk for both the incidence and mortality of cardiovascular disease (CVD), including coronary artery disease, stroke, and heart failure, as well as all-cause

mortality [4]. Beyond its clinical burden, MetS adversely affects quality of life [5] and contributes to rising healthcare costs [6]. Lifestyle factors such as smoking and physical inactivity further exacerbate these risks. For example, smokers with MetS are nearly twice as likely to develop CVD [7], and physically inactive individuals have up to 2.75 times higher risk of CVD-related mortality than active individuals without MetS [4].

Pharmacological therapy has demonstrated meaningful efficacy in the management of MetS, with weight-reduction effects of up to 15%, while lifestyle modification typically results in a 5% to 10% reduction in body weight [8]. Furthermore, evidence indicates that combining lifestyle modification with pharmacological therapy leads to greater improvements in systolic and diastolic blood pressure and total cholesterol levels than pharmacotherapy alone [9]. Prior studies have also shown that exercise and the Mediterranean diet produce significant improvements in blood pressure, lipid profiles, waist circumference, and glycemic control in individuals with MetS [10,11]. Additionally, sleep disturbances and shorter smoking cessation durations have been associated with increased MetS and CVD risk [12,13].

Despite these promising findings, most existing studies have focused on short-term outcomes, and evidence regarding the long-term effects of non-pharmacological exposures on CVD incidence, CVD-related mortality, and all-cause mortality in MetS populations remains limited. Because MetS and CVD are chronic conditions that develop over decades, long-duration studies are essential to capture the sustained effect of lifestyle exposures on clinical outcomes [4]. While randomized controlled trials (RCTs) provide strong causal evidence for short-term changes in risk factors (e.g., such as blood pressure) high-quality observational cohort studies are indispensable for evaluating long-term clinical outcomes, including mortality, in real-world settings [14].

Therefore, this systematic review and meta-analysis synthesizes current evidence from cohort and case-control studies to assess the long-term impact of non-pharmacological exposures, including physical activity, diet, sleep, and smoking, on CVD incidence, CVD mortality, and all-cause mortality in individuals with MetS. The findings underscore the importance of evidence-based nursing interventions and contribute to the development of effective, patient-centered strategies for chronic disease prevention and health promotion.

METHODS

1. Study Design

This study is a systematic review and meta-analysis conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) [15] 2020 statement [16]. The review protocol was registered in PROSPERO (CRD42024584658).

2. Primary Research Questions and Eligibility Criteria

The primary research question for this systematic review and meta-analysis was: "What are the effects of non-pharmacological exposures on CVD incidence, CVD mortality, and all-cause mortality in patients with MetS?" All peer-reviewed studies were eligible, and inclusion criteria were defined using the PECOS framework (Population, Exposure, Comparator, Outcome, Study Design): (1) P: patients with MetS diagnosed according to established criteria, including the National Cholesterol Education Program–Adult Treatment Panel III (NCEP-ATP III), American Heart Association (AHA), the harmonized MetS definition, the Diabetes Society of the Chinese Medical Association, or the International Diabetes Federation (IDF) guidelines; (2) E: non-pharmacological exposures such as physical activity, diet, smoking, and sleep. Because this review aimed to comprehensively examine lifestyle-related exposures, we did not restrict the scope to predefined categories; (3) C: patients with MetS who were either unexposed or had relatively low exposure levels compared with higher-exposure groups. For example, physical activity was compared between sedentary patients and those engaging in light or moderate-to-high activity, and coffee consumption was compared across gradations of intake (1, 2, 3, or ≥4 cups/day) versus none; (4) O: CVD incidence, CVD mortality, and all-cause mortality; (5) S: cohort or case-control studies. Exclusion criteria were: (1) studies not published in English or Korean, (2) duplicate publications, (3) conference abstracts or unpublished studies, and (4) studies in which the reference population did not consist of patients with MetS.

3. Literature Search and Selection Process

A systematic search was conducted across four international databases (PubMed, Embase, CINAHL, Cochrane)

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and three Korean databases (RISS, NDSL, KoreaMed) from August 7, 2024 to December 1, 2024. MeSH terms in PubMed, Subject Headings in CINAHL, and Emtree terms in Embase were incorporated into the search strategy. Search terms included "metabolic syndrome," "cohort study" (longitudinal stud* OR cohort stud*), "case-control study" (case-control stud* OR case-controlled stud*), and "follow-up" (follow-up stud* OR follow-up*), aligned with the PECOS framework (Supplementary Data 1). Synonyms and related terminology were verified for each database. Reference lists of the retrieved articles were also manually screened to identify additional eligible studies.

Duplicate articles retrieved from all databases were removed using EndNote ver. 20 (Clarivate Analytics, Philadelphia, PA, USA). Three authors (DEL, ML, and DY) independently screened titles, abstracts, and full texts. Any discrepancies identified during the initial screening were re-evaluated in a secondary review by the same authors. Remaining disagreements after the secondary review were resolved through discussion with a fourth author (HL), who facilitated consensus-building.

Three authors (DEL, ML, and DY) independently extracted data on study characteristics and outcome variables. Extracted information included first author, publication year, country, study design, sample size, mean age, sex distribution, MetS diagnostic criteria, follow-up duration, exposure variables, and outcome measures. Any discrepancies were resolved through discussion among the three authors.

4. Quality Assessment of Included Studies

Study quality was evaluated using the Newcastle-Ottawa Scale (NOS) across the selection, comparability, and outcome domains. Items in the selection domain were marked with a "+" when high-quality criteria were met. For representativeness of the exposed cohort, studies including at least 200 subjects were considered representative [17]. In the comparability domain, one "+" was assigned when exposed and unexposed groups were matched at the design stage and sex was adjusted as a covariate; an additional "+" was given when other covariates were adjusted, up to a maximum of two "+" marks [18]. In the outcomes domain, each high-quality criterion was assigned a "+," and a minimum follow-up duration of 5 years was considered adequate [19]. A study received a "+" in the adequacy-of-follow-up category when the number and reasons for loss to follow-up were reported. According to NOS guidelines, studies were classified as good quality with 3–4 "+" in selection, 1–2 in comparability, and 2–3 in outcomes; fair quality with two in selection, 1–2 in comparability, and 2–3 in outcomes; and poor quality with 0–1 "+" in any domain. Quality assessment was independently conducted by three authors (DEL, ML, and DY), with disagreements resolved through discussion or consultation with the fourth author (HL).

5. Ethical Considerations

This study is a meta-analysis. In accordance with the Bioethics and Safety Act of Korea and the regulations of the Institutional Review Board (IRB) of Pusan National University, this research did not involve direct intervention with human participants or the use of human-derived materials. Therefore, it was exempt from IRB review, and no application was submitted to the Pusan National University IRB.

6. Data Analysis

Meta-analysis of cardiovascular outcomes was conducted in RStudio (version 4.5.0; Posit, Boston, MA, USA) using the metafor and meta packages. Meta-analyses were carried out when identical outcome variables were reported or when effect sizes (relative risk [RR], odds ratio [OR], or hazard ratio [HR]) with 95% confidence intervals (CIs) were available. RR quantified relative risk, OR compared the odds of events versus non-events, and HR assessed differences in event rates over time [20]. All ratio measures (RR, OR, HR) were log-transformed to stabilize variance and enhance comparability [20], and pooled using random-effects models. For CVD incidence and all-cause mortality, when both HR and RR were available, HR was assumed to approximate RR under conditions of low baseline event risk; thus, RR values after log transformation were used [21]. Standard errors were calculated using the RevMan 5.4.1 calculator. When studies presented adjusted effect estimates, adjusted values were used [22]. Heterogeneity was assessed using the Higgins I^2 statistic, with thresholds of 0%, 30%–60%, and 75% indicating no, moderate, and high heterogeneity, respectively [23]. Because of variability in study populations and exposures, random-effects models were chosen to improve generalizability. Sensitivity analyses included leave-one-out procedures and evaluation of Baujat plots to identify influential studies. Publication bias

was assessed with funnel plots and Egger's test [24]. When funnel plots suggested asymmetry and Egger's test produced $p < .05$, a trim-and-fill analysis was performed [25]. Fail-Safe N was calculated using Rosenthal's method to estimate the number of unpublished studies needed to nullify the observed effects [26].

RESULTS

A total of 11,956 publications were identified across seven databases. After removing 4,179 duplicates, 7,777 records were screened by title and abstract. During screening, 7,470 records were excluded based on title and 198 based on abstract, leaving 109 studies for full-text review. Of these, five full texts were unavailable, resulting in 104 articles assessed for eligibility. Following full-text evaluation, studies were excluded for the following reasons: not relevant population (n=67), not a non-pharmacological exposure (n=17), not a cohort or case-control design (n=3), not published in English or Korean (n=4), not reporting HRs, ORs, or RRs (n=2), and not using patients with MetS as the reference group (n=3). Ultimately, eight studies met the inclusion criteria. Three additional studies were identified through hand searching; one could not be retrieved, one involved an irrelevant population, and one was eligible, resulting in nine studies included in the systematic review [7,27-34]. One study was excluded due to low quality, leaving eight studies for the final meta-analysis (Figure 1).

1. Characteristics of Included Studies

Of the nine cohort studies, eight (88.9%) were published after 2020. Four studies (44.5%) were conducted in South Korea and three (33.3%) were conducted in China. Six studies (66.7%) included sample sizes exceeding 10,000 participants, and three studies (33.3%) reported a mean age of 55 years or older. The harmonized criteria were used to define MetS in six studies (66.7%), while the AHA, IDF, and Diabetes Society of the Chinese Medical Association criteria were each applied in one study (11.1%). Regarding exposures, physical activity was most frequently investigated (four studies, 44.5%), followed by diet (two studies, 22.2%), with lifestyle intervention, sleep, and smoking each examined in one study (11.1%). For outcomes, five studies (55.6%) reported both CVD incidence and CVD mortality, and seven studies (77.8%) reported all-cause mortality (Table 1).

2. Quality Assessment

Nine cohort studies were evaluated using the NOS (Table 2). All studies met the representativeness criteria in the selection domain. Non-exposed cohorts were drawn from the same populations as exposed groups, and exposures were primarily assessed via self-reported questionnaires. All nine studies confirmed that the outcome of interest was absent at baseline. In the comparability domain, all studies controlled for sex and additional covariates. In the outcomes domain, eight studies verified outcomes using record linkage, whereas Ye et al. [27] relied on direct surveys. Six studies had a follow-up period of ≥5 years, while three had <5 years [7,27,28]. Overall, eight studies were rated as good quality and one study as poor quality [27].

3. Summary Effect Sizes

Associations between non-pharmacological exposures and CVD incidence, CVD mortality, and all-cause mortality in MetS patients were examined (Table 3). Meta-analysis was conducted only when three or more studies were available, which occurred only for physical activity; these results are provided in Supplementary Data 2. Covariate adjustments varied across studies—from no adjustment to multivariable adjustment for age, sex, and additional covariates. Detailed information on subgroup classifications, exposure characteristics, reference groups, outcome types, population categories, adjustment variables, and extracted outcome counts is provided in Supplementary Data 3 and 4.

1) CVD incidence

Four studies reported 12 effect estimates for CVD incidence [7,28-30]. The pooled analysis indicated no significant association between non-pharmacological exposures and CVD incidence (RR=0.95, 95% CI, 0.81–1.10; $p=.470$), with substantial heterogeneity ($I^2=99.3\%$).

2) CVD mortality

Five studies provided 20 effect estimates for CVD mortality [30-34]. The pooled results demonstrated a significant association between non-pharmacological exposures and reduced CVD mortality (RR=0.81, 95% CI, 0.73–0.91; $p<.001$), although heterogeneity remained high ($I^2=81.7\%$).

3) All-cause mortality

Seven studies reported 27 outcomes for all-cause mortal-

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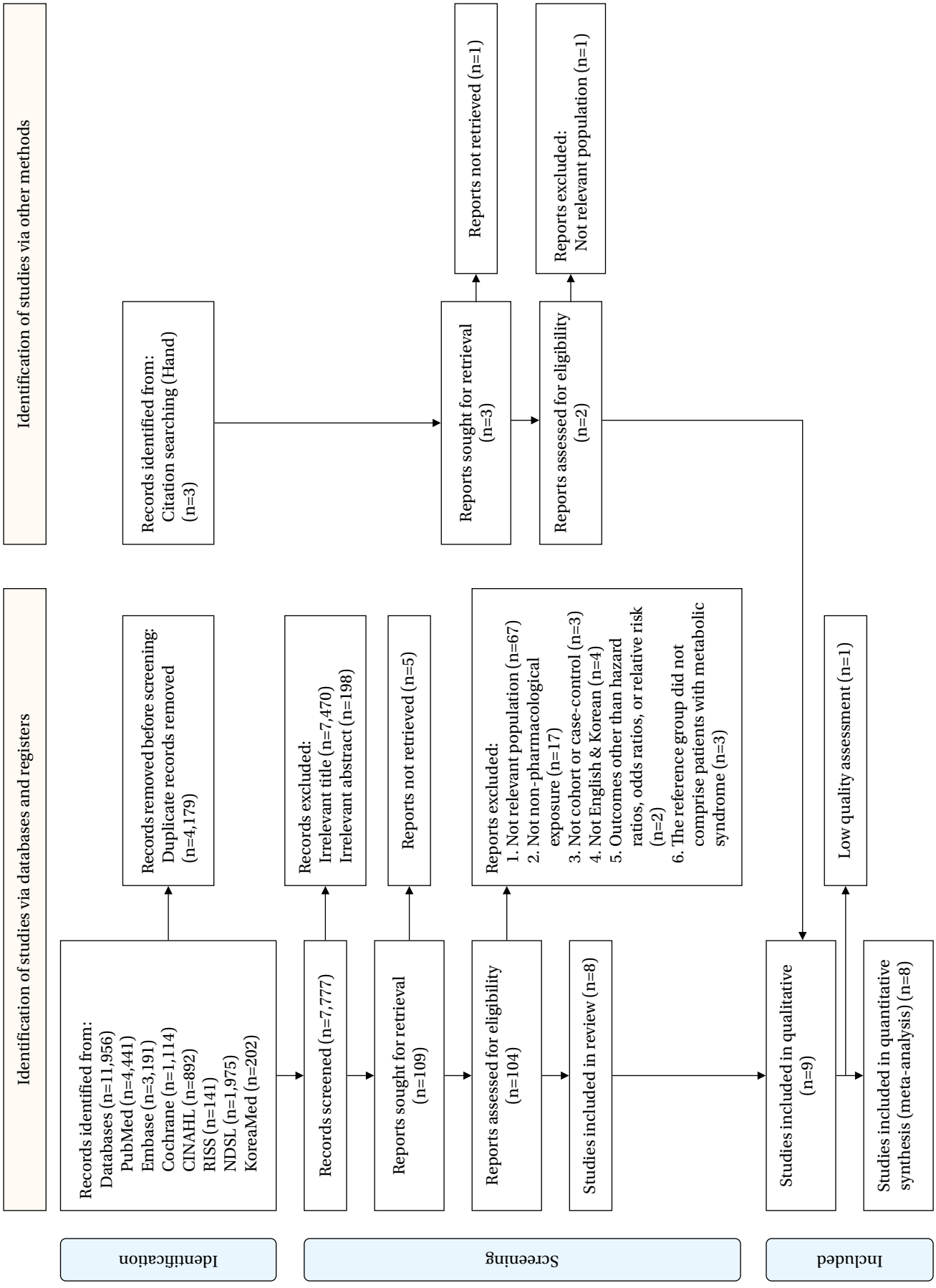

Figure 1. Flow diagram of the study selection process.

Table 1. Descriptive Summary of the Included Studies (K = 9)

Characteristics	Categories	n (%)
Publication year	< 2020	1 (11.1)
	≥ 2020	8 (88.9)
Publication country	China	3 (33.3)
	Korea	4 (44.5)
	Norway	1 (11.1)
	Sweden	1 (11.1)
Sample size	< 10,000	3 (33.3)
	≥ 10,000	6 (66.7)
Study design	Cohort	9 (100.0)
Mean age of participants	< 55	4 (44.5)
	≥ 55	3 (33.3)
	Not reported	2 (22.2)
Definition of MetS	American Heart Association	1 (11.1)
	Harmonized definition	6 (66.7)
	International Diabetes Foundation	1 (11.1)
	The Diabetes Society of Chinese Medical Association	1 (11.1)
Type of exposure	Diet	2 (22.2)
	Lifestyle intervention	1 (11.1)
	Physical activity	4 (44.5)
	Sleeping	1 (11.1)
	Smoking	1 (11.1)
Outcomes	CVD incidence†	5 (55.6)
	Mortality	
	All-cause†	7 (77.8)
	CVD†	5 (55.6)

CVD = cardiovascular disease; K = total number of included studies; MetS = metabolic syndrome; †Angina pectoris, ischemic stroke, myocardial infarction.

ity [28-34]. The pooled effect showed a significant association between non-pharmacological exposures and lower all-cause mortality (RR = 0.80, 95% CI, 0.75–0.85; $p < .001$), with high heterogeneity ($I^2 = 94.8\%$).

4. Publication Bias

Publication bias was assessed using a funnel plot, which showed slight asymmetry (Supplementary Data 5). Egger's test indicated no bias for CVD incidence ($p = .292$) or all-cause mortality ($p = .721$), but detected bias for CVD mortality ($p = .007$), prompting a trim-and-fill analysis. After imputing seven studies, the effect size shifted from HR = 0.81 (95% CI, 0.73–0.91) to HR = 0.93 (95% CI, 0.81–1.06), suggesting possible publication bias and the need for cautious interpretation. Fail-Safe N analysis using Rosenthal's method yielded a fail-safe N of 36, indicating moderate robustness despite the possibility of unpublished null results [26].

5. Sensitivity Analysis

For CVD incidence, random-effects models yielded RRs ranging from 0.90 to 0.96, with heterogeneity between 98.5% and 99.4%. The Baujat plot identified Park et al. [7] (current heavy smokers with chronic MetS) as the most influential study; excluding it reduced the pooled RR to 0.90 (95% CI, 0.80–1.01) (Supplementary Data 6).

For CVD mortality, random-effects models produced HRs of 0.80 to 0.84, with heterogeneity ranging from 77.1% to 82.7%. The Baujat plot identified Wu et al. [33] (coffee intake ≥ 4 cups/day) and Wu et al. [34] (healthy lifestyle

Table 2. Quality Assessment of Included Studies using the Newcastle-Ottawa Scale Cohort Studies (K = 9)

Author (year)	Selection					Comparability		Outcome				Quality rating
	A	B	C	D	Sub-sum	E	Sub-sum	F	G	H	Sub-sum	
Ekblom-Bak et al. (2021) [30]	+	+	–	+	3	++	2	+	+	+	3	Good
Fan et al. (2023) [31]	+	+	–	+	3	++	2	+	+	+	3	Good
Lee et al. (2023) [29]	+	+	–	+	3	++	2	+	+	+	3	Good
Park et al. (2021) [7]	+	+	–	+	3	++	2	+	–	+	2	Good
Park et al. (2020) [28]	+	+	–	+	3	++	2	+	–	+	2	Good
Stensvold et al. (2011) [32]	+	+	–	+	3	++	2	+	+	+	3	Good
Wu et al. (2023) [33]	+	+	–	+	3	++	2	+	+	+	3	Good
Wu et al. (2022) [34]	+	+	–	+	3	++	2	+	+	+	3	Good
Ye et al. (2020) [27]	+	+	–	+	3	++	2	–	–	+	1	Poor

A = representativeness of the exposed cohort; B = selection of the non-exposed cohort; C = ascertainment of exposure; D = demonstration that outcome of interest was not present at start of study; E = comparability of cohorts based on the design or analysis; F = assessment of outcome; G = follow-up long enough; H = adequacy of follow; K = total number of included studies.

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Table 3. Effects of Non-pharmacological Factors over Follow-up Duration (K = 8)

Outcomes	Total		
	k	Pooled HR or RR (95% CI; *p*)	I^2 (*p*)
CVD incidence†	4	0.95 (0.81–1.10; .470)§	99.3% (< .001)
CVD mortality†	5	0.81 (0.73–0.91; < .001)‡	81.7% (< .001)
All-cause mortality†	7	0.80 (0.75–0.85; < .001)§	94.8% (< .001)

CI = confidence interval; CVD = cardiovascular disease; HR = hazard ratio; K = total number of included studies; k = number of studies; RR = relative risk; †Covariates: age, alcohol consumption, body mass index, educational level, income, marital status, sex, smoking, and other covariates; ‡HR; §RR.

scores 6–8) as the most influential studies. Excluding Wu et al. [33] resulted in an HR of 0.80 (95% CI, 0.72–0.89) with 77.9% heterogeneity, while excluding Wu et al. [34] led to an HR of 0.84 (95% CI, 0.76–0.93) with 77.1% heterogeneity (Supplementary Data 7).

For all-cause mortality, random-effects models yielded RRs of 0.79 to 0.82, with heterogeneity between 93.8% and 95.0%. The Baujat plot identified Lee et al. [29] (metabolic equivalent of task [MET] score 1–499) and Wu et al. [34] (healthy lifestyle scores 6–8) as the most influential studies. Excluding Lee et al. [29] resulted in an RR of 0.80 (95% CI, 0.75–0.85) with 94.4% heterogeneity, while excluding Wu et al. [34] (healthy lifestyle scores 6–8) yielded an RR of 0.82 (95% CI, 0.77–0.86) with 94.3% heterogeneity (Supplementary Data 8).

DISCUSSION

This systematic review and meta-analysis was conducted to evaluate the effects of non-pharmacological exposures on the risks of CVD incidence, CVD-related mortality, and all-cause mortality among patients with MetS. Of the included studies, eight were published after 2020, reflecting a recent increase in cohort research on lifestyle factors in MetS populations. Physical activity was the most frequently investigated exposure, followed by diet, smoking, and sleep. Lifestyle modification plays a critical role in preventing and managing CVD complications in MetS. Previous studies have demonstrated that, among patients with CVD, combining pharmacological therapy with lifestyle modification yields greater improvements in cholesterol levels and blood pressure than pharmacological therapy alone [9]. Consistent with these findings, the present study identified significant associations between non-pharmacological exposures and reduced CVD mortality and all-cause mortality, reinforcing the need to integrate lifestyle-focused guidance into education and intervention programs for MetS patients.

In this study, non-pharmacological exposures were not significantly associated with reduced CVD incidence among patients with MetS. Sensitivity analyses supported this finding; however, the Baujat plot revealed substantial heterogeneity driven by the heavy-smoker and light-to-moderate–smoker groups reported by Park et al. [7]. This heterogeneity likely reflects differences in exposure type and covariate adjustment. Park et al. [7] focused primarily on smoking as the main exposure and adjusted only for sex and age, whereas Ekblom-Bak et al. [30], Lee et al. [29], and Park et al. [28] examined physical activity and incorporated broader multivariable adjustments. These methodological discrepancies may have contributed to the observed inconsistency. Thus, large prospective studies are needed to clarify the long-term impact of smoking history and other lifestyle factors on CVD outcomes in MetS, with attention to comprehensive exposure measurement and covariate control.

This study found that non-pharmacological exposures were associated with reductions in both CVD mortality and all-cause mortality among patients with MetS. Sensitivity analyses confirmed the stability of these associations, indicating that the findings were not driven by any individual study. However, for the lifestyle score reported by Wu et al. [34], which combined diet, smoking, sleep, social support, and physical activity, exclusion of the 6- to 8-point category strengthened the observed association with reduced CVD mortality. This suggests that composite lifestyle indices may influence meta-analytic outcomes differently from single-exposure measures. Future research should therefore distinguish between composite indices, such as lifestyle scores, and single exposures when evaluating their impact on CVD outcomes. Furthermore, the Baujat plot indicated that the result for coffee consumption of ≥ 4 cups per day reported by Wu et al. [33] and physical activity MET scores reported by Lee et al. [29] contributed substantially to the overall heterogeneity. While Fan [31] assessed overall dietary patterns using the alternative Mediterranean diet index score, Wu et al. [34] focused on a single dietary factor (namely, coffee consumption). In addition, for all-cause mortality, the follow-up duration of Lee et al. [29] was only 8 years, the shortest among the included studies. These differences in exposure definitions, measurement

methods, and study design likely contributed to the observed heterogeneity.

Subgroup analyses based on characteristics of non-pharmacological exposures were attempted; however, due to the limited number of eligible studies, meta-analysis was feasible only for physical activity. The results showed that physical activity was significantly associated with reductions in both CVD mortality and all-cause mortality. Furthermore, intensity-specific analyses demonstrated that low-, moderate-, and high-intensity physical activity were all associated with lower all-cause mortality. These results align with prior findings indicating that regular physical activity reduces the risk of CVD and mortality [28-30,32]. Accordingly, even low-intensity exercise should be encouraged among sedentary individuals with MetS, highlighting the importance of structured physical activity counseling by nurses. Nonetheless, given the small number of available studies, these findings should be interpreted cautiously.

In addition to physical activity, cohort studies examining smoking, sleep, and diet were identified. For smoking, both past and current smokers had higher CVD risk than non-smokers [7]. However, because only one study was available and no information was provided on smoking duration or time since cessation, further research is needed. Sleep was also associated with cardiovascular risk, with both long sleep duration (≥9 hours) and short sleep duration (<6 hours) linked to increased risk of cerebrovascular and CVD [27]. Regarding diet, adherence to healthier dietary patterns such as the Mediterranean diet has been shown in earlier research to reduce CVD risk through improvements in blood pressure and lipid profiles [10,31]. Similarly, Zhu et al. [35] similarly reported that dietary exposures, including more than eight hours of sleep and a tuber-meat dietary pattern, were associated with higher MetS prevalence. These findings highlight the importance of adopting a comprehensive lifestyle modification approach, including diet, smoking cessation, adequate sleep, and physical activity, for MetS management. However, current evidence remains limited, as only one cohort study was available for both smoking and sleep, and dietary exposures were restricted to the Mediterranean diet, coffee, and tea. Therefore, future large-scale cohort studies with standardized exposure definitions, extended follow-up, and thorough covariate adjustment are necessary.

RCTs provide strong causal evidence for the short-term effects of non-pharmacological interventions, such as diet and physical activity, on cardiovascular risk factors. However, their limited duration and highly controlled settings restrict their generalizability to real-world contexts. In contrast, cohort studies allow the evaluation of long-term effects of lifestyle factors on cardiovascular outcomes under naturalistic conditions [14]. The present study is therefore significant in that it integrates cohort data to clarify the long-term impact of non-pharmacological exposures on patients with MetS, thereby complementing short-term evidence derived from experimental trials.

Nevertheless, several limitations should be acknowledged. First, only eight studies were included in the meta-analysis, which restricted subgroup analyses to physical activity alone. Further research is needed to examine the long-term effects of other non-pharmacological factors—such as diet, smoking, and sleep—on CVD outcomes in MetS populations. Second, the limited number of eligible studies prevented the use of meta-regression, constraining a more detailed investigation of heterogeneity. Subgroup analyses were conducted to partially address this issue, but the inability to apply meta-regression remains an important limitation. Third, for CVD mortality, publication bias could not be excluded based on the funnel plot and Egger's regression test, indicating that the findings should be interpreted with caution. Fourth, potential publication bias may have been present because gray literature, including dissertations, was not included in the search. Finally, for CVD mortality, Egger's test again suggested potential publication bias, reinforcing the need for cautious interpretation of the results.

CONCLUSION

This systematic review and meta-analysis confirm that non-pharmacological exposures are associated with reduced cardiovascular and all-cause mortality among patients with MetS. Physical activity, in particular, demonstrated protective effects against both CVD incidence and all-cause mortality, with consistent benefits observed across light-, moderate-, and high-intensity activity levels. These findings suggest that incorporating education and interventions focused on non-pharmacological exposures, alongside pharmacological treatment, may help prevent and manage complications in patients with MetS. However, due to the limited number of eligible studies, subgroup analyses examining smoking, sleep, and diet could not be performed. As additional evidence emerges, future re-

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search should further investigate the long-term effects of individual non-pharmacological factors, specifically diet, smoking, and sleep, by evaluating their respective contributions to CVD outcomes in populations with MetS.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

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DATA AVAILABILITY STATEMENT

The data can be obtained from the corresponding authors.

SUPPLEMENTARY MATERIAL

Supplementary materials can be found via https://doi.org/10.7475/kjan.2025.0827_2.

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Factors Influencing the Quality of Self-Care among Continuous Ambulatory Peritoneal Dialysis Patients in Central Java, Indonesia: A Cross-Sectional Study

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Purpose: This study examined the associations between sociodemographic characteristics, knowledge, self-efficacy, social support, comorbidities, and self-care quality among CAPD patients in Central Java, Indonesia. **Methods:** This cross-sectional study included CAPD patients recruited from two tertiary referral hospitals in Central Java (Dr. Kariadi Hospital and Dr. Moewardi Hospital). Data were collected from April to May 2025, with a total sample of 72 patients. The study instruments comprised the Self-care Scale for Peritoneal Dialysis Patients, a knowledge questionnaire, the Duke-UNC Functional Social Support Questionnaire, and the General Self-Efficacy Scale. Data analysis was performed using the chi-square test, Spearman's rank correlation, and univariate logistic regression. **Results:** Univariate logistic regression analysis demonstrated that the presence of comorbidities was associated with significantly lower odds of good self-care quality (odds ratio [OR], 0.05; 95% confidence interval [CI], 0.01–0.18; $p < .001$). Higher levels of knowledge (OR, 1.45; 95% CI, 1.19–1.78; $p < .001$), self-efficacy (OR, 1.27; 95% CI, 1.14–1.42; $p < .001$), and social support (OR, 1.38; 95% CI, 1.16–1.64; $p < .001$) were significantly associated with better self-care quality. Sociodemographic factors showed no statistically significant associations with self-care quality (all $p > .05$). **Conclusion:** Among CAPD patients in Central Java, higher levels of knowledge, self-efficacy, and social support were associated with better self-care quality, whereas the presence of comorbidities was associated with factors hindering optimal self-care. Sociodemographic variables did not demonstrate clear associations with self-care quality, which may be partly attributable to limited statistical power in this sample.

Key Words: Self care; Peritoneal dialysis; Self efficacy; Social support; Comorbidity

INTRODUCTION

Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function persisting for more than 3 months, with implications for health, including a glomerular filtration rate of less than 60 mL/min/1.73 m² [1,2]. CKD has emerged as a major global health problem, with its prevalence continuing to increase worldwide. Recent

estimates indicate that approximately 10% of the global population, corresponding to more than 800 million individuals, are affected by CKD [3]. In Indonesia, the prevalence of CKD has also risen steadily over time. According to the 2023 Indonesian Health Survey, CKD affects approximately 0.2% of individuals aged over 15 years, representing 638,178 people nationwide. Notably, Central Java ranks third among the 38 provinces, with 88,180 reported cases of CKD [4].

Management of CKD primarily relies on renal replacement therapies, most notably hemodialysis and continuous ambulatory peritoneal dialysis (CAPD). Hemodialysis involves the use of an external machine to filter blood, whereas CAPD allows patients to independently perform dialysis at home through the instillation of dialysis fluid into the peritoneal cavity. Although CAPD is increasingly adopted in Indonesia as a modality for CKD management, it remains associated with a substantial risk of peritonitis. A systematic review of CAPD data from Southeast Asia (2010–2020) reported a peritonitis proportion of 32% among Indonesian patients, defined as the percentage of patients experiencing at least one episode among 1,456 total cases [5]. Regional variability has been documented: a local study in Denpasar, Bali, reported a lower proportion of 16.7% (13 of 78 patients), which may reflect differences in sample size and observation duration [6]. In contrast, major hospitals on Java Island, including those in Jakarta and Bandung, have reported higher proportions ranging from 35% to 40%, suggesting potential regional challenges related to self-care management or access to care [5]. Importantly, these estimates represent patient proportions rather than incidence rates per patient-year, limiting direct comparisons because of heterogeneity in study design, follow-up periods, and population characteristics. Nevertheless, the consistently high proportions reported on Java, including Central Java, underscore the need for targeted strategies to improve patient self-care and reduce the burden of peritonitis.

Building on these regional challenges, particularly in Central Java, there is a clear need for context-specific research examining factors that support or impede high-quality self-care among CAPD patients. Despite the growing global and national utilization of CAPD, evidence remains limited regarding determinants of self-care quality within specific regional contexts, including Central Java. Many previous studies have examined dialysis populations in aggregate, without adequately distinguishing factors unique to CAPD. In the context of CAPD, self-care refers to a deliberate and routine set of actions performed independently by patients to effectively manage their dialysis treatment. These actions include conducting peritoneal dialysis fluid exchanges under strict aseptic conditions, maintaining appropriate hand hygiene, monitoring for early signs of complications such as peritonitis, and adhering to prescribed treatment regimens designed to minimize infection risk and optimize clinical outcomes.

Research has demonstrated that effective self-care is crucial for reducing the occurrence of complications, particularly peritonitis, which remains a leading cause of morbidity and technique failure among CAPD patients [7]. In addition, comorbidities and cognitive impairments may function as factors that challenge optimal self-care, thereby necessitating targeted support to enhance patients' capabilities and promote better clinical outcomes. Comorbidities are common among patients with CKD and play a crucial role in influencing quality of life as well as the management of dialysis therapy, including CAPD. Patients with multiple comorbidities may therefore benefit from tailored strategies to support consistent self-care practices, which can ultimately lead to improved outcomes in CAPD [8].

Promoting self-care behaviors is critical, as addressing factors that hinder effective self-care, such as challenges in adherence and consistency, has been shown to improve clinical outcomes and enhance quality of life in dialysis patients. In the context of CAPD, gaps in self-care practices can be addressed to achieve optimal self-care quality, thereby contributing to a lower incidence of peritonitis. Adherence to hygiene protocols, including proper hand washing and correct fluid exchange techniques, has been shown to significantly reduce the risk of infection [9]. Consequently, strengthening patients' knowledge, self-efficacy, and social support is essential for preventing complications and safeguarding long-term health.

Previous studies indicate that enhancing knowledge of self-care procedures, particularly aseptic techniques in dialysis, can help overcome barriers to optimal self-care, thereby reducing the frequency of peritonitis and improving health outcomes. Furthermore, a strong understanding of hygiene practices and fluid exchange techniques enhances self-care agency, defined as an individual's ability to independently meet health needs, consistent with Orem's Theory, which emphasizes knowledge as a foundational component of self-care [10]. Strong self-care practic-

es, in turn, reduce technical errors and lower the risk of complications.

Patient confidence also plays a critical role in self-care performance; as complications decrease, self-efficacy increases, leading to greater consistency in daily procedures such as proper hand washing and aseptic fluid exchanges. Increased self-efficacy strengthens patients' confidence in their ability to perform care procedures correctly. Successful completion of these procedures without complications further reinforces confidence, which subsequently increases motivation, resilience in the face of challenges, and consistency in daily self-care tasks, even in difficult or monotonous situations. As a result, higher self-efficacy directly promotes sustained self-care behaviors, leading to a reduced risk of peritonitis and improved health outcomes [11].

Moreover, social support provides a sense of security and reduces anxiety, which in turn enhances self-efficacy and engagement in self-care, thereby significantly lowering the risk of peritonitis [8]. Social support plays a crucial role in strengthening patients' self-efficacy in managing their health conditions by offering encouragement, emotional assistance, and reinforcement that bolster confidence in performing care procedures effectively [12]. Consequently, this enhanced self-efficacy contributes to more consistent self-care behaviors and a reduced risk of peritonitis.

Although this study is geographically limited, addressing gaps in local data regarding factors influencing self-care among CKD patients remains essential. The findings are expected to contribute meaningfully not only within the local context but also more broadly, by providing a foundation for personalized interventions aimed at improving quality of life among similar patient populations in other regions. Accordingly, this study aimed to investigate the associations between sociodemographic variables, knowledge, self-efficacy, social support, comorbidities, and self-care quality among CAPD patients in Central Java, Indonesia. The prespecified hypothesis was that these factors would be significantly associated with self-care quality.

METHODS

1. Study Design

This cross-sectional study was conducted among patients undergoing CAPD in Central Java, Indonesia, with the objective of identifying factors associated with the quality of self-care in this population. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Setting and Samples

This study was conducted at two major referral hospitals in Central Java, namely Dr. Kariadi Hospital and Dr. Moewardi General Hospital, both of which serve as primary referral centers for CAPD patient management. These institutions provide comprehensive CAPD facilities and services and receive patients from multiple districts across the region. The study population consisted of 117 CAPD patients registered at the two hospitals. Given the relatively small population size, a total sampling approach was applied, whereby all patients meeting the inclusion criteria were invited to participate. The inclusion criteria were age between 18 and 65 years, receipt of CAPD therapy for at least three months, not being hospitalized at the time of data collection, ability to operate smartphones and computers, sufficient cognitive capacity to complete digital questionnaires, and provision of written informed consent. The participant selection process proceeded as follows: 117 registered CAPD patients, 109 patients meeting the inclusion criteria, 88 patients providing informed consent, and 72 patients completing the questionnaire fully and validly.

3. Measurements/Instruments

The dependent variable in this study was the quality of self-care among CAPD patients. Independent variables included sociodemographic characteristics (age, sex, education level, marital status, and duration of CAPD therapy), as well as social support, self-care knowledge, comorbidities, and self-efficacy. During the initial exploratory phase, continuous variables such as knowledge, self-efficacy, age, CAPD duration, and social support were dichotomized. However, in the univariate logistic regression analyses, these variables were treated as continuous using their original questionnaire scores, in accordance with methodological recommendations to improve statistical sensitivity and minimize information loss [13]. All independent variables were specified as predictors of the binary dependent variable, self-care quality ("poor" vs. "good"), and together constituted the primary explanatory variables for the study outcome.

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1) Self-care quality

Self-care quality was measured using the Self-care Scale for Peritoneal Dialysis Patients, a 28-item instrument scored on a 4-point Likert scale ranging from 0 ("never") to 3 ("always"), yielding a total score range of 0–84, with higher scores indicating better self-care [14]. The instrument has demonstrated excellent content validity (content validity index [CVI], 0.963) and high internal consistency (Cronbach's α = .93). Although the original scale classifies scores into three categories—poor (< 50), moderate (50–66), and good (≥ 67)—for analytical purposes in this study, the "moderate" category was combined with the "poor" category. This resulted in a binary classification of self-care quality as poor (< 67) or good (≥ 67). In statistical analyses, this variable was coded dichotomously as 1 = poor and 2 = good. The selection of a cutoff score of 67 was supported by both empirical and methodological considerations. First, this threshold is consistent with prior studies in middle-income countries, where a score ≥ 67 has similarly been classified as "good" self-care among CAPD patients facing comparable sociocultural barriers [14]. Second, the cutoff was statistically optimized using receiver operating characteristic (ROC) curve analysis based on the study sample (n = 72), which yielded the highest Youden index (0.43), with a sensitivity of 68%, specificity of 75%, and an area under the curve (AUC) of 0.78 (95% confidence interval [CI], 0.71–0.85), indicating strong discriminative power.

Among the 72 participants, 51 (70.8%) were classified as having poor self-care quality, while 21 (29.2%) were classified as having good self-care quality. This distribution is consistent with findings reported in middle-income settings, where sociodemographic and structural barriers frequently contribute to suboptimal self-care practices. Although the distribution of self-care categories was imbalanced, the ROC analysis demonstrated adequate discriminatory ability (AUC = 0.78), and the use of the Youden index ensured that the cutoff value remained statistically optimal and not biased by sample distribution. Accordingly, the cutoff score of 67 was not solely based on convention but was empirically validated for the present study context.

2) Self-care knowledge

Self-care knowledge was assessed using a questionnaire developed by the researchers, consisting of 10 items related to CAPD management. Content validity was evaluated using the CVI approach by five CAPD specialists, with all items achieving an item-level CVI (I-CVI) of at least 0.80, indicating adequate content validity. Internal consistency reliability was confirmed with a Cronbach's α of .857. Each correct response was assigned a score of 10 points, yielding a total possible score range of 0 to 100. Knowledge scores were analyzed as a continuous variable, with higher scores indicating greater self-care knowledge.

3) Social support

Social support was measured using the Duke-UNC Functional Social Support Questionnaire (Duke-UNC-11), an 11-item self-report instrument designed to assess functional social support across affective and confidant domains. The instrument demonstrates strong content validity supported by qualitative and factor-analytic evidence and has shown high internal consistency, with reported Cronbach's α values ranging from .85 to .92. Participants rated each item on a 5-point Likert scale from 1 ("never") to 5 ("always"), resulting in a total score range of 11 to 55. Higher scores indicated stronger perceived social support, and scores were treated as continuous variables in the analyses.

4) Self-efficacy

Self-efficacy was assessed using the General Self-Efficacy Scale, a 10-item instrument developed by Schwarzer and Jerusalem [15]. Content validity was established through expert review, with all items demonstrating an I-CVI ≥ 0.80. Confirmatory factor analysis supported a unidimensional structure, with acceptable model fit indices (comparative fit index > 0.89; goodness-of-fit index > 0.90), consistent with previous validation studies [16]. Items were rated on a 4-point Likert scale ranging from 1 ("not at all true") to 4 ("exactly true"), producing a total score range of 10 to 40. Higher scores reflected greater perceived self-efficacy, and the variable was analyzed as continuous.

5) Sociodemographic and clinical variables

Sociodemographic and clinical variables included age, sex, education level, marital status, duration of CAPD therapy, and comorbidities. For analytical purposes, variables were classified as categorical or continuous. Categorical variables included education level, sex, marital status, and comorbidities, while continuous variables included age (in years), knowledge scores (0–100), and CAPD duration (in months). Categorical variables were coded as follows: sex (1 = male, 2 = female); education level (1 = primary, 2 = secondary, 3 = higher education); marital status (1 = single, 2 = married/divorced/widowed); and comorbidities (1 = present, 2 = absent).

4. Data Collection/Procedure

Data were collected using an online questionnaire distributed via Google Forms to patients residing in Central Java Province, Indonesia. Participants were patients receiving care at Dr. Moewardi Hospital in Surakarta and Dr. Kariadi Hospital in Semarang, both of which serve as recognized CAPD referral centers in Central Java. Patients who met the inclusion criteria and voluntarily consented to participate were recruited as study respondents. Following completion of data collection, responses were compiled, cleaned, and prepared for statistical analysis to generate the study findings.

5. Ethical Considerations

This publication reports variables derived from a dissertation study that received ethical approval from the Ethics Committee of Dr. Moewardi Hospital on March 11, 2025, under approval number 508/III/HERC/2025. Data collection was conducted between April and May 2025. Written informed consent was obtained from all participants prior to study enrollment, and the confidentiality of participant data was strictly maintained throughout the research process. During the recruitment phase, all eligible patients were actively and non-discriminatively informed about the study objectives, procedures, potential benefits, and possible risks. Each individual was provided with an equal opportunity to make a voluntary decision regarding participation, free from coercion or undue influence. This process ensured that participation was based on full understanding and autonomy, thereby minimizing potential selection bias. A total sampling approach was employed to include all eligible patients from the registered population. Importantly, patients who declined participation experienced no reduction in the quality of medical care they received. The study was conducted in strict accordance with the ethical principles of the Declaration of Helsinki, ensuring protection of participants' rights, dignity, and well-being.

6. Data Analysis

Data were analyzed using IBM SPSS ver. 26.0 (IBM Corp., Armonk, NY, USA). To assess associations among variables, two analytical approaches were applied based on variable type and whether statistical assumptions were met. For categorical variables, including education level, sex, and comorbidities, Pearson's chi-square test was initially used to examine associations with the dependent variable, provided that no expected cell frequency was less than five. However, because several cells in the contingency tables, particularly those involving marital status, had expected frequencies below five, Fisher's exact test was used as an alternative, in accordance with established statistical guidelines and reviewer recommendations.

For continuous variables, including age, duration of CAPD therapy, knowledge level, self-efficacy, and social support, associations with the dependent variable (self-care quality, dichotomized as poor versus good) were evaluated using Spearman's rank correlation. This nonparametric method was selected because it does not require the assumption of normality and is appropriate for data that are ordinal, non-normally distributed, or influenced by outliers.

Given the relatively small sample size (n = 72) and the inclusion of nine predictor variables, the events-per-variable ratio was substantially below the recommended minimum threshold of 10. This limitation increased the risk of overfitting, unstable coefficient estimates, and inflated standard errors. Accordingly, univariate logistic regression analyses were performed to examine the independent effect of each predictor on the likelihood of achieving good self-care quality. Results are presented as odds ratios (ORs) with corresponding 95% CIs, reflecting the magnitude and direction of associations.

RESULTS

1. General and Clinical Characteristics of Study Participants

The general and clinical characteristics of the study participants, as shown in Table 1, are presented to provide demographic and social context for patients undergoing CAPD. Key variables included age, sex, educational level, and other sociodemographic characteristics. This information was considered essential for characterizing the study population, examining relationships between independent variables and self-care quality, and assessing the representativeness of the sample.

Table 1 presents the demographic and clinical characteristics of the 72 patients undergoing CAPD in this study. The mean age of participants was 41.64 ± 11.67 years, with 48 (66.7%) males and 24 (33.3%) females. With respect to edu-

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cational attainment, seven participants (9.7%) had primary education, 23 (31.9%) had secondary education, and 42 (58.3%) had completed higher education. Regarding marital status, 17 participants (23.6%) were single, while 55 (76.4%) were married, widowed, or divorced. Comorbidities were present in 49 participants (68.1%) and absent in 23 (31.9%). The mean duration of CAPD therapy was 43.28±47.56 months. The mean knowledge score was 63.06±13.28, the mean self-efficacy score was 21.90±9.09, and the mean social support score was 27.94±10.91. With respect to self-care quality, 51 participants (70.8%) were classified as having poor self-care, while 21 (29.2%) demonstrated good self-care.

Table 1. General and Clinical Characteristics of Study Participants (N=72)

Variables	Categories	M±SD or n (%)
Age (year)	-	41.64±11.67
Sex	Male	48 (66.7)
	Female	24 (33.3)
Education level	Primary	7 (9.7)
	Secondary	23 (31.9)
	Higher education	42 (58.3)
Marital status	Single	17 (23.6)
	Married/widowed/divorced	55 (76.4)
Duration of CAPD (month)	-	43.28±47.56
Comorbidities	Absent	23 (31.9)
	Present	49 (68.1)
Quality of self-care	Poor	51 (70.8)
	Good	21 (29.2)
Knowledge	-	63.06±13.28
Self-efficacy	-	21.90±9.09
Social support	-	27.94±10.91

CAPD=continuous ambulatory peritoneal dialysis; M=mean; SD=standard deviation.

2. Associations between Independent Variables and Self-Care Quality

Table 2 illustrates the associations between various independent variables and self-care quality. Table 2 presents the results of chi-square and Fisher's exact tests examining associations between independent variables and quality of self-care among 72 participants. For education level, among participants with primary or secondary education (n=30), 22 (73.3%) had poor self-care and 8 (26.7%) had good self-care (p=.518). Among participants with higher education (n=42), 29 (69.0%) had poor self-care and 13 (31.0%) had good self-care. For sex, among male participants (n=48), 35 (72.9%) had poor self-care and 13 (27.1%) had good self-care (p=.582), whereas among female participants (n=24), 16 (66.7%) had poor self-care and 8 (33.3%) had good self-care. With respect to marital status, 13 single participants (76.5%) had poor self-care and 4 (23.5%) had good self-care (p=.762, Fisher's exact test), while among married, widowed, or divorced participants (n=55), 38 (69.1%) had poor self-care and 17 (30.9%) had good self-care. In contrast, comorbidities showed a statistically significant association with self-care quality. Among participants with comorbidities present (n=49), 44 (89.8%) had poor self-care and 5 (10.2%) had good self-care (p<.001). Among those without comorbidities (n=23), 7 (30.4%) had poor self-care and 16 (69.6%) had good self-care. The results of the Spearman's rank correlation test between the independent variables and self-care quality are presented in Table 3.

Table 3 presents the results of Spearman's rank correla-

Table 2. Associations between Independent Variables and Quality of Self-Care (N=72)

Variables	Categories	Poor group of quality of self-care	Good group of quality of self-care	χ^2	p
		n (%)			
Education level	Primary & secondary	22 (73.3)	8 (26.7)	1.31	.518
	Higher education	29 (69.0)	13 (31.0)		
Sex	Male	35 (72.9)	13 (27.1)	0.30	.582
	Female	16 (66.7)	8 (33.3)		
Marital status	Single	13 (76.5)	4 (23.5)	-	.762†
	Married/widowed/divorced	38 (69.1)	17 (30.9)		
Comorbidities	Present	44 (89.8)	5 (10.2)	26.60	<.001*
	Absent	7 (30.4)	16 (69.6)		

All tests were two-sided.
*p<.05; †Fisher's exact test (due to expected counts <5 in >20% of cells; lowest=4.96).

tion analyses examining associations between selected variables and quality of self-care among the 72 participants. The correlation coefficient between knowledge level and self-care quality was .80 (p<.001). Self-efficacy was also strongly correlated with self-care quality (r=.68, p<.001), as was social support (r=.69, p<.001). In contrast, age showed a weak and non-significant correlation with self-care quality (r=.10, p=.450), and duration of CAPD therapy was not correlated with self-care quality (r=.05, p=.890).

3. Univariate Logistic Regression Analysis on Self-Care Quality

This section presents the results of univariate logistic regression analyses examining associations between individual predictors and self-care quality among patients undergoing CAPD. The univariate analyses indicated that several psychosocial and clinical factors were significantly associated with self-care quality.

Univariate logistic regression analysis showed that for each one-point increase in score, the odds of being classified in the "good" self-care quality category increased by 45% for knowledge (OR, 1.45; 95% CI, 1.19–1.78; p<.001), 27% for self-efficacy (OR, 1.27; 95% CI, 1.14–1.42; p<.001), and 38% for social support (OR, 1.38; 95% CI, 1.16–1.64; p<.001). Conversely, the presence of comorbidities was associated with substantially lower odds of good self-care quality (OR, 0.05; 95% CI, 0.01–0.18; p<.001). For age, the OR was 1.03 per additional year (95% CI, 0.99–1.08; p=.174). For education level, the OR was 1.67 for primary education (95% CI, 0.33–8.57; p=.537) and 0.62 for secondary education (95% CI, 0.19–2.03; p=.430), both relative to higher education. Male sex, compared with female sex, was not significantly associated with self-care quality (OR, 0.74; 95% CI, 0.26–2.15; p=.583). Similarly, single marital status compared with married status showed no significant association (OR, 0.31; 95% CI, 0.03–2.94; p=.306). Duration of CAPD therapy was also not significantly associated with self-care quality, with an OR of 0.99 per additional month (95% CI, 0.98–1.01; p=.295).

Table 3. Associations with Quality of Self-Care (N=72)

Independent variable	M±SD	r	p
Age (year)	41.64±11.67	.10	.450
Duration of CAPD (month)	43.28±47.56	.05	.890
Knowledge level	63.06±13.28	.80	<.001*
Self-efficacy	21.90±9.09	.68	<.001*
Social support	27.94±10.91	.69	<.001*

CAPD=continuous ambulatory peritoneal dialysis; M=mean; SD=standard deviation. *p<.05.

DISCUSSION

The univariate logistic regression analysis presented in Table 4 indicates that comorbidities function as barriers to self-care quality among CAPD patients, whereas knowledge, self-efficacy, and social support emerge as supportive factors. These findings underscore the urgency of nursing interventions that target modifiable determinants, particularly by strengthening knowledge and social support, to mitigate the negative impact of comorbidities and enhance patient autonomy overall. In Indonesia, where access to peritoneal dialysis remains constrained by limitations in facilities and specialized expertise [17], such strategies may serve as a key approach for optimizing CAPD management at the community level.

Building on this, the findings of the present study

Table 4. Univariate Logistic Regression Analysis for Self-Care Quality (N=72)

Predictor	Level reference/unit	OR (95% CI)	p
Age	Years	1.03 (0.99–1.08)	.174
Education	Primary (ref: higher education)	1.67 (0.33–8.57)	.537
	Secondary (ref: higher education)	0.62 (0.19–2.03)	.430
Sex	Male (ref: female)	0.74 (0.26–2.15)	.583
Duration of CAPD	Month	0.99 (0.98–1.01)	.295
Marital Status	Single (ref: married)	0.31 (0.03–2.94)	.306
Comorbidities	Present (ref: absent)	0.05 (0.01–0.18)	<.001*
Level of knowledge	Score (per 1-point increase on the scale)	1.45 (1.19–1.78)	<.001*
Self-efficacy	Score (per 1-point increase on the scale)	1.27 (1.14–1.42)	<.001*
Social support	Score (per 1-point increase on the scale)	1.38 (1.16–1.64)	<.001*

CAPD=continuous ambulatory peritoneal dialysis; CI=confidence interval; OR=odds ratio; ref=reference. *p<.05.

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demonstrate a strong association between comorbidities and self-care quality. Consistent with previous literature, comorbidities have been repeatedly identified as a major barrier to effective self-care, primarily due to increased complexity in simultaneously managing pharmacological regimens, nutritional requirements, and symptom control across multiple conditions [18]. This mechanism is further supported by evidence showing that individuals with multiple comorbidities have a reduced capacity to sustain optimal self-care behaviors. These observations align with Orem's Nursing: Concepts of Practice, which posits that while multiple chronic conditions increase self-care demands, successful fulfillment of these demands depends heavily on self-efficacy and the availability of adequate systemic support [10]. Moreover, patients with comorbidities consistently report lower quality of life, particularly in physical and social functioning domains, compared with patients without comorbidities [18].

The clinical implications for nursing practice are substantial, as nurses must assume central roles as coordinators of integrated educational programs that extend beyond technical instruction in peritoneal dialysis procedures. Such programs should actively promote self-efficacy, strengthen patients' understanding of interconnected chronic conditions, and systematically assess readiness for independent self-care management [19]. A holistic and integrated management approach that encompasses comprehensive comorbidity care is essential for achieving optimal outcomes, as emphasized by prior work advocating specialized self-care measurement tools for peritoneal dialysis populations [11,14]. Accordingly, evidence-based training programs that prioritize patient autonomy and complication prevention are particularly critical for populations with high comorbidity burdens [20]. This highlights the necessity of implementing structured, evidence-driven strategies to address the complex demands imposed by multiple chronic conditions.

The findings further reveal a significant positive relationship between patient knowledge and self-care quality in CAPD, with each one-unit increase in knowledge corresponding to a measurable improvement in outcomes. This reinforces the central role of patient education in empowering individuals to manage their treatment effectively. Structured educational programs have consistently been shown to improve adherence and self-care behaviors in dialysis populations [21]. According to Orem [10], knowledge constitutes the foundational basis for meeting self-care needs, and when combined with self-efficacy, it substantially strengthens patient autonomy.

The primary mechanisms underlying this relationship include improved understanding of sterile techniques and fluid management. In addition, early recognition of complications and consistency in home dialysis routines represent critical components of effective self-care. Evidence from skill-based training programs indicates that targeted educational interventions can significantly reduce the risk of peritonitis [22], while simultaneously reinforcing patients' sense of responsibility for their own care. Within the Indonesian context, comprehensive CAPD training programs have been associated with increased patient independence and reduced complication rates [20].

In clinical practice, healthcare providers should lead integrated care models that account for patients' cognitive, emotional, and practical readiness for self-care. Evidence-based strategies, including readiness assessments and autonomy-focused training in peritoneal dialysis management, offer scalable models for proactive CKD care. These approaches have been shown not only to improve survival outcomes but also to enhance overall quality of life. Recent narrative reviews further emphasize the importance of individualized pre-training assessments, while underscoring that structured educational interventions remain essential for achieving optimal self-care outcomes among peritoneal dialysis patients [23].

Self-efficacy demonstrated a significant positive association with self-care quality among patients undergoing CAPD. Specifically, each one-unit increase in self-efficacy scores was associated with a corresponding improvement in self-care outcomes. These results reaffirm self-efficacy as a major predictor of self-care behavior within this patient population.

These findings are consistent with Orem's self-care theory [10], which emphasizes patient confidence as a fundamental component in the management of chronic diseases such as CKD. By strengthening self-efficacy through targeted nursing interventions, including skills training, emotional support, and personalized education, patients may become more autonomous in performing self-care activities, improve adherence to CAPD protocols, and substantially reduce the risk of complications such as peritonitis.

Recent evidence suggests that self-efficacy functions as a key mediator between knowledge and self-care among patients with early-stage CKD [24]. This finding creates opportunities for nurses to design responsive interventions

that tailor educational content to patients' levels of self-confidence. A systematic review by Riski et al. [25] further confirms that self-efficacy–based interventions are particularly effective in addressing sex differences and the complexity associated with comorbid conditions among peritoneal dialysis patients.

Ultimately, evidence-based nursing programs that prioritize the development of self-efficacy represent a critical factor in improving long-term prognosis, reducing morbidity, and enhancing quality of life among patients with CKD. These findings are consistent with epidemiological data [3], which demonstrate that the effectiveness of dialysis therapy is closely linked to patient behavior and the quality of self-care practices adopted.

Social support also demonstrated a significant positive association with self-care quality among patients undergoing CAPD, such that each one-unit increase on the social support scale corresponded to improved self-care quality. This finding highlights the critical role of strong social networks in promoting adherence and sustained engagement in CAPD self-care. These results are consistent with Orem's self-care theory, which posits that external support systems enhance patients' capacity to meet self-care demands despite the burdens imposed by CKD, including emotional stress and the complexity of daily treatment routines, thereby reducing isolation and supporting long-term independence.

This interpretation is reinforced by existing literature. A qualitative study by Fox et al. [12] highlights how family and peer networks within the peritoneal dialysis experience alleviate psychological stress and strengthen adherence to daily routines, which in turn reduces the risk of peritonitis through shared accountability. In addition, a systematic review by Riski et al. [25] identifies social support as a primary predictor of self-care behavior among CKD patients, underscoring its critical role in addressing comorbidities and sex disparities that frequently exacerbate inconsistencies in the peritoneal dialysis population. This mechanism likely operates through a buffering process, whereby community involvement enhances motivation and problem-solving capacity, as evidenced by a cross-sectional analysis of preventive self-care factors among peritoneal dialysis patients that links family support to improved technique mastery and quality of life [11].

In clinical nursing practice, these findings support the implementation of integrated interventions, such as family training programs grounded in peritoneal dialysis education frameworks described by Jaelani et al. [20]. These interventions aim to prevent complications by establishing a robust supportive environment, thereby contributing to improved health outcomes, as summarized in the CKD epidemiology review by Kovesdy [3]. This holistic approach may be particularly effective in resource-limited settings such as Indonesia, where national health surveys indicate a rising prevalence of CKD [4].

Demographic variables, including age, sex, education level, duration of CAPD therapy, and marital status, showed no statistically significant associations with self-care quality. The absence of significant relationships may be attributable to sample homogeneity and limited variability, which could reduce statistical power and obscure more subtle effects [26]. Therefore, these null findings should not be interpreted as evidence of no association in broader populations, but rather as a caution against overgeneralization and an indication of the need for larger and more diverse samples to detect nuanced influences.

While these associations provide a foundation for targeted interventions, several study limitations must be acknowledged to appropriately contextualize the findings. The cross-sectional design precludes causal inference, as it captures associations at a single time point rather than directional or temporal effects. Thus, the observed relationships should be interpreted as correlational rather than causal.

Furthermore, the relatively small sample size (n = 72) limits the precision and generalizability of the findings. Although the 95% CIs for key predictors such as knowledge (1.19–1.78), self-efficacy (1.14–1.42), and social support (1.16–1.64) are relatively narrow, indicating reasonable precision, the CIs for other variables (e.g., primary education, 0.33–8.57; marital status, 0.03–2.94; age, 0.99–1.08) are wide, reflecting substantial uncertainty and exploratory associations. As a result, multivariable analyses to adjust for potential confounders such as age or treatment duration were not feasible, which limits the robustness of the observed effects.

The use of an online survey method, while practical, may have introduced selection bias by excluding patients without reliable digital access, who are more likely to be older or have lower educational attainment. This limitation may restrict the generalizability of the findings and reduce the ability to evaluate potential non-response bias.

Future research should employ longitudinal study designs, inclusive recruitment strategies, and a priori power

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calculations, assuming an OR of approximately 2.5 to achieve at least 80% statistical power. Such approaches would strengthen causal inference and ensure that self-care enhancement strategies can be evaluated and applied across more diverse patient populations.

CONCLUSION

In this sample of CAPD patients in Central Java, higher levels of knowledge, self-efficacy, and social support were associated with improved self-care quality, whereas comorbidities were associated with barriers to optimal self-care. Sociodemographic variables, including age, sex, education, marital status, and treatment duration, showed no clear associations with self-care quality, potentially due to limited statistical power to detect moderate effects. These findings underscore the need for interventions that target knowledge enhancement, psychosocial support, and comorbidity management to improve self-care among this population.

To translate these findings into practice, clinical recommendations include targeted patient education using brief digital videos and visual aids focused on infection detection, aseptic techniques, and comorbidity management. Delivering content in simple, accessible language may enhance health literacy and adherence, while strengthening peer- and family-based social support systems can further reinforce sustained self-care behaviors.

For future research, larger longitudinal studies incorporating multivariable analyses are recommended to control for key confounders such as self-efficacy and comorbidities. The use of hybrid data collection approaches, combining online surveys with in-person interviews, may reduce selection bias and improve the generalizability of findings within Indonesian populations with CAPD.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and design acquisition - MSASN; data collection - MSASN; data analysis - YW; the interpretation of the results - ETP; drafting and critical revision of the manuscript - RS; and final approval - RS.

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DATA AVAILABILITY STATEMENT

Based on the characteristics of the study and the data utilized, no new data were generated or analyzed in this research; therefore, the data sharing statement is not applicable to this article. This manuscript reports the analysis of previously collected data as part of my doctoral dissertation project. The dataset is neither publicly available nor deposited in any data repository.

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Clinical Research Nursing Activities in Korea: Frequency, Importance, and Implications from an Importance–Performance Analysis

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Purpose: This study aimed to investigate the frequency and perceived importance of 52 clinical research nursing activities in Korea and to apply importance–performance analysis (IPA) to identify areas requiring improvement. **Methods:** A descriptive survey was conducted among 96 clinical research nurses (CRNs) with ≥2 years of experience. Data were collected online in May 2022 using a questionnaire addressing 14 general characteristics and 52 clinical research nursing activities across five dimensions: clinical practice (CP), study management (SM), care coordination and continuity, human subjects protection, and contributing to the science (CS), as defined by the US National Institutes of Health (NIH). Frequency and importance were evaluated on a 6-point Likert scale. Analyses included descriptive statistics, Pearson correlation coefficients, the t-test, analysis of variance with Duncan post hoc tests, and IPA. **Results:** The mean frequency and importance scores for the 52 activities were 2.02±1.27 and 2.91±1.24, respectively. CP activities were performed most often and rated as most important, whereas CS activities were performed least often and rated as least important. Higher education, certification, and professional association membership were associated with higher CS activity frequencies. IPA revealed strengths in CP and core SM activities, while regulatory reporting, data integrity assurance, and site audits were underperformed despite being highly important. **Conclusion:** Korean CRNs play essential roles in CP and SM but require enhanced education, institutional support, and clearer role delineation in regulatory and quality-assurance activities. These findings provide evidence to guide CRN education, policy development, and the strengthening of professional identity among CRNs in Korea.

Key Words: Clinical study; Nurses; Nursing

INTRODUCTION

Clinical research refers to studies in which investigators directly engage with living human subjects, human-derived specimens, behaviors, or phenomena. Among these, clinical trials assess the safety and efficacy of investigational medicinal products, medical devices, and advanced regenerative biotechnologies and monitor adverse events [1,2]. In Korea, clinical research has expanded markedly in recent years. As of 2023, Korea ranked fourth globally in clinical trial market share, and Seoul has held the top global position for the number of clinical trial activities for seven consecutive years since 2017. Various professionals contribute to clinical research, with clinical research coor-

dinators (CRCs) representing 21.5% of the workforce [3]. In Korea, most CRCs (89.7%–89.8%) are nurses, and the term "clinical research nurse" (CRN) is frequently used interchangeably with CRC [4,5]. The textbook Basic Education for Clinical Trial Personnel, published by the Ministry of Food and Drug Safety in 2005, also referred to CRCs as CRNs [6].

International discussions regarding CRN roles date back to the 1910s, and by the 1960s, the need for specialized knowledge and skills had become evident [7]. With the expansion of clinical trials, the number of CRNs grew throughout the 1980s and 1990s, accompanied by a growing body of literature describing their roles. In 2009, the National Institutes of Health (NIH) Clinical Center in the United States formally defined CRN roles and identified 52 core professional nursing activities organized into five dimensions: clinical practice (CP), study management (SM), care coordination and continuity (CCC), human subjects protection (HSP), and contributing to the science (CS) [8].

Bevans et al. [9] conducted a role delineation study using these 52 activities and reported that CP had the highest frequency and importance, whereas CS had the lowest. The single most frequently performed activity was "Provide direct care to research participant" within CP, while the least frequently performed was "Serve as an Institutional Review Board (IRB) member" within HSP. However, that study did not prioritize improvement needs because it did not assess discrepancies between frequency and importance.

Since then, the American Nurses Association officially recognized clinical research nursing as a nursing specialty in 2016 and published Clinical Research Nursing: Scope and Standards of Practice in 2017. In 2021, the International Association of Clinical Research Nurses developed a core curriculum to advance CRN professional development, further systematizing CRN identity and standards of practice [10,11].

In Korea, the demand for CRNs has increased alongside the rapid growth of clinical research. However, clear definitions and empirical studies of clinical research nursing practice remain limited. Do [12] cataloged 121 research nurse tasks based on four roles—educator, advocate, direct care provider, and clinical trial operator—outlined by the Korea Food and Drug Administration. Hwang [13] developed a job description for oncology clinical trial nurses. Yet, these studies, conducted more than 15 years ago, do not adequately reflect the rapidly evolving clinical research environment.

Therefore, research is needed to examine CRN activities in Korea using the 52 core activities across five dimensions identified by the NIH Clinical Center [8] and Bevans et al. [9]; to compare Korean CRN activities with international benchmarks; and to apply importance–performance analysis (IPA) to identify key areas for improvement. Such research could clarify CRN roles, provide evidence for education and policy development, and strengthen professional nursing practice in the Korean context. Accordingly, this study assessed the frequency and perceived importance of the 52 clinical research nursing activities across five dimensions among Korean CRNs and applied IPA to evaluate current practices, identify critical improvement needs, and propose strategic directions to enhance CRN professionalism.

The specific objectives of this study were as follows: (1) to identify the general characteristics of participants, (2) to investigate the frequency, importance, and correlations of the 52 clinical research nursing activities across five dimensions, (3) to compare differences in activity frequency across dimensions according to participants' characteristics, and (4) to visualize the distribution of the frequency and importance of the 52 activities using scatterplots and to conduct IPA to identify key activities requiring improvement.

METHODS

1. Study Design

This study employed a descriptive survey design to examine the frequency, perceived importance, and correlations of clinical research nursing activities performed by CRNs in Korea, using the list of 52 clinical research nursing activities defined by the NIH Clinical Center. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Setting and Samples

The participants were CRNs working in Korea. To ensure sufficient clinical research experience, inclusion criteria required nurses to have participated in clinical research for at least two years within the past five years. Exclusion criteria were as follows: individuals who participated in clinical research without any direct face-to-face interaction with

research participants throughout the study period (for example, those involved only in data entry, data management, or medical record review), and those who conducted only in vitro diagnostic medical device studies using residual specimens.

The required sample size for correlation analysis was calculated using G*Power 3.1.9.7. Assuming a correlation coefficient of 0.3, a significance level of .05, a statistical power of .8, and a two-tailed test, the minimum required sample size was 84 participants [14]. In this study, 96 participants were ultimately included.

3. Measurements

1) General characteristics of the participants

Fourteen items were used to assess participants' demographic and work-related characteristics. These included age, sex, educational level, marital status, region, annual salary, place of work, employment type, clinical research experience within the past five years, number of ongoing projects, types of clinical research participated in, possession of clinical trial professional certification, affiliation with a relevant professional association, and the presence of job guidelines. Initially, possession of clinical trial professional certification was surveyed as two separate credentials, but these were combined into a single variable for analysis to reflect their stepwise structure.

2) Frequency and importance of clinical research nursing activities

The frequency and perceived importance of clinical research nursing activities were measured using the list of 52 activities across five dimensions developed by the NIH Clinical Center Nursing Team [8]. This tool is publicly available for download and use by CRNs. As no prior studies had used an officially translated Korean version, the 52 activities were translated into Korean by the researcher, reviewed by five practicing CRNs for accuracy and clarity, and further refined through consultation with a bilingual Korean-American nursing faculty member and a Korean nursing faculty member. The five dimensions are (1) CP, (2) SM, (3) CCC, (4) HSP, and (5) CS. (1) The CP dimension (4 items) involves providing direct care and support to research participants and their families. (2) The SM dimension (23 items) includes ensuring participant safety, addressing clinical needs, and supporting protocol integrity and data collection. (3) The CCC dimension (10 items) focuses on integrating research and clinical activities and coordinating study requirements. (4) The HSP dimension (6 items) emphasizes advocacy for participant safety and rights. (5) The CS dimension consists of nine items representing activities that contribute to science in general, particularly to nursing science and practice, including developing new ideas, exploring innovations, and applying research findings to practice [15].

In this study, the frequency score indicated how often a CRN performs each activity, whereas the importance score reflected the perceived significance of each activity in the CRN's role [9]. Each item was rated on a 6-point Likert scale. For frequency 0, not part of my practice; 1, infrequently/1 to 2 times per year; 2, monthly; 3, weekly; 4, once per day; 5, multiple times per day. For importance 0, not part of my role; 1, not important to my role; 2, somewhat important to my role; 3, important to my role; 4, very important to my role; 5, essential to my role. A higher frequency score indicated more frequent performance of the activity, and a higher importance score indicated greater perceived importance in the clinical research environment. Bevans et al. [9] reported Cronbach's $\alpha = .95$ for frequency and $\alpha = .96$ for importance. In the present study, Cronbach's α was .94 for frequency and .98 for importance.

4. Data Collection

Data were collected from May 13 to May 17, 2022. To recruit participants, an IRB-approved recruitment notice was posted on three online platforms where CRCs with nursing licenses actively participate. The notice included the study topic, purpose, inclusion and exclusion criteria, participation procedures, estimated time required, potential benefits, principal investigator's information, survey link, and contact details. Eligible individuals who consented to participate accessed the survey link independently, completed the online questionnaire, and submitted their responses. The questionnaire required approximately 15 minutes to complete. In this online survey, completion of all items was mandatory for submission; therefore, no missing data were present.

5. Ethical Considerations

This study was conducted after obtaining approval from the Institutional Review Board (IRB) of Kangwon National University Hospital (IRB No. 2022-03-002). Upon accessing

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the survey link, participants received the IRB contact information to ensure their rights and protection. Information regarding data security and disposal was provided, and informed consent for the collection of personal information was obtained. Upon completing the questionnaire, all participants received a mobile beverage coupon as compensation.

6. Data Analysis

Data were analyzed using IBM SPSS Statistics ver. 28.0 (IBM Corp., Armonk, NY, USA). The general characteristics of participants were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The reliability of the measurement tool was assessed using Cronbach's α.

The mean and standard deviation of frequency and importance of the 52 clinical research nursing activities across the five dimensions were calculated using descriptive statistics. Correlations between frequency and importance were examined using Pearson's correlation coefficient. Data normality was verified by confirming sample size adequacy based on the Central Limit Theorem and by evaluating skewness and kurtosis according to the criteria proposed by Kline [16]. Differences in activity frequency across dimensions based on participants' characteristics were analyzed using the independent t-test and one-way analysis of variance (ANOVA), followed by Duncan's post hoc test.

The distribution of frequency and importance of the 52 activities was visualized using scatterplots. Frequency scores were plotted on the x-axis as a proxy indicator of performance, and importance scores were plotted on the y-axis. Mean values of frequency and importance were used as reference lines to divide the scatterplots into four quadrants. Based on this framework, IPA was conducted to identify key activities requiring improvement. IPA is an analytical technique that visualizes a two-dimensional graph using importance and performance as its axes and is applied to determine priorities effectively [17].

RESULTS

1. General Characteristics of Participants

The general characteristics of the participants are presented in Table 1. The mean age was 32.81±6.91 years, and the majority were female (n=91, 94.8%). Most participants held a bachelor's degree (76.0%), and more than half reported an annual salary of less than 40 million KRW (n=49, 51.0%). The largest proportion were employed at university hospitals (72.9%), and 31 participants (32.3%) were permanent employees. Only 24 participants (25.0%) held a clinical trial professional certification, and 23 (24.0%) reported affiliation with a relevant professional association. Furthermore, 45 participants (46.9%) indicated that they either had no job guidelines or were unaware of such guidelines.

2. Frequency, Importance, and Correlation of 52 Clinical Research Nursing Activities across 5 Dimensions

Table 2 presents the frequency, perceived importance, and correlation of clinical research nursing activities. The overall mean frequency score for the 52 activities was 2.02±1.27. The most frequently performed activity was "Collect data on research participant based on study endpoints (SM13)" (3.67±1.17), whereas the least frequently performed activity was "Serve as an IRB member (HSP5)" (0.46±0.79). The overall mean importance score was 2.91±1.24. The highest-rated activity in terms of importance was "Comply with International Conference on Harmonization (ICH) Good Clinical Practice guidelines and Korean Good Clinical Practice guidelines (SM12)" (3.66±1.25), while the lowest-rated activity was "Serve as an expert in a specialty area (e.g., grant reviewer, editorial board, presenter, etc.) (CS2)" (1.89±1.35).

Correlation analysis showed that four activities exhibited no statistically significant relationship between frequency and importance: "Participate in study development" ($r=.17$, $p=.094$), "Participate in site visits and/or audits" ($r=.17$, $p=.090$), "Serve as an IRB member" ($r=.07$, $p=.514$), and "Disseminate clinical expertise and best practices related to clinical research through presentations, publications and/or interactions with nursing colleagues" ($r=.18$, $p=.079$). The remaining 48 activities demonstrated significant positive correlations.

The results by dimension are summarized in Table 3. The CP dimension had the highest mean frequency (3.04±1.09), followed by SM (2.24±0.69), CCC (1.99±0.79), HSP (1.80±0.81), and CS (1.18±0.82). In terms of importance, the CP dimension again ranked highest (3.58±1.10), followed by SM (3.04±0.90), HSP (2.91±1.02), CCC (2.80±0.90), and CS (2.37±1.00). This ranking closely mirrored the frequency order.

Correlation analysis also indicated significant positive associations between frequency and importance across all

Table 1. General Characteristics of the Participants (N=96)

Characteristics	Categories	n (%)	M±SD
Age (year)	20–29	8 (8.3)	32.81±6.91
	30–39	58 (60.4)	
	40–49	25 (26.0)	
	50–59	5 (5.2)	
Sex	Female	91 (94.8)	
	Male	5 (5.2)	
Education level	Associate degree	10 (10.4)	
	Bachelor	73 (76.0)	
	Master	11 (11.5)	
	Doctoral	2 (2.1)	
Marital status	Single	34 (35.4)	
	Married/divorced	62 (64.6)	
Region	Capital area	75 (78.1)	
	Noncapital area	21 (21.9)	
Annual salary (₩10,000)	<4,000	49 (51.0)	
	4,000–4,999	39 (40.6)	
	≥5,000	8 (8.3)	
Place of work	University hospital	70 (72.9)	
	General hospital	20 (20.8)	
	Research center/private company	6 (6.2)	
Employment type	Permanent	31 (32.3)	
	Contract	17 (17.7)	
	Private	48 (50.0)	
Clinical research experience (years)	≥2 to <3	35 (36.5)	
	≥3 to <5	30 (31.3)	
	≥5	31 (32.3)	
Number of ongoing projects	1–5	63 (65.6)	5.24±4.51
	6–10	23 (24.0)	
	≥11	10 (10.4)	
Type of clinical research participated in	Phase 1	23 (24.0)	
	Phase 2	50 (52.1)	
	Phase 3	62 (64.6)	
	Phase 4 and PMS	53 (55.2)	
	Others	45 (46.9)	
Clinical trial professional certification	Yes	24 (25.0)	
	No	72 (75.0)	
Affiliation with relevant professional association	Yes	23 (24.0)	
	No	73 (76.0)	
Job guideline	Yes	51 (53.1)	
	No	33 (34.4)	
	Don't know	12 (12.5)	

M=mean; PMS=post-market surveillance; SD=standard deviation.

five dimensions: CP (r=.66, p<.001), SM (r=.58, p<.001), CCC (r=.48, p<.001), HSP (r=.44, p<.001), and CS (r=.30, p=.003).

3. Differences in the Frequency of Clinical Research Nursing Activities across Five Dimensions according to Participants' Characteristics

Differences in the frequency of clinical research nursing activities across the five dimensions according to participants' characteristics are presented in Table 4. Education

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Table 2. Frequency, Importance, and Correlations of Clinical Research Nursing Activities

Activities	Frequency	Importance	r (*p*)
	M ± SD		
Overall frequency and importance score	2.02 ± 1.27	2.91 ± 1.24	
Clinical practice			
1. Provide direct nursing care to research participants	2.96 ± 1.23	3.65 ± 1.12	.37 (< .001)
2. Provide teaching to research participants and family regarding study participation, participant's current clinical condition, and/or disease process	2.81 ± 1.48	3.49 ± 1.11	.55 (< .001)
3. Monitor the research participant and report potential adverse events to a member of the research team	2.90 ± 1.28	3.55 ± 1.20	.59 (< .001)
4. Record research data (example: documentation of vital signs, administration of a research compound, participant responses, etc.) in approved source document (example: medical records, data collection sheets, etc.)	3.51 ± 1.41	3.61 ± 1.31	.72 (< .001)
Study management			
1. Participate in study development	1.58 ± 1.43	2.61 ± 1.10	.17 (.094)
2. Participate in research participant recruitment	2.18 ± 1.44	2.78 ± 1.35	.51 (< .001)
3. Participate in screening potential research participants for eligibility	2.97 ± 1.27	3.50 ± 1.16	.62 (< .001)
4. Coordinate and facilitate the collection of research specimens	2.66 ± 1.30	3.27 ± 1.25	.54 (< .001)
5. Develop study specific materials for research participant education	1.61 ± 1.26	2.79 ± 1.15	.39 (< .001)
6. Perform quality-assurance activities to assure data integrity	1.43 ± 1.30	3.00 ± 1.20	.44 (< .001)
7. Participate in the preparation of reports for appropriate regulatory and monitoring bodies/boards	1.90 ± 1.14	2.94 ± 1.19	.47 (< .001)
8. Facilitate accurate communication among research sites	3.06 ± 1.24	3.36 ± 1.22	.56 (< .001)
9. Facilitate communication within the research team	3.31 ± 1.21	3.57 ± 1.11	.74 (< .001)
10. Contribute to the development of case report forms	1.11 ± 1.20	2.59 ± 1.29	.38 (< .001)
11. Participate in the set-up of a study specific database	1.20 ± 1.33	2.36 ± 1.27	.47 (< .001)
12. Comply with International Conference on Harmonization (ICH) Good Clinical Practice guidelines and Korean Good Clinical Practice guidelines	3.45 ± 1.42	3.66 ± 1.25	.74 (< .001)
13. Collect data on research participant based on study endpoints	3.67 ± 1.17	3.64 ± 1.15	.64 (< .001)
14. Facilitate scheduling and coordination of study procedures	2.25 ± 1.60	3.08 ± 1.26	.52 (< .001)
15. Provide nursing expertise to the research team during study development and implementation	2.22 ± 1.42	3.07 ± 1.04	.45 (< .001)
16. Protect research participant data in accordance with regulatory requirements	3.36 ± 1.31	3.50 ± 1.34	.72 (< .001)
17. Participate in site visits and/or audits	1.05 ± 1.16	2.91 ± 1.38	.17 (.090)
18. Support study grant and budget development	0.94 ± 1.15	2.25 ± 1.25	.32 (.002)
19. Oversee human resources (people) related to research process	1.14 ± 1.19	2.49 ± 1.21	.38 (< .001)
20. Record data on approved study documents (Example: Case Report Forms, research/study database, etc.)	3.48 ± 1.44	3.63 ± 1.34	.74 (< .001)
21. Facilitate processing and handling (storage and shipping) of research specimens	2.43 ± 1.42	3.13 ± 1.26	.55 (< .001)
22. Identify clinical care implications during study development (example: staff competencies and resources, equipment, etc.)	2.31 ± 1.42	2.96 ± 1.24	.56 (< .001)
23. Participate in the identification and reporting of research trends	2.10 ± 1.17	2.94 ± 1.18	.50 (< .001)
Care coordination and continuity			
1. Facilitate the education of the interdisciplinary team on study requirements	1.41 ± 1.40	2.41 ± 1.17	.28 (.005)
2. Collaborate with the interdisciplinary team to create and communicate a plan of care that allows for safe and effective collection of clinical research data	1.59 ± 1.24	2.67 ± 1.25	.55 (< .001)
3. Coordinate research participant study visits	3.24 ± 1.41	3.51 ± 1.24	.67 (< .001)
4. Provide nursing leadership within the interdisciplinary team	1.61 ± 1.32	2.52 ± 1.19	.44 (< .001)
5. Coordinate interdisciplinary meetings and activities in the context of a study	1.36 ± 1.18	2.28 ± 1.25	.38 (< .001)
6. Coordinate referrals to appropriate interdisciplinary services outside the immediate research team	1.49 ± 1.22	2.35 ± 1.23	.49 (< .001)
7. Communicate the impact of study procedures on the research participants	2.46 ± 1.25	3.07 ± 1.26	.50 (< .001)
8. Provide nursing expertise to community-based health care personnel related to study participation	1.13 ± 1.29	2.40 ± 1.24	.46 (< .001)

(Continued on the next page)

Table 2. Continued

Activities	Frequency M±SD	Importance M±SD	r (*p*)
9. Facilitate research participant inquiries and concerns	2.95±1.11	3.47±1.09	.61 (<.001)
10. Provide indirect nursing care (example: participation in clinical, unit, and/or protocol rounds; scheduling study related tests, etc.) in the context of research participation	2.68±1.37	3.28±1.23	.58 (<.001)
Human subjects protection			
1. Facilitate the initial and ongoing informed consent/assent process	2.70±1.28	3.35±1.23	.58 (<.001)
2. Support research participant in defining his/her reasons and goals for participating in a study	2.71±1.32	3.20±1.28	.55 (<.001)
3. Collaborate with the interdisciplinary team to address ethical conflicts	1.45±1.25	2.78±1.22	.45 (<.001)
4. Coordinate research activities to minimize subject risk	2.17±1.40	3.18±1.19	.44 (<.001)
5. Serve as an IRB member	0.46±0.79	2.28±1.50	.07 (.514)
6. Manage potential ethical and financial conflicts of interest for self	1.33±1.14	2.66±1.35	.47 (<.001)
Contributing to the science			
1. Disseminate clinical expertise and best practices related to clinical research through presentations, publications and/or interactions with nursing colleagues	1.08±1.40	2.25±1.29	.18 (.079)
2. Serve as an expert in a specialty area (example: grant reviewer, editorial board, presenter, etc.)	0.54±0.88	1.89±1.35	.25 (.015)
3. Participate in the query and analysis of research data	2.14±1.48	2.94±1.34	.55 (<.001)
4. Generate practice questions as a result of a new study procedure or intervention	1.54±1.24	2.57±1.19	.40 (<.001)
5. Collaborate with the interdisciplinary team to develop innovations in care delivery that have the potential to improve patient outcomes and accuracy of data collection	1.10±1.23	2.33±1.19	.29 (.004)
6. Identify questions appropriate for clinical nursing research as a result of study team participation	0.90±1.21	2.06±1.22	.29 (.004)
7. Mentor junior staff and students participating as members of the research team	1.35±1.26	2.85±1.31	.40 (<.001)
8. Perform secondary data analysis to contribute to the development of new ideas	0.69±1.01	2.02±1.25	.26 (.009)
9. Serve as a resource to new investigators	1.27±1.20	2.44±1.30	.41 (<.001)

IRB = Institutional Review Board; M = mean; SD = standard deviation.

Table 3. Frequency, Importance, and Correlations of Clinical Research Nursing Practice Dimensions

Clinical research nursing practice dimension	Frequency M±SD	Importance M±SD	r (*p*)
Clinical practice	3.04±1.09	3.58±1.10	.66 (<.001)
Study management	2.24±0.69	3.04±0.90	.58 (<.001)
Care coordination and continuity	1.99±0.79	2.80±0.90	.48 (<.001)
Human subjects protection	1.80±0.81	2.91±1.02	.44 (<.001)
Contributing to the science	1.18±0.82	2.37±1.00	.30 (.003)

M = mean; SD = standard deviation.

level was significantly associated with differences in SM (F=5.32, p=.007) and CS (F=3.72, p=.028). Post hoc analysis indicated that participants with a master's degree or higher reported significantly higher activity frequencies than those with an associate or bachelor's degree. Marital status showed significant differences only in the HSP dimension (t=2.12, p=.037), with single participants reporting higher activity frequencies than married or divorced participants. Annual salary demonstrated significant differences in SM (F=4.09, p=.020) and CS (F=8.50, p<.001). Participants with higher salaries reported greater involvement in these activities than those with lower salaries. Place of work was significantly associated with both CP (F=4.78, p=.011) and CS (F=6.45, p=.002). Participants working at research centers or private companies reported higher frequencies in CS activities compared to those at university hospitals. Employment type was significantly associated with differences in CP (F=5.99, p=.004) and CS (F=13.20, p<.001). Private employees reported significantly higher frequencies in CP compared to permanent employees. Clinical research experience was significantly associated with differences in CP (F=4.02, p=.021) and CS (F=3.29, p=.042). Participants with ≥5 years of experience reported higher frequencies in CP, whereas those with 3 to 5 years of experience reported higher frequencies in CS. The number of ongoing projects was significantly related to CP (F=7.95, p<.001). Participants involved in more than six projects reported higher frequencies for CP than those involved in fewer projects. Clinical trial professional certification was associated with significant differences in CP

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Table 4. Differences in the Frequency of Clinical Research Nursing Activities across Five Dimensions according to Participants' Characteristics

Characteristics	Categories	n (%)	Clinical practice			Study management			Care coordination and continuity			Human subjects protection			Contributing to the science		
			M±SD	F/t	*p* (Duncan)	M±SD	F/t	*p* (Duncan)	M±SD	F/t	*p* (Duncan)	M±SD	F/t	*p* (Duncan)	M±SD	F/t	*p* (Duncan)
Education level	Associate degree[a]	10 (10.4)	3.08±1.21	0.23	.793	1.85±0.40	5.32	.007 (a, b<c)	1.76±0.51	1.64	.200	1.35±0.58	2.80	.066	0.83±0.65	3.72	.028 (a<c)
	Bachelor[b]	73 (76.0)	3.01±1.15			2.20±0.67			1.96±0.82			1.80±0.82			1.14±0.81		
	Master or higher[c]	13 (13.6)	3.23±0.66			2.73±0.81			2.32±0.72			2.14±0.78			1.69±0.85		
Marital status	Single	34 (35.4)	3.18±1.10	0.88	.383	2.33±0.73	1.00	.319	2.18±0.88	1.71	.090	2.03±0.89	2.12	.037	1.38±0.79	1.78	.078
	Married/ divorced	62 (64.6)	2.97±1.09			2.18±0.68			1.89±0.72			1.67±0.74			1.07±0.83		
Annual salary (₩10,000)	<4,000[a]	49 (51.0)	2.97±1.15	0.50	.608	2.04±0.61	4.09	.020	1.82±0.74	2.59	.081	1.65±0.75	1.73	.183	0.87±0.73	8.50	<.001 (a<b, c)
	4,000–4,999[b]	39 (40.6)	3.17±1.01			2.44±0.76			2.19±0.83			1.97±0.88			1.45±0.82		
	≥5,000[c]	8 (8.3)	2.84±1.20			2.39±0.62			2.10±0.71			1.92±0.70			1.74±0.65		
Place of work	University hospital[a]	70 (72.9)	3.25±1.09	4.78	.011	2.29±0.72	2.43	.093	2.01±0.84	0.32	.729	1.76±0.87	1.40	.252	1.02±0.75	6.45	.002 (a<c)
	General hospital[b]	20 (20.8)	2.49±0.94			1.96±0.58			1.88±0.63			1.79±0.66			1.52±0.85		
	Research center/ private company[c]	6 (6.2)	2.54±0.97			2.54±0.53			2.12±0.78			2.33±0.33			1.96±0.89		
Employment type	Permanent[a]	31 (32.3)	2.54±0.76	5.99	.004 (a<c)	2.21±0.60	0.56	.572	1.98±0.61	0.21	.811	1.97±0.60	1.07	.346	1.73±0.77	13.20	<.001 (a>b, c)
	Contract[b]	17 (17.7)	3.04±1.20			2.10±0.81			1.89±0.81			1.67±0.95			0.98±0.65		
	Private[c]	48 (50.0)	3.37±1.13			2.30±0.72			2.03±0.89			1.74±0.87			0.89±0.74		
Clinical research experience (year)	≥2 to <3[a]	35 (36.5)	2.79±1.17	4.02	.021 (a, b<c)	2.12±0.66	0.90	.411	1.83±0.85	1.46	.238	1.71±0.80	0.63	.535	1.01±0.82	3.29	.042 (a, c<b)
	≥3 to <5[b]	30 (31.3)	2.89±1.02			2.25±0.65			2.16±0.64			1.93±0.68			1.49±0.82		
	≥5[c]	31 (32.3)	3.48±0.96			2.35±0.77			2.02±0.85			1.78±0.94			1.07±0.77		
No. of ongoing projects	1–5[a]	63 (65.6)	2.75±1.14	7.95	<.001 (a<b, c)	2.12±0.65	2.66	.075	1.90±0.75	1.36	.262	1.73±0.74	2.45	.092	1.31±0.85	2.73	.070
	6–10[b]	23 (24.0)	3.67±0.76			2.50±0.83			2.20±0.98			2.11±0.93			1.02±0.79		
	≥11[c]	10 (10.4)	3.48±0.67			2.33±0.49			2.12±0.44			1.55±0.81			0.73±0.45		
Clinical trial professional certification	Yes	24 (25.0)	2.65±1.15	–2.10	.039	2.26±0.84	0.18	.858	2.12±0.79	0.92	.358	2.10±0.71	2.15	.034	1.88±0.72	5.46	<.001
	No	72 (75.0)	3.18±1.05			2.23±0.65			1.95±0.79			1.70±0.82			0.95±0.72		
Affiliation with relevant professional association	Yes	23 (24.0)	2.47±0.70	–3.86	<.001	2.20±0.51	–0.31	.757	2.13±0.55	1.00	.322	1.98±0.61	1.20	.234	1.82±0.67	4.75	<.001
	No	73 (76.0)	3.23±1.14			2.25±0.75			1.95±0.85			1.75±0.86			0.98±0.76		

M = mean; SD = standard deviation.

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(t=–2.10, p=.039), HSP (t=2.15, p=.034), and CS (t=5.46, p<.001), with certified participants reporting higher frequencies for HSP and CS, but lower frequencies for CP. Affiliation with a relevant professional association was also significantly associated with differences in CP (t=–3.86, p<.001) and CS (t=4.75, p<.001), with affiliated participants reporting higher activity frequencies in CS, but lower activity frequencies in CP, than those without an affiliation. With respect to other variables, sex was excluded from the statistical analysis because the number of male participants was very small compared to females. In addition, age, region, and job guidelines were omitted from the results table because no significant differences were observed for these variables.

4. Importance–Performance Analysis of Clinical Research Nursing Activities

The IPA results are presented in Figure 1. Clinical research nursing activities were distributed across all four quadrants, highlighting both areas of strength and those requiring targeted improvement.

1) Quadrant I (keep up the good work)

This quadrant included activities with high frequency and high importance. Most activities in the CP dimension (e.g., CP1, providing direct care; CP2, education; CP3, monitoring adverse events; CP4, recording data) and key activities in the SM dimension (e.g., SM3, screening participants; SM4, specimen collection; SM12, Good Clinical Practice compliance; SM13, endpoint data collection; SM16, data protection) were located here. In addition, several CCC activities (CCC3, CCC7, CCC9, CCC10) and HSP activities (HSP1, HSP2, HSP4) appeared in this quadrant, indicating that these core responsibilities are consistently performed and regarded as highly important in practice.

2) Quadrant II (concentrate here)

Activities with high importance but relatively low performance were placed in this quadrant, representing priority areas for improvement. Three SM activities—SM6 (quality assurance for data integrity), SM7 (regulatory reporting), and SM17 (site visits and audits)—were included, suggesting a need to strengthen competencies related to data quality assurance and regulatory compliance among CRNs.

3) Quadrant III (low priority)

This quadrant comprised activities rated low in both importance and frequency. Many SM activities (e.g., SM1, study development; SM5, participant education material development; SM18, budget development), CCC activities (e.g., CCC1, interdisciplinary team education; CCC5, interdisciplinary coordination), HSP activities (e.g., HSP3, ethical conflict resolution; HSP5, IRB membership), and CS activities (e.g., CS1, dissemination; CS2, expert role; CS8, secondary data analysis) were located here. These results suggest that these activities are viewed as peripheral to the primary responsibilities of CRNs within the Korean clinical research environment.

4) Quadrant IV (possible overkill)

Only one activity, SM2 (participant recruitment), appeared in this quadrant, indicating comparatively high performance relative to its perceived importance. This finding suggests that the level of effort or resources allocated to participant recruitment may exceed its relative value when compared with other essential areas.

DISCUSSION

This study is the first in Korea to systematically evaluate the frequency and perceived importance of 52 clinical research nursing activities across five dimensions and to apply IPA to identify key areas for improvement. The findings provide meaningful insights into the current status of CRN practice in Korea, with implications for education, policy development, and professional advancement.

Consistent with the findings of Bevans et al. [9], this study showed that activities within the CP dimension were performed most frequently and were rated as most important. Activities such as direct patient care, participant education, adverse event monitoring, and research data documentation remained central to CRN practice in both contexts. This consistency reinforces that the core function of CRNs in Korea also lies in balancing protocol fidelity and participant protection, reflecting international trends emphasized in recent scoping reviews [18]. In contrast, activities in the CS dimension were performed least often and were perceived as less important, mirroring international patterns. However, whereas Bevans et al. [9] primarily presented overall role delineation, the present study advanced the analysis by applying IPA to prioritize improvement needs, thereby identifying specific dimensions requiring targeted intervention.

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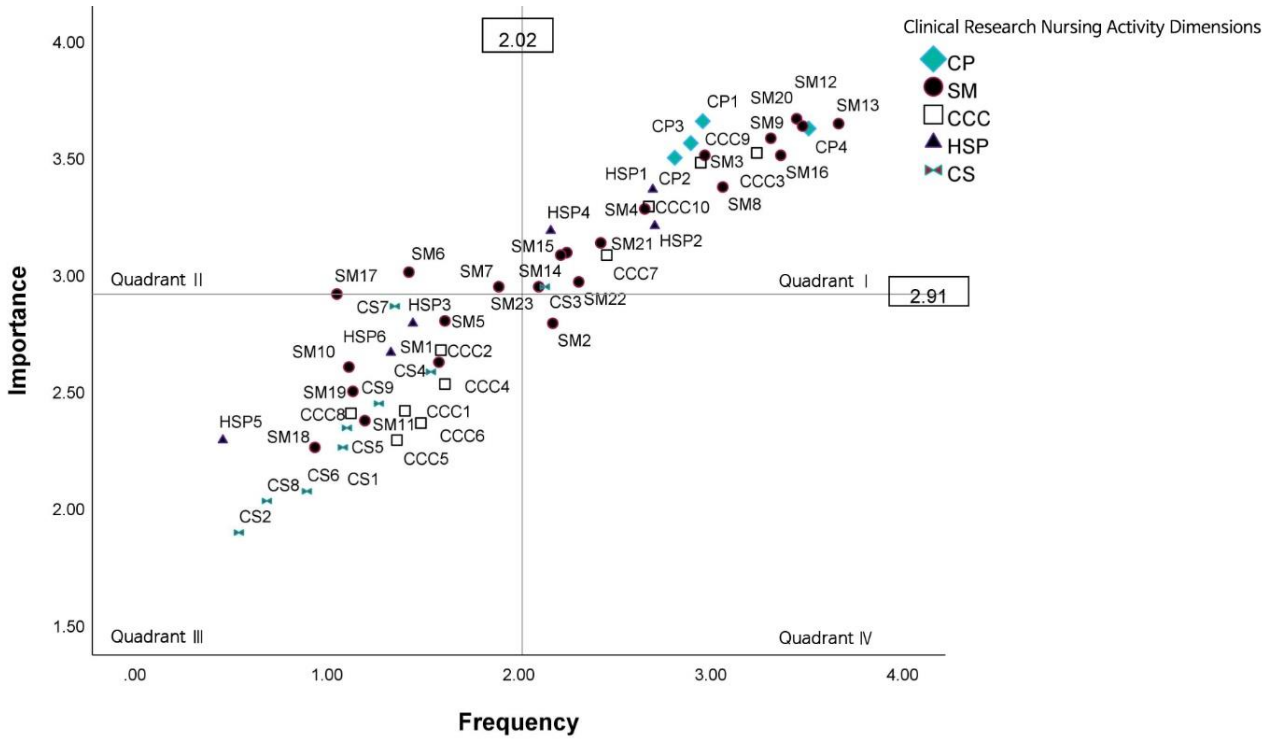

Quadrant	CP	SM	CCC	HSP	CS
Quadrant I (Keep up the good work)	CP1, CP2, CP3, CP4	SM3, SM4, SM8, SM9, SM12, SM13, SM14, SM15, SM16, SM20, SM21, SM22, SM23	CCC3, CCC7, CCC9, CCC10	HSP1, HSP2, HSP4	CS3
Quadrant II (Concentrate here)		SM6, SM7, SM17			
Quadrant III (Low Priority)		SM1, SM5, SM10, SM11, SM18, SM19	CCC1, CCC2, CCC4, CCC5, CCC6, CCC8	HSP3, HSP5, HSP6	CS1, CS2, CS4, CS5, CS6, CS7, CS8, CS9
Quadrant IV (Pssible Overkill)		SM2			

Figure 1. Importance–performance analysis of clinical research nursing activities. For description of each item (e.g., CP1), please refer to Table 2. CCC = care coordination and continuity; CP = clinical practice; CS = contributing to the science; HSP = human subjects protection; SM = study management.

The analysis of participant characteristics revealed important trends. Higher education levels, professional certification, and membership in professional associations were significantly associated with greater activity frequencies across multiple dimensions. These findings underscore the value of formal education, certification processes, and active professional engagement in promoting CRN competencies. Such professionalization pathways serve as essential mechanisms that contribute to the systematic development of advanced research competencies in CRNs, enhancing their understanding of clinical trials, improving the accuracy of result interpretation, strengthening scientific rigor, and promoting the advancement of nursing science [19]. Additionally, CRNs employed in university hospitals reported greater involvement in CP, whereas those in research centers or private companies showed higher en-

gagement in CS, reflecting differing institutional roles and expectations. These variations highlight the need for training and policy support tailored to specific organizational contexts.

The IPA revealed strong performance in CP and selected SM activities, which is consistent with previous studies emphasizing the critical role of CRNs in participant management, safety monitoring, and protocol implementation [19,20]. CRNs occupy a unique position by simultaneously providing continuous nursing care to research participants and adhering rigorously to study protocols as part of the investigative team, a dual role documented in both earlier and more recent literature [9,18]. The high levels of performance in CP and SM activities observed in this study indicate successful implementation of these core CRN responsibilities in Korean clinical research settings. However, despite these strengths, Quadrant II (concentrate here) highlighted that quality assurance for data integrity, regulatory reporting, and site visits or audits were highly important yet underperformed. Quality-assurance activities are increasingly recognized as essential components of clinical trial quality management systems, playing a pivotal role in ensuring data consistency and participant safety [21]. These findings indicate that Korean CRNs may face insufficient institutional support, limited training, or lack of authority to fully engage in these critical functions. This aligns with global challenges frequently reported by clinical trial professionals [22]. Additionally, the lower involvement may reflect common role separation in clinical research operations, where specialized monitors or auditors often assume responsibility for such tasks rather than CRNs [2]. Nevertheless, the high perceived importance of these functions among CRNs indicates a strong awareness of the centrality of quality assurance and regulatory compliance to research integrity. This recognition underscores the potential for CRNs to play an expanded role in research quality management. International studies have noted that CRNs increasingly serve as central figures in ensuring data integrity and compliance and have the potential to advance as key agents of research quality oversight [19]. Therefore, targeted educational opportunities and supportive institutional policies are needed to enable CRNs to take a more active role in monitoring, quality assurance, and regulatory processes.

Activities in Quadrant III (low priority), such as IRB membership, dissemination of expertise, and budget development, were infrequently performed and regarded as peripheral to CRN practice. This phenomenon may reflect the reality that CRNs primarily focus on clinical research support and administrative management, leaving limited time and resources for academic or scientific activities that contribute to research advancement. Restricted awareness of such roles and limited opportunities for professional development may also contribute. Previous studies likewise reported that CRNs' responsibilities center on clinical support and administrative tasks, with relatively low involvement in scientific or academic functions [19,20]. Furthermore, limited engagement in research decision-making and scholarly leadership reflects a broader global challenge in CRN professionalization, where constrained autonomy and ambiguous role definitions limit participation in strategic domains such as research ethics review [18]. Although these activities may not be immediate priorities, expanding CRN involvement in dissemination and professional leadership may foster long-term role development and recognition. Participant recruitment (SM2), located in Quadrant IV (possible overkill), suggested potential inefficiencies in resource allocation, indicating a need for improved balance in workload distribution. While recruitment is a critical early step in the research process, excessive investment in recruitment tasks, even when successful, may signal an imbalanced workload. This aligns with findings that high workload and insufficient resource allocation contribute substantially to stress and high turnover among clinical trial professionals [22]. Drawing on previous studies of general clinical nurses, where misalignment between assigned roles and actual tasks has been associated with reduced job satisfaction and diminished work efficiency [23], organizational measures that enable CRNs to focus on core clinical research nursing activities as perceived by themselves may be beneficial. In accordance with the classic IPA framework proposed by Martilla and James [17], institutions can enhance the overall quality of clinical trials and improve CRN retention by reallocating resources from over-invested areas.

The findings indicate that Korean CRNs are well positioned to provide direct clinical and research care but require additional training and institutional support in regulatory and data quality dimensions. Educational programs should integrate modules on Good Clinical Practice compliance as a foundation and must also cover data integrity assurance and regulatory reporting. Furthermore, certification and professional association membership should be promoted as mechanisms to enhance competencies and

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standardize CRN practice. At the policy level, establishing formal guidelines and role definitions specific to CRNs in Korea could reduce variability, strengthen quality assurance, and align domestic practice with international benchmarks. Ultimately, these tailored educational and policy interventions will strengthen CRN competencies and standardize practice, enabling CRNs to participate more actively in research governance and quality management systems, thereby safeguarding data integrity and participant safety [18,21].

This study has several limitations. First, the data were collected through an online survey of 96 CRNs in Korea, which restricts the generalizability of the findings. Additionally, the activity list used as the study instrument was originally developed in the United States and may not fully reflect the Korean clinical research environment. Future research should employ random sampling of CRNs across national research institutions and utilize face-to-face data collection methods to enhance the reliability and representativeness of the results. Furthermore, to more accurately define the unique activities and professional competencies of CRNs, it is necessary to identify activity items that are contextually appropriate for the Korean clinical research environment. Based on this need, the development of a domestically tailored clinical research nursing activity assessment tool is warranted.

CONCLUSION

This study is the first in Korea to systematically evaluate the frequency and perceived importance of 52 clinical research nursing activities across five dimensions and to apply IPA to identify key areas for improvement. The findings confirmed that CRNs play a central role in CP and SM while also revealing critical gaps in regulatory and quality assurance functions.

These results suggest that additional education, training, and institutional support are required to strengthen CRN competencies in areas such as compliance with ICH and Korean Good Clinical Practice guidelines, regulatory reporting, and data integrity assurance. Moreover, clinical trial professional certification and participation in professional associations were associated with higher performance across multiple dimensions, underscoring their importance as key contributors to advancing CRN professionalism.

Ultimately, this study clarified the activities of CRNs in Korea and proposed strategic directions for improvement, thereby providing foundational evidence for the advancement of CRN education, contributions to policy development, and the strengthening of professional identity. Defining the unique competencies and explicit roles of CRNs is essential for integrating nursing expertise into the clinical research environment, and further research, as well as broader recognition of CRN professionalism in Korea, are needed to achieve this goal.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and design - JYP; data acquisition and analysis - DSL and JYP; investigation - DSL and JYP; methodology - DSL and JYP; project administration - DSL and JYP; resources - DSL and JYP; software - DSL and JYP; supervision - DSL; validation - DSL and JYP; visualization - DSL and JYP; drafting and critical revision of the manuscript - DSL and JYP.

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DATA AVAILABILITY STATEMENT

The data can be obtained from the corresponding authors.

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The Relationship of Autonomy, Self-Efficacy, and Social Support with Rehabilitation Motivation in Patients with Acute Stroke: A Cross-Sectional Study

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Purpose: This study investigated the relationships of autonomy, self-efficacy, and social support with rehabilitation motivation in patients who had undergone acute stroke management. **Methods:** A cross-sectional descriptive correlational study was conducted at a tertiary university hospital in Suwon, South Korea. Data were collected from June 1, 2023, to June 1, 2024, using structured self-reported questionnaires administered to patients scheduled for discharge after their first-ever acute stroke management. A total of 231 patients diagnosed with stroke participated in the study. Hierarchical multiple regression analysis was performed to identify predictors of rehabilitation motivation. **Results:** Positive bivariate relationships were observed between autonomy ($r = .26$, $p < .001$), self-efficacy ($r = .26$, $p < .001$), social support from family ($r = .22$, $p < .001$), social support from medical teams ($r = .26$, $p < .001$), and rehabilitation motivation. In the hierarchical multiple regression analyses, patients with paralysis ($\beta = -.21$, $p = .001$), higher autonomy ($\beta = .19$, $p = .003$), and higher social support from the medical team ($\beta = .22$, $p < .001$) demonstrated higher rehabilitation motivation. **Conclusion:** Based on these findings, nursing interventions and educational strategies that enhance patient autonomy and strengthen support from medical teams should be developed and implemented to improve rehabilitation motivation, engagement, and health outcomes in acute stroke care.

Key Words: Motivation; Personal autonomy; Self efficacy; Social support; Stroke rehabilitation

INTRODUCTION

Stroke is a neurological condition caused by either obstruction or rupture of cerebral blood vessels, resulting in impaired blood flow, damage to brain cells, and subsequent neurological deficits [1]. It is considered a chronic condition, and as its duration increases, patients often experience more severe physical disabilities and limitations in daily activities. These impairments hinder independent living, reduce social role functioning, and diminish overall quality of life [2]. Therefore, once the acute medical condition stabilizes, early and active rehabilitation is essential to minimize functional impairment, prevent secondary complications, and maintain an optimal quality of life [3].

Stroke phases are commonly categorized as acute (<7 days after onset), subacute (7 days to 6 months), and chronic (>6 months) [4]. Neurological recovery is most active within the first 2 to 3 months after stroke, with maximal recovery typically occurring within 6 months [5]. Thus, the acute phase represents a critical window for promoting functional and neurological recovery. Stroke rehabilitation involves individualized interventions tailored to onset tim-

ing and neurological severity, along with strategies to prevent secondary complications and recurrence [6]. Current clinical guidelines emphasize early intervention and recommend initiating rehabilitation evaluations within 72 hours of hospitalization [5], underscoring the importance of timely therapeutic interventions during the acute phase.

Stroke rehabilitation requires extensive time and effort, and active, sustained patient participation is needed to minimize long-term disability [6]. Although not all patients are discharged with residual symptoms, it remains essential to foster rehabilitation motivation during the acute phase to support effective engagement and reduce recurrence risk. Rehabilitation motivation is defined as the psychological willingness to participate in rehabilitation activities [7] and functions as a key driving force that enhances patient commitment, participation, and self-management during recovery [8]. A previous study demonstrated that group exercise nursing interventions significantly improved rehabilitation motivation and reduced depression in stroke patients [9]. Rehabilitation motivation is essential for initiating, sustaining, and achieving successful rehabilitation outcomes [10]. Furthermore, promoting motivation is particularly important for patients experiencing negative psychological states, as it can improve adherence and overall rehabilitation outcomes [11]. Assessing motivation at discharge after acute treatment may therefore be important for guiding nursing interventions that enhance patient engagement. Accordingly, it is necessary to examine rehabilitation motivation in the acute phase of stroke and identify factors associated with patients' willingness to participate in rehabilitation.

Self-determination theory (SDT) explains human behavioral motivation by emphasizing autonomous motivation as a driver of positive behavioral change when three basic psychological needs—autonomy, competence, and relatedness—are satisfied [12]. Autonomy refers to perceived volition and self-regulation of one's actions [13], whereas competence reflects the effective use of one's abilities within the environment [14]. In prior research, competence and self-efficacy, defined as the belief in one's ability to successfully perform a task [15], have been used interchangeably [16]. Relatedness, the need for meaningful social connections [13], aligns with the concept of social support, specifically the emotional and practical assistance provided by family members and healthcare providers [17]. Social support plays a crucial role in stroke recovery by reducing recovery time and enhancing rehabilitation outcomes [18]. Although SDT has been widely applied to investigate rehabilitation motivation in patients in the chronic phase of stroke undergoing outpatient rehabilitation, less is known about how these psychological needs function in the acute phase, when patients are at a critical point in initial recovery. Using the SDT framework, this study sought to clarify whether autonomy, self-efficacy, and social support are associated with rehabilitation motivation among patients at the early stages of recovery, thereby addressing a key gap in the existing literature. Therefore, this study aimed to investigate the relationships between autonomy, self-efficacy, and social support (from family and medical teams) and rehabilitation motivation among patients with acute-phase stroke at discharge, using SDT as the guiding framework.

METHODS

1. Study Design

This cross-sectional descriptive correlational study was developed using SDT as the theoretical framework, with the aim of identifying levels of autonomy, self-efficacy, and social support in patients with acute-phase stroke and examining their relationships with rehabilitation motivation. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Setting and Sample

The participants were patients who had been diagnosed with stroke for the first time and were scheduled for discharge within 1 month of hospitalization. The selection criteria for research participants were as follows: (1) adults older than 19 years; (2) patients diagnosed with a first-ever stroke within the past month who were currently hospitalized with planned discharge; and (3) patients diagnosed with one of the following conditions as classified by the Korean Standard Classification of Diseases (KCD): subarachnoid hemorrhage (I60), intracerebral hemorrhage (I61), other nontraumatic intracranial hemorrhage, cerebral infarction (I63), and stroke not specified as hemorrhage or infarction (I64). Patients were excluded if they had communication difficulties resulting from reduced consciousness, defined as having a Glasgow Coma Scale score of 12 or below. However, patients who had difficulty communicating verbally because of stroke-related symptoms but

were able to communicate in writing were included in the study. The required sample size was calculated using G*Power 3.1, based on an effect size of 0.15 reported in a previous study on rehabilitation adherence in stroke patients [6]. Using a significance level of .05, statistical power of .95, and 19 independent variables, the minimum required sample size was 217 participants. To account for possible attrition or incomplete responses, a total of 231 participants were recruited. All 231 questionnaires were returned fully completed with no dropouts or missing responses. Accordingly, the entire dataset was included in the analysis with no missing data.

3. Study Measurements

A structured questionnaire was used in this study, with permission obtained from the authors of both the original and revised versions of the instruments. Specifically, permission to use the self-efficacy questionnaire was granted by the author of the revised version, whereas authorization for the social support questionnaire was obtained from the author of the original form. The final instrument consisted of 63 items, including 15 items on demographic and disease-related characteristics, six items measuring autonomy, 10 items measuring self-efficacy, 16 items assessing social support (including family and medical team support), and 16 items evaluating rehabilitation motivation.

1) General characteristics and disease characteristics

General characteristics included 10 items regarding participants' sex, age, education level, marital status, primary caregiver, employment status, monthly income, smoking and alcohol consumption, and physical exercise prior to hospitalization. Disease characteristics consisted of five items on the frequency of stroke occurrence, type of stroke, presence of paralysis, presence of other diseases, and presence of language disorders.

2) Autonomy

Autonomy was measured using a 6-item scale related to autonomy from the Korean version of the Basic Psychological Needs Scale (BPNS), adapted by Lee and Kim [19] based on Deci and Ryan [13]. Each item was scored on a 5-point Likert scale ranging from "strongly disagree" (1 point) to "strongly agree" (5 points), with four reverse-coded items. Total scores range from 6 to 30, with higher scores indicating greater fulfillment of autonomy needs. The reliability of the autonomy scale at the time of development was Cronbach's α = .90 [19], and in this study, Cronbach's α was .87 for the study participants.

3) Self-efficacy

Self-efficacy was measured using a tool developed by Park [20] and later modified and supplemented by Kim [21] to assess specific self-efficacy in stroke patients. The tool consists of 10 items addressing confidence in health responsibility (four items), dietary control (two items), exercise (two items), and stress management (two items). Each item was rated on a Likert scale ranging from "not confident at all" (1 point) to "very confident" (4 points), with total scores ranging from 10 to 40, where higher scores indicate higher self-efficacy. In Kim's study [21], Cronbach's α was .88, and in this study, Cronbach's α was also .88 for the study participants.

4) Social support

Social support was measured using a tool developed by Tae [22] to assess social support in patients with cancer, which was later modified and supplemented by Kim [23] for use in stroke patients. The tool consists of 16 items, with eight items assessing family support and eight items assessing medical team support. Each item was scored on a 5-point Likert scale, ranging from "strongly disagree" or "never provided" (1 point) to "always agree" or "always provided" (5 points). Family and medical team support were each scored from 8 to 40, with higher scores indicating greater social support. The reliability of the original tool was high, as shown by Cronbach's α values of .87 for both family support and medical team support [22]. In Kim's study [23], the reliability of the modified medical team support tool was demonstrated by a Cronbach's α value of .90. In this study, Cronbach's α was .92 for family support and .88 for medical team support.

5) Rehabilitation motivation

The Rehabilitation Motivation Tool developed by Han and Lim [7] to measure rehabilitation motivation in individuals with disabilities was modified by Lee [24] to better reflect the characteristics of rehabilitation motivation in stroke patients. The tool consists of five subtypes of motivation, with each subtype comprising eight items. Each item was scored on a 4-point Likert scale, where "strongly disagree" was assigned 1 point and "strongly agree" was assigned 4 points, with two items assessing lack of motivation

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being reverse-coded. Total scores range from 16 to 64, with higher scores indicating greater rehabilitation motivation. The reliability of the tool was shown by Cronbach's α values of .86 in Han and Lim's study [7] and .89 in Lee's study [24]. In this study, Cronbach's α was .80 for the participants.

4. Recruitment and Data Collection

Data collection was conducted over a 1-year period, from June 1, 2023, to June 1, 2024, at a tertiary general hospital located in Suwon, South Korea. Before data collection began, approval and permissions were obtained from the hospital's nursing director and head nurses of the relevant wards. Participants were recruited from the neurosurgery, neurology, and rehabilitation wards. These units were selected because patients were typically in the recovery phase after active treatment and were preparing for discharge. The researcher reviewed electronic medical records to identify potential participants diagnosed with stroke. Individuals were screened according to the inclusion criteria, and eligible participants were then recruited. The researcher provided a detailed explanation of the purpose and procedures of the study to all prospective participants, and informed consent was obtained. The questionnaire required approximately 20 minutes to complete. For participants unable to complete the questionnaire independently because of physical impairments such as hemiplegia or visual disturbances, the researcher read the questions aloud and recorded the participants' responses.

5. Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of Seoul National University Bundang Hospital (IRB No. B-2304-820-301). Informed consent was obtained from all participants, and ethical standards were upheld throughout the study. Participants received a written explanation assuring confidentiality and the exclusive use of their data for research purposes. They were informed of their right to refuse or withdraw from participation at any time. Participants were also assured that withdrawal would not negatively affect the quality of their healthcare. All completed questionnaires were stored in a locked cabinet accessible only to the research team, and electronic files were password-protected. In accordance with institutional guidelines, all research data will be destroyed three years after study completion.

6. Data Analysis

Data analysis was performed using IBM SPSS/WIN ver. 29.0 (IBM Corp., Armonk, NY, USA). For descriptive statistics, continuous variables were evaluated for normality, and assumptions of normality were met, with skewness and kurtosis values less than 2. Categorical variables were summarized using frequencies and percentages, and continuous variables were described using means and standard deviations. Levels of autonomy, self-efficacy, social support, and rehabilitation motivation were also summarized using means and standard deviations. Differences in rehabilitation motivation according to general and clinical characteristics were examined using the independent t-test and one-way analysis of variance, with the Scheffé post-hoc test. Pearson's correlation coefficients were calculated to analyze the relationships among autonomy, self-efficacy, social support, and rehabilitation motivation. Hierarchical multiple regression analysis was then conducted to identify predictors of rehabilitation motivation. The regression assumptions of multicollinearity and independence of residuals were confirmed with a tolerance value greater than 0.1, a variance inflation factor below 10, and a Durbin–Watson statistic close to 2.

RESULTS

1. General and Disease-Related Characteristics of the Participants

The characteristics of the 231 participants are summarized in Table 1. Among the participants, 62.3% were male, and the mean age was 64.81 years. Approximately 46.3% had completed high school or higher, and 77.9% were married or cohabiting with a partner. Primary caregivers were spouses (48.1%), other family members (28.6%), and non-family caregivers (23.4%). Regarding health-related behaviors, 22.1% of participants were current smokers, and 67.1% reported alcohol use. For clinical characteristics, 75.8% had experienced ischemic stroke, whereas 24.2% had hemorrhagic stroke. Paralysis was reported in 26.4% of participants, 55.4% had comorbidities, and 13.4% had language disorders.

Table 1. General and Disease-Related Characteristics of the Participants (N=231)

Variables	Categories	n (%) or M±SD
Sex	Male	144 (62.3)
	Female	87 (37.7)
Age (year)		64.81±16.21
	<65	99 (42.9)
	≥65	132 (57.1)
Education level	≤Middle school	124 (53.7)
	≥High school	107 (46.3)
Marital status	Married	180 (77.9)
	Alone	51 (22.1)
Main caregiver	Spouse	111 (48.1)
	Family (except spouse)	66 (28.6)
	Care worker	54 (23.4)
Current employment	Yes	108 (46.8)
	No	123 (53.2)
Monthly income (1,000 KRW)	<3,000	179 (77.5)
	≥3,000	52 (22.5)
Current smoking	Yes	51 (22.1)
	No	180 (77.9)
Current alcohol consumption	Yes	155 (67.1)
	No	76 (32.9)
Exercise	None	52 (22.5)
	1–3 times per week	159 (68.8)
	5 or more times per week	20 (8.7)
Type of stroke	Ischemic stroke	175 (75.8)
	Hemorrhagic stroke	56 (24.2)
Hemiplegia	Yes	61 (26.4)
	No	170 (73.6)
Dysphasia	Yes	31 (13.4)
	No	200 (86.6)
Comorbidity	Yes	128 (55.4)
	No	103 (44.6)

KRW=South Korean Won; M=mean; SD=standard deviation.

2. Levels of Autonomy, Self-Efficacy, Social Support, and Rehabilitation Motivation

The levels of autonomy, self-efficacy, social support, and rehabilitation motivation are presented in Table 2. The mean autonomy score was 24.78±4.34 (range, 6–30), and the mean self-efficacy score was 34.53±4.69 (range, 10–40). For social support, the mean scores were 36.14±5.98 (range, 8–40) for family support and 31.77±6.88 (range, 8–40) for medical team support. The mean rehabilitation motivation score was 46.30±8.78 (range, 16–64).

Table 2. Levels of Autonomy, Self-Efficacy, Social Support, and Rehabilitation Motivation (N=231)

Variables	M±SD	Min	Max
Autonomy	24.78±4.34	6	30
Self-efficacy	34.53±4.69	10	40
Social support-family	36.14±5.98	8	40
Social support-medical team	31.77±6.88	8	40
Rehabilitation motivation	46.30±8.78	16	64

M=mean; SD=standard deviation.

3. Differences in Rehabilitation Motivation according to General and Disease Characteristics

Differences in rehabilitation motivation according to general and clinical characteristics are summarized in Table 3. Significant differences were found for sex, education, employment status, income, smoking, alcohol consumption, physical activity, and paralysis. Male participants exhibited higher motivation than females (t=–2.08, p=.019). Participants with a high school education or higher showed greater motivation than those with a middle school education or less (t=–3.07, p=.002). Employed participants had higher motivation than those who were unemployed (t=3.48, p<.001), and individuals earning more than 3 million KRW reported higher motivation than those earning less (t=–2.05, p=.042). Smokers (t=2.31, p=.022) and alcohol users (t=2.06, p=.041) demonstrated higher motivation than non-users. Participants who exercised more than five times per week showed significantly higher motivation than those who did not exercise (F=6.03, p=.003). Those with paralysis exhibited higher motivation (48.98±10.18) than those without paralysis (45.34±8.04) (t=2.82, p=.005).

4. Bivariate Relationship between Autonomy, Self-Efficacy, Social Support, and Rehabilitation Motivation

Correlations among autonomy, self-efficacy, social support, and rehabilitation motivation are provided in Table 4. Rehabilitation motivation was positively correlated with autonomy (r=.26, p<.001), self-efficacy (r=.26, p<.001), family support (r=.22, p<.001), and medical team support (r=.26, p<.001). Autonomy was positively correlated with self-efficacy (r=.30, p<.001) and family support (r=.18, p=.006). Self-efficacy was positively correlated with family support (r=.33, p<.001) and medical team support (r=.17, p=.010). In addition, family support and medical team support were positively correlated (r=.37, p<.001).

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Table 3. Differences in Rehabilitation Motivation by General and Disease-Related Characteristics (N=231)

Variables	Categories	Rehabilitation motivation		
		M±SD	t or F	p (Scheffe)
Sex	Male	47.23±8.70	−2.08	.019
	Female	44.77±8.77		
Age (year)	<65	47.06±8.23	1.14	.257
	≥65	45.73±9.17		
Education level	≤Middle school	44.69±9.19	−3.07	.002
	≥High school	48.18±7.92		
Marital status	Married	46.94±7.77	1.70	.094
	Alone	44.04±11.49		
Main caregiver	Spouse	47.20±8.20	1.13	.326
	Family (except spouse)	45.36±9.58		
	Care worker	45.64±8.93		
Current employment	Yes	48.38±7.91	3.48	<.001
	No	44.48±9.13		
Monthly income (1,000 KRW)	<3,000	44.78±4.73	−2.05	.042
	≥3,000	45.51±6.49		
Current smoking	Yes	48.78±8.99	2.31	.022
	No	45.60±8.62		
Current drinking	Yes	47.13±8.56	2.06	.041
	No	44.62±9.05		
Frequency of physical activity	None[a]	42.69±10.46	6.03	.003 (a<c)
	1–3 times per week[b]	47.25±8.15		
	≥5 times per week[c]	48.20±8.88		
Type of stroke	Ischemic stroke	46.38±9.07	.26	.794
	Hemorrhagic stroke	46.04±7.89		
Hemiplegia	Yes	48.98±10.18	2.82	.005
	No	45.34±8.04		
Dysphasia	Yes	49.06±10.78	1.89	.060
	No	45.88±8.38		
Comorbidity	Yes	45.26±7.73	−1.62	.106
	No	47.14±9.50		

KRW=South Korean Won; M=mean; SD=standard deviation.

5. Factors Influencing Rehabilitation Motivation in Patients with Acute Stroke

To identify factors associated with rehabilitation motivation, a hierarchical multiple regression analysis was conducted in two steps (Table 5). In step 1, general and clinical characteristics significantly associated with rehabilitation motivation—sex, education level, employment status, monthly income, smoking status, alcohol use, physical exercise, and paralysis—were converted into dummy variables and included in the model. The analysis showed that more frequent physical exercise prior to hospitalization (β=.18, p=.012) and the presence of paralysis (β=−.15, p=.021) were significantly associated with rehabilitation motivation. The model explained 8.3% of the variance and was statistically significant (F=3.60, p<.001).

In step 2, psychological and social variables—autonomy, self-efficacy, family support, and medical team support—were added. The results indicated that higher autonomy (β=.19, p=.003), greater medical team support (β=.22, p<.001), and the presence of paralysis (β=−.21, p=.001) were significantly associated with rehabilitation motivation. The explanatory power of the model increased to 20.6%, and the model remained statistically significant (F=5.97, p<.001).

DISCUSSION

This study aimed to examine the relationships between autonomy, self-efficacy, social support, and rehabilitation motivation among patients with acute-phase stroke at discharge. Factors associated with rehabilitation motivation in this population included the presence of paralysis, autonomy, and social support from the medical team. Because re-

Table 4. Correlations between Autonomy, Self-Efficacy, Social Support, and Rehabilitation Motivation (N=231)

Variables	Autonomy	Self-efficacy	Social support		Rehabilitation motivation
			Family	Medical team	
	r (p)				
Autonomy	1				
Self-efficacy	.30 (<.001)	1			
Social support					
Family	.18 (.006)	.33 (<.001)	1		
Medical team	.04 (.508)	.17 (.010)	.37 (<.001)	1	
Rehabilitation motivation	.26 (<.001)	.26 (<.001)	.22 (<.001)	.26 (<.001)	1

Table 5. Factors influencing Rehabilitation Motivation (N=231)

Variables	Model 1					Model 2				
	B	SE	β	t	p	B	SE	β	t	p
Constant	46.81	2.17		21.62	.001	19.43	5.16		3.77	<.001
Sex (male)	−0.59	1.29	−.03	−0.46	.649	−0.59	1.20	−.03	−0.49	.624
Education level (>middle school)	1.97	1.47	.12	1.34	.182	2.34	1.39	.13	1.68	.094
Job Status (no)	−1.50	1.50	−.09	−1.00	.317	−0.46	1.41	−.03	−0.32	.746
Monthly income (1,000 KRW) (≥3,000)	−0.21	1.52	−.01	−0.14	.890	−0.31	1.42	−.02	−0.22	.827
Smoking (no)	−2.14	1.52	−.10	−1.40	.162	−2.35	1.44	−.11	−1.64	.103
Drinking (no)	1.84	1.51	.10	1.22	.224	1.51	1.42	.08	1.07	.288
Exercise (no)	3.82	1.51	.18	2.53	.012	2.03	1.44	.10	1.41	.161
Paralysis (no)	−3.06	1.31	−.15	−2.33	.021	−4.07	1.25	−.21	−3.27	.001
Autonomy						0.39	0.12	.19	3.03	.003
Self-efficacy						0.21	0.12	.11	1.70	.091
Social support										
Family						0.10	0.10	.07	0.96	.338
Medical team						0.28	0.08	.22	3.37	<.001
Adjusted R^2			.083					.206		
F			3.60					5.97		
p			<.001					<.001		

SE=standard error; KRW=South Korean Won.

habilitation motivation is a critical factor that can enhance rehabilitation outcomes, it is essential to consider both general characteristics, such as prehospitalization exercise habits, and disease-specific factors, such as the degree of paralysis. Support from the medical team plays a central role in fostering patient autonomy based on individual needs. Therefore, our findings provide partial support for SDT as a framework for understanding rehabilitation motivation among patients in the acute phase of stroke, particularly given the limited associations observed for self-efficacy and family support.

Patients with paralysis in the acute phase of stroke exhibited higher rehabilitation motivation than those without paralysis. This finding contrasts with previous research involving patients in the chronic phase, which reported that individuals with less paralysis tend to demonstrate higher rehabilitation motivation [25]. This discrepancy may be explained by differences in recovery stages. In the acute phase, paralysis is perceived as a visible and potentially reversible symptom of stroke recovery. Patients experiencing acute-phase paralysis may demonstrate increased motivation to engage in rehabilitation to prevent deterioration and promote functional improvement [26]. Thus, the findings suggest that salient physical limitations may heighten patients' motivation for rehabilitation. This underscores the importance of early rehabilitation for improving both the speed and extent of recovery.

In this study, autonomy was a significant predictor of rehabilitation motivation, with higher autonomy associated with stronger rehabilitation motivation among patients in

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the acute phase of stroke. These findings align with previous studies indicating that greater autonomy enhances intrinsic motivation and supports engagement in behavioral change [14]. This result suggests that patients who perceive a higher level of autonomy in managing their recovery are more inclined to actively participate in rehabilitation. This highlights the value of nursing interventions that promote patient decision-making and self-regulation during the acute phase of stroke. An intervention study examining autonomy support combined with an information technology device among individuals in the subacute or chronic phases of stroke found that autonomy support improved the use of the more affected arm [27]. From a clinical perspective, nursing practices aimed at enhancing autonomy can be applied in the acute stroke care setting. For example, nurses may create opportunities for patients to make choices regarding their self-care routines, such as selecting the sequence of rehabilitation exercises or daily activities, involving patients in shared decision-making about treatment goals and rehabilitation plans, and tailoring educational materials to health literacy levels and individual needs. Even small opportunities for choice, such as deciding the timing of specific activities or the use of assistive devices, may strengthen patients' sense of control. These autonomy-supportive strategies can empower patients, reduce passivity within the hospital environment, and ultimately enhance motivation to actively participate in rehabilitation.

Among the types of social support, support from medical teams was significantly associated with rehabilitation motivation. According to a scoping review, patients in the acute phase of stroke, faced with an abrupt diagnosis, may have heightened expectations and strong motivation, which increases their dependence on and need for support from healthcare teams [28]. A previous systematic review also demonstrated that professional support from medical staff or structured support from community systems can be critical for strengthening rehabilitation motivation [29]. Therefore, support from medical teams can promote rehabilitation motivation and encourage active patient engagement in self-care activities. In particular, emotional support delivered through consistent feedback, empathic communication, and encouragement has been suggested to reinforce patients' motivation and perceived autonomy. A review study reported that supportive and empathic communication from healthcare providers improves treatment adherence and psychological adjustment among patients with chronic illnesses [30]. In the context of stroke care, motivational interviewing has been shown to reduce low mood and improve rehabilitation engagement in the early post-stroke period [31]. Furthermore, social-emotional factors such as empathy and emotional support have been linked to better functional recovery and enhanced quality of life in stroke survivors [32]. However, direct evidence on how these factors influence rehabilitation motivation in the acute phase remains limited, underscoring the need for further research to clarify the mechanisms through which emotional support from medical teams affects rehabilitation motivation.

In addition to emphasizing the importance of medical team support, it is necessary to consider concrete strategies that can be implemented in clinical practice. Structured multidisciplinary interventions that involve collaboration among physicians, nurses, therapists, social workers, and psychologists can provide comprehensive and individualized rehabilitation care. Regular patient–provider counseling sessions may also reinforce motivation by helping set realistic goals, monitor progress, and address emotional challenges faced by patients and their families. Furthermore, psychosocial education programs tailored to stroke patients and caregivers can enhance understanding of the disease, promote self-management, and strengthen resilience throughout the rehabilitation process. Incorporating such strategies into acute stroke care may maximize the positive impact of medical team support on patients' rehabilitation motivation and overall health outcomes.

In the present study, self-efficacy was not significantly associated with rehabilitation motivation, which differs from the findings of previous research. Although self-efficacy has been shown to influence behavioral change, health behaviors, and rehabilitation adherence in stroke patients [6], it did not significantly affect rehabilitation motivation in this sample of acute-phase participants, despite demonstrating a positive bivariate correlation. This suggests that the relative contributions of the SDT components may differ depending on the stage of recovery. It may reflect the fact that participants were diagnosed within a month, and their readiness for behavior change likely differs from individuals in later stages of recovery. It is possible that increasing autonomy during the acute phase may subsequently strengthen self-efficacy as patients transition to chronic care, thereby improving rehabilitation motivation.

Similarly, family support was not significantly associated

with rehabilitation motivation in this study. However, previous research has reported a positive relationship between family support and rehabilitation motivation [33], suggesting that the impact of family support may vary across different phases of stroke recovery. In this study, the nonsignificant association between family support and motivation suggests that support from the medical team may be more influential for patients in the acute phase of stroke. As patients transition to home-based rehabilitation after discharge, family support becomes increasingly important. Therefore, both families and medical professionals are essential contributors to patient recovery and successful rehabilitation [34]. Another study suggested that family and medical team support may function jointly and contribute to motivation [35]. In this study, family support was not a significant predictor of rehabilitation motivation. This finding suggests that although family support becomes critical after discharge or in the chronic phase, medical team support may play a more decisive role during the acute stage.

This study had several limitations. First, it was conducted among patients with acute stroke in a single region of South Korea, limiting the generalizability of the findings. Second, because this was a descriptive study based on self-reported surveys, causality could not be established. Third, the place of discharge, which could influence rehabilitation motivation, was not considered. Fourth, variations in rehabilitation services based on the presence of residual symptoms may have influenced the outcomes. The participants included patients who initially presented with such symptoms upon admission, some of whom later recovered, while others continued to experience them, which may have shaped their perceptions of rehabilitation motivation. However, other common post-stroke sequelae—such as dysphagia, sensory disturbances, cognitive impairment, depression, and fatigue—were not assessed. Considering only paralysis and language impairment may oversimplify the complex relationship between functional limitations and rehabilitation motivation. The finding that patients with paralysis had higher motivation should therefore be interpreted cautiously, as the functional status of patients without paralysis was not fully evaluated. Future studies should incorporate a broader range of stroke-related sequelae to provide a more comprehensive understanding of how residual disabilities influence rehabilitation motivation. Furthermore, the measurement tool used in this study focused primarily on physical rehabilitation, potentially overlooking broader aspects such as stroke recurrence prevention. Therefore, future research should include larger sample sizes, differentiate between patients who received rehabilitation and those who did not, and employ assessment tools that capture broader conceptualizations of rehabilitation motivation.

CONCLUSION

This descriptive cross-sectional study aimed to examine the relationships between autonomy, self-efficacy, social support, and rehabilitation motivation among patients with acute-phase stroke at discharge. The findings indicated significant positive relationships between residual symptoms of paralysis, autonomy, medical team support, and rehabilitation motivation among patients in the acute phase of stroke. Despite several limitations, these results suggest that fostering patient autonomy and reinforcing support from medical teams—particularly for patients with paralysis—are essential strategies for promoting rehabilitation motivation in acute stroke care. These findings emphasize the need to develop nursing interventions and educational programs that enhance autonomy and strengthen medical team support, thereby facilitating greater rehabilitation engagement and improving health outcomes in the acute phase of stroke care.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and/or design acquisition - SJH; analysis - SJH; interpretation of the data - SJH and MJ; and drafting or critical revision of the manuscript for important intellectual content - SJH and MJ.

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The data can be obtained from the first author.

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The Effect of a Post-discharge Tailored Telephone Follow-up Program for Patients after Percutaneous Coronary Intervention with Low Health Literacy: A Pilot Study

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Purpose: This study aimed to examine the effects of a post-discharge tailored telephone (TATE) follow-up program for patients with low health literacy (LHL) who had undergone percutaneous coronary intervention. **Methods:** This pilot study employed a non-equivalent control group pretest–posttest design to evaluate the preliminary effects of a TATE follow-up program at a university hospital in Seoul. Data were collected from July 2020 to September 2021. A total of 51 patients were recruited, and 46 completed the study. Patients were divided into three groups: an intervention group with LHL, a control group with LHL, and a control group with high health literacy. The intervention group received two 15-minute phone calls as part of the TATE follow-up program. **Results:** The TATE follow-up program significantly improved disease-related knowledge in the intervention group compared with the control groups ($p = .001$). The intervention group also reported significantly higher satisfaction with nursing services than the other two groups ($p = .006$). However, there were no significant differences in changes in health behavior adherence among the groups, although the intervention group with LHL showed the greatest increase of 17.5 points after the intervention. **Conclusion:** This pilot study demonstrated that the TATE follow-up program was effective and feasible for improving disease-related knowledge and satisfaction with nursing services among patients with LHL. These findings highlight the importance of tailored transitional care interventions to support cardiovascular disease management and secondary prevention.

Key Words: Coronary artery disease; Health behavior; Health literacy; Knowledge; Telephone

INTRODUCTION

Coronary artery disease (CAD), a leading cause of death worldwide, has increased by 23.5% in South Korea over the past decade and now ranks as the second leading cause of mortality [1]. Percutaneous coronary intervention (PCI) is commonly performed to treat CAD, but a substantial proportion of patients experience major cardiac events within a year after the procedure [2]. These events include death, acute myocardial infarction, angina pectoris, and in-stent restenosis, with contributing factors such as hypertension, hyperlipidemia, diabetes, discontinuation of prescribed medication, and smoking [3]. Therefore, reducing the risk of major cardiac events requires active management of these risk factors by improving lifestyle habits such as medication adherence, diet, and physical activity after PCI [4,5].

Cardiac rehabilitation (CR), which integrates medical management, exercise training, and patient education, has been shown to improve prognosis and quality of life in patients with CAD [6]. However, participation in CR remains low. In Korea, the participation rate is approximately 31%, and non-attenders tend to be older and less educated than attenders [7]. Major barriers include logistical and socioeconomic factors such as distance to hospitals, transportation difficulties, cost, time constraints, and comorbidities, all of which hinder regular participation [7]. These barriers underscore the need for alternative, accessible, and individualized education strategies for CAD patients after discharge.

Health literacy is a key element in programs aimed at reducing CAD risk and enhancing secondary prevention [8]. It refers to an individual's ability to obtain, process, and understand health information, influencing both health behaviors and overall outcomes [9]. Individuals with low health literacy (LHL) may struggle to understand medical advice or navigate healthcare systems [10], which can lead to lower participation and higher dropout rates in CR programs [8].

As a result, these individuals face barriers to engagement and continued participation in rehabilitation services and may miss the physiological and psychosocial benefits following coronary events [8]. Patients with LHL are particularly vulnerable because they often have difficulty interpreting health information, possess limited disease-related knowledge, and find it challenging to follow medical guidance [10]. Consequently, they are less likely to adopt heart-healthy behaviors such as regular exercise, balanced nutrition, moderation of alcohol intake, smoking cessation, and stress management [11]. Thus, health literacy serves as a crucial determinant of successful cardiovascular disease management [9].

After PCI, many patients experience difficulties during the early recovery phase due to short hospital stays and limited interaction with healthcare providers [12]. Busy ward environments and rapid patient turnover often prevent clinicians from providing individualized instruction or addressing specific concerns. Consequently, patients frequently leave the hospital without a clear understanding of how to manage their care at home [12]. Older patients, in particular, report feeling confused, anxious, and helpless after discharge, as they struggle to comprehend their hospitalization experience and adapt to post-procedure life. Because discharge counseling is often brief, patients receive only fragmentary or superficial information about their medication, condition, and required lifestyle modifications [12]. As a result, many feel unprepared for self-care and uncertain about how to apply medical advice to daily life.

In addition, these patients frequently demonstrate limited knowledge and misconceptions about their disease and risk factors [13]. Those with LHL are especially disadvantaged, as they may fail to understand information presented with medical jargon or rapid explanations from healthcare professionals [14]. Previous studies of Korean cardiovascular patients [15] have reported that some individuals were unable to interpret prescription labels or were unsure which health information sources to trust due to the overwhelming volume of available materials. Early identification of such patients and the delivery of education tailored to their comprehension level are therefore essential for effective secondary prevention.

Telephone-based interventions have emerged as a feasible means of post-discharge education and follow-up support. These interventions enable continuous communication between patients and healthcare providers, reinforce disease-related knowledge, and promote adherence to healthy lifestyle behaviors [16]. Personalized education and counseling after discharge have also been shown to enhance satisfaction with nursing services [17]. However, most existing telephone-based programs for PCI patients deliver standardized information that does not account for individual differences in health literacy.

To address this gap, the present study developed and evaluated the effectiveness of a tailored telephone (TATE) follow-up program specifically designed for PCI patients with LHL. The intervention aimed to provide individualized education and counseling adapted to each patient's comprehension level to improve disease-related knowledge, adherence to health behaviors, and satisfaction with nursing services.

METHODS

1. Study Design

This pilot study adopted a non-equivalent control group pretest–posttest design to examine the effects of the TATE follow-up program. To ensure accurate evaluation, participants who underwent PCI were divided into three groups according to their health literacy levels: an intervention group with LHL (LHL-I), a control group with LHL

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(LHL-C), and a control group with high health literacy (HHL-C). This study was reported in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guidelines.

2. Setting and Samples

Recruitment took place at a university hospital in Seoul from March to August 2021. The target population comprised adult patients diagnosed with CAD who were hospitalized and had undergone PCI for the first time, with the ability to communicate via telephone. Among those who met the inclusion criteria, patients planning to participate in a CR program within one month after discharge, those who experienced severe arrhythmia following the procedure, and those with musculoskeletal or chronic obstructive pulmonary disease limiting physical activity were excluded.

In pilot studies, it is important that the sample reflects the characteristics of the target population for the main study. Experts generally recommend recruiting approximately 10% of the target sample size for the pilot [18]. Accordingly, based on a previous study [19] and recruitment feasibility during the study period, a total of 51 participants were enrolled, with 17 participants per group.

To minimize contamination between groups, the researcher first assessed participants' health literacy levels and then sequentially assigned them to one of the three groups: 17 participants to the LHL-C, 17 to the HHL-C, and the remaining 17 to the LHL-I.

3. Measurements and Instruments

In this study, specialized health literacy tools were employed to identify patients with low levels of CAD-related health literacy. The original instruments—including the Rapid Estimate of Adult Literacy in Medicine (REALM) [20], which evaluates linguistic health literacy; the short version of the Korean Functional Health Literacy Test (S-KHLT) [21], which measures functional health literacy; and the Newest Vital Sign (NVS) [22], which assesses the ability to understand food and nutrition information—were deemed unsuitable for CAD patients. Therefore, the researchers adapted and simplified these instruments for use in screening CAD patients in clinical settings. Furthermore, the REALM, originally requiring "yes" or "no" responses, was modified into a 4-point scale using the Korean Health Literacy Assessment Tool as a reference [23]. The three adapted tools used as screening instruments comprised a total of 40 questions, with scores ranging from 0 to 100. Higher scores indicated higher health literacy.

Because the purpose of this study was to adapt and simplify existing tools for clinical screening, content validity was established through expert review rather than formal content validity index testing. The revised version maintained relevance, clarity, and conceptual consistency with the original tools through evaluation by a panel of experts, including two nursing professors certified as nurse practitioners and one medical professor who served as the cardiologist for the study participants. The first nursing expert was a senior nurse with extensive experience in acute and coronary care settings and longstanding research in cardiovascular health, tailored self-care interventions, and transitional care. The second nursing expert, a senior nurse and researcher, focused on health literacy, chronic disease management, and patient-centered education through biopsychosocial and digital health approaches. All experts agreed on the final revised version.

According to Davis et al. [20], individuals scoring below 60 were classified as having LHL in this study. The instrument used demonstrated a Cronbach's α of .95.

Socio-demographic data—including age, sex, education level, occupation, and monthly household income—and disease-related data such as diagnosis, comorbidities, smoking, and alcohol consumption were collected from medical records and questionnaires.

Disease-related knowledge was assessed using the Knowledge of Disease Questionnaire for CAD patients developed by Kim and Park [24]. Because some CAD patients do not take cardiac stimulants, related items were removed, and other modifications were made to align with current clinical practice and the study's objectives. Content validity was again reviewed by the same expert panel to ensure item relevance and clarity. The questionnaire consists of 29 items covering disease characteristics, risk factors, diet, medication, daily life, and exercise. Responses of "I don't know" or incorrect answers were scored as 0, while correct answers were scored as 1. Higher total scores indicated greater disease-related knowledge, with possible scores ranging from 0 to 29. Cronbach's α was .75 in the original study [24] and .90 in this study.

Adherence to health behaviors was measured using the Korean version of the Health-Promoting Lifestyle Profile II, translated and modified by Seo and Hah [25]. To suit pa-

tients who had undergone PCI for CAD, the tool was modified by removing the subdomains of spiritual growth and interpersonal relations and by replacing items referring to moderate or vigorous physical activity and weight management with items concerning light physical activity. The same expert panel reviewed the revisions to ensure clarity and relevance for post-PCI patients. The modified instrument included 19 items across four domains: health responsibility, physical activity, nutrition, and stress management. Each item was rated on a 4-point Likert scale, with higher scores reflecting greater adherence to health behaviors (range, 19–76). Cronbach's α was .92 in the previous study [25] and .90 in this study.

Satisfaction with nursing service was evaluated using the translated Client Satisfaction Questionnaire-8 [17]. To better align with the study's purpose, two items—such as those asking whether participants would want to receive the same service for other illnesses—were excluded, and remaining items were revised to reflect pre-discharge education and the TATE follow-up program. The same expert panel reviewed the adapted instrument for relevance and comprehensibility. The final version contained six items addressing the quality and usefulness of telephone counseling, adequacy of time provided, fulfillment of patient needs, likelihood of recommending the service to others, and overall satisfaction. Each item was rated on a 4-point Likert scale, with higher scores indicating greater satisfaction with nursing services (range, 6–24). Cronbach's α was .91 in both the previous study [17] and this study.

4. Data Collection and Procedure

Data collection and intervention were conducted directly by the researcher, who personally recruited all participants meeting the inclusion criteria. Based on participants' health literacy survey results, 34 individuals with LHL were sequentially assigned to the LHL-C and LHL-I groups, with 17 participants in each, while 17 participants with HHL were assigned to the HHL-C.

At the study hospital, cardiovascular education is routinely provided to patients before discharge through a 30-minute session using a booklet, delivered by a cardiovascular education nurse. During the pretest phase, the researcher explained how to complete the health diary and collected baseline data through questionnaires and medical record review.

The TATE follow-up program was developed based on educational resources from the Korean Society of Cardiology, such as Our Family's Heart Keeper, and previous studies involving CAD patients. The program followed a structured telephone counseling protocol [16,26]. All intervention sessions were conducted exclusively by the same researcher, who had five years of experience as a cardiovascular research nurse. Each session adhered to a predefined sequence of educational topics—including understanding CAD, physical activity, medication adherence, and dietary modification—to ensure consistency of delivery across participants. To maintain fidelity, the researcher strictly followed a standardized script and recorded session duration, participant responses, and content coverage immediately after each call.

Furuya et al. [26] suggested that the first two weeks after hospital discharge are a critical period for telephone follow-up, as patients transition from hospital to home and require substantial support for lifestyle adjustment and medication adherence. Similarly, a prior study [27] implemented telephone consultations within 2 to 5 days of PCI to promote early compliance with self-care behaviors. Considering these findings and the short hospital stays typical of PCI patients, this program included two sessions—one per week for two weeks—to provide timely, practical, and continuous support during the most vulnerable post-discharge period. Each counseling call lasted approximately 15 minutes, taking into account the average participant age of around 70 years and referring to the 10 to 20 minute duration used by Won [28].

To provide tailored counseling, the researcher further assessed the intervention group's health literacy level to identify their comprehension capabilities. Individualized consultations were prepared before each session. The researcher reviewed each participant's discharge summary, baseline questionnaires, comorbidities, medication regimen, blood pressure, lipid profile, and lifestyle habits. Based on these data, a simple individualized counseling plan was developed for each participant, outlining priority topics and educational emphases according to personal risk factors and literacy levels.

During the first-week telephone counseling session, information was provided on understanding CAD, physical activity, and medication adherence, customized to each individual's health literacy level. In the second week, the focus shifted to individualized risk factors for CAD and dietary modification using the Dietary Approach to Stop Hypertension (DASH) plan, emphasizing a low-salt, low-fat,

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and high-fiber diet. Medication adherence was also reviewed, and any challenges in implementation were identified. If needed, strategies such as setting mobile phone alarms were discussed to enhance compliance.

Jung and Hwang [29] reported that the average linguistic health literacy of Korean CAD patients corresponds to the 4th–6th grade level in elementary school. Accordingly, educational materials were adjusted to a reading level of grade 6 or below using the Korean Vocabulary Difficulty Analysis Program (Natmal Corporation, Seoul, Korea). Medical terminology was replaced with plain language, and the researcher used a slower speech rate to enhance comprehension.

The teach-back method was employed to verify and reinforce understanding after each telephone counseling session. After delivering the educational content, the researcher asked open-ended questions to evaluate participants' comprehension in key areas such as disease understanding, medication management, exercise, and dietary control. For example, participants were asked questions such as, "Can you explain in your own words what coronary artery disease is?," "When should you stop exercising immediately?," and "What precautions should you follow when taking antiplatelet medication?" Participants restated the information in their own words to confirm understanding. When responses were inaccurate or incomplete, the researcher re-explained the material using simpler language and familiar examples until the participant demonstrated correct understanding. Each session concluded with a reflective question such as, "Is there anything you still find confusing or want to ask about your disease or daily management?" to encourage two-way communication and identify remaining uncertainties. This interactive and iterative process enabled the researcher to detect misunderstandings in real time and provide immediate, individualized re-education.

Additionally, the "Ask Me 3" framework developed by the Institute for Healthcare Improvement (Boston, MA, USA) was incorporated to structure the delivery of essential educational content. This framework has been shown to improve patient knowledge after myocardial infarction when used as an educational tool [30]. Instead of prompting participants to generate and ask the three questions themselves, the researcher organized the telephone education according to the three core Ask Me 3 questions: (1) "What is my main problem?"—explaining that the participant had CAD treated with PCI and required ongoing secondary prevention; (2) "What do I need to do?"—outlining specific lifestyle and treatment strategies, including smoking cessation, dietary control, weight management, physical activity, and medication adherence; and (3) "Why is it important for me to do this?"—emphasizing that these behaviors help prevent restenosis and reduce the risk of recurrent cardiac events.

Furthermore, all participants were provided with a health diary as a self-monitoring tool to record medication intake, DASH diet adherence, physical activity, and other health behaviors, as well as blood pressure measurements. During the telephone consultations, the researcher reviewed participants' diary entries and encouraged consistent use to promote self-management behaviors.

The content validity of the TATE follow-up program was reviewed and confirmed by a panel of two nursing professors and one cardiologist. All experts agreed on the clarity, relevance, and appropriateness of the revised content. After incorporating their feedback, the final version of the program was completed (Table 1).

The posttest was conducted 3 to 4 weeks after discharge. In the posttest evaluation, satisfaction with nursing service reflected different contexts between groups: for the control groups, it represented satisfaction with discharge education provided by the cardiovascular educator nurse, while for the intervention group, it evaluated satisfaction with the nursing services received through the TATE follow-up program.

5. Ethical Considerations

This study was not registered in a public clinical trial registry because it was a pilot, non-randomized intervention study that did not meet the criteria for clinical trial registration. However, ethical approval was obtained from the Korea University Anam Hospital's Institutional Review Board (IRB No. K2020-1301-002) prior to data collection. Written informed consent was obtained from all participants after explaining the study's purpose, procedures, and voluntary participation. Confidentiality was maintained by assigning identification codes instead of names, and all data were stored in password-protected files accessible only to the research team. Participants were informed that they could withdraw at any time without any disadvantage regarding medical or nursing care, and anonymity was strictly preserved. As a token of appreciation, participants were given pedometers.

Table 1. Content of the TATE Follow-up Program

Week	Topic	Contents	Time (min)
1	Orientation	Introduce and greet the researcher Check the status of the subject and writing health diary	1
	Ask Me 3	Explain the need for secondary prevention after PCI	1
	Understanding CAD	Provide information on the cause, type, symptoms of CAD, and precautions after discharge	5
	Health behavior	Educate precautions for physical activity and encourage records of the amount of walking Guidelines for precautions on taking medication and how to take antithrombotic and nitroglycerin Inspire subjects to follow medication protocol	5
	Teach-back	Confirm the subject's perception of the information provided and retrain and question and answer	2
	Termination	Encourage keeping a health diary Make an appointment for the next phone call schedule	1
2	Introduction	Introduce and greet a researcher Check the status of the subject and writing health diary	1
	Ask Me 3	Explain the need for secondary prevention after PCI	1
	Risk factors of CAD	Provide information on smoking, obesity, stress, hypertension, hyperlipidemia, diabetes mellitus, and so on	5
	Health behavior	Educate a basic diet and food-related to atherosclerosis Inspire DASH diet Encourage records the amount of walking Check and encourage adherence to medication using a health diary	5
	Teach-back	Confirm the subject's perception of the information provided and retrain and question and answer	2
	Termination	Encourage keeping a health diary Check an appointment for the next outpatient schedule	1

CAD = coronary artery disease; DASH = Dietary Approach to Stop Hypertension; PCI = percutaneous coronary intervention; TATE = tailored telephone.

6. Data Analysis

Data were analyzed using IBM SPSS Statistics ver. 26.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. For variables that did not satisfy normality assumptions, nonparametric tests were applied. To examine baseline homogeneity among the three groups, descriptive statistics, the chi-square test, the Fisher exact test, one-way analysis of variance, and the Kruskal–Wallis test were used as appropriate. Post hoc analyses with Bonferroni correction were conducted for variables showing significant group differences, testing all pairwise comparisons among the LHL-I, LHL-C, and HHL-C groups.

To evaluate the effectiveness of the intervention, generalized estimating equations (GEEs) were applied to analyze disease-related knowledge, which showed a non-normal distribution. The GEE method was selected because it accounts for within-subject correlations and provides robust parameter estimates for repeated measures data that do not meet normality assumptions. In contrast, linear mixed models were used to analyze adherence to health behaviors, as these data met normality assumptions and required modeling of both fixed (group, time, and group × time interaction) and random (individual variability) effects.

Satisfaction with nursing service was analyzed using analysis of covariance, adjusting for age, with post hoc comparisons conducted using Bonferroni correction. Among the demographic variables, age was the only factor showing significant pairwise group differences in the Bonferroni post hoc test and was therefore included as a covariate in the model. Although education level and occupation also differed descriptively at baseline, they were not included due to the small pilot sample size and concerns about potential multicollinearity. This limitation may have introduced residual confounding.

RESULTS

A total of 57 patients who underwent PCI were initially approached for participation. Of these, six declined to participate, resulting in 51 participants who completed the pretest. During the follow-up period, five participants (9.8%) dropped out before completing the posttest. Specifically, two participants (11.8%) in the LHL-C group and one participant (5.9%) in the HHL-C group declined to complete the posttest, while two participants (11.8%) in the LHL-I group were lost to contact during follow-up. Thus, the final analysis included 46 participants (90.2%): 15 in LHL-C, 16 in HHL-C, and 15 in LHL-I (Figure 1).

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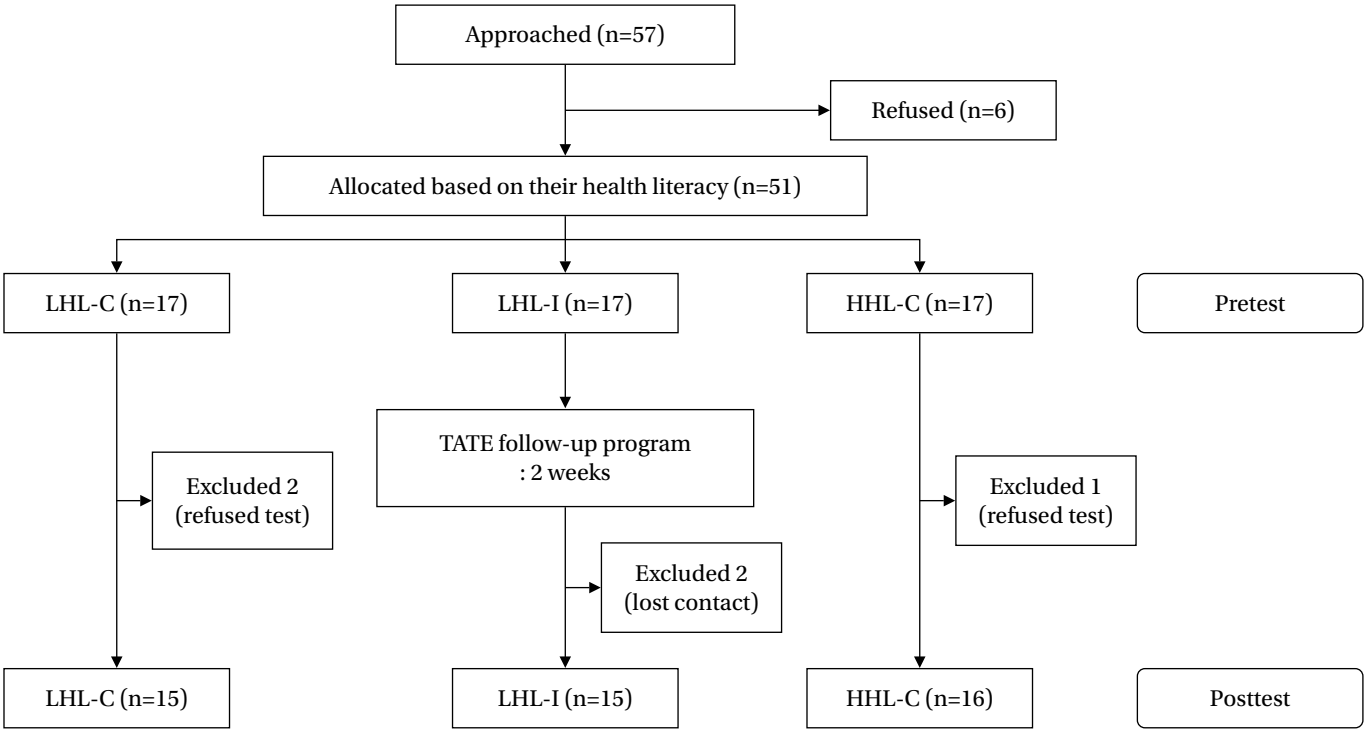

Figure 1. Flow chart of recruitment and follow-up process. HHL-C = control group 2 with high health literacy; LHL-C = control group 1 with low health literacy; LHL-I = intervention group with low health literacy; TATE = tailored telephone.

Participants in the intervention group received tailored phone consultations once a week for two consecutive weeks, totaling two sessions, with an average duration of 16.17 ± 7.30 minutes. The first session ranged from 12 to 27 minutes, and the second from 12 to 47 minutes. These findings confirm that the planned two-session intervention was feasible and well tolerated by participants.

According to the health literacy screening results, the total score among the 46 participants ranged from 6 to 88, with a mean of 53.48 ± 18.44. The average scores for LHL-I, LHL-C, and HHL-C were 44.40 ± 14.70, 42.47 ± 14.08, and 72.31 ± 7.17, respectively, confirming that the groups were appropriately classified according to literacy level. Detailed item-level analyses are provided in Supplementary Data 1.

1. Socio-Demographic and Disease-Related Characteristics of Participants, and Disease-Related Knowledge and Adherence to Health Behavior at the Pretest

The age of the participants in this study ranged from 43 to 84 years. The mean ages for LHL-I, LHL-C, and HHL-C were 69.67 ± 6.43, 70.13 ± 10.81, and 59.19 ± 7.94 years, respectively. Participants in the two LHL groups were significantly older than those in the HHL-C group (p = .001), indicating that lower health literacy was associated with older age. Most participants in the LHL-I and LHL-C groups (86.7% and 80.0%) were aged 65 years or older, compared with only 37.5% in the HHL-C group (p = .008).

The proportions of female participants were 33.3% in LHL-I, 46.7% in LHL-C, and 6.2% in HHL-C, demonstrating a significant sex difference among the groups (p = .029). Regarding education level, participants with middle school education or lower accounted for 46.7% of LHL-I , 60.0% of LHL-C, 6.3% of HHL-C, showing a significant group difference (p = .015). Employment status also differed significantly (p = .005), with more than half of the LHL-I and LHL-C participants being unemployed (66.7% and 53.3%, respectively), whereas 87.5% of HHL-C participants were employed. Although pairwise differences in education and occupation were not statistically significant after Bonferroni adjustment, descriptive trends indicated that participants with lower health literacy tended to have lower education levels and were less likely to be employed. These trends align with the typical demographic characteristics of individuals with limited health literacy, who are often older adults with lower educational attainment and fewer socioeconomic resources. The results of the homogeneity test thus showed that, despite some demographic differences

across the three groups, the sample composition appropriately represented the target population for interventions focusing on individuals with LHL.

At the pretest, disease-related knowledge scores were significantly higher in the HHL-C group (mean = 22.63) compared with LHL-I (mean = 18.07) and LHL-C (mean = 14.40) (F = 17.20, $p < .001$). Although adherence to health behavior did not differ significantly among groups, the HHL-C group demonstrated numerically higher adherence scores, suggesting a possible association between higher health literacy and better baseline disease knowledge and self-care behavior (Table 2).

2. Intervention Effects on Disease-Related Knowledge and Adherence to Health Behavior

In the LHL-I group, disease-related knowledge increased significantly by 6.86 points to 25.31 after the intervention, a significantly greater improvement than in the LHL-C (increase of 3.53) and HHL-C (increase of 1.88) groups

Table 2. Comparison of Participants' Socio-demographic, Disease-Related Characteristics, and Baseline Disease Knowledge and Health Behavior Adherence According to Health Literacy Level

Variables	Total (n = 46)	LHL-I[a] (n = 15)	LHL-C[b] (n = 15)	HHL-C[c] (n = 16)	F	*p*	Bonferroni
	Mean ± SD or n (%)						
Age (year) (range 43–84)	66.17 ± 9.84	69.67 ± 6.43	70.13 ± 10.81	59.19 ± 7.94	14.59	.001	a, b > c
< 65	15 (32.6)	2 (13.3)	3 (20.0)	10 (62.5)	9.39	.008	
≥ 65	31 (67.4)	13 (86.7)	12 (80.0)	6 (37.5)			
Sex							
Men	33 (71.7)	10 (66.7)	8 (53.3)	15 (93.8)	6.75	.029	
Women	13 (28.3)	5 (33.3)	7 (46.7)	1 (6.2)			
Education level							
≤ Middle school	17 (37.0)	7 (46.7)	9 (60.0)	1 (6.3)	12.05	.015	
High school	14 (30.4)	5 (33.3)	3 (20.0)	6 (37.5)			
≥ College	15 (32.6)	3 (20.0)	3 (20.0)	9 (56.3)			
Occupation							
Yes	26 (56.5)	5 (33.3)	7 (46.7)	14 (87.5)	10.12	.005	
No	20 (43.5)	10 (66.7)	8 (53.3)	2 (12.5)			
Monthly household income (KRW)							
≤ 2,000,000	24 (52.2)	10 (66.7)	9 (60.0)	5 (31.3)	4.64	.324	
2,010,000–4,000,000	13 (28.3)	3 (20.0)	3 (20.0)	7 (43.8)			
≥ 4,010,000	9 (19.6)	2 (13.3)	3 (20.0)	4 (25.0)			
Diagnosis							
STEMI	11 (23.9)	5 (33.3)	3 (20.0)	3 (18.8)	12.07	.057	
NSTEMI	4 (8.7)	3 (20.0)	1 (6.7)	0 (0.0)			
Unstable angina	3 (6.5)	2 (13.3)	1 (6.7)	0 (0.0)			
Stable angina	27 (58.7)	4 (26.7)	10 (66.7)	13 (81.3)			
Mixed angina	1 (2.2)	1 (6.7)	0 (0.0)	0 (0)			
Comorbidity, yes	39 (84.8)	12 (80.0)	14 (93.3)	13 (81.3)	1.34	.670	
Numbers	1.96 ± 1.28	2.00 ± 1.36	2.27 ± 1.22	1.63 ± 1.26			
Hypertension	31 (67.4)						
Hyperlipidemia	20 (43.5)						
Diabetes mellitus	15 (32.6)						
Smoking, yes	8 (17.4)	3 (20.0)	1 (6.7)	4 (25.0)	1.93	.491	
Drinking, yes	15 (32.6)	6 (40.0)	2 (13.3)	7 (43.8)	3.88	.184	
Disease-related knowledge		18.07 ± 5.64	14.40 ± 7.00	22.63 ± 2.83	17.20	< .001	a, b > c
Adherence to health behavior		44.67 ± 13.47	40.87 ± 9.61	46.13 ± 9.30	0.95	.396	

HHL-C = control group 2 with high health literacy; KRW = Korean won; LHL-C = control group 1 with low health literacy; LHL-I = intervention group with low health literacy; NSTEMI = non-ST elevation myocardial infarction; SD = standard deviation; STEMI = ST elevation myocardial infarction.

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(χ^2 = 13.60, p = .001) (Table 3). These results indicate that the TATE follow-up program effectively enhanced disease-related understanding among patients with LHL. The marked improvement underscores the importance of literacy-sensitive, individualized telephone counseling in bridging comprehension gaps that frequently hinder effective post-discharge cardiac care.

In contrast, no significant differences were observed among groups in changes in adherence to health behavior (F = 1.93, p = .157). Nevertheless, the LHL-I group exhibited the greatest increase, from 44.35 to 61.82 (a rise of 17.47 points), compared with increases of 10.80 (to 51.31) in LHL-C and 10.69 (to 57.45) in HHL-C (Table 3). This upward trend across all groups suggests that participation in the study and enhanced disease awareness may have contributed to improved health behaviors overall, even though the two-week intervention period was likely insufficient to achieve statistically significant behavioral changes.

3. Intervention Effects on Satisfaction with Nursing Service

The satisfaction-with-nursing-service scores were 22.47 for LHL-I, 19.07 for LHL-C, and 20.38 for HHL-C, showing a significant difference among the groups (F = 10.20, p = .003). Post hoc analysis revealed that satisfaction with nursing service in the LHL-I group was significantly higher than in both control groups (a > b, c) (Table 4). This result indicates that the tailored and interactive follow-up approach was well received by patients with LHL, likely because it provided a sense of individualized attention and reassurance during the vulnerable post-discharge transition period.

DISCUSSION

This study evaluated the effectiveness of the TATE follow-up program developed for patients with LHL who underwent PCI for CAD. The intervention group (LHL-I) demonstrated significantly greater improvement in disease-related knowledge and higher posttest satisfaction with nursing services than the two control groups, confirming the effectiveness of a literacy-tailored, telephone-based follow-up intervention. Participants with LHL in this study were mainly older adults with lower education levels and employment rates compared to those with HHL (HHL-C). These characteristics are consistent with previous studies [31-33] showing that aging, low educational attainment, and unemployment are associated with limited health literacy. These findings highlight the importance of tailoring educational interventions to meet the cognitive, linguistic, and informational needs of older adults.

The significant improvement in disease-related knowledge among the LHL-I group can be explained by several

Table 3. Changes in Disease-Related Knowledge and Adherence to Health Behavior between Pretest and Posttest Based on Health Literacy Levels

Variables	Group	Pre	Post	Post-Pre	Group		Time		Age		Group × time	
		Mean (SD)			χ^2/F	p	χ^2/F	p	χ^2/F	p	χ^2/F	p
Disease-related knowledge†	LHL-I	18.45 (0.42)	25.31 (0.80)	6.86 (4.55)	25.11	< .001	37.66	< .001	1.70	.192	13.60	.001
	LHL-C	17.36 (0.67)	20.89 (1.04)	3.53 (5.90)								
	HHL-C	19.49 (0.42)	21.37 (0.78)	1.88 (3.05)								
Adherence to health behavior‡	LHL-I	44.35 (2.55)	61.82 (2.55)	17.47 (10.16)	3.38	.044	65.49	< .001	0.40	.529	1.93	.157
	LHL-C	40.51 (2.56)	51.31 (2.56)	10.80 (11.79)								
	HHL-C	46.76 (2.62)	57.45 (2.62)	10.69 (10.64)								

HHL-C = control group 2 with high health literacy; LHL-C = control group 1 with low health literacy; LHL-I = intervention group with low health literacy; SD = standard deviation; †Generalized estimating equation was applied to control age and estimate changes over time; ‡A linear mixed model was applied to estimate changes over time while controlling age and reducing the effect of missing values.

Table 4. Differences in Satisfaction with Nursing Care

Variables	LHL-I[a] (n = 15)	LHL-C[b] (n = 15)	HHL-C[c] (n = 16)	F	p	Bonferroni
	Mean (SD)					
Satisfaction with nursing care	22.47 (1.77)	19.07 (2.84)	20.38 (3.50)	10.20	.003	a > b, c

HHL-C = control group 2 with high health literacy; LHL-C = control group 1 with low health literacy; LHL-I = intervention group with low health literacy; SD = standard deviation.

mechanisms. First, the structured, literacy-adjusted approach—using simplified language, slower speech, and teach-back techniques—likely enhanced comprehension and retention. Second, the Ask Me 3 framework and the two-session design provided opportunities for repetition and reinforcement, which are known to facilitate learning among individuals with limited literacy. Third, individualized counseling that considered patients' comorbidities, medication profiles, and lifestyle factors increased relevance and engagement, thereby supporting active learning. Collectively, these mechanisms demonstrate how literacy-sensitive interventions can effectively reduce the knowledge gap between LHL and HHL patients, aligning with prior evidence that tailored education improves chronic disease management [34].

Although adherence to health behaviors improved in all three groups, the differences were not statistically significant. Several factors may explain this outcome. The short two-week intervention period may not have been sufficient for measurable behavioral changes to occur, as previous studies have conducted interventions lasting 6 to 8 weeks [16]. Additionally, the small pilot sample may have limited statistical power to detect differences between groups, especially given the variability of individual lifestyles. Moreover, adherence was assessed using self-report measures, which are subject to recall and social desirability biases. Because behavioral change generally requires sustained reinforcement and environmental support, future research should employ longer follow-up periods and objective compliance measures, such as wearable activity trackers, to capture behavioral outcomes more accurately.

The higher satisfaction with nursing services observed in the LHL-I group likely reflects both informational and emotional support. The first four weeks after discharge are not only a period of physical recovery and adaptation but also a time marked by anxiety about recurrence, depression, uncertainty about disease progression, and adjustment to new medication routines. The TATE follow-up program, which provided two post-discharge phone calls during this vulnerable period, was associated with high satisfaction among intervention participants. The individualized telephone consultations offered a platform for older patients to ask questions and receive reassurance, addressing both knowledge gaps and emotional concerns in the early recovery phase. Consistent with findings by Walters et al. [35], this empathetic, one-on-one communication via telephone mentoring enhances patients' confidence, self-management motivation, and overall satisfaction with care—particularly among older adults who may feel less confident interacting with healthcare providers.

In terms of clinical feasibility, the TATE program was delivered entirely by a single cardiovascular nurse using structured protocols, suggesting that such interventions can be feasibly incorporated into routine nursing workflows. However, in real-world practice, allocating sufficient time for telephone consultations during regular working hours may be challenging, particularly in high-acuity hospital settings. To improve sustainability, healthcare institutions could integrate literacy-tailored interventions into transitional care programs, supported by experienced nurse educators or telemedicine teams. Despite these logistical challenges, the program's high satisfaction rates and significant improvements in knowledge indicate that this approach is both effective and meaningful for patient-centered nursing care.

The originality of this study lies in its health literacy–based strategies tailored to individual patient needs to enhance self-management adherence by improving disease knowledge during the hospital-to-home transition. The findings provide new evidence supporting literacy-sensitive education within cardiovascular transitional care, particularly for patients with LHL—a population often overlooked in standard discharge education. This focus on differentiated health literacy represents an important contribution to existing literature.

There are several limitations to this study. First, it was conducted at a single site with a small pilot sample, which limits generalizability. Second, the short intervention and follow-up periods may have reduced the likelihood of detecting behavioral changes. Third, adherence data were self-reported and thus potentially affected by reporting bias. Fourth, the absence of randomization and residual confounding—particularly from variables such as education and occupation that were not included in the statistical models—may have influenced the results. Finally, validating these findings will require large-scale randomized controlled trials with extended follow-up and objective adherence measurements in future research.

Based on these findings, several recommendations can be made for clinical nursing practice and future studies. First, nurses should assess patients' health literacy during hospitalization and provide tailored education and follow-up according to individual needs. Second, healthcare

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institutions should integrate structured, telephone-based follow-up interventions into transitional care services, particularly for older adults and those with limited health literacy. Finally, future research should involve larger and more diverse samples, longer intervention periods, and objective measures of adherence to evaluate the long-term effects of tailored interventions on health behaviors and cardiovascular outcomes.

CONCLUSION

This pilot study underscores the value of tailored transitional care interventions that address patients' specific health literacy levels and cardiovascular risk factors. It also emphasizes the importance of continuity in nursing care that extends beyond acute treatment to support secondary prevention of cardiovascular disease. The TATE program demonstrates a feasible and effective approach to improving patient outcomes during the critical post-discharge transition period through individualized interventions for patients with LHL. This approach not only meets immediate educational needs but also lays the foundation for sustained health behavior changes that can reduce cardiovascular risk over time.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and design - MK, NMS, and JP; data curation and methodology - MK; formal analysis and methodology - MK and NMS; funding acquisition - NMS; resources - JP; project administration - NMS; supervision and validation - NMS and JP; software - MK; drafting and critical revision of the manuscript - MK, NMS, and JP.

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DATA AVAILABILITY STATEMENT

The data underlying this article will be shared on reasonable request to the corresponding author

SUPPLEMENTARY MATERIAL

Supplementary materials can be found via https://doi.org/10.7475/kjan.2025.0827.

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Determining the Optimal Cut-off Score on the Pressure Ulcer Scale for Healing: A Retrospective Study

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Purpose: This study aimed to identify a clinically meaningful cut-off score on the Pressure Ulcer Scale for Healing tool for objectively determining healing in adult inpatients with pressure injury. **Methods:** A retrospective analysis was conducted using electronic health records from adult inpatients at a tertiary hospital in South Korea. Pressure Ulcer Scale for Healing scores were calculated based on wound size, exudate amount, and tissue type. Receiver operating characteristic curve analyses were performed, and optimal cut-off scores were identified using the Youden Index. Stratified analyses by pressure injury stage were also conducted to evaluate predictive performance. **Results:** A total of 20,476 pressure injuries were analyzed, of which 5,873 were classified as healed. Although all stages were initially included, stage 1 pressure injuries demonstrated limited discriminative ability (area under the curve = 0.612) and were therefore excluded from cut-off derivation. For stage 2 or higher pressure injuries, the optimal cut-off score was 3.5, yielding an area under the curve of 0.721, with a sensitivity of 59.8% and a specificity of 72.0%. **Conclusion:** The identified threshold for stage 2 or higher pressure injuries demonstrated meaningful discriminative ability for determining wound healing status. Application of this criterion may support more objective and consistent clinical decision-making when using the Pressure Ulcer Scale for Healing in nursing practice.

Key Words: Pressure ulcer; Wound healing; Nursing assessment

INTRODUCTION

A pressure injury (PI) involves localized damage to the skin and underlying tissues that is primarily caused by prolonged pressure or shear force [1]. PI development or progression prolongs hospitalization and increases the burden on both patients and healthcare systems. According to a recent systematic review, the occurrence of pressure ulcers extended hospital length of stay by an average of 12.9 days [2]. Nurses play a pivotal role in preventing PI, identifying early signs of skin breakdown, and facilitating wound healing through evidence-based interventions [1,3]. As PI prevention and management are core components of independent nursing practice, accurate clinical judgment is essential for improving patient outcomes. Therefore, consistent and objective assessment using reliable tools is crucial for accurately evaluating wound healing and supporting effective nursing decision-making [4].

Various tools have been developed to objectively evaluate and monitor PI healing, including the Bates-Jensen Wound Assessment Tool (BWAT), the Photographic Wound Assessment Tool (PWAT), and the Pressure Ulcer Scale for

Healing (PUSH). The BWAT provides a comprehensive evaluation across 13 wound-related parameters [5]. However, limited reliability evidence and variation in evaluation time across wound sites hinder its feasibility in busy clinical settings [6]. The PWAT enables objective and reproducible wound assessment through the use of standardized photographic images [7]. However, its clinical feasibility may be constrained by requirements for consistent image quality and appropriate imaging equipment [8].

Given these limitations, a simpler and more clinically applicable tool is necessary for the routine evaluation of PI healing. PUSH, developed by the National Pressure Injury Advisory Panel (NPIAP), assesses wound healing using three components—wound size, exudate amount, and tissue type—thereby enabling a streamlined and consistent evaluation process in clinical practice. Previous validation studies have demonstrated the effectiveness of PUSH in monitoring PI healing [9,10], and a recent systematic review reported comparatively higher levels of evidence for its validity and responsiveness relative to other wound assessment instruments [8].

PUSH evaluates PI healing based on three components, allowing changes in the total score to reflect either improvement or deterioration [11]. Because PI healing is an important indicator of nursing practice quality and patient outcomes [12], accurate assessment of healing status is essential. Although previous studies have validated PUSH and examined healing trajectories through reductions in score [11], a score of 0 may not always represent the only state of complete healing. According to the international clinical practice guideline issued by the NPIAP, a PI is considered to have healed when complete epithelialization has occurred with no open areas [1]. However, in clinical practice, even when full epithelialization is observed, nurses may experience difficulty documenting a wound size of zero because of subtle pigmentation differences or the presence of thin, newly formed epithelial layers. Accordingly, clinically healed wounds may not consistently receive a PUSH score of 0 in real-world practice.

Therefore, identifying a clinically meaningful cut-off score that reflects documentation patterns in routine clinical settings may enhance the interpretability of PUSH scores and improve objectivity in wound healing assessment. This study aims to determine an objective and practical cut-off point that can support consistent nursing assessment and enhance the clinical utility of PUSH in PI management.

METHODS

1. Study Design

This retrospective study was conducted at a tertiary general hospital in South Korea. Data were extracted from the hospital's electronic health record (EHR) system. The study period spanned from January 1, 2022, to December 31, 2024, and focused on nursing documentation related to PI management, including wound assessments and documentation of healing status. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Study Population

This study included adult inpatients aged 19 years or older who had PIs either present at the time of admission (community-acquired) or that developed during hospitalization (hospital-acquired). For the purpose of determining the cut-off PUSH score for wound healing, patients were categorized into two groups: those whose nursing records explicitly documented the wound as "healed," and those without such documentation, for whom the most recent PUSH score prior to discharge was used as a proxy indicator of non-healed status.

Patients were excluded if they were younger than 19 years of age, discharged on the same day as admission, or if the PI occurred in a location outside the general ward or intensive care unit. These cases were excluded because patients in non-inpatient settings are not consistently evaluated using standardized wound assessment protocols, which makes it difficult to determine the timing and origin of the injury, ensure accurate staging, and distinguish PIs from other wound types. In addition, cases in which the onset and healing dates of the PI were recorded as occurring on the same day were excluded, as these were considered likely to reflect documentation errors. A total of 20,476 PIs were included in the final analysis.

3. Data Collection

Data required to calculate the PUSH score were extracted from the hospital's EHR system. The EHR system contained structured and coded wound assessment fields aligned with the PUSH tool, allowing nurses to document wound size, exudate amount, and tissue type using predefined cat-

egories (e.g., none, light, moderate, heavy for exudate amount).

A single researcher, a registered nurse with more than 10 years of clinical experience and formal training in wound assessment, reviewed the extracted data and computed the total PUSH score based on the documented values. Because the PUSH tool applies explicit scoring criteria, the researcher verified the individual item values and calculated the summed scores without subjective interpretation.

When a patient had multiple PIs, each wound was analyzed as an independent case. Cases were included only when complete data for all three PUSH components were available; records with missing values were excluded because total scores could not be calculated.

Healing status was also obtained from structured EHR fields. In the system, wounds documented as "healed" were coded as such by nurses as part of routine clinical documentation practices. For the receiver operating characteristic (ROC) analysis, this variable was used as the state indicator, with "1" representing healed wounds and "0" representing non-healed wounds.

4. Ethical Considerations

This study was approved by the Institutional Review Board of Samsung Medical Center prior to data collection (IRB No. SMC IRB 2025-02-130). Given the retrospective nature of the study, the requirement for informed consent was waived by the IRB. To ensure confidentiality, all personally identifiable information was either deleted or encrypted during the data extraction process.

5. Data Analysis

All statistical analyses were performed using IBM SPSS ver. 28.0 (IBM Corp., Armonk, NY, USA), with the significance level set at $p < .05$.

For continuous variables, independent-samples t-tests were used to compare differences between the healed and non-healed groups. Categorical variables were analyzed using chi-square tests. The normality of the final PUSH score was assessed using the Kolmogorov–Smirnov test, and as it violated the assumption of normality, the Mann–Whitney U test was additionally performed.

To determine the optimal cut-off value of the PUSH score for predicting wound healing, ROC curve analysis was conducted. The area under the curve (AUC) was calculated to evaluate the discriminatory power of the PUSH score, and the optimal cut-off point was identified using the Youden Index, which maximizes the sum of sensitivity and specificity.

RESULTS

1. Participant Characteristics

A total of 20,476 PIs were included in the analysis. Among these, 5,873 cases (28.7%) were classified as healed and 14,603 cases (71.3%) as non-healed, based on documented healing status in the EHR. Participant characteristics are summarized in Table 1.

Patients in the healed group were younger than those in the non-healed group ($p < .001$), and the proportion of male patients was higher in the healed group. Hospital-acquired PIs were more common overall, and their proportion was significantly higher in the non-healed group. PIs

Table 1. Comparison of Participant Characteristics between Healed and Non-healed Pressure Injuries

Variables	Healed (n=5,873)	Non-healed (n=14,603)	*p*-value
	M±SD or n (%)		
Age (year)	66.24±14.24	68.63±13.63	<.001
Sex			<.001
Female	1,718 (29.3)	5,115 (35.0)	
Male	4,155 (70.7)	9,488 (65.0)	
PI origin			<.001
Hospital-acquired	4,336 (73.8)	11,844 (81.1)	
Community-acquired	1,537 (26.2)	2,759 (18.9)	
Ward type			<.001
General ward	4,039 (68.8)	12,300 (84.2)	
Intensive care unit	1,834 (31.2)	2,303 (15.8)	
PI stage			<.001
Stage 1	3,073 (52.3)	5,389 (36.9)	
Stage 2	1,496 (25.5)	4,753 (32.5)	
Stage 3	90 (1.5)	611 (4.2)	
Stage 4	6 (0.1)	91 (0.6)	
Unstageable	328 (5.6)	1,446 (9.9)	
Deep tissue injury	880 (15.0)	2,313 (15.8)	
PI location			<.001
Coccyx	949 (16.2)	4,924 (33.7)	
Ear	2,374 (40.4)	3,362 (23.0)	
Buttock	557 (9.5)	1,623 (11.1)	
Trochanter	232 (4.0)	983 (6.7)	
Initial PUSH score	4.64±3.24	6.21±3.70	<.001
Final PUSH score†	3.62±3.18	5.96±3.76	<.001

M=mean; PI=pressure injury; PUSH=Pressure Ulcer Scale for Healing; SD=standard deviation; †Mann-Whitney U test.

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associated with intensive care unit stays accounted for a larger proportion of healed cases than non-healed cases.

Stage distribution also differed between groups, with stage 1 more frequently observed among healed PI, whereas stage 1 and stage 2 were both common in the non-healed group. The most frequent anatomical sites were the coccyx and the ear, with coccygeal PIs more common in the non-healed group and ear-related PIs more frequent in the healed group.

Taken together, these findings indicate meaningful baseline differences between the healed and non-healed groups with respect to demographic characteristics, care setting, and wound-related features.

2. Distribution and Trends of PUSH Scores

The distribution of PUSH scores differed between the healed and non-healed groups. Overall, the healed group demonstrated lower PUSH scores with a narrower distribution, whereas the non-healed group exhibited higher scores with greater variability. Specifically, the mean PUSH score was lower in the healed group than in the non-healed group, indicating a more favorable wound status among healed cases. These findings suggest distinct score patterns between groups and support the relevance of PUSH scores in reflecting wound healing status.

3. ROC Curve Analysis

The predictive performance of the PUSH score for identifying PI healing was evaluated using ROC curve analysis. Across all PI stages, the PUSH score demonstrated acceptable discriminatory ability, with an AUC of 0.684 and an optimal cut-off value of 4.5 as determined by the Youden Index (Figure 1). Stage-specific analyses showed increasing discriminative performance with greater PI severity, with the highest AUC observed in stage 3 injuries.

To account for clinical variation and the high prevalence of stage 1 PI, additional stratified analyses were performed. When analyses were restricted to stage ≥2 cases, the AUC increased to 0.721, and further increased to 0.738 among stage ≥3 cases, indicating enhanced predictive utility in more advanced wounds. These findings suggest that PUSH scores are more informative for wounds involving tissue loss and may serve as a useful tool for supporting clinical decision-making in PI management. Detailed ROC results and cut-off values by PI stage are summarized in Table 2.

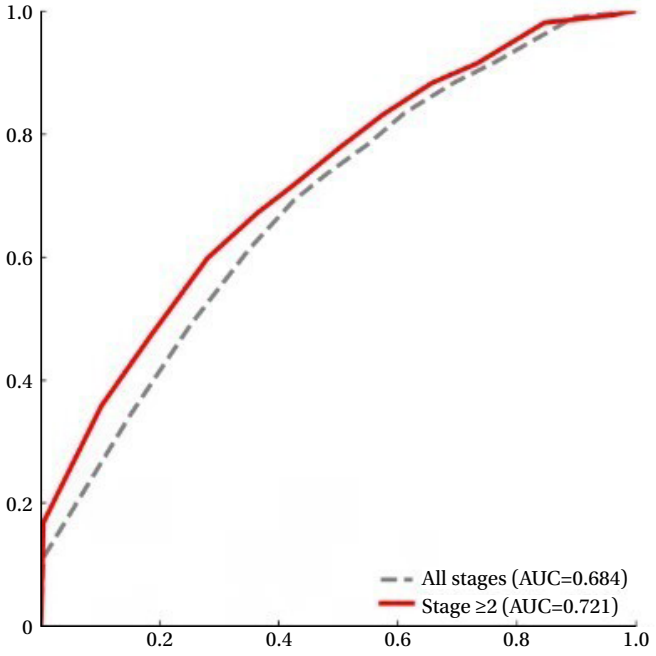

Figure 1. Receiver operating characteristic curves for Pressure Ulcer Scale for Healing scores in predicting pressure injury healing in all stages vs. stage ≥2. AUC = area under the curve.

Table 2. Receiver Operating Characteristic Curve Analysis of Pressure Ulcer Scale for Healing Scores by Pressure Injury Stage

PI stages	AUC (95% CI)	Cut-off	Sensitivity (%)	Specificity (%)	Youden Index
Stage 1	0.612 (0.600–0.624)	4.5	71.2	46.8	0.180
Stage 2	0.708 (0.692–0.723)	3.5	63.4	67.0	0.303
Stage 3	0.781 (0.733–0.830)	7.5	78.9	64.0	0.429
Stage 4	0.532 (0.240–0.824)	9.5	50.0	78.0	0.280
Unstageable	0.705 (0.673–0.737)	4.5	57.0	72.1	0.291
Deep tissue injury	0.729 (0.709–0.748)	5.5	72.5	60.8	0.333
All stages	0.684 (0.676–0.692)	4.5	69.2	57.5	0.267
Stage ≥2	0.721 (0.711–0.732)	3.5	59.8	72.0	0.318
Stage ≥3	0.738 (0.722–0.753)	4.5	62.6	71.6	0.341

AUC = area under the curve; CI = confidence interval; PI = pressure injury.

DISCUSSION

This study identified a clinically meaningful cut-off score of 3.5 on the PUSH tool for predicting healing in stage ≥2 PI. Although the PUSH tool is widely used to monitor wound progression in clinical practice [9], a specific threshold indicating wound healing has not been clearly established. The present finding provides objective evidence to support more consistent and clinically interpretable use of PUSH scores in the inpatient setting.

This study aimed to establish a clinically interpretable healing threshold for PIs that can be meaningfully applied in clinical settings. To place the proposed healing cut-off within an appropriate clinical context, stratified analyses by PI stage were conducted (Table 2), with interpretation guided by stage-specific clinical characteristics and documentation patterns.

Stage 1 PIs were not considered appropriate for defining a healing cut-off. Clinically, stage 1 PIs present as non-blanching erythema without overt tissue damage and frequently resolve without formal intervention [13]. From a documentation perspective, healing of stage 1 injuries is often not explicitly recorded in retrospective EHR–based data, increasing the risk of misclassification. Consistent with prior research that excluded stage 1 PIs from predictive analyses to enhance classification validity [14], this study omitted stage 1 injuries to improve reliability in determining true healing status.

Conversely, defining a cut-off based solely on stage ≥3 PIs was also considered inappropriate. Although stage ≥3 PIs tended to demonstrate better discriminatory performance, such severe wounds account for a relatively small proportion of cases encountered in routine clinical practice. As a result, thresholds derived exclusively from stage ≥3 PIs are difficult to generalize to the broader inpatient population.

In contrast, stage ≥2 PIs represent wounds that are commonly encountered, require ongoing clinical assessment, and necessitate active wound management. These injuries are also more consistently documented in clinical records, providing a stable and clinically meaningful basis for interpretation. Within this clinically relevant context, the present study identified a PUSH cut-off score of 3.5 for stage ≥2 PI.

Previous research has primarily reported average PUSH scores for healed and unhealed wounds rather than identifying a specific healing threshold. For example, one study reported baseline mean PUSH scores of 7.00±0.48 and 13.2±2.11 for healed and unhealed PI, respectively [14], demonstrating that complete wound closure did not necessarily correspond to a PUSH score of zero. This observation supports the rationale for the present study by emphasizing the need for a clinically interpretable cut-off score rather than assuming that wound resolution equates to a score of zero.

The present study differs from prior research by explicitly defining a clinically interpretable healing cut-off and by grounding this threshold in a broader and more representative clinical context. Whereas earlier studies were restricted to narrower stage ranges—typically including only stage 2, 3, and 4 PI—and small sample sizes, the current analysis incorporated a wide spectrum of PI, including unstageable and deep tissue injuries, using a large real-world inpatient dataset. This broader inclusion more closely reflects routine clinical practice and strengthens the generalizability and robustness of the proposed cut-off.

Nevertheless, several limitations should be acknowledged when interpreting these findings. First, this study employed a retrospective design and relied solely on nursing documentation, which may vary in completeness and accuracy. Second, only cases explicitly documented as "healed" were classified as healed; therefore, wounds that were nearly healed but not recorded as such may have been misclassified, potentially introducing selection bias. Third, the analysis was conducted in a single tertiary hospital and included only adult inpatients aged 19 years or older, which may limit generalizability to other healthcare settings or patient populations. Finally, the PUSH score was applied retrospectively rather than in real time, which may not fully reflect its use in routine clinical practice.

Future research may build on these findings through prospective, multicenter studies to validate the proposed cut-off across diverse clinical settings. In addition, predictive modeling approaches incorporating patient characteristics and baseline wound parameters—such as logistic regression or other multivariable methods—could be applied to estimate healing probability at earlier stages of care [15,16]. Building on the cut-off identified in the present study, such approaches may further support clinical decision-making by offering earlier prognostic insight.

Despite these limitations, this study advances understanding of PI healing by establishing a statistically and clinically meaningful PUSH cut-off score for stage ≥2 PI. By grounding this threshold in a large real-world inpatient

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dataset and routine documentation practices, the present study moves beyond descriptive reporting of PUSH score trajectories and provides a practical reference for assessing healing status. This contribution supports a more objective, consistent, and evidence-based interpretation of PUSH scores and facilitates wider integration of standardized PI assessments into routine nursing practice.

CONCLUSION

This study established a clinically meaningful PUSH cut-off score of 3.5 for identifying healing in stage ≥2 PIs. Stratified analyses demonstrated that stage ≥2 PIs represent the most appropriate population for applying this threshold. By providing an objective criterion for interpreting PUSH scores, these findings support more consistent PI assessment and may enhance clinical decision-making in practice.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and design acquisition - JL and SP; data curation and analysis - JL and SP; funding acquisition - SP and JH; investigation - JL; project administration and supervision - JL, SP, and JH; resources and software - JL; validation - JL and SP; visualization - JL; and drafting and critical revision of the manuscript - JL, SP, and JH.

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DATA AVAILABILITY STATEMENT

This study used electronic health records from Samsung Medical Center. The data are not publicly available due to institutional regulations but may be available upon reasonable request to the corresponding author with approval from the Institutional Review Board.

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Perceived Threat of the Risk for Graft Rejection and Its Related Factors in Kidney Transplant Recipients: A Cross-Sectional Study

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Purpose: Concern about graft rejection is a major issue among kidney transplant recipients. However, integrated studies that examine diverse factors influencing the perceived threat of the risk of graft rejection (PTGR) remain rare. This study explored levels of PTGR and the factors associated with PTGR in kidney transplant recipients. **Methods:** A cross-sectional study was conducted with 194 kidney transplant recipients recruited from a tertiary hospital in South Korea. The PTGR scale assesses graft-related threat, intrusive anxiety, and lack of control, and was administered alongside measures of transplant-related symptoms, anxiety, depression, social support, and self-efficacy. **Results:** Approximately 70.1% of participants reported strong graft-related threat beliefs, 57.2% experienced high intrusive anxiety, and 46.9% reported a low sense of control related to PTGR. Demographic factors (age, gender, education level, and kidney donor), clinical factors (transplant complications, posttransplant duration, and symptoms), and psychosocial factors (anxiety, depression, and social support) were associated with PTGR. Women, higher education levels, longer posttransplant duration, and donor relationship predicted graft-related threat, whereas anxiety and donor relationship predicted intrusive anxiety. **Conclusion:** Many kidney transplant recipients experience high levels of PTGR, which are associated with demographic, clinical, and psychosocial factors. Healthcare providers should consider these factors when assessing PTGR and incorporate them into targeted interventions to support kidney transplant recipients.

Key Words: Anxiety; Graft rejection; Kidney transplantation; Perception; Transplant recipients

INTRODUCTION

Kidney transplantation is a renal replacement therapy and represents the optimal treatment for patients with end-stage renal disease [1]. Globally, the number of kidney transplantations has increased in recent years [2]. In 2023, approximately 43,090 kidney transplants were performed in the Americas, 27,229 in Europe, and 21,108 in the Western Pacific [2]. Advances in surgical techniques, immunosuppressants, and desensitization therapies have contributed to improved outcomes [3]. In 2024, 1-year graft survival rates in South Korea were predicted to be 98.77%, with 5-year survival rates estimated at 96.17% [4].

Because transplantation involves the implantation of an organ or tissue from another person, graft rejection can occur. A systematic review reported that the incidence of

acute rejection ranges from 1.1% to 21.5%, with most studies reporting rates of 3.0% to 12.0% within the first-year posttransplantation [5]. Chronic rejection occurs in 7.5% to 20.1% of kidney recipients up to ten years after transplantation, and rejection is a well-established risk factor for graft failure [5]. As a result, recipients are educated to recognize early symptoms of graft rejection and to maintain vigilance in their daily lives [6].

Transplant recipients perceive graft rejection as a serious threat [7,8]. The perceived threat of the risk for graft rejection (PTGR) refers to the persistent fear experienced by organ transplant recipients [9]. High PTGR contributes to psychological stress and reduced quality of life [9], adverse emotional responses that affect psychophysiological and social well-being [8,9], and disruptions to daily life [6].

PTGR has been associated with demographic, clinical, and psychosocial characteristics. Older age and women are associated with higher PTGR [9,10], as have a history of graft rejection–related symptoms and longer posttransplant duration [10]. Depression and anxiety are also correlated with PTGR [10], and PTGR has been shown to be negatively associated with self-efficacy in lung and heart transplant recipients [10,11].

Kidney transplant recipients often experience changes in self-identity, adjustment difficulties, and both psychological and physical problems as they adapt to a transplanted organ [12]. Accordingly, adequate physiological, psychological, and social resources are essential for successful adaptation. Support from family members and healthcare professionals facilitates adjustment and helps recipients overcome posttransplant challenges [13]. Social support has been associated with illness perceptions and psychosocial adaptation in kidney transplant recipients [14], and support from family and friends facilitates self-management, including emotional management, in this population [15]. Thus, social support may play an important role in PTGR among kidney transplant recipients.

Although kidney transplant recipients report greater PTGR related to acute rejection than recipients of liver, heart, or lung transplants [9], studies focusing exclusively on kidney transplant recipients remain limited. Existing studies on PTGR have primarily focused on demographic and clinical factors. Self-efficacy has been reported as a factor associated with PTGR in lung and heart transplant recipients, but studies examining this relationship in kidney transplant recipients are scarce. Social support has been identified as a major factor influencing disease awareness and psychological adaptation in this population [14,15], yet its relationship with PTGR has not been sufficiently examined. Previous studies have rarely comprehensively evaluated factors related to PTGR, including depression, anxiety, self-efficacy, social support, and clinical factors, in kidney transplant recipients. Therefore, this study aimed to identify PTGR levels and to investigate demographic, clinical, psychosocial (depression, anxiety, and social support), and cognitive (self-efficacy) factors associated with PTGR in kidney transplant recipients.

METHODS

1. Study Design

A descriptive, cross-sectional study design was used. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Setting and Samples

This study included 194 kidney transplant recipients recruited from a tertiary hospital in South Korea. Convenience sampling was used to enroll patients who were visiting the transplant surgery outpatient clinic or receiving inpatient treatment in the transplant surgery ward. The inclusion criteria were as follows: 1) age ≥20 years, 2) receipt of a kidney transplant from either a living or deceased donor, and 3) not undergoing dialysis after kidney transplantation. The exclusion criteria were as follows: 1) diagnosis of a major psychiatric disorder (e.g., major depression, bipolar disorder), and 2) confirmed graft rejection based on renal biopsy.

Participants in the outpatient clinic were approached either before or after their scheduled appointments. Inpatients were approached during rest periods following examinations or treatments. All participants were provided with detailed information about the study, and written informed consent was obtained prior to participation.

The sample size for this study was calculated using the G*Power 3.1.9.7 program. A medium effect size of .15 for multiple regression analysis, a power of 0.80 (1–β), a significance level of .05, and 22 predictor variables were specified for the calculation, resulting in a required sample size of 163 participants. Considering a 20% dropout rate, the target sample size was set at 204 participants. To recruit 204

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participants, 300 kidney transplant recipients were invited to participate in the study; however, 96 declined participation. After data collection, ten participants were excluded because they had undergone two kidney transplants. Consequently, data from 194 participants were included in the final analysis.

3. Instruments

1) Perceived threat of the risk for graft rejection

In this study, the PTGR instrument developed by Nilsson et al. [9] was used, with permission obtained from the original author for Korean translation. The Korean translation of the PTGR followed a multistep process, including initial translation, expert review, back-translation, and a pilot study, resulting in a final Korean version developed in accordance with the World Health Organization guidelines for translation and cultural adaptation of instruments [16].

During the initial translation phase, two bilingual nursing researchers independently translated the English instrument into Korean. A third researcher compared the two translated versions to determine the most appropriate Korean wording. The research team then reconciled discrepancies, with particular attention to Item 9 ("Graft rejection was almost always in my mind"), and revised the item accordingly. Subsequently, another bilingual expert conducted a back-translation, after which the researchers compared the original and back-translated versions for conceptual equivalence. The Korean version was then pilot-tested with ten kidney transplant recipients hospitalized in the transplant unit. Due to the lack of institutional review board approval at that stage, demographic and clinical information were not collected. During the pilot testing phase, participants reported difficulty understanding Item 10 ("I can't affect graft rejection personally") and Item 11 ("I can't affect how it will turn out to be"). The researchers revised both items to enhance clarity while maintaining consistency with the original meanings. The revised and supplemented scale was subsequently pilot-tested with five additional kidney transplant recipients, and no items were found to be incomprehensible. Based on these results, the final Korean version of the PTGR was completed.

The PTGR scale consists of 12 items across three subscales, rated on a 5-point Likert scale: three items assessing graft-related threat, six items assessing intrusive anxiety, and three items assessing lack of control. The PTGR scale is designed to be interpreted at the subdomain level and does not generate a total score [9]. Graft-related threat reflects perceived risk of harm, including concerns that the primary disease may recur, health may deteriorate, or an explicit fear of graft loss. Scores for graft-related threat range from 3 to 15, with scores greater than 9 indicating a strong perceived threat. Intrusive anxiety reflects stress responses and anxiety related to graft rejection, with scores ranging from 6 to 30, and scores greater than 18 indicating high intrusion. Lack of control reflects the perception that graft rejection is beyond personal control, with scores ranging from 3 to 15, and scores greater than 9 indicating a low perceived ability to reduce the risk of graft rejection [9,10]. In the original study, Cronbach's α values were .81 for graft-related threat, .91 for intrusive anxiety, and .82 for lack of control [9]. In the present study, Cronbach's α values were .86 for graft-related threat, .90 for intrusive anxiety, and .65 for lack of control.

2) Modified Transplant Symptom Occurrence and Distress Scale

Transplant-related symptoms were assessed using the Korean version of the modified Transplant Symptom Occurrence and Distress Scale [17,18], which was used with permission from the copyright holder. The scale consists of two domains: symptom occurrence and symptom distress. Each domain includes 59 items rated on a 5-point Likert scale ranging from 0 to 4. Total scores for each domain range from 0 to 236, with higher scores indicating greater symptom occurrence or symptom-related distress [17].

3) Anxiety and depression

Anxiety and depression were measured using the Korean version of the Hospital Anxiety and Depression Scale [19,20]. Permission for use in this study was obtained from the copyright holder. The scale consists of 14 items, with seven items assessing anxiety and seven assessing depression, each rated from 0 (none) to 3 (severe). Higher scores indicate greater levels of anxiety and depression. In the original study [20], Cronbach's α ranged from .80 to .93 for anxiety and from .81 to .90 for depression. In the Korean validation study [19], Cronbach's α was .89 for anxiety and .86 for depression. In the present study, Cronbach's α was .84 for anxiety and .73 for depression.

4) Multidimensional Scale of Perceived Social Support

Social support was measured using the Korean version of the Multidimensional Scale of Perceived Social Support

[21,22]. For use in this study, approvals were obtained from both the developers of the original scale and those of the Korean version. This scale has previously been used to measure social support in patients who underwent liver transplantation [23]. The 12-item scale assesses perceived support from family, friends, and significant others. Each item is rated on a 5-point Likert scale, with higher scores indicating greater perceived social support. Cronbach's α ranged from .84 to .92 in the original study [22], was .91 in the Korean validation study [21], and was .90 in the present study.

5) Self-efficacy scale

Self-efficacy was measured using the Korean version of the self-efficacy scale [24,25], which is publicly available and was used with permission from the developer of the Korean version. This scale has been used previously to assess self-efficacy in kidney transplant recipients [24]. The scale consists of 17 items rated on a 5-point Likert scale, with higher scores indicating greater self-efficacy. Cronbach's α was .86 in the original study [25], .86 in the study of Korean kidney transplant recipients [24], and .90 in the present study.

6) Other demographic and clinical characteristics

Demographic characteristics included gender, age, education level, occupation, marital status, and religion. Clinical characteristics included duration of dialysis, cause of kidney injury, posttransplant duration, donor relationship, history of transplant rejection, transplant complications, number and type of immunosuppressive drugs, transplant surgery complications, and body mass index. Demographic and clinical characteristics were assessed through participant self-report or by reviewing medical records.

4. Data Collection

Data were collected between January 25 and March 21, 2024, from kidney transplant recipients who visited the transplant surgery outpatient clinic or were hospitalized in the transplant surgery ward. Data collection was conducted using structured questionnaires. When participants had difficulty completing the questionnaire independently, the researcher read the questionnaire verbatim and recorded participants' responses. Completion of the questionnaire required approximately 20 to 25 minutes when self-administered and approximately 40 minutes when read aloud. When a considerable amount of time had elapsed, the researcher periodically assessed participants' comfort and reminded them that participation could be discontinued at any time. Because the social support questionnaire included questions related to family support, participants completed the survey in a quiet and private setting. In the outpatient clinic, empty consultation or patient education rooms were used. In the ward, surveys were conducted either in single-patient rooms or in interview rooms designated for multi-patient wards.

5. Ethical Considerations

This study was approved by the Institutional Review Board of Asan Medical Center (IRB No. 2024-0108). The researcher explained the study's purpose and procedures to all participants and obtained written informed consent prior to participation. All collected data will be used exclusively for research purposes. To ensure participant anonymity, questionnaire data will be coded and stored on a password-protected, encrypted computer for three years following completion of the study. In addition, participants were informed that they could withdraw from the study at any time without penalty.

6. Data Analysis

Collected data were analyzed using IBM SPSS ver. 29.0 (IBM Corp., Armonk, NY, USA). Demographic, clinical, psychosocial, and cognitive characteristics, as well as PTGR levels, were summarized using descriptive statistics. Differences in PTGR according to demographic and clinical characteristics were examined using independent t-tests, analysis of variance (ANOVA) with post hoc Scheffé tests, and nonparametric analyses using the Kruskal-Wallis test. For variables that did not meet the assumption of normality, the Kruskal-Wallis test was applied. Correlations between PTGR and study variables were examined using Pearson correlation coefficients. Because the study was not based on an explicit theoretical framework and the explanatory variables were not clearly established, stepwise multiple regression analysis was conducted. Statistical significance was set at $p < .05$.

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RESULTS

1. Demographic, Clinical, Psychosocial, and Cognitive Characteristics of the Participants

Regarding demographic characteristics, 106 participants (54.6%) were men, with a mean age of 50.98 years, and the largest age group was 50 to 59 years (28.9%). Approximately 62.4% of participants had attained education beyond the college level, and 151 participants (77.8%) were employed (Table 1).

With respect to clinical characteristics, 17 participants (8.8%) experienced graft rejection, including manifestations such as increased creatinine levels, decreased urine output, or weight gain associated with reduced graft kidney function. The mean posttransplant duration was 85.47 months. Donor types included deceased donors (n=57, 29.4%), siblings or relatives (n=44, 22.7%), spouses (n=39, 20.1%), and parents (n=35, 18.0%). Six participants (3.1%) received organs from friends or nonprofit organizations. Eighty-four participants (43.3%) experienced transplant-related complications, including cytomegalovirus infection, *Pneumocystis carinii* pneumonia, urinary tract infection, and immunosuppressant-induced diabetes. The

Table 1. Demographic and Clinical Characteristics of Participants (N=194)

Variables	Categories	n (%)	M±SD
Demographic characteristics			
Gender	Men	106 (54.6)	
	Women	88 (45.4)	
Age (year)	≤39	34 (17.5)	50.98±11.82
	40–49	50 (25.8)	
	50–59	56 (28.9)	
	≥60	54 (27.8)	
Education level	High school	73 (37.6)	
	≥College	121 (62.4)	
Employment	Yes	151 (77.8)	
	No	43 (22.2)	
Spouse	Yes	157 (80.9)	
	No	37 (19.1)	
Religion	Yes	108 (55.7)	
	No	86 (44.3)	
Clinical characteristics			
Dialysis duration (month)	<3.0	43 (22.2)	47.47±62.66
	3.0–5.9	12 (6.2)	
	6.0–11.9	33 (17.0)	
	12.0–119.9	71 (36.6)	
	≥120	35 (18.0)	
Diseases causing kidney injury[†]	Hypertension	52 (26.8)	
	Diabetes mellitus	41 (21.1)	
	Polycystic kidney disease	8 (4.1)	
	Unknown	47 (24.2)	
	Glomerulonephritis	10 (5.2)	
	Others	46 (23.7)	
Posttransplant duration (year)	<1.0	36 (18.6)	7.12±7.01
	1.0–2.9	38 (19.6)	
	3.0–9.9	64 (33.0)	
	≥10	56 (28.9)	
Kidney donor	Deceased donor	57 (29.4)	
	Parent	35 (18.0)	
	Spouse	39 (20.1)	
	Children (daughter or son)	13 (6.7)	
	Sibling or relative	44 (22.7)	
	Others[‡]	6 (3.1)	
History of graft rejection	Yes	17 (8.8)	
	No	177 (91.2)	
Transplant complication	Yes	84 (43.3)	
	No	110 (56.7)	
No. of immunosuppressants			2.73±0.46
	1–2	52 (26.8)	
	3	141 (72.7)	
	≥4	1 (0.5)	
Use of immunosuppressant[†]	Tacrolimus	172 (88.7)	
	Cyclosporine	18 (9.3)	
	Sirolimus	12 (6.2)	
	Everolimus	6 (3.1)	
	Leflunomide	1 (0.5)	
	Adrenocorticoids	176 (90.7)	
	Mycophenolate	144 (74.2)	
Transplant surgery complication	Yes	31 (16.0)	
	No	163 (84.0)	
Body mass index (kg/m^2)	<18.5	18 (9.3)	22.73±3.59
	18.5–22.9	95 (49.0)	
	23.0–24.9	42 (21.6)	
	≥25.0	39 (20.1)	
Modified Transplant Symptom Occurrence and Distress Scale			
Symptom occurrence			48.99±29.15
Symptom distress			43.66±30.57

Graft rejection includes increased creatinine, decreased urine output, and weight gain related to decreased graft kidney function; transplant complication includes cytomegalovirus infection, *Pneumocystis carinii* pneumonia, urinary tract infection associated with transplanted kidney, and diabetes caused by immunosuppressants; transplant surgery complication includes surgical site bleeding, infections, ureteral leak, and ureteral stricture.
M=mean; SD=standard deviation; [†]Multiple responses; [‡]Friend or nonprofit social organization.

mean number of immunosuppressive medications was 2.73±0.46, and tacrolimus use was reported in 88.7% of participants. Sixteen percent of participants experienced transplant surgery complications, including bleeding, infections, ureteral leak, and ureteral stricture. According to the modified Transplant Symptom Occurrence and Distress Scale, mean symptom occurrence was 48.99±29.15 and mean symptom distress was 43.66±30.57 (Table 1). These scores were slightly lower than those reported in previous Korean studies [26].

Among psychosocial and cognitive characteristics, mean scores for depression, anxiety, social support, and self-efficacy were 5.47±3.63, 5.01±3.91, 3.62±0.76, and 61.98±10.11, respectively.

2. Descriptive Data of PTGR among the Participants

The mean scores for the PTGR subdomains of graft-related threat, intrusive anxiety, and lack of control were 10.95±3.37, 17.38±6.28, and 9.06±2.41, respectively. Among participants, 136 (70.1%) reported strong graft-related threat beliefs, 111 (57.2%) experienced significant intrusive anxiety, and 91 (46.9%) perceived low control over their ability to reduce the risk of graft rejection (Table 2).

Table 2. Psychosocial and Cognitive characteristics and Perceived Threat of the Risk for Graft Rejection of the Participants (N=194)

Variables	Categories	M±SD (range) or n (%)
Psychosocial and cognitive characteristics		
Depression		5.47±3.63 (0–21)
Anxiety		5.01±3.91 (0–21)
Social support		3.62±0.76 (1–5)
Self-efficacy		61.98±10.11 (17–85)
Perceived threat of the risk for graft rejection		
Graft-related threat		10.95±3.37 (3–15)
	Strong belief (>9)	136 (70.1)
	Not strong belief (≤9)	58 (29.9)
Intrusive anxiety		17.38±6.28 (6–30)
	Great (>18)	111 (57.2)
	Not great (≤18)	83 (42.8)
Lack of control		9.06±2.41 (3–15)
	Low control (>9)	91 (46.9)
	Not low control (≤9)	103 (53.1)

M=mean; SD=standard deviation.

3. Demographic, Clinical, Psychosocial, and Cognitive Characteristics Associated with PTGR

1) Demographic, clinical, psychosocial, and cognitive characteristics associated with graft-related threat in PTGR

With respect to the graft-related threat subdomain, women (t=–3.20, p=.002) and participants with higher education levels (≥college) (t=3.09, p=.002) had significantly higher graft-related threat scores. Significant differences in graft-related threat were also observed according to donor type (χ^2=15.05, p=.010), with higher perceived threat reported when the donor was a deceased donor or a parent. In addition, participants who experienced transplant complications had higher graft-related threat scores than those without complications (t=1.98, p=.049) (Table 3). Correlation analysis showed that a longer posttransplant duration (r=.18, p=.015) was associated with higher graft-related threat (Table 4).

2) Demographic, clinical, psychosocial, and cognitive characteristics associated with intrusive anxiety in PTGR

In the intrusive anxiety subdomain, women (t=–2.01, p=.046) demonstrated higher intrusive anxiety scores than men (Table 3). Higher symptom occurrence (r=.16, p=.029), higher symptom distress (r=.18, p=.010), greater depression (r=.15, p=.040), and higher anxiety (r=.36, p<.001) were significantly associated with increased intrusive anxiety scores (Table 4).

3) Demographic, clinical, psychosocial, and cognitive characteristics associated with lack of control in PTGR

Older age (r=.17, p=.021), higher anxiety (r=.20, p=.005), and lower social support (r=–.15, p=.043) were significantly associated with higher lack-of-control scores (Table 4). Lack-of-control scores were not significantly associated with any demographic or clinical characteristics in group comparison analyses (Table 3).

4. Factors Influencing PTGR in Kidney Transplant Recipients

Stepwise multiple regression analysis was conducted to identify factors influencing PTGR in kidney transplant recipients. Variables with p-values less than .10 in univariate analyses were included as independent variables.

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Table 3. Perceived Threat of the Risk for Graft Rejection According to Demographic and Clinical Characteristics

Variables	Categories	Graft-related threat		Intrusive anxiety		Lack of control	
		M±SD	t or χ^2 (p)	M±SD	t or χ^2 (p)	M±SD	t or χ^2 (p)
Demographic characteristics							
Gender	Men	10.26±3.44	−3.20 (.002)	16.56±5.87	−2.01 (.046)	9.11±2.34	0.36 (.721)
	Women	11.77±3.10		18.36±6.64		8.99±2.50	
Education level	High school	10.01±3.57	3.09 (.002)	17.15±6.99	0.37 (.711)	9.04±2.31	0.07 (.944)
	≥College	11.51±3.12		17.51±5.83		9.07±2.48	
Employment	Yes	10.73±3.51	−1.99 (.050)	17.21±6.13	−0.68 (.496)	9.13±2.38	0.82 (.413)
	No	11.72±2.70		17.95±6.83		8.79±2.52	
Spouse	Yes	10.94±3.40	0.11 (.910)	17.30±6.40	0.35 (.726)	9.17±2.34	−1.30 (.195)
	No	11.00±3.24		17.70±5.81		8.59±2.68	
Religion	Yes	10.95±3.40	0.05 (.962)	17.56±6.25	0.45 (.657)	9.25±2.41	1.25 (.211)
	No	10.94±3.34		17.15±6.35		8.81±2.40	
Clinical characteristics							
Diseases causing renal failure							
Hypertension	Yes	11.35±3.12	1.01 (.315)	17.54±6.21	0.22 (.828)	8.98±2.57	−0.27 (.791)
	No	10.80±3.45		17.32±6.32		9.08±2.36	
Diabetes mellitus	Yes	10.59±3.68	−0.77 (.445)	17.00±6.09	−0.43 (.667)	8.41±2.70	−1.94 (.054)
	No	11.04±3.29		17.48±6.34		9.29±2.30	
Kidney donor	Deceased donor	11.67±3.34	15.05‡ (.010)	17.44±6.09	9.54‡ (.090)	9.04±2.07	0.69‡ (.228)
	Parent	11.83±3.48		18.17±5.73		8.71±2.79	
	Spouse	10.03±3.61		17.00±6.76		9.05±2.44	
	Children (daughter or son)	9.46±2.50		18.08±6.25		8.31±2.69	
	Sibling or relative	10.61±2.94		17.75±6.49		9.77±2.30	
	Others†	10.67±4.08		10.33±3.62		7.67±2.42	
History of graft rejection	Yes	10.94±3.49	−0.01 (.998)	17.12±7.02	−0.18 (.859)	8.18±2.04	−1.58 (.115)
	No	10.95±3.36		17.40±6.22		9.14±2.43	
Transplant complication	Yes	11.48±3.03	1.98 (.049)	17.70±6.25	0.63 (.529)	9.20±2.50	0.74 (.463)
	No	10.54±3.57		17.13±6.32		8.95±2.53	
Transplant surgery complication	Yes	11.65±3.24	1.26 (.209)	18.19±5.76	0.79 (.431)	8.39±2.33	−1.70 (.091)
	No	10.82±3.38		17.22±6.38		9.18±2.41	

M = mean; SD = standard deviation; †Friend or nonprofit social organization; ‡Kruskal-Wallis test.

1) Factors influencing graft-related threat in PTGR among kidney transplant recipients

Factors influencing graft-related threat included gender (women) (β = .27, p < .001), higher education level (≥college) (β = .26, p < .001), longer posttransplant duration (β = .16, p = .015), and donor type (brain-dead donor or parent) (β = .16, p = .019). These variables explained 16.3% of the variance in graft-related threat (adjusted R^2 = .16, F = 10.22; p < .001).

To assess multicollinearity among independent variables, tolerance values and variance inflation factors (VIFs) were calculated. Tolerance values ranged from 0.926 to 0.997, exceeding the minimum threshold of 0.10, and VIFs ranged from 1.003 to 1.080, remaining well below 10, indicating that multicollinearity was not present. The Durbin-Watson statistic was 2.030, which is close to the ideal value of 2.0, suggesting independence of error terms and the absence of autocorrelation.

2) Factors influencing intrusive anxiety in PTGR among kidney transplant recipients

Factors influencing intrusive anxiety included anxiety (β = .34, p < .001) and donor type (excluding "others") (β = .15, p = .025). These variables accounted for 14.3% of the variance in intrusive anxiety (adjusted R^2 = .14, F = 6.78; p < .001). The tolerance value was 0.979, the VIF was 1.022, and the Durbin-Watson statistic was 1.827, indicating the absence of multicollinearity.

Table 4. Correlations among Perceived Threat of the Risk for Graft Rejection and Other Variables

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
	r (*p*)											
X_2	.11 (.117)											
X_3	.30 (<.001)	–.01 (.928)										
X_4	.03 (.712)	–.20 (.006)	.11 (.143)									
X_5	–.07 (.352)	–.01 (.960)	–.12 (.094)	.01 (.980)								
X_6	–.03 (.713)	–.06 (.402)	–.13 (.083)	.02 (.770)	.91 (<.001)							
X_7	–.16 (.022)	–.02 (.824)	–.02 (.816)	.11 (.116)	.53 (<.001)	.48 (<.001)						
X_8	–.06 (.448)	–.03 (.665)	–.04 (.605)	.07 (.322)	.64 (<.001)	.58 (<.001)	.54 (<.001)					
X_9	–.08 (.269)	–.09 (.197)	–.10 (.167)	–.03 (.672)	–.25 (<.001)	–.21 (.003)	–.44 (<.001)	–.31 (<.001)				
X_{10}	–.12 (.104)	–.05 (.516)	.04 (.630)	–.03 (.701)	–.30 (<.001)	–.29 (<.001)	–.38 (<.001)	–.33 (<.001)	.47 (<.001)			
X_{11}	–.09 (.197)	.01 (.872)	.18 (.015)	–.02 (.750)	.09 (.190)	.11 (.146)	.01 (.999)	.12 (.097)	.01 (.924)	–.02 (.802)		
X_{12}	–.07 (.362)	.09 (.213)	.04 (.571)	.09 (.192)	.16 (.029)	.18 (.010)	.15 (.040)	.36 (<.001)	–.13 (.072)	–.12 (.092)	.36 (<.001)	
X_{13}	.17 (.021)	–.02 (.780)	.05 (.485)	.08 (.243)	.09 (.200)	.10 (.183)	.05 (.462)	.20 (.005)	–.15 (.043)	–.03 (.700)	.23 (.001)	.37 (<.001)

X_1 = age; X_2 = dialysis duration; X_3 = Posttransplant duration; X_4 = body mass index; X_5 = symptom occurrence; X_6 = symptom distress; X_7 = depression; X_8 = anxiety; X_9 = social support; X_{10} = self-efficacy; X_{11} = graft-related threat; X_{12} = intrusive anxiety; X_{13} = lack of control.

3) Factors influencing lack of control in PTGR among kidney transplant recipients

Factors influencing lack of control included anxiety (β = .23, p = .001), older age (β = .19, p = .008), and transplant surgery complications (β = –.16, p = .021). These variables explained 8.2% of the variance in lack of control (adjusted R^2 = .08, F = 6.78; p < .001) (Table 5). Tolerance values ranged from 0.978 to 0.993, VIFs ranged from 1.007 to 1.993, and the Durbin-Watson statistic was 2.189, indicating that multicollinearity was not present.

DISCUSSION

This study was conducted to examine the level of PTGR and to identify factors associated with PTGR among kidney transplant recipients. The PTGR scale is designed to be interpreted at the subdomain level rather than as a total score; accordingly, analyses in this study were conducted separately for each subdomain. Among kidney transplant recipients, PTGR was associated with demographic, clinical, and psychosocial factors.

In this study, 70.1% of participants demonstrated a strong belief in graft-related threat, 57.2% reported high intrusive anxiety, and 46.9% reported a high level of lack of control. These findings indicate that PTGR levels among kidney transplant recipients are higher than those reported in previous studies involving lung transplant recipients and mixed organ transplant populations [10,11], with a particularly high proportion exhibiting strong graft-related threat beliefs. This difference may be attributable to the higher proportion of women and the longer posttransplant duration in the present study compared with prior studies [10,11]. Accordingly, healthcare professionals should systematically assess PTGR in kidney transplant recipients, with particular attention to graft-related threat among the PTGR subdomains.

In this study, demographic factors, including gender, education level, and age, were associated with PTGR. Gender (women) and higher education level influenced graft-related threat, whereas older age was associated with lack of control. A previous study reported higher graft-related threat among women than men, although the difference

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Table 5. Multiple Regression Analysis of Factors Influencing Perceived Threat of the Risk for Graft Rejection

Variables	B	SE	β	t	*p*
Graft-related threat					
(Constant)	7.93	0.52		15.20	<.001
Gender (women)	1.82	0.46	.27	3.95	<.001
Education level (≥college)	1.81	0.48	.26	3.82	<.001
Posttransplant duration	0.01	0.01	.16	2.45	.015
Donor type (deceased donor or parent)	1.06	0.45	.16	2.36	.019
R^2			.18		
Adjusted R^2			.16		
F (*p*)			10.22 (<.001)		
Intrusive anxiety					
(Constant)	9.34	2.38		3.92	<.001
Anxiety	0.54	0.11	.34	5.01	<.001
Donor type (not others)	5.50	2.44	.15	2.26	.025
R^2			.15		
Adjusted R^2			.14		
F (*p*)			17.07 (<.001)		
Lack of control					
(Constant)	6.57	0.78		8.45	<.001
Anxiety	0.14	0.04	.23	3.32	.001
Age	0.04	0.01	.19	2.70	.008
Transplant surgery complication	−1.07	0.46	−.16	−2.33	.021
R^2			.10		
Adjusted R^2			.08		
F (*p*)			6.78 (<.001)		

SE = standard error.

was not statistically significant, and also found higher intrusive anxiety in women, supporting the importance of considering gender when evaluating PTGR [10]. Education level has not been examined previously; however, higher education was associated with higher graft-related threat in this study. This finding is consistent with research on fear of cancer recurrence, in which higher education predicted greater fear, possibly because individuals with higher educational attainment are more likely to seek additional information about their illness, treatment, and prognosis [27]. Although graft-related threat is not identical to fear of cancer recurrence, both constructs reflect heightened awareness of potential future health threats. Recipients with higher education levels may acquire more information about rejection risk and, paradoxically, experience stronger graft-related threat. Further research is needed to examine differences in graft-related threat according to educational level and to ensure that information provided to recipients is accurate and balanced to prevent unnecessary fear. In a previous study examining the relationship between age and PTGR [10], recipients aged 50 years or older had higher graft-related threat; however, in the present study, age was associated only with lack of control. Because few studies have examined demographic characteristics in relation to PTGR, additional research is warranted.

Among clinical factors, posttransplant duration and donor type influenced PTGR. The association between posttransplant duration and PTGR may reflect awareness of the expected lifespan of a transplanted kidney, which is generally reported to be 11.7 to 19.2 years [4], potentially heightening graft-related threat as time since transplantation increases. In a previous study, PTGR according to posttransplant duration was described, but differences were not statistically analyzed [10]. Therefore, further studies are needed to examine PTGR levels across different posttransplant time periods. In this study, donor type was also influential, with graft-related threat being significantly higher when the donor was a deceased donor or a parent. This finding is likely related to donor age and graft prognosis. Previous studies have reported lower graft survival when donors are older, and when the donor is a parent, the donor is necessarily older than the recipient [28-30]. In addition, graft survival is shorter among recipients of deceased donors compared with those receiving kidneys from living donors [31], and survival is further reduced when deceased donors are older [28]. Therefore, donor type should be carefully considered when evaluating graft-related threat.

With respect to psychosocial factors, anxiety influenced PTGR, and both depression and anxiety were associated with intrusive anxiety in this study. These findings are consistent with previous studies demonstrating associations among anxiety, depression, and intrusive anxiety [10,11]. Anxiety and depression are also associated with clinical parameters such as serum creatinine, hemoglobin levels, and both physical and mental health in kidney transplant recipients [32]. Consequently, interventions aimed at reducing anxiety and depression may contribute to improvements in both clinical and psychological outcomes. In addition, higher levels of social support were associated with lower levels of lack of control. Although direct comparison is limited by the paucity of prior studies, a recent study in-

volving kidney transplant recipients with graft failure reported similar findings [33]. In that study, participants indicated that support from family members, healthcare professionals, fellow patients, and friends provided comfort and strength to overcome difficulties [33]. Because social support may enhance recipients' perceived control over their situation, healthcare professionals and families should work collaboratively to strengthen support systems.

Unlike findings from previous studies, self-efficacy as a cognitive factor was not directly associated with PTGR in this study. However, self-efficacy was associated with depression and anxiety, which were themselves related to intrusive anxiety. In a prior study, self-efficacy showed strong associations with intrusive anxiety during heart transplantation [10]. Therefore, future research is needed to clarify the relationships among self-efficacy, depression, anxiety, and intrusive anxiety using advanced analytical approaches such as path analysis. Additionally, the lack of association between self-efficacy and PTGR observed in this study may be attributable to the measurement instrument used. Because no transplant-specific self-efficacy scale currently exists, generic instruments, such as the Self-Efficacy for Managing Chronic Disease 6-Item Scale, are often used in transplant populations [34]. Given that self-efficacy is behavior-specific and that transplant recipients must manage complex self-care behaviors, including adherence to immunosuppressive therapy and monitoring for symptoms and signs of graft rejection [5], the development of a transplant-specific self-efficacy scale is warranted.

This study has several limitations. First, generalizability is limited because the study was conducted among inpatients and outpatients at a single tertiary hospital. Second, the reliability of the lack-of-control subdomain of the PTGR scale was relatively low, likely due to the small number of items comprising this subscale (three items) [35]. Furthermore, during pilot testing of the Korean version, participants reported difficulty understanding Items 10 and 11, which necessitated multiple revisions. Consequently, further research is needed to examine and refine the psychometric properties of the Korean version of the PTGR scale. Finally, factors influencing PTGR were examined without an explicit theoretical framework and were selected based on previous studies. Because this study employed a cross-sectional design, causal relationships among variables could not be clearly established. Future research should incorporate theoretical frameworks and apply analytic approaches such as path analysis or structural equation modeling, as well as longitudinal designs, to better clarify causal relationships.

This study also has several strengths. First, it highlights PTGR levels in kidney transplant recipients, a population with substantial concern about acute rejection, thereby addressing the limited number of PTGR studies conducted among organ transplant recipients. Second, this study integrates demographic, clinical, psychosocial, and cognitive factors associated with PTGR in kidney transplant recipients, contributing to a more comprehensive understanding of PTGR in this population.

1. Implications for Clinical Practice

Because women may experience higher PTGR levels than men, nurses should pay particular attention to graft-related threat among female recipients and assess their PTGR levels carefully. In addition, it is important to identify factors associated with PTGR in women and to implement interventions tailored to those factors. As age and education level are related to PTGR, healthcare professionals should verify whether recipients possess accurate information about graft rejection and should provide clear explanations that take age and educational background into account to avoid unnecessarily heightened threat perceptions. In particular, older adults and individuals with lower educational levels should receive information presented in an accessible and understandable manner to ensure accurate comprehension of transplantation-related issues. Moreover, graft-related threat increased with longer post-transplant duration. Therefore, the graft-related threat subdomain of PTGR should be evaluated even in long-term recipients who do not exhibit overt physical problems.

Strategies are needed to manage modifiable factors related to PTGR, including transplant surgery complications and anxiety. Nurses should closely monitor recipients for complications following transplant surgery, and early detection and timely treatment of these complications may help reduce PTGR. Because anxiety predicts intrusive anxiety and is associated with social support, healthcare professionals should implement interventions that incorporate social support to reduce anxiety among recipients, which may represent an effective strategy for managing PTGR.

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CONCLUSION

Many kidney transplant recipients experience high levels of PTGR, which are associated with demographic, clinical, and psychosocial factors. Healthcare providers should consider these characteristics when assessing PTGR in transplant recipients.

Although kidney transplantation is a primary and highly effective treatment option for patients with end-stage renal disease, recipients continue to face multiple challenges following the procedure. To prevent recipients from experiencing vague or persistent concerns about potential graft rejection, healthcare providers should consistently attend to patients' PTGR and ensure that recipients receive systematic and comprehensive education to support effective PTGR management.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and/or design acquisition - SB, SRK, KK, and YP; analysis - SB and SRK; interpretation of the data - SB, SRK, KK, and YP; and drafting or critical revision of the manuscript for important intellectual content - SB, SRK, KK, and YP.

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DATA AVAILABILITY STATEMENT

The data can be obtained from the corresponding authors.

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Self-Efficacy As a Mediator between Functional Independence, Social Networks, and Dementia-Prevention Behaviors in Community-Dwelling Older Adults: A Cross-Sectional Study

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Purpose: While capability and opportunity factors in dementia prevention have been extensively studied, the motivational mechanisms that translate these resources into behavior remain relatively underexplored. This study examined the mediating effect of self-efficacy on the relationships between instrumental activities of daily living (IADL), social networks, and dementia-prevention behaviors among community-dwelling older adults, guided by the capability, opportunity, motivation-behavior (COM-B) theoretical framework. **Methods:** A cross-sectional study was conducted with 205 community-dwelling adults aged 65 years and older residing in Gyeongsangnam Province, South Korea. Data were collected between July and September 2024 using validated instruments, including the Korean Instrumental Activities of Daily Living, Social Network Measurement Scale, General Self-Efficacy Scale, and Korean Health Behavior for Dementia Prevention Scale. Mediation analysis was performed using Hayes' PROCESS macro (model 4) with bootstrap resampling (5,000 iterations) to estimate indirect effects, while controlling for demographic and health-related covariates. **Results:** Self-efficacy significantly mediated both the IADL–dementia-prevention behavior relationship (indirect effect, −0.33; 95% confidence interval [CI], −0.61 to −0.12) and the social network–dementia-prevention behavior relationship (indirect effect, 0.08; 95% CI, 0.002 to 0.19). The mediation models explained 40.7% and 48.5% of the variance in dementia-prevention behaviors, respectively. Bootstrap CIs confirmed significant partial mediation effects in both pathways. **Conclusion:** These findings provide empirical support for the COM-B model's theoretical proposition that motivation serves as a critical bridge linking capability and opportunity factors to actual behavior. Nursing interventions should therefore integrate self-efficacy–enhancement strategies alongside traditional capability-building and opportunity-provision approaches to maximize the effectiveness of dementia-prevention programs for older adults.

Key Words: Aged; Dementia; Health behavior; Motivation; Self-efficacy

INTRODUCTION

South Korea is undergoing unprecedented demographic change. As of 2025, adults aged 65 years and older comprise approximately 10.58 million individuals, accounting for 20.0% of the total population, with this proportion pro-

jected to increase to 24.5% by 2030 [1]. This rapid population aging is accompanied by a substantial rise in dementia prevalence. According to the 2025 National Dementia Epidemiological Survey, approximately 970,000 older adults (9.2% of those aged 65 years and older) are currently living with dementia, with projections exceeding 1 million by 2026 and 2 million by 2044 [2]. Notably, the 2020 Lancet Commission reported that approximately 40% of dementia cases could be prevented or delayed through behavioral interventions targeting modifiable risk factors [3]. Key dementia-prevention behaviors include regular physical exercise, social engagement, cognitive stimulation, cardiovascular health management (such as blood pressure control, weight maintenance, and diabetes management), smoking cessation, and healthy dietary practices [3]. Together, these converging demographic and epidemiological trends, combined with substantial prevention potential, underscore the urgent need to understand and promote effective dementia-prevention strategies.

At the individual level, dementia progressively undermines functional independence, erodes personal identity, and diminishes quality of life [3]. Families experience substantial caregiving burdens, with approximately 45.8% of family caregivers reporting significant physical, emotional, and financial strain [4]. At the societal level, economic costs are both considerable and escalating: total dementia-related management costs reached approximately 20 trillion won in 2025 and are projected to increase to 63 trillion won by 2040 [1,4]. These profound individual, familial, and societal consequences collectively highlight the critical importance of effective dementia-prevention strategies.

Despite considerable advances in dementia-prevention knowledge and widespread public awareness campaigns, translating knowledge into sustained behavioral practice remains challenging. Among older adults in South Korea, engagement in dementia-prevention behaviors remains suboptimal, with average scores of only 56 to 63 points out of 100 and preventive activities practiced just 1 to 2 days per week [5]. Several factors contribute to this persistent knowledge-behavior gap. First, traditional health education approaches have primarily emphasized information delivery, operating under the flawed assumption that knowledge directly translates into behavior change, an assumption consistently refuted by health behavior literature [6,7]. Second, older adults face multiple concurrent barriers, including physical limitations, demands related to chronic disease management, and diminished psychological resources, all of which may impede preventive action despite adequate knowledge [5,7]. Third, dementia prevention requires sustained engagement across multiple complex behavioral domains, including cognitive stimulation, physical activity, social participation, and lifestyle modification, making long-term adherence particularly difficult in the absence of strong motivational foundations [8,9]. This substantial gap between awareness and action highlights the limitations of traditional prevention approaches that prioritize information dissemination without adequately addressing the psychological mechanisms necessary for translating knowledge into sustained behavioral practice [6,7].

The capability, opportunity, motivation-behavior (COM-B) model provides a comprehensive theoretical framework for understanding the complex mechanisms underlying health behavior change [7]. It proposes that behavior emerges from the dynamic interaction of three essential components: capability, defined as the physical and psychological capacity to perform behaviors; opportunity, referring to the environmental and social conditions that enable those behaviors; and motivation, encompassing the psychological processes that energize and direct behavior. While previous dementia-prevention research has extensively examined capability factors, such as knowledge, cognitive function, and physical health, as well as opportunity factors, including social support and resource availability, the motivational component remains significantly underexplored. In particular, the psychological mechanisms through which capabilities and opportunities are translated into sustained behavioral engagement have received limited empirical attention. Beyond dementia prevention, the COM-B model has been widely applied across diverse health behaviors, demonstrating the value of explicitly specifying capability, opportunity, and motivation when designing behavior change interventions [7]. However, most COM-B–based applications have focused on single behavioral targets and have rarely examined multidomain, long-term dementia-prevention lifestyles in community-dwelling older adults, underscoring the need for the present study.

Among motivational factors, including outcome expectations, attitudes, and intentions, self-efficacy is particularly critical for understanding health behavior change in older adults. Self-efficacy, defined as individuals' confidence in their capacity to execute specific behaviors [10], differs from other motivational constructs by emphasizing per-

ceived capability rather than behavioral desirability or intention [6]. Meta-analytic evidence indicates that self-efficacy is among the strongest predictors of both health behavior initiation and long-term maintenance, especially for behaviors requiring sustained effort and self-regulation, such as dementia prevention [11].

Self-efficacy assumes heightened importance in older adult populations due to age-specific challenges that uniquely threaten behavioral confidence. According to Bandura social cognitive theory, self-efficacy develops through mastery experiences, vicarious learning, social persuasion, and the interpretation of physiological states [10]. Older adults encounter distinctive obstacles across all four sources. Functional declines, including reduced strength, slower processing speed, and diminished sensory acuity, undermine mastery experiences; smaller social networks and declining peer health limit opportunities for vicarious learning; ageist attitudes from family members and healthcare providers may weaken social encouragement; and chronic physical symptoms are often misinterpreted as evidence of incapacity [3,9]. Although self-efficacy facilitates behavior change across the lifespan, it assumes disproportionate importance in later life [8,10]. Younger adults' relatively stable functioning and broader social networks allow other motivational factors, such as outcome expectations and intentions, to more readily drive behavior. In contrast, for older adults facing functional decline, social network contraction, and age-related messaging, self-efficacy becomes the critical psychological resource determining whether knowledge and opportunities are translated into actual preventive behavior [7,8,11].

Two key factors that may influence dementia-prevention behaviors through self-efficacy pathways are instrumental activities of daily living (IADL) and social networks. Within the COM-B framework, IADL represents a central capability factor, reflecting the physical and cognitive capacities required for independent functioning. In COM-B, capability is interpreted in relation to the target behavior, and dementia-prevention behaviors require sufficient functional capacity to plan, initiate, and sustain daily activities. IADL tasks, including financial management, medication adherence, transportation use, and household management, require the integration of multiple cognitive and executive functions [12,13]. From the perspective of Bandura social cognitive theory, mastery experiences constitute the most powerful source of self-efficacy [10]. Successful performance of IADL tasks may therefore serve as such experiences, providing older adults with tangible evidence of their continued competence. While IADL reflects functional capacity as a capability construct, self-efficacy represents motivational confidence to enact target behaviors. Previous research has demonstrated significant positive associations between IADL and self-efficacy [14]. This conceptualization of functional independence as a capability factor is further supported by COM-B–informed health behavior research, in which activities of daily living, including instrumental domains, have been mapped onto capability as indicators of the physical and psychological capacities influencing behavioral engagement in older adults [15].

Social networks represent the opportunity component within this framework, providing the environmental and social conditions that enable behavior change [3,7,16,17]. Social connections enhance self-efficacy through multiple mechanisms, including vicarious learning, such as observing peers' successful behaviors; verbal persuasion, through encouragement from network members; and emotional support, which reduces stress and enhances positive affect [6,9,10]. This relationship is bidirectional. Higher self-efficacy can motivate older adults to maintain social connections despite age-related barriers, such as mobility limitations and hearing loss, whereas lower self-efficacy may contribute to social withdrawal, initiating a cycle that erodes both social resources and behavioral confidence [6,10]. Empirical evidence supports this reciprocal pathway, with prior studies demonstrating significant associations between social networks and self-efficacy, as well as self-efficacy's mediating role in social support-health behavior relationships [8,9].

Despite this strong theoretical foundation, few studies have explicitly examined the mediating role of self-efficacy in the pathways linking IADL and social networks to dementia-prevention behaviors. Most existing research has examined these factors in isolation or has focused primarily on their direct effects, thereby overlooking potentially critical motivational mechanisms that translate available resources into sustained behavioral engagement. Clarifying these pathways is essential, as it may inform the design of more effective dementia-prevention programs and guide more strategic allocation of intervention resources.

The COM-B model's proposition that capability and opportunity factors influence behavior through motivational mechanisms provides an appropriate framework for examining these relationships. However, few studies have empirically tested this pathway within the context of dementia

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prevention, and many current prevention programs continue to emphasize capability-building or opportunity enhancement while giving limited attention to motivational processes. Identifying the mediating role of self-efficacy may therefore support the development of more comprehensive interventions that integrate all three COM-B components, addressing persistent gaps in both theory and practice.

Therefore, this study aimed to examine self-efficacy as a motivational mediator in the relationships between functional capability, specifically IADL, social opportunity, represented by social networks, and dementia-prevention behaviors among community-dwelling older adults. We hypothesized that greater independence in IADL would be associated with higher self-efficacy, which would, in turn, predict stronger engagement in dementia-prevention behaviors. We further hypothesized that stronger social networks would be associated with higher self-efficacy, which would subsequently predict greater engagement in dementia-prevention behaviors. By testing these mediational pathways, this study sought to provide empirical support for the theoretical propositions of the COM-B model and to inform the development of more effective, theoretically grounded dementia-prevention interventions that simultaneously address motivational, capability, and opportunity factors.

METHODS

1. Study Design

This descriptive cross-sectional study examined the mediating effects of self-efficacy on the relationships among IADL, social networks, and dementia-prevention behaviors in community-dwelling older adults, using the COM-B theoretical framework. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Study Participants

Participants were community-dwelling adults aged 65 years and older residing in Changwon City, Gyeongsangnam Province, South Korea, who understood the purpose of the study and provided informed consent. Convenience sampling was employed. Inclusion criteria were as follows: (1) aged 65 years or older with the ability to read, comprehend, and communicate, and (2) scoring within the "no cognitive impairment" range on the Korean Mini-Mental State Examination–2 Short Form (K-MMSE-2: SF) [18]. Exclusion criteria included (1) current treatment for physician-diagnosed psychiatric disorders and (2) a diagnosis of dementia.

The required sample size was calculated using G*Power 3.1.9.7 [19] for mediation analysis, following sample size guidelines for mediation models proposed by Sim et al. [20]. Parameters included a significance level of $\alpha = 0.05$, a medium effect size ($f^2 = 0.15$) consistent with prior self-efficacy and COM-B–based health behavior research [8,11], and high statistical power ($1-\beta = 0.95$) to minimize type II error in detecting indirect effects. The model included 14 potential predictor variables, comprising six demographic variables, four health-related variables, and four study variables. This yielded a minimum sample size of 194 participants.

However, after preliminary analyses and consideration of multicollinearity, the final mediation models included only six control variables: age, education level, living arrangements, monthly income, chronic disease status, and subjective health status. These variables demonstrated significant associations with dementia-prevention behaviors in bivariate analyses. To account for the characteristics of the older adult population and the complexity of the mediation analysis, the target sample size was set at 224 participants, allowing for an anticipated dropout rate of 15%. According to Fritz and MacKinnon [21], this sample size is sufficient to detect medium-sized indirect effects with 80% statistical power in mediation analyses using bootstrapping methods.

Initial cognitive screening was conducted with 230 older adults. Two participants were excluded due to cognitive impairment based on K-MMSE-2: SF results, yielding 228 eligible participants. Of these, 23 were excluded because of incomplete responses, corresponding to a dropout rate of 10.1%. The final analytic sample therefore comprised 205 participants, exceeding the minimum sample size required for robust mediation analysis.

3. Measurements

1) General and health-related characteristics

General and health-related characteristics were assessed using questionnaire items adapted from previous studies [22]. General characteristics included seven items: sex, age,

education level, religion, living arrangement, economic activity status, and monthly income level. Health-related characteristics included the presence of chronic disease(s) and subjective health status.

2) Dementia-prevention behaviors

Dementia-prevention behaviors were measured using the Korean Health Behavior for Dementia Prevention Scale (K-HBDP), developed by Kim et al. [23]. Permission to use the K-HBDP was obtained from the original developer via e-mail prior to data collection. The scale comprises 23 items across five subdomains: intellectual-social activity (seven items), health management (six items), lifestyle (five items), smoking and drinking (two items), and dietary habits (three items). Items are rated on a 4-point Likert scale ranging from "hardly ever" (1) to "always" (4), with higher scores indicating stronger engagement in dementia-prevention behaviors. Cronbach's α was .90 in the original development study [23] and .89 in the present study.

3) Instrumental activities of daily living

IADL were assessed using the Korean Instrumental Activities of Daily Living (K-IADL) scale, adapted by Won et al. [24] from the Self-Maintaining and IADL scale originally developed by Lawton and Brody [12]. Permission to use the K-IADL was obtained from the original developer via e-mail prior to the study. The scale consists of 10 items rated on a 3-point Likert-type scale: "completely independent" (1), "needs some help" (2), and "needs complete help" (3). Higher scores indicate greater dependence in IADL. Cronbach's α was .94 in the validation study of Won et al. [24] and .89 in the present study.

4) Social networks

Social networks were measured using the functional characteristics of natural relationships subscale from the Social Network Measurement Scale developed by Jung [25] for older adults, based on earlier foundational research [26]. Permission to use this scale was obtained from the original developer via e-mail prior to data collection. The scale comprises 12 items across four subdomains: emotional relationships, informational relationships, instrumental relationships, and social activity relationships, each consisting of three items. Items are rated on a 5-point Likert scale ranging from "not at all true" (1) to "very true" (5), with higher scores indicating stronger social networks. Cronbach's α was .91 in Jung's development study [25] and .92 in the present study.

5) Self-efficacy

Self-efficacy was measured using the Self-efficacy Scale adapted for Korean populations by Oh [27] from the General Self-Efficacy Scale (GSES) originally developed by Sherer et al. [28]. Permission to use the GSES for research purposes was obtained from one of the original developers via e-mail prior to data collection. The scale consists of 17 items designed to assess general self-efficacy expectations without reference to specific behavioral domains. Items are rated on a 5-point Likert scale ranging from "not at all true" (1) to "very true" (5), with higher scores indicating stronger self-efficacy. Cronbach's α was .71 in the original study of Sherer et al. [28], .80 in Oh's validation study [27], and .72 in the present study. All measurement instruments were used with permission from the original developers or copyright holders.

4. Data Collection

Data were collected from July 2 to September 18, 2024, using structured questionnaires administered by the researcher at community locations, including traditional markets, beauty salons, and senior centers, within the city. After obtaining permission from site managers, the researcher approached older adults, explained the study purpose, and screened potential participants for eligibility (age ≥65 years, community-dwelling status, ability to communicate in South Korean, and no prior diagnosis of dementia). Individuals who met the eligibility criteria and agreed to participate received a more detailed explanation of the study and provided written informed consent. Questionnaires were completed either through self-administration or with assistance from the researcher; for participants with visual or literacy difficulties, items were read aloud and responses were recorded by the researcher. Participation was entirely voluntary, and participants were informed that they could skip any question or withdraw from the study at any time without penalty. Each survey required approximately 30 to 40 minutes to complete. Of the 228 questionnaires returned (response rate: 100%), 205 were included in the final analysis after excluding incomplete responses.

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5. Ethical Considerations

This study was approved by the Institutional Review Board of Gyeongsang National University (IRB No. GIRB-A24-NY-0062). The study purpose, procedures, voluntary nature of participation, and confidentiality safeguards were clearly explained to all participants. Only individuals who provided written informed consent were included in the study. All collected data were anonymized and securely stored for three years before disposal.

6. Data Analysis

Data were analyzed using IBM SPSS ver. 28.0 (IBM Corp., Armonk, NY, USA). *p*-values of less than 0.05 were considered significant. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to describe participants' general and health-related characteristics as well as key study variables. Group differences were examined using the independent t-test and one-way analysis of variance, with Scheffé test applied for post hoc comparisons. Associations among IADL, social networks, self-efficacy, and dementia-prevention behaviors were assessed using Pearson correlation coefficients. To examine the mediating effects of self-efficacy in the relationships between IADL and dementia-prevention behaviors, as well as between social networks and dementia-prevention behaviors, Hayes' SPSS PROCESS macro version 4.2 (model 4) was employed [29]. This analytical approach was selected because it yields robust estimates of indirect effects through bias-corrected bootstrap 95% confidence intervals (CIs), which are considered more accurate than traditional methods such as the Sobel test [30]. Bootstrap resampling with 5,000 iterations was conducted to estimate direct and indirect effects and to generate bias-corrected 95% CIs. Mediation effects were considered statistically significant when the 95% CI did not include zero [29]. Partial mediation was defined as the presence of statistically significant direct and indirect effects, whereas complete mediation was defined as a statistically significant indirect effect in the absence of a significant direct effect. Prior to mediation analysis, key regression assumptions were evaluated. Independence of observations was assessed using the Durbin-Watson statistic. Multicollinearity was examined using variance inflation factors, with values below 10 considered acceptable [31]. Linearity and homoscedasticity were assessed through inspection of residual plots. All mediation analyses controlled for variables that demonstrated significant associations with dementia-prevention behaviors, including age, education level, living arrangement, monthly income, presence of chronic diseases, and subjective health status. Internal consistency reliability of all measurement instruments was confirmed using Cronbach's α [32].

RESULTS

1. General and Health-Related Characteristics of Participants

The final sample comprised 205 community-dwelling older adults, with a mean age of 75.68±6.85 years. Women accounted for 51.2% (n=105) of the sample, while men comprised 48.8% (n=100). By age group, 43.9% (n=90) were aged ≤74 years, 43.4% (n=89) were aged 75 to 84 years, and 12.7% (n=26) were aged ≥85 years. Regarding educational attainment, 29.8% (n=61) had completed elementary school or less, 56.6% (n=116) had completed middle or high school, and 13.7% (n=28) had attained a college-level education or higher. More than half of the participants reported a religious affiliation (58.0%, n=119). Approximately two-thirds of the participants (66.8%, n=137) lived with others, whereas 33.2% (n=68) lived alone. Most participants were not economically active (71.2%, n=146), and 59.5% (n=122) reported monthly household incomes below 1 million KRW (Korean won). Three quarters of the sample (75.1%, n=154) reported having at least one chronic disease. Subjective health status was rated as good by 23.9% (n=49), moderate by 61.0% (n=125), and poor by 15.1% (n=31) (Table 1).

2. Differences in Study Variables According to Participant Characteristics

Significant differences in study variables were observed across demographic and health-related characteristics. IADL dependence differed significantly according to age ($F=21.11$, $p<.001$), education level ($F=11.75$, $p<.001$), living arrangement ($t=4.88$, $p=.001$), economic activity ($t=-5.63$, $p<.001$), monthly income ($F=8.33$, $p<.001$), presence of chronic diseases ($t=3.69$, $p<.001$), and subjective health status ($F=26.99$, $p<.001$). Social networks differed significantly by education level ($F=7.28$, $p<.001$), religion ($t=2.41$, $p=.017$), living arrangement ($t=4.30$,

Table 1. General and Health-Related Characteristics and Differences in Study Variables (N=205)

Characteristics	Categories	n (%) or M±SD	IADL	Social networks	Self-efficacy	Dementia-prevention behaviors
			M±SD, t/F (p)			
Sex	Male	100 (48.8)	11.73±2.46	40.28±10.25	61.53±9.86	64.63±12.61
	Female	105 (51.2)	11.97±3.75	40.29±9.86	60.57±10.30	64.19±13.38
			0.54 (.585)	0.01 (.997)	–0.68 (.497)	–0.24 (.809)
Age (year)	≤74[a]	90 (43.9)	10.93±1.98	40.37±9.02	61.70±9.82	63.72±12.99
	75–84[b]	89 (43.4)	12.08±3.00	40.88±10.61	61.39±10.05	66.81±12.38
	≥85[c]	26 (12.7)	15.72±5.60	36.83±11.90	55.72±10.64	56.06±12.62
		75.68±6.85	21.11 (<.001)	1.23 (.294)	2.81 (.062)	5.65 (.004)
			a<b<c			c<b
Education	≤Elementary[a]	61 (29.8)	13.78±4.20	36.89±10.66	57.79±10.42	57.40±13.40
	Middle-High school[b]	116 (56.6)	10.98±2.17	40.48±9.37	61.20±9.78	65.89±12.33
	≥College[c]	28 (13.7)	10.36±0.73	47.32±6.61	66.75±9.09	72.39±9.58
			11.75 (<.001)	7.28 (<.001)	3.88 (.005)	8.22 (<.001)
			b, c<a	a<b, c	a<b, c	a<b, c
Religion	Yes	119 (58.0)	11.68±3.27	41.70±9.71	62.21±10.52	65.25±13.04
	No	86 (42.0)	12.09±3.06	38.33±10.18	59.42±9.25	63.23±12.88
			–0.91 (.361)	2.41 (.017)	1.97 (.500)	1.10 (.273)
Living arrangement	Alone	68 (33.2)	12.87±3.73	36.50±10.68	58.24±9.98	59.68±13.85
	With others	137 (66.8)	10.93±1.87	42.61±8.68	62.03±10.04	67.54±11.28
			4.88 (.001)	4.30 (.002)	2.20 (.070)	4.22 (.003)
Economic activity	Yes	58 (28.3)	10.55±1.01	43.60±9.97	64.31±10.57	66.59±13.87
	No	146 (71.2)	12.38±3.59	38.97±9.80	59.84±9.59	63.58±12.59
			–5.63 (<.001)	3.03 (.003)	2.91 (.004)	1.49 (.137)
Monthly income (10^4 KRW)	≤99[a]	122 (59.5)	12.70±3.78	38.39±10.78	59.39±10.26	62.50±13.11
	100–299[b]	62 (30.2)	10.61±1.11	42.59±7.86	62.72±8.76	65.05±12.52
	≥300[c]	21 (10.2)	10.29±0.56	46.76±7.47	66.57±10.39	71.86±11.26
			8.33 (<.001)	5.83 (.001)	4.03 (.008)	4.11 (.007)
			b, c<a	a<b, c	a<b, c	a<b, c
Chronic diseases	Yes	154 (75.1)	12.17±3.53	39.19±9.93	61.08±10.32	62.86±13.05
	No	51 (24.9)	10.90±1.38	43.59±9.66	60.90±9.42	69.08±11.67
			3.69 (<.001)	–2.76 (.006)	0.11 (.911)	–3.02 (.003)
Subjective health	Good[a]	49 (23.9)	11.67±2.83	43.55±10.05	64.24±10.94	69.41±13.42
	Moderate[b]	125 (61.0)	11.08±2.11	41.33±8.88	61.61±9.35	65.34±11.50
	Poor[c]	31 (15.1)	15.26±4.81	30.90±9.09	53.68±7.98	52.71±11.17
			26.99 (<.001)	19.99 (<.001)	12.14 (<.001)	19.57 (<.001)
			a, b<c	c<a, b	c<a, b	c<a, b

Different superscript letters indicate significant differences in post hoc analysis using Scheffé test.
IADL=instrumental activities of daily living; KRW=Korean won; M=mean; SD=standard deviation.

p=.002), economic activity (t=3.03, p=.003), monthly income (F=5.83, p=.001), chronic disease status (t=–2.76, p=.006), and subjective health status (F=19.99, p<.001). Self-efficacy showed significant differences according to education level (F=3.88, p=.005), economic activity (t=2.91, p=.004), monthly income (F=4.03, p=.008), and subjective health status (F=12.14, p<.001). Dementia-prevention behaviors varied significantly by age (F=5.65, p=.004), education level (F=8.22, p<.001), living arrangement (t=4.22, p=.003), monthly income (F=4.11, p=.007), presence of chronic diseases (t=–3.02, p=.003), and subjective health status (F=19.57, p<.001) (Table 1).

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3. Levels of Study Variables

Prior to the main analyses, normality was evaluated using skewness and kurtosis values. All study variables demonstrated values within acceptable ranges (skewness, –0.28 to 1.98; kurtosis, –0.95 to 6.12), supporting the use of parametric statistical procedures. Mean scores for the study variables indicated generally favorable functional and psychosocial status among participants. IADL dependence was low, with a mean score of 1.19 ± 0.32 on a 3-point scale, reflecting relatively high functional independence. Social networks had a mean score of 3.36 ± 0.84 on a 5-point scale. Among the four subdomains, informational networks demonstrated the highest scores, followed by emotional, instrumental, and social activity networks (data not shown). Self-efficacy averaged 3.59 ± 0.59 on a 5-point scale. Dementia-prevention behaviors had a mean score of 2.80 ± 0.56 on a 4-point scale, corresponding to approximately 70% of the maximum possible score (Table 2).

Table 2. Levels of Study Variables (N = 205)

Variables	Range	Min	Max	M ± SD	Mean score†
IADL	1–30	10	27	11.42 ± 3.18	1.19 ± 0.32
Social networks	12–60	12	60	40.28 ± 10.02	3.36 ± 0.84
Self-efficacy	17–85	39	85	61.04 ± 10.08	3.59 ± 0.59
Dementia-prevention behaviors	23–92	34	89	62.40 ± 12.98	2.80 ± 0.56

IADL = instrumental activities of daily living; M = mean; SD = standard deviation; †Mean score = total score/number of items.

4. Correlations among Study Variables

Correlation analysis revealed statistically significant associations among all study variables. IADL was negatively correlated with social networks (r = –.42, p < .001), self-efficacy (r = –.39, p < .001), and dementia-prevention behaviors (r = –.41, p < .001), indicating that greater functional independence was associated with stronger social connections, higher self-efficacy, and better engagement in dementia-prevention behaviors. Social networks were positively correlated with self-efficacy (r = .54, p < .001) and dementia-prevention behaviors (r = .62, p < .001). Self-efficacy also demonstrated a significant positive correlation with dementia-prevention behaviors (r = .46, p < .001).

5. Mediating Effects of Self-Efficacy

Before conducting mediation analyses, regression assumptions were examined and met. Durbin-Watson statistics (1.738 for the IADL model and 1.505 for the social networks model) confirmed the independence of observations, and variance inflation factor values ranging from 1.209 to 4.466 indicated the absence of multicollinearity. Inspection of residual plots supported assumptions of linearity and homoscedasticity. The resulting mediation models are illustrated in Figure 1.

1) Self-efficacy as a mediator between IADL and dementia-prevention behaviors

After controlling for age, education level, living arrangement, monthly income, chronic disease status, and subjec-

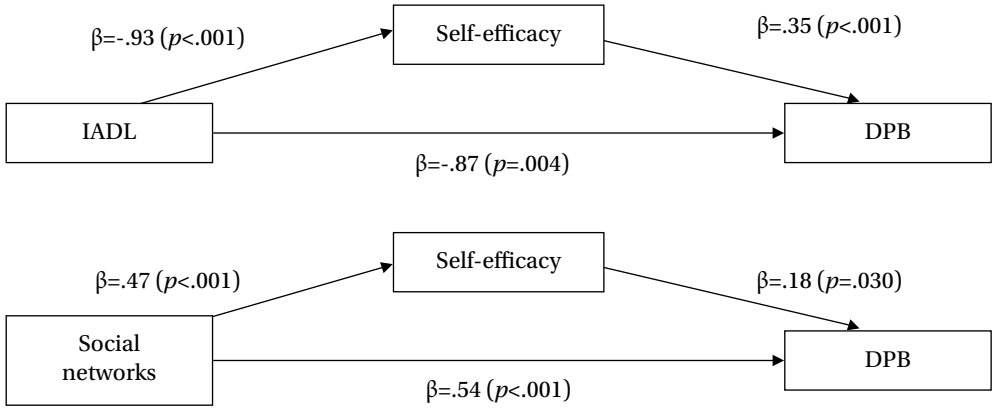

Figure 1. Mediation models of self-efficacy among instrumental activities of daily living (IADL), social networks, and dementia-prevention behaviors (DPB). Standardized regression coefficients (β) are adjusted for age, education level, living arrangement, monthly income, chronic disease status, and subjective health status. All paths shown are statistically significant (p < .05). The top model represents the IADL–self-efficacy–DPB pathway, and the bottom model represents the social networks–self-efficacy–DPB pathway.

tive health status, mediation analysis demonstrated that self-efficacy significantly mediated the relationship between IADL and dementia-prevention behaviors (Figure 1). In the mediator model, IADL significantly predicted self-efficacy (B = −0.29, standard error [SE] = 0.25, β = −.93, p < .001). In the outcome model, both IADL (B = −0.21, SE = 0.29, β = −.87, p = .004) and self-efficacy (B = 0.27, SE = 0.08, β = .35, p < .001) were significant predictors of dementia-prevention behaviors. The total effect of IADL on dementia-prevention behaviors was B = −1.20 (95% CI, −1.80 to −0.61), which decreased to a direct effect of B = −0.87 (95% CI, −1.46 to −0.28) after inclusion of self-efficacy in the model. The indirect effect via self-efficacy was statistically significant (B = −0.33; 95% CI, −0.61 to −0.12), indicating partial mediation. This model explained 40.7% of the variance in dementia-prevention behaviors (R^2 = 0.41, F = 8.63, p < .001) (Table 3).

2) Self-efficacy as a mediator between social networks and dementia-prevention behaviors

Self-efficacy also significantly mediated the relationship between social networks and dementia-prevention behaviors (Figure 1). Social networks significantly predicted self-efficacy (B = 0.47, SE = 0.06, β = .47, p < .001). In the outcome model, both social networks (B = 0.42, SE = 0.08, β = .54, p < .001) and self-efficacy (B = 0.14, SE = 0.08, β = .18, p = .030) were significant predictors of dementia-prevention behaviors. The total effect of social networks on dementia-prevention behaviors was B = 0.63 (95% CI, 0.48 to 0.79), with a direct effect of B = 0.54 (95% CI, 0.37 to 0.72) and a significant indirect effect through self-efficacy (B = 0.08; 95% CI, 0.002 to 0.19), supporting partial mediation. This model accounted for 48.5% of the variance in dementia-prevention behaviors (R^2 = 0.49, F = 11.88, p < .001) (Table 4).

Bootstrap analysis using 5,000 resamples confirmed the statistical significance of both indirect effects, as neither confidence interval included zero, providing robust support for the mediating role of self-efficacy in both pathways.

DISCUSSION

This study examined how self-efficacy functions as a motivational mediator between functional capability, represented by IADL, social opportunity, represented by social networks, and dementia-prevention behaviors among community-dwelling older adults within the COM-B theoretical framework. The findings provide empirical evidence that self-efficacy operates as a critical psychological mechanism that transforms capability and opportunity factors into sustained health behaviors. In doing so, the results extend beyond traditional approaches that emphasize skill acquisition or environmental resource enhancement alone.

The central finding of this study—that self-efficacy partially mediates both the IADL–dementia-prevention behavior relationship and the social network–dementia-prevention behavior relationship—supports the COM-B model's theoretical proposition that motivation bridges the gap be-

Table 3. Mediating Effect of Self-Efficacy between IADL and Dementia-Prevention Behaviors (N = 205)

Variables	B	SE	β	t	p	95% CI
Mediator model (DV: self-efficacy)						
IADL	−0.29	0.25	−.93	−3.68	< .001	−1.42 to −0.43
			F = 4.41, R^2 = 0.26, p < .001			
Outcome model (DV: dementia-prevention behaviors)						
IADL	−0.21	0.29	−.87	−2.92	.004	−1.46 to −0.28
Self-efficacy	0.27	0.08	.35	4.29	< .001	0.19 to 0.52
			F = 8.63, R^2 = 0.41, p < .001			
Effect decomposition	Effect		SE		95% CI	
Effect type						
Total effect	−1.20		0.30		−1.80 to −0.61	
Direct effect	−0.87		0.29		−1.46 to −0.28	
Indirect effect	−0.33		0.12		−0.61 to −0.12	

Model diagnostics: Durbin-Watson = 1.738, tolerance = 0.224–0.827, variance inflation factor = 1.209–4.466. Controlled variables: age, education, living arrangement, monthly income, chronic diseases, subjective health.
CI = confidence interval; DV = dependent variable; IADL = instrumental activities of daily living; SE = standard error.

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Table 4. Mediating Effect of Self-Efficacy between Social Networks and Dementia-Prevention Behaviors (N=205)

Variables	B	SE	β	t	p	95% CI
Mediator model (DV: self-efficacy)						
Social networks	0.47	0.06	.47	7.00	<.001	0.34 to 0.61
			$F=7.55$, $R^2=0.36$, $p<.001$			
Outcome model (DV: dementia-prevention behaviors)						
Social networks	0.42	0.08	.54	6.23	<.001	0.37 to 0.72
Self-efficacy	0.14	0.08	.18	2.18	.030	0.01 to 0.34
			$F=11.88$, $R^2=0.49$, $p<.001$			
Effect decomposition	Effect		SE		95% CI	
Effect type						
Total effect	0.63		0.07		0.48 to 0.79	
Direct effect	0.54		0.08		0.37 to 0.72	
Indirect effect	0.08		0.04		0.002 to 0.19	

Model diagnostics: Durbin-Watson = 1.505, tolerance = 0.226–0.818, variance inflation factor = 1.222–4.417. Controlled variables: age, education, living arrangement, monthly income, chronic diseases, subjective health.
CI = confidence interval; DV = dependent variable; SE = standard error.

tween capability and opportunity factors and actual behavior [7,16]. This finding extends previous COM-B research in several important respects [33]. While earlier qualitative studies identified motivational barriers to health behaviors in dementia-related contexts [34], these investigations primarily mapped barriers and facilitators onto COM-B domains without empirically testing the mechanisms through which capability and opportunity exert their effects. By contrast, the present quantitative analysis provides direct empirical evidence for the specific motivational pathways through which these factors influence behavior.

The observation of partial, rather than complete, mediation in both pathways carries important theoretical and practical implications. Partial mediation indicates that IADL and social networks influence dementia-prevention behaviors through two complementary mechanisms: a direct pathway reflecting habitual, structural, or contextual determinants, and an indirect pathway operating through enhanced self-efficacy beliefs. This pattern aligns with Bandura social cognitive theory [10], which emphasizes that although self-efficacy is a powerful determinant of behavior, it functions alongside other cognitive, environmental, and contextual influences rather than acting as the sole mediator.

Differences in the magnitude of mediation effects across the two pathways provide additional insight into how capability and opportunity factors generate motivation. The stronger mediation observed in the IADL pathway, compared with the social networks pathway, may reflect fundamental differences in the sources of self-efficacy. IADL performance constitutes direct mastery experience, identified by Bandura as the most influential source of self-efficacy, because it provides individuals with immediate and personal evidence of their functional competence [10,12,13]. Successfully managing finances, medications, and transportation demonstrates concrete proficiency in complex cognitive and executive tasks that closely resemble those required for dementia-prevention behaviors [12,13]. In contrast, social networks influence self-efficacy through more indirect mechanisms, including vicarious learning, verbal persuasion, and emotional support [6,10], which may exert a less immediate impact on behavior-specific confidence. These findings suggest that interventions aimed at strengthening functional independence may have particularly strong motivational effects on dementia-prevention behaviors.

Notably, the present findings parallel those reported by Chen et al. [33], who demonstrated that physical activity motivation partially mediated the relationships between frailty and physical activity, as well as between physical and social support and physical activity, in older adults with subjective cognitive decline. In both studies, partial rather than complete mediation was observed, indicating that capability and opportunity factors retain direct effects on behavior even after accounting for motivational processes [33]. However, the present study extends Chen et al.'s work in three key ways [33]. First, whereas Chen et al. [33] focused on physical activity as a single behavioral domain, this study examined a comprehensive set of dementia-prevention behaviors encompassing cognitive stimula-

tion, social engagement, and lifestyle modification, reflecting the multidimensional nature of dementia prevention [3]. Second, Chen et al. [33] operationalized motivation as domain-specific physical activity motivation, whereas this study examined self-efficacy as a more fundamental motivational construct that may generalize across multiple behavioral domains [10,11]. Third, the present study focused on cognitively intact, community-dwelling older adults, demonstrating that these motivational pathways operate in primary prevention contexts, not only among higher-risk populations with existing cognitive decline.

Beyond the mediation pathways, the observed correlations among study variables warrant further consideration. The negative correlations between IADL dependence and social networks, self-efficacy, and dementia-prevention behaviors reflect a cascading process in which functional limitations undermine social engagement, erode confidence, and reduce preventive action. Although similar associations have been reported in previous research, viewing these relationships through the COM-B framework provides additional interpretive depth [7,12]. Rather than representing isolated bivariate associations, these correlations illustrate interconnected pathways through which functional capability shapes health behavior engagement.

A particularly noteworthy finding is the strong positive correlation between social networks and self-efficacy, which exceeded the correlation between IADL and self-efficacy despite the weaker mediation effect observed in the social networks pathway. This apparent discrepancy can be understood by distinguishing between correlation strength and mediation strength. Social networks may be strongly associated with general self-efficacy through their roles in emotional support, social identity, and reinforcement of self-worth [6,9,17]. However, their influence on behavior-specific efficacy beliefs, and consequently on dementia-prevention behaviors, may be more limited unless explicitly targeted. This pattern suggests that while social networks broadly support psychological well-being, additional intervention components may be required to translate social resources into concrete preventive actions. This interpretation is consistent with longitudinal evidence indicating that restricted social networks are associated with an increased risk of incident dementia [35].

Finally, the significant influence of education across all study variables, consistent with previous research, underscores education's role as a foundational determinant that simultaneously shapes multiple COM-B components [8,22]. Higher educational attainment enhances psychological capability through improved health literacy and information-processing skills, expands opportunity through broader social networks and greater access to resources, and strengthens motivation through an increased sense of control and self-efficacy [3,6,8,22]. This multi-pathway influence suggests that educational disparities in dementia risk operate through complex, interconnected mechanisms rather than through single, linear causal pathways [3].

These findings have important implications for the development of dementia-prevention programs and nursing practice. Traditional interventions have often emphasized capability enhancement, through education and skill training, or opportunity improvement, through resource provision and social programming. The present results indicate that such approaches may be insufficient if the motivational component is not adequately addressed. Effective interventions should therefore integrate self-efficacy–enhancement strategies alongside improvements in capability and opportunity [7].

For older adults with good functional independence and strong social networks but low self-efficacy, interventions may focus on guided mastery experiences in which individuals practice dementia-prevention behaviors with gradually reduced support, allowing confidence to develop through repeated successful performance [6,10]. For those with functional limitations or weaker social networks, interventions should concurrently address these structural barriers while building self-efficacy through alternative pathways, such as vicarious learning opportunities or verbal persuasion delivered by credible sources [6,10].

From a nursing practice perspective, these findings underscore the importance of systematically assessing and addressing self-efficacy in addition to traditional capability and opportunity factors. Nurses working with older adults should implement interventions that not only provide information and resources but also actively cultivate confidence in patients' ability to carry out dementia-prevention behaviors. The strong associations between social networks, self-efficacy, and prevention behaviors further suggest that family-centered approaches and peer-support programs represent essential components of comprehensive dementia-prevention initiatives [8,9,17].

This study has several limitations that warrant consideration. The cross-sectional design precludes causal inference regarding the directionality of relationships among

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the study variables. Dementia-related knowledge and depressive symptoms were not measured, which may have resulted in residual confounding. The reliance on self-report measures introduces the possibility of response bias, potentially affecting the accuracy of the findings. In addition, convenience sampling from a single metropolitan area may limit the generalizability of the results to populations in different geographic or sociocultural contexts. Future longitudinal studies are needed to establish temporal relationships and to examine how these mediation pathways evolve over time.

CONCLUSION

This study provides empirical evidence that self-efficacy functions as a crucial motivational mediator in the relationships among functional capabilities, social opportunities, and dementia-prevention behaviors in older adults. These findings extend the theoretical understanding of the COM-B model while offering practical guidance for the development of dementia-prevention interventions. Rather than focusing exclusively on enhancing capabilities and opportunities, effective programs should prioritize motivational enhancement through self-efficacy–building strategies. By addressing the psychological mechanisms that translate resources into action, such interventions may promote more sustainable behavioral change and ultimately reduce dementia risk in aging populations.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and/or design acquisition - JYK and HKC; analysis - JYK and HKC; interpretation of the data - JYK and HKC; and drafting or critical revision of the manuscript for important intellectual content - JYK and HKC.

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DATA AVAILABILITY STATEMENT

The data can be obtained from the corresponding authors.

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The Effects of an Individual and Family Self-Management Program for Slowing Disease Progression via a Mobile Application on Self-Management Behaviors and Clinical Outcomes in Patients with Stage 3 Chronic Kidney Disease in Thailand: A Quasi-Experimental Study

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Purpose: Stage 3 chronic kidney disease (CKD) is highly prevalent and often progresses to end-stage renal disease without effective self-management. This study examined the effects of an Individual and Family Self-Management Program delivered via a mobile communication application on self-management behaviors and clinical outcomes among patients with stage 3 CKD. **Methods:** A 12-week quasi-experimental study with a pretest-posttest control group design was conducted among 50 patients with stage 3 CKD at a tertiary hospital in Thailand, between January and May 2024. The intervention group received a self-management program grounded in Individual and Family Self-Management Theory and delivered via the LINE chatbot. The program included educational content, self-regulation strategies, and structured family support, while the control group received usual care. Outcomes included self-management behaviors, estimated glomerular filtration rate (eGFR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and hemoglobin A1c (HbA1c). Analysis of covariance was used to adjust for baseline differences. **Results:** After adjustment for baseline values, the intervention group showed significantly greater improvements in self-management behaviors ($F = 7.92$, $p < .05$) and eGFR ($F = 52.92$, $p < .001$) compared with the control group. Significant reductions were also observed in SBP ($F = 26.84$, $p < .001$), DBP ($F = 12.61$, $p < .05$), and HbA1c levels ($F = 7.74$, $p < .05$). **Conclusion:** A mobile-based Individual and Family Self-Management Program effectively improved self-management behaviors and key clinical outcomes among patients with stage 3 CKD, supporting the integration of family engagement and digital technology in chronic disease care.

Key Words: Disease progression; Glomerular filtration rate; Mobile applications; Renal insufficiency; Self-management

INTRODUCTION

Chronic kidney disease (CKD) is a major public health problem worldwide, including in Thailand, affecting more than 10% of the global population, or over 800 million individuals [1]. In Thailand, recent findings indicate that the prevalence of CKD among the Thai population has increased to 17.5%, corresponding to approximately 11.6 million individuals [2], and the number of deaths attributable to CKD is expected to continue rising. In 2020, a total of 10,758 deaths were attributed to CKD [3]. When CKD prevalence was examined by disease stage in the Thai population, stage 3 CKD was found to be the most common, accounting for as much as 43.38% of cases in 2024.

CKD cannot be completely cured once kidney deterioration has occurred, and without effective slowing of disease progression, CKD will advance to end-stage renal disease (ESRD), necessitating renal replacement therapy. CKD arises from multiple contributing factors. Evidence from the literature indicates that hypertension and elevated blood glucose levels are key predictive factors associated with declining glomerular filtration rate (GFR) and disease progression [4,5]. Patients with CKD and uncontrolled hypertension experience a GFR decline exceeding 4 mL/min/1.73 m^2 per year [6]. In addition, patients with CKD and poorly controlled blood glucose levels have a 2.51-fold higher risk of developing kidney failure compared with those whose blood glucose is well managed [7]. Consistent with these findings, data from the Nephrology Society of Thailand [8] indicate that most new patients receiving renal replacement therapy had diabetes (32.2%), followed by hypertension (29.2%).

The Nephrology Society of Thailand [8] and the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines [9] recommend comprehensive strategies to slow kidney deterioration in patients with stage 3 CKD. According to the KDIGO 2022 guideline, stage 3 CKD is defined as a moderate reduction in kidney function, characterized by an estimated glomerular filtration rate (eGFR) of 30–59 mL/min/1.73 m^2 sustained for at least three months. Recommended management strategies include blood pressure control, blood glucose control, health behavior modification, and adherence to prescribed medications. These self-management activities are essential for delaying disease progression. When patients engage effectively in these behaviors, renal function decline may be substantially slowed, thereby delaying progression to ESRD [9,10].

Although programs aimed at slowing kidney deterioration in patients with stage 3 CKD have been developed, many patients continue to engage in inappropriate behaviors that contribute to disease progression [11]. Previous studies have reported that 24% to 33% of patients with CKD are overweight or obese [12], while 11.1% do not engage in regular physical activity [13]. In addition, 89.6% continue to consume salty foods [14], 65.1% report excessive fat intake [13], and 80% demonstrate only moderate adherence to prescribed medication regimens [15]. Furthermore, 9.8% of patients smoke [16], and 10% engage in heavy alcohol consumption [17]. These findings underscore the persistent need for interventions that support patients with CKD in modifying risk behaviors to delay kidney deterioration.

A review of the literature on behavior modification programs designed to delay kidney deterioration indicates that effective interventions should integrate essential knowledge related to disease progression, tailor self-management strategies, enhance patients' awareness of their capacity to adopt these behaviors, provide motivational counseling to facilitate behavior change, and incorporate social support [18]. However, many existing programs do not comprehensively address the guideline recommendations for slowing CKD progression established by KDIGO. In addition, although numerous programs target CKD across multiple disease stages, relatively few focus specifically on stage 3 CKD, despite its high prevalence. Furthermore, while most programs implemented in Thailand are conducted over a 12-week period and have demonstrated effectiveness, they often lack a critical component, social support, and do not fully encompass the recommended content outlined in the guidelines of the Nephrology Society of Thailand. Family members, in particular, play a vital role in supporting patients' self-management behaviors. Collectively, these gaps present ongoing challenges for nurses in developing new programs that effectively delay kidney deterioration.

The current care model for patients with stage 3 CKD in Thailand primarily focuses on preventing progression to more advanced stages of the disease. Patients with stage 3 CKD typically receive care through scheduled follow-up appointments in outpatient departments. However, due to limited consultation time and constraints in healthcare service accessibility, patients often receive insufficient information to support effective self-management. Previous research has shown that individuals with stage 3 CKD re-

ceiving outpatient services obtain relatively limited guidance from healthcare providers [19]. In recent years, health innovations have been developed to improve patient access to healthcare services [20]. A national survey reported that 90.9% of the Thai population has internet access, and 99.4% use social networks for consultation and medical services, particularly through e-Health platforms [21].

Although previous intervention studies addressing CKD have been conducted, important gaps remain in adequately covering the guideline recommendations for slowing kidney deterioration established by the Nephrology Society of Thailand and KDIGO. In addition, family involvement in supporting behavioral changes aimed at slowing disease progression remains limited. The current care model for patients with CKD also restricts the amount of time available for healthcare services, further compounding these challenges. To address these gaps, this study developed an Individual and Family Self-Management Program based on Ryan and Sawin's Individual and Family Self-Management Theory (IFSMT) [22]. The program was designed using a family-centered approach grounded in IFSMT. Social support from family members was deliberately incorporated because patients with stage 3 CKD often rely on family assistance for medication management, lifestyle modification, appointment adherence, and monitoring of clinical symptoms. Family members were encouraged to participate in educational activities, provide daily support, and reinforce self-management behaviors, thereby enhancing the feasibility and sustainability of behavior change.

The selection of dependent variables in this study was guided by their established relevance as behavioral and clinical indicators of CKD progression, in accordance with recommendations from KDIGO and national clinical practice guidelines. Self-management behaviors were included to capture a broad range of patient practices influencing disease control, including blood pressure regulation, glycemic management, lifestyle modification, and adherence to prescribed medications. eGFR was identified as the primary indicator of renal function and CKD staging, whereas systolic and DBP were incorporated because of their roles as major modifiable risk factors associated with accelerated renal deterioration. Hemoglobin A1c (HbA1c) was selected because glycemic control is a critical determinant of CKD progression among individuals with comorbid diabetes.

The self-management program evaluated in this study was designed to strengthen behaviors that mitigate kidney function decline through structured family participation, comprehensive alignment with the guidelines of the Nephrology Society of Thailand and KDIGO, and attention to individualized patient needs. Integration of a LINE-based chatbot was intended to enhance access to reliable health information and facilitate sustained engagement by both patients and family members. Collectively, these program components were designed to improve self-management capacity, slow disease progression, and reduce the overall burden of CKD. Accordingly, this study aimed to examine changes in self-management behaviors and clinical outcomes—including eGFR, systolic blood pressure (SBP), diastolic blood pressure (DBP), and HbA1c—within the intervention and control groups from baseline to follow-up, as well as to compare differences in these outcomes between groups following the intervention.

METHODS

1. Study Design

A 12-week quasi-experimental study was conducted to examine the effects of an Individual and Family Self-Management Program for slowing CKD progression, delivered via a mobile communication application, on self-management behaviors and clinical outcomes among patients with stage 3 CKD.

2. Setting and Samples

This study was conducted in the outpatient department of a tertiary hospital in Chonburi, Thailand. Participants were patients diagnosed by a physician with stage 3 CKD or those with an eGFR between 30 and 59 mL/min/1.73 m^2 for at least three months. Inclusion criteria were as follows: (1) age 18 years or older; (2) living with a family member who served as the primary caregiver; (3) presence of comorbid uncontrolled diabetes (HbA1c >7%) and/or uncontrolled hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg); (4) intact orientation with no cognitive impairment; (5) ability to read and communicate in Thai; and (6) ownership of a smartphone capable of installing the LINE chatbot application. Participants were excluded if they changed their treatment regimen during the program, such as modifying blood glucose-lowering or antihypertensive medications, progressed from stage 3 CKD to a more advanced stage, or developed complications requir-

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ing urgent dialysis. Primary caregivers were eligible if they were aged 18 years or older, able to communicate in Thai, and had no hearing or visual impairments.

The sample size was calculated using the G*Power program ver. 3.1.9, based on the effect size reported in a previous study with a similar research design [23], which yielded an effect size of 3.29. Because this effect size was considered excessively large and resulted in an unrealistically small sample size, an alternative effect size of 0.80 was selected. This value represents a large effect size commonly accepted in health research [24]. The level of statistical significance (α) was set at .05, and statistical power was set at .80, using a one-tailed test. Based on these parameters, the required sample size was 21 participants per group, for a total of 42 participants. To compensate for potential attrition, the sample size was increased by 20% [25], resulting in 25 participants per group and a total sample of 50 participants. No participants withdrew during the study, yielding a final sample of 50 participants (Figure 1). All participants completed the 12-week study period, with no loss to follow-up in either group. Therefore, baseline comparisons between those retained and those lost to follow-up were not applicable.

3. Measurements/Instruments

1) Personal demographic and health status questionnaire

A personal demographic and health status questionnaire was used to collect baseline participant information. The demographic section consisted of six items assessing gender, age, education level, monthly income, income sufficiency, and primary caregiver status. Health status information was obtained using seven items, including weight, height, eGFR, HbA1c, and blood pressure measurements. Kidney function was assessed using eGFR calculated with the CKD-EPI equation based on standardized serum creatinine values. Glycemic control was evaluated using HbA1c levels. Laboratory data were retrieved from Burapha University Hospital and analyzed using standardized laboratory equipment certified by the Department of Medical Sciences, Ministry of Public Health. Blood pressure was measured using a digital blood pressure monitor that undergoes annual quality verification by a certified company in accordance with Ministry of Public Health medical device testing standards (TP-MMD-01). All blood pressure measurements were performed by the researcher in accordance with the guidelines of the Thai Hypertension Society [26]. Body mass index (BMI) was calculated from measured weight and height using the formula kg/m². Obesity classification followed the World Health Organization criteria for Asians, with BMI values of 25.00–29.99 kg/m² classified as

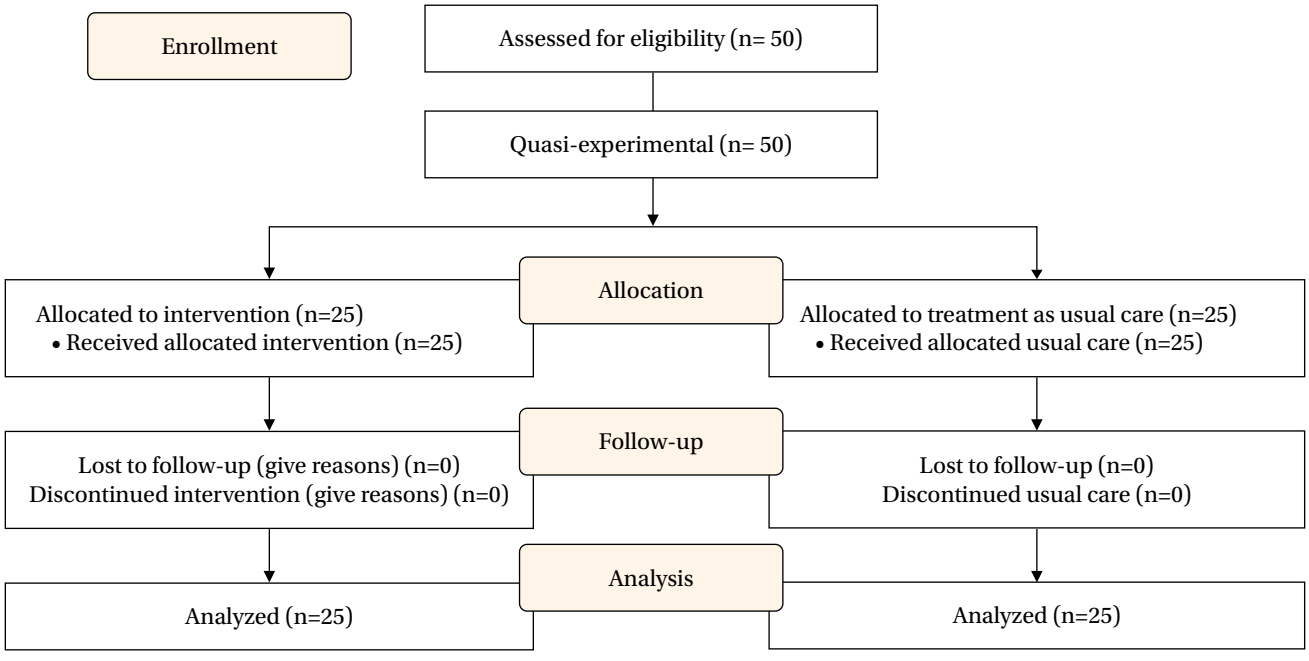

Figure 1. CONSORT 2010 flow diagram.

obesity class I and BMI values ≥30.00 kg/m² classified as obesity class II. These classifications were used to describe baseline health characteristics in the study results.

2) Self-management behaviors for slowing CKD progression questionnaire

The self-management behaviors for slowing CKD progression questionnaire was developed by the research team based on guidelines from the Nephrology Society of Thailand [8], the Thai Hypertension Society [26], and the Diabetes Association of Thailand [27], as well as a comprehensive review of relevant literature on self-management strategies for patients with stage 3 CKD and uncontrolled diabetes and/or hypertension. The questionnaire was designed to assess behaviors related to slowing kidney deterioration and consisted of four domains: blood glucose control (4 items), blood pressure control (3 items), health behavior modification (22 items), and medication adherence (7 items), for a total of 36 items. Each item was rated on a 4-point Likert scale ranging from 1 ("never") to 4 ("consistently"). Mean scores were calculated for each domain and for the overall scale. Higher mean scores indicated more consistent and effective engagement in CKD self-management behaviors, whereas lower scores reflected insufficient or inconsistent engagement. The theoretical mean score range for both domain-specific and total scores was 1.00 to 4.00. Content validity was evaluated by three experts, yielding a Content Validity Index of 0.86, which exceeds the acceptable standard of 0.80 [25]. Internal consistency reliability was assessed using Cronbach's α coefficient, resulting in a value of .83, which is above the accepted threshold of .70 [28].

3) Research intervention instrument

The research intervention instrument was the Individual and Family Self-Management for Slowing CKD Progression Program, developed based on Ryan and Sawin's IFSMT [22]. The program was designed to enhance participants' capacity to manage stage 3 CKD through three core components: enhancement of knowledge and beliefs, development of self-regulation skills, and social facilitation.

4. Data Collection/Procedure

Data were collected between January and May 2024 at the outpatient department of Burapha University Hospital in Chonburi, Thailand. Recruitment was conducted through posted announcements, and individuals who expressed interest were screened by the researcher according to predefined inclusion and exclusion criteria. Group assignment was determined by recruitment period rather than individual randomization. Participants enrolled during the initial recruitment phase were allocated to the control group, whereas those enrolled during the subsequent phase were assigned to the experimental group. Because participants were not individually randomized, this allocation procedure is consistent with a quasi-experimental design. To minimize contamination between groups, participants in the control and experimental arms were scheduled for follow-up activities at different times.

The first author implemented the self-management program, delivered educational sessions, provided instructional materials, and coordinated follow-up activities through a mobile application under the supervision of CCOP and PP. Participant engagement was monitored throughout the 12-week intervention period, and clarification or adherence support was provided as needed. Pretest and posttest data were collected using a structured electronic questionnaire administered via Google Forms. Baseline assessments were completed during outpatient visits before participants were informed of their group assignment to avoid response bias. Posttest assessments were completed at the 12-week follow-up through Google Forms.

Although participants were aware of their group assignment during posttest data collection, they were instructed not to disclose this information to maintain assessor blinding during data analysis. All clinical outcomes, including eGFR, systolic and DBP, and HbA1c, were obtained using standardized laboratory and automated measurement procedures. These procedures minimized measurement bias and supported the feasibility of maintaining assessor blinding. No protocol deviations occurred during the study. All procedures were conducted in accordance with the approved research protocol and ethical guidelines.

The intervention used in this study was a mobile communication application developed based on the Individual and Family Self-Management Program to slow the progression of CKD. The program was delivered through the LINE chatbot platform, which enabled continuous communication among participants, their family members, and the research team. The chatbot was developed in collaboration with PCOP, who provided technical and clinical consultation in designing the chatbot structure and interactive

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functions to support self-management activities. Development of the intervention followed the KDIGO guidelines and the clinical practice guidelines of the Nephrology Society of Thailand for slowing kidney deterioration. Educational materials were deliberately designed to be concise, user-friendly, and accessible, using plain language, large fonts, clear typography, intuitive illustrations, and short videos to enhance comprehension and engagement. All content was reviewed by three nephrology nursing specialists and two nephrologists to ensure content validity and clinical accuracy, and revisions were made based on expert feedback and pilot testing prior to implementation.

The intervention was guided by Ryan and Sawin's IFSMT [22], which emphasizes enhancing knowledge and beliefs, strengthening self-regulation skills, and fostering social facilitation through family engagement to improve self-management behaviors and health outcomes. To operationalize IFSMT within the program, each intervention component was systematically aligned with the theory's three core constructs. The knowledge and beliefs construct was addressed through structured educational sessions, an electronic self-management manual, and multimedia instructional videos. The self-regulation construct was reinforced through guided goal setting, regular self-monitoring of blood pressure and body weight, monthly behavior-tracking forms, and individualized action plan development. The social facilitation construct was integrated by actively engaging family caregivers in all educational and coaching sessions and by using the LINE chatbot to deliver reminders, enhance motivation, and support ongoing communication among participants, caregivers, and the research team. Collectively, these strategies ensured coherent translation of the theoretical framework into practical implementation of the intervention.

The intervention consisted of four integrated components. First, the self-management manual (e-book) addressed four key topics: blood pressure control, blood sugar control, health behavior modification—including physical activity, weight management, smoking cessation, dietary adjustments, and avoidance of secondhand smoke—and medication adherence. Second, multimedia educational videos were developed to complement the manual. Five short videos addressed blood sugar management, blood pressure management, behavioral and lifestyle modification, dietary recommendations, and medication management, and were embedded within the LINE platform to allow flexible and repeated viewing. Third, the self-management record system, developed using Google Forms, enabled participants to document their self-management behaviors. Participants recorded blood pressure measurements for three consecutive days each month, tracked monthly body weight, and completed a personalized action plan for slowing stage 3 CKD progression, thereby supporting self-monitoring and reflection over time. Finally, educational notification messages were used to reinforce knowledge and support behavior change. Concise messages were delivered three times per week (Monday, Wednesday, and Friday) through the LINE chatbot, with each message addressing a single topic using clear and supportive language to sustain engagement among participants and caregivers.

The intervention was delivered over a 12-week period through five structured sessions, as summarized in Table 1. All sessions were conducted via LINE video calls and the chatbot platform, allowing integration of real-time and asynchronous communication. Session 1 focused on building rapport, collecting baseline data, and orienting participants and caregivers to the digital platform. Session 2 emphasized enhancing knowledge and beliefs related to CKD through interactive discussions and scenario-based analyses. Sessions 3 and 4 focused on developing self-regulation skills, including goal setting, self-monitoring, planning, self-evaluation, and management of emotional and behavioral responses. Session 5 was conducted in week 12 as a follow-up to evaluate changes in self-management behaviors and clinical outcomes. Participants in the control group received standard care, consisting of routine follow-up visits and standard health education provided by the nephrology outpatient clinic. Between scheduled educational sessions, ongoing intervention activities were continuously implemented. Participants recorded their daily self-management behaviors through the LINE chatbot, received educational messages three times per week, and accessed automated chatbot support. The research team monitored adherence and provided follow-up reinforcement as needed. Family members supported daily self-management practices as part of the family-centered approach. Throughout the 12-week program, family members played an active role by participating in all educational and coaching sessions, assisting participants with goal setting, and helping monitor daily self-management behaviors, including medication adherence, dietary control, symptom observation, and blood pressure monitoring. Family members also supported participants in using the

Table 1. Overview of an Individual and Family Self-Management Program via a Mobile Application

Activities	Time	Materials used
Session 1: week 1 day 1 (face-to-face) This initial face-to-face session will focus on establishing rapport and building a therapeutic relationship with participants and their primary caregiver. The session will include: - Building rapport through friendly and welcoming interactions. - Conducting a comprehensive assessment, including the collection of personal information, health status, and current self-management behaviors related to slowing the progression of CKD. - Orienting the experimental group and their primary caregiver to the media and equipment that will be utilized throughout the intervention.	60 minutes	- The personal demographic questionnaires - The health status questionnaires - Self-management behaviors for slowing CKD progression questionnaires - Multimedia - Self-management for slowing CKD progression record - LINE Official Account and Chatbot - LINE video call
Session 2: week 1 day 2 (video calls) Activity 1: belief reflection activity (video calls) - Exchange experiences and beliefs about CKD, the researcher will reflect on these beliefs to identify misconceptions and provide accurate information.	20 minutes	- LINE video call - Multimedia - The self-management manual for slowing CKD progression (e-book)
Activity 2: educational activity (video calls) - Assess knowledge of the experimental group and their primary caregiver after studying the multimedia. - Provide example situations for the experimental group and their primary caregiver to jointly analyze how to slow kidney failure progression.	40–60 minutes	- LINE video call - The self-management manual for slowing CKD progression (e-book)
Session 3: week 1 day 3 (video calls) Activity 3: Self-Management Skills Training, Part 1 This session will focus on practical applications of self-management skills. - The experimental group will engage in guided practice of key self-management skills, including goal setting, self-monitoring and reflective thinking, decision-making, and action planning related to slowing CKD progression. - Participants will record their daily self-management behaviors related to slowing CKD progression using a Google Form accessible via the Line chatbot. This daily recording will continue until the end of the program. - The researcher will send a message via LINE three times a week (Mondays, Wednesdays, and Fridays) with a single topic related to CKD self-management. These messages will continue until the program's conclusion.	40–60 minutes	- LINE video call - Educational notification message - Self-management for slowing CKD progression record - LINE Official Account and Chatbot
Session 4: week 2 day 3 (video calls) Activity 3: self-management skills training, part 2 - This session will build upon the skills learned in the previous session and introduce additional self-management techniques. - The experimental group will practice self-management skills, including self-evaluation and response management related to their CKD. - Participants will continue to record their daily self-management behaviors related to slowing CKD progression using a Google Form accessible via the Line chatbot. This daily recording will continue until the end of the program.	30 minutes	- Educational notification message - Self-management for slowing CKD progression record - LINE Official Account and Chatbot
Session 5: week 12 (face-to-face) This final face-to-face session will serve as a follow-up assessment after completion of the program. The session will include: - Post-program evaluation of self-management behaviors related to slowing CKD progression. - Collection of clinical data, including estimated glomerular filtration rate, systolic blood pressure, diastolic blood pressure, and hemoglobin A1c.	30 minutes	- Self-management behaviors for slowing CKD progression questionnaires

CKD = chronic kidney disease.

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LINE chatbot by assisting with data entry and reviewing educational messages. During weeks without scheduled sessions, family members provided ongoing encouragement, reminding participants about necessary health behaviors. This structured involvement was intended to strengthen social support and enhance the sustainability of self-management behaviors.

5. Ethical Considerations

This study was approved by the Institutional Review Board of Burapha University (No. G-HS055/2566) and registered with the Thai Clinical Trials Registry (TCTR20240920001). Participants received detailed information regarding the study objectives, procedures, potential benefits, and their right to decline or withdraw from participation at any time. Written informed consent was obtained prior to data collection. All data were kept confidential and reported in aggregate form only. Research documents and electronic data will be securely destroyed one year after publication of the study findings, with paper records shredded using a cross-cut shredder and electronic files permanently deleted using data-erasure software.

6. Data Analysis

Data were analyzed using IBM SPSS ver. 26 (IBM Corp., Armonk, NY, USA), with statistical significance set at $p < .05$. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic characteristics and baseline health data. Baseline comparisons between experimental and control groups were conducted using the chi-square test and Fisher exact test, as appropriate. Prior to inferential analyses, all dependent variables were assessed for normality using the Shapiro-Wilk test, boxplots, and Q-Q plots. No significant outliers were identified, and assumptions for parametric testing were satisfied. Within-group changes were examined using the paired t-test, while between-group comparisons were conducted using the independent t-test. Analysis of covariance (ANCOVA) was used to adjust for baseline differences. The Levene test confirmed homogeneity of variance ($p > .05$), and the interaction between group assignment and baseline covariates was not statistically significant ($p > .05$), indicating parallel regression slopes and confirming the appropriateness of ANCOVA.

RESULTS

1. Demographic Data, Health Information Data, and Homogeneity of Study Sample

A total of 50 participants were enrolled in the study, with 25 assigned to the experimental group and 25 to the control group. In the experimental group, most participants were male (60.0%). The majority were in the middle to late elderly age range, with more than half aged over 70 years (52.0%). Regarding educational attainment, most participants (52.0%) had completed primary school or less. Most participants (68.0%) reported having sufficient income or savings to meet their living expenses. Primary caregiving responsibilities were most commonly provided by relatives (60.0%). In the control group, most participants were female (60.0%). A higher proportion were aged over 70 years compared with the experimental group (80.0%). Educational attainment was generally lower, with 76.0% having completed primary school or less. Most participants (60.0%) indicated that they had sufficient income or savings to support their living expenses. Similarly, most primary caregivers were relatives (72.0%).

In terms of health-related characteristics, participants in the experimental group showed the following clinical profiles: 48.0% were classified as having obesity class I (BMI, 25.00–29.99 kg/m^2), and 64.0% were diagnosed with stage 3a CKD, defined by an eGFR of 45–59 mL/min/1.73 m^2. In addition, 44.0% had HbA1c levels above 7.0%, 68.0% had SBP values greater than 140 mmHg, and 8.0% had DBP values above 90 mmHg. All participants in this group had a diagnosis of hypertension, and 80.0% had comorbid diabetes mellitus and hyperlipidemia. With respect to pharmacologic management, all participants were prescribed antihypertensive medications, 80.0% received antidiabetic agents, 96.0% were receiving lipid-lowering therapy, and 24.0% were prescribed medications for anemia. Among participants in the control group, 40.0% were classified as having obesity class I, and a higher proportion (80.0%) had stage 3a CKD. Forty percent had HbA1c levels above 7.0%, and 72.0% had SBP values exceeding 140 mmHg. Regarding comorbidities, 96.0% were diagnosed with hypertension, 88.0% with diabetes mellitus, and 76.0% with hyperlipidemia. In terms of pharmacologic treatment, 84.0% were prescribed antihypertensive medications, 88.0% received antidiabetic therapy, 80.0% were treated with lipid-lowering agents, and 28.0% received medications for

anemia. A summary of health-related characteristics is presented in Table 2.

No statistically significant differences were observed between the experimental and control groups with respect to demographic, socioeconomic, or clinical characteristics at baseline. These findings indicate that the two groups were comparable prior to the intervention.

Table 2. Demographic Data, Health Information Data, and Homogeneity of Study Sample (N=50)

Variables	Experimental group (n=25)	Control group (n=25)	χ^2	*p*-value
	n (%)			
Sex			2.00	.157
Male	15 (60.0)	10 (40.0)		
Female	10 (40.0)	15 (60.0)		
Age (year)†			5.46	.065
49–59	6 (24.0)	1 (4.0)		
60–69	6 (24.0)	4 (16.0)		
≥70	13 (52.0)	20 (80.0)		
Education†			4.07	.138
Primary school and lower	12 (48.0)	19 (76.0)		
Secondary school	4 (16.0)	2 (8.0)		
Bachelor's degree or higher	9 (36.0)	4 (16.0)		
Sufficient income			0.35	.556
Insufficient	8 (32.0)	10 (40.0)		
Sufficient income/savings	17 (68.0)	15 (60.0)		
Primary caregivers			0.80	.370
Husbands/wives/children	10 (40.0)	7 (28.0)		
Relatives	15 (60.0)	18 (72.0)		
BMI (kg/m^2)†			1.26	.931
<18.50	1 (4.0)	1 (4.0)		
18.50–22.99	4 (16.0)	3 (12.0)		
23.00–24.99	3 (12.0)	5 (20.0)		
25.00–29.99	12 (48.0)	10 (40.0)		
>30.00	5 (20.0)	6 (24.0)		
Estimated glomerular filtration rate (mL/min/1.73 m^2)				
45–59 (3a)	16 (64.0)	20 (80.0)	1.59	.208
30–44 (3b)	9 (36.0)	5 (20.0)		
Hemoglobin A1c			0.08	.770
Less than 7%	14 (56.0)	15 (60.0)		
More than 7%	11 (44.0)	10 (40.0)		
Blood pressure (mmHg)				
Systolic†			0.09	.758
<140	8 (32.0)	7 (28.0)		
>140	17 (68.0)	18 (72.0)		
Diastolic†			2.08	.149
<90	23 (92.0)	25 (100)		
>90	2 (8.0)	0 (0.0)		
Comorbidities or other conditions				
Diabetes†			0.59	.702
Present	20 (80.0)	22 (88.0)		
Absent	5 (20.0)	3 (12.0)		

(Continued on the next page)

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Table 2. (Continued)

Variables	Experimental group (n=25)	Control group (n=25)	χ^2	*p*-value
	n (%)			
Hypertension†			1.02	>.999
Present	25 (100)	24 (96.0)		
Absent	0 (0.0)	1 (4.0)		
Hyperlipidemia			0.12	.733
Present	20 (80.0)	19 (76.0)		
Absent	5 (20.0)	6 (24.0)		
Other diseases†			0.22	>.999
Present	3 (12.0)	2 (8.0)		
Absent	22 (88.0)	23 (92.0)		
Current medications				
Antidiabetic drugs†			0.59	.702
Yes	20 (80.0)	22 (88.0)		
No	5 (20.0)	3 (12.0)		
Antihypertensive drugs†			4.35	.110
Yes	25 (100)	21 (84.0)		
No	0 (0.0)	4 (16.0)		
Antihyperlipidemic drugs†			3.03	.189
Yes	24 (96.0)	20 (80.0)		
No	1 (4.0)	5 (20.0)		
Anemia medications			0.10	.747
Yes	6 (24.0)	7 (28.0)		
No	19 (76.0)	18 (72.0)		

BMI=body mass index; †Fisher's exact test.

2. Within-Group Changes in Self-Management Behavior, eGFR, SBP, DBP, and HbA1c in the Intervention and Control Groups from Baseline to Follow-up

Within the experimental group, participation in the self-management program was associated with significant improvements across several outcomes (Table 3). Self-management behavior scores increased significantly ($p<.001$), and renal function improved, as reflected by a significant increase in eGFR values ($p<.05$). Significant reductions were also observed in SBP ($p<.001$) and DBP ($p<.05$). In contrast, HbA1c levels did not change significantly, indicating that glycemic control remained stable over the 12-week study period. In the control group, self-management behavior scores also showed a statistically significant improvement following receipt of standard care ($p<.001$). However, renal function declined, as evidenced by a significant reduction in eGFR from baseline to follow-up ($p<.001$). Both SBP and DBP increased significantly during the study period (SBP, $p<.05$; DBP, $p<.05$), indicating worsening blood pressure control under standard care conditions. Glycemic control, assessed using HbA1c, did not change significantly, with the difference between baseline and follow-up remaining non-significant ($p=.440$).

3. Between-Group Changes in Self-Management Behavior, eGFR, SBP, DBP, and HbA1c in the Intervention and Control Groups from Baseline to Follow-up

Baseline comparisons showed no statistically significant differences between the experimental and control groups in eGFR ($p=.278$), SBP ($p=.231$), DBP ($p=.611$), or HbA1c ($p=.973$) prior to the intervention (Table 3). A statistically significant difference in self-management behavior scores was observed between groups at baseline ($p<.05$). Before conducting the ANCOVA, the interaction between group assignment and baseline covariates was examined and found to be non-significant ($p>.05$), supporting the assumption of parallel regression slopes. After adjustment for baseline values, participation in the Individual and Family Self-Management Program resulted in significant improvements across multiple outcomes (Table 3). Self-manage-

Table 3. Changes in Self-Management Behavior, Estimated Glomerular Filtration Rate, Systolic Blood Pressure, and Diastolic Blood Pressure among the Intervention and Control Groups from Baseline to Follow-up (N=50)

Variables	Exp. (n=25)		Cont. (n=25)		Within-group comparisons†		Between-group comparisons‡		ANCOVA§
	Baseline	Follow-up	Baseline	follow-up	Exp.	Cont.	Baseline	Follow-up	F (p)
	M±SD		M±SD		t (p)		t (p)		
Self-management behaviors for slowing CKD progression scores	2.41±0.30	2.71±0.15	2.28±0.19	2.55±0.18	6.15 (<.001)	6.34 (<.001)	1.82 (<.05)	3.45 (.001)	7.92 (.007)
Estimated glomerular filtration rate	48.06±6.16	51.14±7.04	49.59±5.23	44.18±4.74	3.00 (.006)	−10.42 (<.001)	−0.95 (.278)	4.10 (<.001)	52.92 (<.001)
Systolic blood pressure	144.64±13.00	132.24±11.81	138±17.37	145.36±14.55	−4.74 (<.001)	2.73 (<.05)	1.53 (.231)	−3.50 (.001)	26.84 (<.001)
Diastolic blood pressure	74.92±12.13	70.08±8.91	70.00±11.59	76.40±12.53	−2.48 (.021)	3.01 (<.05)	1.47 (.611)	−2.06 (.045)	12.61 (<.001)
Hemoglobin A1c	6.92±1.78	6.64±1.30	7.06±1.72	7.19±1.37	1.89 (.072)	0.78 (.440)	−0.28 (.973)	−1.46 (.150)	7.74 (.008)

CKD=chronic kidney disease; Cont.=control group; Exp.=experimental group; †Paired t-test; ‡Independent t-test; §Analysis of covariance (ANCOVA); covariate (baseline scores).

ment behavior scores increased significantly in the intervention group compared with the control group (F=7.92, $p<.05$). Renal function, measured by eGFR, also improved significantly (F=52.92, $p<.001$), indicating a clinically meaningful improvement among participants with stage 3 CKD. Significant reductions in blood pressure were observed in the intervention group, with marked decreases in SBP (F=26.84, $p<.001$) and DBP (F=12.61, $p<.001$). Glycemic control, reflected by HbA1c levels, also improved significantly in the intervention group (F=7.74, $p<.05$). Collectively, these findings demonstrate strengthened self-management behaviors and improvements in key clinical outcomes over the 12-week intervention period. Overall, the results indicate that the Individual and Family Self-Management Program effectively enhanced behavioral outcomes and contributed to improved renal function, blood pressure control, and glycemic regulation among patients with stage 3 CKD.

4. Additional Findings

No adverse events or unintended effects were reported in either group during the study period. Participants actively engaged with the self-management program through a structured recording system. They monitored blood pressure for three consecutive days each month, tracked monthly body weight, and completed individualized action plans designed to slow stage 3 CKD progression. Adherence to these activities was high, with full participation reported (100%). Participants also reported that the mobile communication application was easy to use and facilitated adherence to recommended self-management behaviors through reminders and regular messaging. Most participants indicated that family members actively supported their participation in the program, which contributed to sustained engagement throughout the 12-week intervention period. These findings suggest that the intervention was feasible, usable, and acceptable for patients with stage 3 CKD.

DISCUSSION

This study demonstrated the effectiveness of an Individual and Family Self-Management Program in slowing the progression of stage 3 CKD. Participants in the intervention group showed significant improvements in self-management behavior scores, eGFR, SBP, and DBP compared with

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both their baseline values and the control group. These findings are consistent with Ryan and Sawin's IFSMT [22], which proposes that effective self-management emerges through three interrelated process dimensions: knowledge and beliefs, self-regulation skills and abilities, and social facilitation. By integrating these components into the intervention, the program supported adaptive self-management behaviors that translated into meaningful behavioral and clinical improvements.

The results further showed that participants in the intervention group experienced significantly greater improvements in self-management behaviors, renal function (eGFR), blood pressure (SBP and DBP), and HbA1c compared with those in the control group. These between-group differences indicate that the intervention produced effects beyond those expected from natural disease variation or routine outpatient care alone. The magnitude and consistency of improvements in the intervention group align with prior evidence indicating that structured self-management support can strengthen treatment adherence and improve physiological outcomes among patients with stage 3 CKD. In contrast, the control group exhibited minimal improvement or clinical deterioration across several outcomes, underscoring the added value of the intervention.

The knowledge and beliefs component of the intervention was addressed through structured educational sessions delivered via LINE video calls and chatbot-based communication. Participants received evidence-based information through an electronic self-management manual, multimedia materials, and scenario-based learning activities. Reflective exercises were incorporated to help participants identify and correct misconceptions related to CKD progression and self-management. This approach fostered accurate disease-related beliefs and increased confidence in applying knowledge to daily self-care. Consistent with IFSMT, individuals who develop adequate knowledge and positive beliefs are more likely to adopt and sustain effective self-management behaviors, which is supported by the improvements observed in this study.

The intervention also emphasized the development of self-regulation skills, including goal setting, self-monitoring, reflective thinking, decision-making, planning, self-evaluation, and management of behavioral and emotional responses. These skills were practiced through daily self-monitoring of blood pressure, body weight, and health behaviors using Google Form-based tools. Participants worked collaboratively with family caregivers and the research team to address barriers, refine action plans, and support adherence to individualized goals. Strengthening these self-regulation skills enabled participants to manage their health behaviors more effectively in accordance with their clinical status, which likely contributed to improved blood pressure control and preservation of kidney function.

Social facilitation was integrated throughout the program through active engagement of family caregivers and the use of digital communication platforms. Caregivers participated in educational and coaching sessions, provided daily support, and assisted patients in implementing self-management strategies. The LINE chatbot and group video calls functioned as continuous channels for information exchange, reminders, and motivational support. Previous studies have highlighted the importance of family involvement and social support in sustaining self-management among patients with chronic illnesses [29,30]. Consistent with these findings, the combination of family engagement and digital support in this study likely contributed to improvements in both behavioral and physiological outcomes. Although formal mediation analyses were not conducted, the pattern of results aligns with the causal pathways proposed by IFSMT, suggesting that coordinated enhancement of knowledge, self-regulation, and social facilitation underpinned the intervention's effectiveness.

Notably, no participant attrition occurred during the 12-week follow-up period. This high retention rate may be attributed to the continuous support provided through the mobile communication application, which enabled regular reminders, timely responses to participants' questions, and sustained engagement with the program. In addition, family involvement in monitoring and supporting self-management behaviors likely enhanced adherence and reduced the likelihood of dropout. Together, these factors contributed to full participation throughout the intervention period.

The findings of this study are consistent with prior research demonstrating the benefits of family-oriented self-management interventions for individuals with chronic conditions. Chamnan et al. [29] reported that an Individual and Family Self-Management Program improved phosphorus control among hemodialysis patients by strengthening knowledge, beliefs, self-regulation skills, and family involvement. Similarly, Vergara Escobar and Carrillo Gonzalez [30] found that a self-management intervention significantly enhanced self-management behaviors, disease knowledge, coping capacity, and the patient–healthcare provider rela-

tionship. Collectively, these studies support the effectiveness of IFSMT-guided interventions that target multiple self-management processes simultaneously.

In contrast, the study did not detect a statistically significant difference in HbA1c levels between the intervention and control groups. Several factors may explain this finding. First, data collection occurred between January and May 2024, overlapping with the Songkran Festival, a national holiday period associated with increased social gatherings and less structured dietary practices, which may have influenced dietary adherence. Second, HbA1c reflects average blood glucose levels over approximately 120 days, corresponding to the lifespan of erythrocytes [31], and therefore requires sufficient time to capture meaningful changes [32]. Similar results have been reported in previous studies. Mata and Chiewchantanakit [33] observed improvements in fasting blood glucose but not HbA1c after a 12-week self-efficacy–based intervention in patients with type 2 diabetes, while Kongtong [34] reported no significant HbA1c change following a 3-month family-supervised behavioral modification program among patients with poorly controlled diabetes. These findings suggest that longer intervention durations or extended follow-up periods may be necessary to observe clinically meaningful changes in HbA1c among patients with stage 3 CKD and comorbid diabetes.

Several previous studies have highlighted the importance of family support in improving self-management among patients with chronic diseases. Research in CKD populations has shown that family involvement enhances medication adherence, dietary control, symptom monitoring, and clinic attendance, which in turn leads to improved clinical outcomes. Similar findings have been reported in studies of diabetes and hypertension, where strong family support has been associated with better lifestyle modification and adherence to treatment. These findings align with the IFSMT and support the results of the present study, in which active participation by family members contributed to improvements in self-management behaviors, blood pressure, and eGFR among participants.

Overall, the results provide strong support for the application of IFSMT to self-management interventions in CKD. By simultaneously targeting knowledge and beliefs, self-regulation skills, and social facilitation, the program achieved measurable improvements in both behavioral and clinical outcomes. The integration of digital platforms, including the LINE chatbot, video calls, and online monitoring tools, facilitated continuity of care, accessibility, and sustained engagement. These features are particularly valuable for patients with chronic diseases who face barriers to frequent in-person care. Collectively, these findings underscore the potential of structured, theory-based, digitally supported interventions to enhance patient self-management and slow disease progression.

1. Implications of the Study

This study demonstrates that an Individual and Family Self-Management Program delivered through a mobile communication platform can improve both self-management behaviors and clinical outcomes among patients with stage 3 CKD. Guided by Ryan and Sawin's IFSMT [22], the program focused on enhancing knowledge and beliefs, strengthening self-regulation skills, and fostering social facilitation through family engagement. As a result, participants showed significant improvements in eGFR, SBP and DBP, and self-management behavior scores, suggesting a slowing of disease progression.

The findings have several important implications. For clinical practice, nurses should integrate structured, theory-based self-management programs into routine care for patients with stage 3 CKD to promote sustained behavior change and improved outcomes. Traditional outpatient consultations often do not provide sufficient time or continuity to support complex lifestyle modifications. In this context, mobile application-based interventions can address these limitations by enabling ongoing communication, reinforcement of self-management behaviors, and active involvement of family members.

For health service administrators and policymakers, implementing IFSMT-based self-management programs for other chronic conditions may improve patient outcomes while optimizing healthcare resource utilization. Such programs should prioritize accessible education, development of behavioral skills, and structured social support mechanisms. These elements can be adapted to different populations and disease contexts, supporting scalable and sustainable approaches to chronic disease management.

For nursing education, integrating training in self-management support, particularly through digital platforms, may better prepare nurses to lead patient- and family-centered interventions. The findings of this study also support the further development of nurse-led digital interventions that extend care beyond traditional clinical settings and

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enhance continuity of care for patients with chronic illnesses, including stage 3 CKD.

2. Limitations of This Study

The use of mobile applications in patient care may pose challenges for older adults or individuals with limited digital literacy. To support effective implementation, additional assistance may be required to help patients and family members navigate the technology. Differences in familiarity with internet-based activities may also influence engagement and intervention outcomes. Future programs should incorporate pre-intervention assessments of digital readiness and provide tailored training to address these disparities.

CONCLUSION

This study provides evidence that a theory-based Individual and Family Self-Management Program can slow disease progression and improve self-management behaviors and clinical outcomes among patients with stage 3 CKD. Integrating this intervention into routine nursing care represents a practical and effective strategy for patients, families, and healthcare teams. Broader implementation of similar digitally supported programs may contribute to improved chronic disease management and better long-term patient outcomes.

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CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Study conception and/or design acquisition - SK, CCOP, PP, and PCOP; analysis - SK, CCOP, PP, and PCOP; interpretation of the data - SK, CCOP, PP, and PCOP; and drafting or critical revision of the manuscript for important intellectual content - SK and CCOP.

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DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Korean Journal of Adult Nursing

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I. AIMS AND SCOPE

The *Korean Journal of Adult Nursing* (KJAN) is the official peer-reviewed research journal of the Korean Society of Adult Nursing (KSAN). KJAN is devoted to the dissemination of groundbreaking research on theory, practice, and education in the field of adult nursing. Research on other subject areas or issues that contribute to adult nursing is published at the discretion of the Editorial Board. The goal of KJAN is to contribute to health maintenance, health promotion, and disease prevention and management in adults by publishing research. KJAN is published four times per year at the end of February, May, August, and November.

II. RESEARCH & PUBLICATION ETHICS

1. Research Ethics

For policies on research and publication ethics that are not stated in these instructions, the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals by the International Committee of Medical Journal Editors (ICMJE) or the Committee on Publication Ethics (COPE) guidance (https://publicationethics.org/guidance) can be applied. Further, all processes of handling research and publication misconduct shall follow the applicable COPE flowchart.

Statements of human and animal rights: Clinical research should be done in accordance with the Ethical Principles for Medical Research Involving Human Subjects, outlined in the Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/). Any study involving human subjects or human data must be reviewed and approved by a responsible institutional review board (IRB). Research involving meta-analyses, systematic reviews, and literature reviews does not require IRB review. For secondary data analyses, IRB review and approval for an exempt study may be required based on the decision of the Editorial Board. When necessary, the Editorial Board may request any documentation regarding ethical issues of the manuscript such as written consent or the approval of the study by the IRB. Furthermore, for studies involving human subjects, the authors must explicitly state in the paper that the research received IRB approval and was conducted in accordance with the relevant standards.

Statement of informed consent: Copies of written informed consent and IRB approval for clinical research should be kept. If necessary, the editor or reviewers may request copies of these documents to resolve questions about IRB approval and study conduct.

Originality and duplicate publication: Duplicate publication or duplicate submission is prohibited in accordance with the ICMJE recommendations (https://www.icmje.org/recommendations/browse/publishing-and-editorial-issues/overlapping-publications.html). Manuscripts that have been published or are being submitted to other journal(s) should not be submitted to KJAN. Manuscripts that have been published or are currently under consideration for publication in KJAN must not be submitted to another journal. The corresponding author must obtain approval from the Editors-in-Chief of both related journals if the author wants to reprint a published manuscript in another language.

If manuscripts have been submitted or are currently under consideration for publication in KJAN, the Editorial Board will determine the nature and degree of duplicate publication or duplicate submission for the manuscript. If a manuscript has been published in KJAN, the KSAN ethics committee will determine the nature and degree of duplication.

2. Authorship

KJAN follows the recommendations for authorship set out by the ICMJE Authorship guidelines (http://www.icmje.org/icmje-recommendations.pdf). Authorship is attributed only to individuals who have directly participated and made significant contributions to the creation of the manuscript. Authorship should be based upon all four of the following criteria: 1) substantial contribution to the concept or design of the work, or the acquisition or analysis and interpretation of data; 2) drafting the work or revising it critically for important intellectual content; 3) final approval of the version submitted for publication; 4) accountability for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All other contributors not listed as authors should be mentioned in the acknowledgements section.

If a manuscript is based on a master's thesis or doctoral dissertation, the author must disclose that the manuscript is the product of his/her thesis or a dissertation for an academic degree. The first author must be the recipient of the academic degree from the work presented in the manuscript.

Any changes in authorship (addition, deletion or change in order of authorship) must be approved by the Editorial Board prior to the manuscript's acceptance for publication. To request such a change, the Editor must receive the following from the corresponding author: (a) the reason(s) for the change in the author list; and (b) written confirmation (e-mail, letter) from all authors that they agree with any addition, removal, or rearrangement.

3. Conflicts of Interest

The corresponding author will be responsible for informing the editor regarding potential conflicts of interest for all listed authors that might influence their interpretation of data. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. If there is no conflict of interest, this should also be explicitly stated as "The author(s) declared no conflict of interest."

4. Registration of a Clinical Trial

This journal follows the data sharing policy described in "Data Sharing Statements for Clinical Trials: A Requirement of the International Committee of Medical Journal Editors" (https://doi.org/10.3346/jkms.2017.32.7.1051). All clinical trials (as defined by the ICMJE) must be registered in a publicly accessible trial registry. For all other types of studies, including systematic reviews, prospective registration is strongly encouraged. If a study has been registered, please cite the registration number in both the abstract and body of the paper. The journal accepts registration in any of the primary registries that participate in the World Health Organization International Clinical Trials Portal (http://www.who.int/ictrp/en/), National Institutes of Health ClinicalTrials.gov (http://www.clinicaltrials.gov/), International Standard Randomized Controlled Trial Number Registry (https://www.isrctn.com/), or the Clinical Research Information Service, Korea Disease Control and Prevention Agency (KDCA) (https://cris.nih.go.kr/cris/index/index.do).

5. Research Data Sharing and Transparency

This journal encourages and enables authors to share data that supports the research publication, where appropriate, and to interlink the data with other published articles. Research data refers to the results of observations or experiments that validate the research findings. To facilitate reproducibility and data reuse, this journal encourages authors to share their software, codes, models, algorithms, protocols, methods, and other useful materials related to the project. Data generated through the participation of subjects and the public should be put to maximum use by the research community and, whenever possible, translated to deliver patient benefits. Data sharing benefits numerous research-related activities: reproducing analyses, testing secondary hypotheses, developing and evaluating novel statistical methods, teaching, aiding the design of future trials and meta-analyses, and helping to prevent error, fraud, and selective reporting. To promote more transparent and reproducible research, we ask authors to submit a Data Availability Statement in the manuscript to help readers understand how they can access the data, code, and other resources that support the research findings.

The following are examples of data-sharing statements:

- Example 1: The data can be obtained from the corresponding authors.
- Example 2: The data can be obtained from the Supplementary Material.
- Example 3: (In the case of healthcare big data) The data can be obtained from __ (the name of the)_repository source.
- Example 4: No new data were created or analyzed during this study. Data sharing is not applicable to this article.

6. Artificial Intelligence (AI)–Assisted Technologies

At submission, authors are required to disclose whether they used AI-assisted technologies (such as Large Language Models [LLMs], chatbots, or image creators) in their work. Authors should describe how they used AI-assisted technologies in both the cover letter and the appropriate section of the manuscript. For example, if AI was used for writing assistance, this should be described in the Acknowledgments section. If AI was used for data collection, analysis, or figure generation, the authors should describe this use in the Methods section. Chatbots (such as ChatGPT) should not be listed as authors because they cannot be held responsible for the accuracy, integrity, and originality of the work, and these responsibilities are required for authorship. Therefore, authors are responsible for any submitted material that included the use of AI-assisted technologies. Authors should carefully review and edit AI-generated results because AI can generate authoritative-sounding output that can be incorrect, incomplete, or biased. Authors must ensure there is appropriate attribution of all quoted material, including full citations, and should not list AI and AI-assisted technologies as an author or co-author, nor cite AI as an author.

7. Process for Managing Publication Malpractice

If reviewers or readers suspect publication malpractice, such as fabrication, falsification, salami slicing, plagiarism, or simultaneous/ duplicate publication, inappropriate changes in authorship, an undisclosed conflict of interest, ethical problems with a submitted manuscript, a reviewer who has appropriated an author's idea or data, complaints against editors, and so on, the process of resolution will be initiated following the flowchart provided by the COPE guidance (https://publicationethics.org/guidance).

If a published manuscript is suspected of an ethics violation, the KSAN ethics committee, which includes the Editor-in-Chief of KJAN, will be convened. The procedure will be conducted in the following order: a preliminary investigation, a second investigation, and decision, in accordance with the prescribed regulations. If a published manuscript is determined to involve an ethics violation, members found to have violated this regulation and the general ethical principles of research will be subject to the following consequences, and other relevant matters shall be determined by the KSAN ethics committee.

1) The published manuscript will be retracted, and a public statement will be made regarding the reason for retraction.
2) Submission privileges to KJAN will be suspended for three years.
3) The retraction of the manuscript will be announced on KJAN's official website and in the printed journal.

III. GUIDELINES FOR MANUSCRIPT PREPARATION

1. Types of Manuscripts

KJAN publishes original articles, review articles, invited articles, and editorials.

1) *Original Articles* include full papers reporting original research. These are reports of empirical findings from high-quality basic and clinical research studies within the scope and focus of KJAN.
2) *Review Articles* include critical presentations of topics relevant to nursing theory, practice, and education regarding adult nursing. Unsolicited reviews will be considered for publication if topical, of high quality, and subject to peer review. The body of a review article should be a comprehensive, scholarly evidence-based review of the literature, accompanied by a critical analysis and reasonable conclusions.
3) *Invited Articles* provide concise reviews of a subject of importance to nursing researchers written by an invited expert in nursing science.
4) *Editorials* are commissioned by editors, and may include comments on manuscripts included, recent research trends in the field of adult nursing, and opinions on relevant topics.

2. General Guidelines

1) **Language and style:** Manuscripts should be written in English. The paper size setting should be A4, and the file should be compatible with Microsoft Word. The formatting requirements are as follows: the texts should be double-spaced and in Times New Roman 12-point font size with margins of top 30 mm, bottom 25 mm, left 25 mm, and right 25 mm. Page numbers are placed at the bottom of each page.

2) **Manuscript length:** The manuscript has different limits depending on the type of article submitted. (1) An original article should be no more than 6,000 words; (2) A review article should not exceed 8,000 words; and (3) An editorial should be no longer than 2,500 words. This word count includes only the main body of the text (i.e., not abstract, references, tables, or figures).

3) **Abbreviations:** Do not use abbreviations in the title or abstract and limit their use in the text. Expand all abbreviations at first mention in the text. Avoid using abbreviations in the article title. For standard abbreviated words and units, refer to the NLM (National Library of Medicine) Style Guide for Authors, Editors, and Publishers, 2nd Edition (2007) (http://www.nlm.nih.gov/citingmedicine).

4) **Description of participants:** Authors should ensure correct use of the terms sex (when reporting biological factors) and gender (identity, psychosocial or cultural factors), and, unless inappropriate, report the sex or gender of study participants, the sex of animals or cells, and describe the methods used to determine sex or gender. If the study was done involving an exclusive population, for example in only one sex, authors should justify why, except in obvious cases (e.g., prostate cancer). Authors should define how they determined race or ethnicity and justify their relevance.

5) **Permissions:** Authors should obtain permission from the copyright owners to use measurements or instruments for their studies. Permission to reproduce previously published material must also be obtained in writing from the copyright holder (usually the publisher) and acknowledged in the manuscript.

6) **Describing machinery or technical equipment:** Generic names should be used. When proprietary brands are used in research, include the name of the brand and the manufacturer, city (state), and nation in parentheses after the first mention of the generic name in the Methods section. Brand names are identified by symbols such as TM and ®, and should only be used when necessary.

7) **References and citation style:** References and citations follow the National Library of Medicine (NLM) Style. The submitting authors are responsible for ensuring adherence to NLM guidelines.

3. Research Reporting Guidelines

Authors are encouraged to adhere to relevant reporting guidelines when describing their study. Reporting guidelines endorsed by the journal are listed below, from the EQUATOR network (https://www.equator-network.org/).

Observational cohort, case-control, and cross-sectional studies
Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)
Meta-analysis of Observational Studies in Epidemiology (MOOSE)
Qualitative studies
Consolidated Criteria for Reporting Qualitative Research (COREQ)
Standards for Reporting Qualitative Research (SRQR)
Quasi-experimental/ non-randomized trials
Transparent Reporting of Evaluations with Non-randomized Designs (TREND)
Randomized (and quasi randomized) controlled trials
Consolidated Standards of Reporting Trials (CONSORT)
Study of Diagnostic accuracy/assessment scale
Standards for the Reporting of Diagnostic Accuracy Studies (STARD)
Systematic Review and meta-analysis
Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)
Meta-analysis of Observational Studies in Epidemiology (MOOSE)
Quality improvement studies
Standards for Quality Improvement Reporting Excellence (SQUIRE)

4. Manuscript Components

The composition of manuscripts shall be in the following order: title page, abstract and keywords, main text, references, tables and figures, and appendices. Each section begins on a new page. The main body of the manuscript (including the references, figures, tables, acknowledgements, and any funding information) should not include any identifying information, such as the authors' names or affiliations, to ensure a blind review.

1) Title page

The following should be included on the title page: (1) the title of the article; (2) the running title; (3) author information (ORCID number is required for all authors); (4) permission for measurements/instruments used in the study; (5) IRB approval institution and number; (6) disclosure; and (7) reporting guidelines checklist relevant to the research design used.

2) Abstract and Keywords

An abstract of up to 250 words for articles (including reviews) should be typed double-spaced on a separate page. It should cover the main factual points, including statements of the Purpose, Methods, Results, and Conclusion. The abstract should be accompanied by a list of three to five keywords for indexing purposes. Medical Subject Headings (MeSH) keywords (http://www.nlm.nih.gov/ mesh/meshhome.html) should be used, with careful selection of keywords that precisely reflect the focus of the study.

3) Main text

The text should be composed in the following order: Introduction, Methods, Results, Discussion, Conclusion, and References.

Introduction: Clearly state the need for this study and the main question or hypothesis of the study. Summarize the literature review or background in the area of the study.

Methods: Describe the study design, setting and samples, measurements/instruments, data collection/procedure, ethical considerations, and data analysis. If a study presents qualitative research, the instrument can be omitted. When discussing research methods, it is important to provide specific and detailed information to enable reproducibility. In the section on ethical considerations, the author should state that the study protocol was approved by the institutional review board (IRB No. ##-##-###). Please provide the initials of institutional names at the time of submission for peer review.

Results: Describe the main results in a concise paragraph. This section should be the most descriptive.

Discussion: The discussion should be based only on the reported results. It is strongly recommended that authors discuss how the study findings relate to advances in nursing practice, nursing knowledge development, and nursing implications.

Conclusion: State the conclusions and recommendations for further study. Do not summarize the study results.

4) References

In-text Citation: Citations of references in the text should follow Citing Medicine: The NLM Style Guide for Authors Editors, and Publishers 2nd edition (http://www.nlm.nih.gov/citingmedicine). References should be numbered serially in the order of appearance in the text, with numbers in brackets [ ] (e.g., social support [1], fatigue [2,3], depression [4-6]). If a reference is cited more than once, use the original reference number (e.g., social support [1,2], fatigue [2-5], depression [1,4-6]).

Reference list: References should be listed on a separate page at the end of the paper in the order of citation. The number of references should be 35 or less for an original article except for a manuscript on model construction, which is allowed to include up to 50 references. Citations of master's and doctoral dissertations should be minimized, with a maximum of three citations.

5) Tables and Figures

There should be no more than five tables and figures in total. Tables and figures should be self-contained and complement, but not duplicate, information contained in the text. Each table and figure should be placed on a separate page. All lines are to be single. Vertical lines are not acceptable. The title of a table should be placed on top. Within the title, the first letters of important words

should be capitalized (e.g., Table 1. Clinical Characteristics of the Sample). The title of the figure should be placed below the figure with the first letter capitalized (e.g., Figure 1. Path diagram of the model.). Tables and Figures should be numbered consecutively in Arabic numerals. All abbreviations used in tables should be explained in footnotes. List abbreviations in alphabetical order; do not include the word "and" before the last abbreviation (e.g., BP = blood pressure; ED = emergency department). Footnote symbols including asterisks and other symbols should be placed after abbreviations in the table. Table footnotes should be indicated with superscript symbols in sequence: †, ‡, §, ‖, ¶, #, *, ††

If the point value of a number can exceed 1, write "0" before the decimal point (e.g., t = 0.26, F = 0.98, R^2 = .61), otherwise do not write "0" before the decimal point (e.g., p < .001). The p value (as an indicator of statistical significance) should be written without a footnote and should be rounded to three decimal places (e.g., p = .003). If "p" is .000, then indicate that p is less than 0.001 (e.g., p < .001). Percentages (%) should be rounded off to one decimal place (e.g., 24.7%); test statistics, such as t, F, x^2, and r, should be rounded off to two decimal places (e.g., t = 0.26, F = 0.98, R^2 = .61).

6) Appendices

Authors should submit an appendix containing the final developed instrument in instrument development studies and a list of reviewed articles in a systematic review or meta-analysis.

5. Reference Format

1) Journals

(1) For six or fewer authors, list all authors:

1. Han S, Min J, Kim DK, Kong ID, Kim N. The understanding and application of telomere length as an emerging biomarker in adult nursing research: a review. Korean J Adult Nurs. 2023;35(1):1-12. https://doi.org/10.7475/kjan.2023.35.1.1

(2) For more than six authors, list the first six followed by et al.

1. Lee S, Kim MK, Hong EY, Lee JJ, Kim HJ, Kim HS, et al. Structural equation modeling on spiritual nursing care of clinical nurses based on the theory of planned behavior. Korean J Adult Nurs. 2022;34(1):27-38. https://doi.org/10.7475/kjan.2022.34.1.27

(3) Forthcoming journal articles

1. van Corven CT, Bielderman A, Wijnen M, Leontjevas R, Lucassen PL, Graff MJ, et al. Defining empowerment for older people living with dementia from multiple perspectives: a qualitative study. Int J Nurs Stud. Forthcoming 2020 Nov 10. https://doi.org/10.1016/j.ijnurstu.2020.103823

2) Periodicals or magazines

1. Rutan C. Creating healthy habits in children. Parish Nurse Newsletter. 2012 May 15:5-6.

3) Newspaper articles

1. Cho CU. Stem cell windpipe gives Korean toddler new life. The Korea Herald. 2013 May 1; Sect. 01.

4) Books

(1) Reference to an entire book

1. Hughes JH. Military veteran psychological health and social care: contemporary issues. 1st ed. London: Taylor & Francis; 2017.
2. Kim SJ. Nursing theory. Seoul: Soomoonsa; 1985.

(2) Chapter in an edited book

1. Miller CW. Applied cardiovascular physiology. In: Wingfield WE, Raffe MR, editors. The veterinary ICU book. Jackson, WY: Teton NewMedia; 2002. p. 1-14.

(3) An edited book

1. Munslow A, Rosenstone RA, editors. Experiments in rethinking history. New York, NY: Routledge; 2004.

(4) Unknown authors or editors

1. Merriam-Webster's collegiate dictionary. 10th ed. Springfield, MA: Merriam-Webster; 1995.

(5) Book with translator(s)

1. McEwen M, Wills EM. Theoretical basis for nursing. 4th ed. Koh CK, translator. Philadelphia, PA: Wolters Kluwer; 2019. p. 20-5.

(6) An encyclopedia or dictionary

1. Sadie S, editor. The New Grove dictionary of music and musicians. 6th ed. London: Macmillan; 1980.
2. Fitzpatrick JJ, Wallace M, editors. Encyclopedia of nursing research. 3rd ed. New York, NY: Springer Publishing Company; 2012.

5) Scientific and technical reports

1. Hong S, Sung M, Choi J, Kim J, Kim S. Family policies implications in the context of an increase in one-person households. Korean Women's Devel-

opment Institute Report. Seoul: Korean Women's Development Institute; 2017 July. Report No.: 1105012716.

6) Unpublished dissertations and theses: Not recommended. Maximally three dissertations and theses in total are al- lowed if necessary.
(1) Dissertations
1. Zhao JJ. Design of a 3D virtual learning environment for acquisition of cultural competence in nursing education: experience of nursing and other health care students, instructors, and instructional designers [dissertation]. Vancouver: University of British Columbia; 2019. p. 100-5.
(2) Theses
1. Huh MS. Effect of Danjeon breathing on stress urinary incontinence and quality of life in middle aged wom- en [master's thesis]. Busan: Dongeui University; 2005.

7) Conference proceedings
(1) Unpublished proceedings
1. Lankntree C, Briere J. Early data on the trauma symp- tom checklist for children (TSCC). Paper presented at: The meeting of the American Professional Society on the Abuse of Children; 1991 January 25; San Diego, CA.
(2) Posters
1. Cho YJ, Han YR. The relationship between the professional self concept, work stresses and their triage competency in emergency nurses. Poster session pre- sented at: Korean Society of Nursing Science; 2020 October 23; Seoul.

8) Web
1. Ministry of the Interior and Safety. Safety experience center [Internet]. Sejong: Ministry of the Interior and Safety; 2022 [cited 2023 January 12]. Available from: https://www.mois.go.kr/frt/sub/a06/b10/safe- tyExperience/screen.do

IV. SUBMISSION AND PEER REVIEW

1. Submission

Manuscripts should be submitted electronically via this journal's submission system (https://submit.kjan.or.kr/). The first and corresponding authors should be members of KSAN, with the exception of non-Korean authors. Under certain circumstances, non-members can submit manuscripts following approval by the Editorial Board. All correspondence, including notification of the editor's decision and requests for revisions, will be processed via this system. Authors should complete the Submission Checklist and sign the Copyright Transfer Agreement form and submit via the submission system. For any questions regarding the use of the online system, please contact the KJAN publication director via phone, fax, or e-mail.

2. Peer Review

This journal follows a double-blind peer review process. Each submission will initially be assessed by the editors to determine suitability for publication in this journal. If a submission is deemed suitable, it will typically be sent to a minimum of three reviewers for an independent expert assessment of the scientific quality. The decision as to whether an article is accepted or rejected will be taken by our editors.

1) **Preview:** The editorial committee initially assesses each submission. The primary goal is to quickly determine which papers should not be sent for peer review and which ones should. To prevent delays for authors who may wish to submit their work elsewhere, papers that do not meet basic standards or are unlikely to be published, even with a favorable peer review—such as those with insufficient novel contributions or unclear relevance to the field—may be rejected at this stage.

2) **Peer-review process:** There is a two-week peer review period, and the first decision is made after the evaluation is finished. Following the review, the Editorial Board will decide between the options: acceptable options include minor revision, major revision, or rejection. The Editorial Board may request authors to make changes to the manuscript in response to reviewers' comments. If the author deems a reviewer's opinion to be unacceptable or thinks that a reviewer has misinterpreted the data, a reasonable explanation should be provided. Authors should try their best to comply with any requests made by the reviewers to modify the manuscript.
After making changes to the manuscript, the author should upload the updated files along with a response to

each reviewer's comment. Revisions from the author must be finished within 14 days of the request. The Editorial Board will inform the author if it is not received by the deadline. The author should discuss an extension with the Editorial Board if they want to prolong the revision window past 14 days. The Editorial Board may consider further review upon the author's request. The Editorial Board will ultimately decide whether to approve the submitted manuscript for publication and may, if necessary, ask for additional alterations, edits, and deletions to the article text. Statistical editing is also done if a statistician needs to review the data professionally.
The Editor-in-Chief of KJAN will make the final decision regarding the manuscript's publication based on the reviewers' comments and the scientific merits of the manuscript. Any potential or existing conflict and issues in the manuscript must be discussed in detail with the Editorial Board.

3) **Appeals of decisions:** Any appeals against the editorial decision must be made within 2 weeks of the date of the decision letter. Authors who wish to appeal against a decision should contact the Editor-in-Chief, explaining in detail the reasons for the appeal. All appeals will be discussed with at least one other associate editor. If consensus cannot be reached thereby, an appeal will be discussed at a full editorial meeting. The process of handling complaints and appeals follows the COPE guidance (https://publicationethics.org/guidance). KJAN does not consider second appeals.

V. FINAL PREPARATION FOR PUBLICATION

1. Final Version

After the paper has been accepted for publication, the author(s) should submit the final version of the manuscript. The names and affiliations of the authors should be double-checked, and if the originally submitted image files were of poor resolution, higher-resolution image files should be submitted at this time. Symbols (e.g., circles, triangles, squares), letters (e.g., words, abbreviations), and numbers should be large enough to be legible on reduction to the journal's column widths. All symbols must be defined in the figure caption. If references, tables, or figures are moved, added, or deleted during the revision process, renumber them to reflect such changes so that all tables, references, and figures are cited in numeric order.

2. Manuscript Corrections

Before publication, the manuscript editor will correct the manuscript so that it meets the standard publication format. The author(s) must respond within 48 hours when the manuscript editor contacts the corresponding author for revisions. If the response is delayed, the manuscript's publication may be postponed to the next issue.

3. Proofs and Reprints

The author(s) will receive the final version of the manuscript as a PDF file. Upon receipt, the author(s) must notify the editorial office of any errors found in the file within 48 hours. Any errors found after this time are the responsibility of the author(s) and will have to be corrected as an erratum.

4. Correction

To correct errors in published articles, the corresponding author should contact the journal's editorial office with a detailed description of the proposed correction. Corrections that seriously affect the interpretation or conclusions of the article will be reviewed by the editors. Corrections will be published as an author correction or a publisher correction in a later issue of the journal.

Minor errors will be corrected directly in the online version of the article. An indication of the correction, along with the date it was made, will be added to the article information in both the HTML and PDF versions. A separate correction note will not be published.

VI. ARTICLE PROCESSING CHARGE

When a manuscript is accepted for publication, an article processing charge (APC) of 600 USD (KRW 600,000) per article is charged to the corresponding author.

VII. COPYRIGHT, OPEN ACCESS POLICY

1. Copyright

All manuscripts published in KJAN are protected by copyright. The copyright and transfer rights of the digital content of the published paper and journal are owned by the

KSAN. Copyright Transfer Agreement form should be submitted online at submission. All authors should print their names and sign the copyright transfer agreement.

2. Open Access Policy

History:

Enacted Jun, 1994
Revised Dec, 1999
Revised Dec, 2002
Revised Dec, 2003
Revised Dec, 2006
Revised Dec, 2007
Revised Jun, 2008
Revised Dec, 2008
Revised Feb, 2009
Revised Jun, 2009
Revised Apr, 2010
Revised Aug, 2010
Revised Jun, 2012
Revised Jul, 2014
Revised Aug, 2016
Revised Feb, 2018
Revised Aug, 2018
Revised Dec, 2018
Revised Jun, 2020
Revised Mar, 2023
Revised Aug, 2023
Revised May, 2025

VIII. OTHER EDITORIAL POLICY

1. Archiving Policy

All manuscripts published in KJAN are freely available through open access to read and download from any electronic link, including those found on the KJAN website (http://www.kjan.or.kr/) immediately and permanently after publication.

Submission Checklist

KJAN
Korean Journal of Adult Nursing

Before submitting the manuscript, please review the following items and mark the applicable content with a "✓" (check-mark).

1. General Considerations

☐ The manuscript should be written according to the research and publication ethics of KJAN.
☐ The first and corresponding authors should be members of the KSAN (*Foreign researchers may submit to KJAN, even though they are not KSAN members).
☐ Copyright transfer agreement signed by all authors and relevant EQUATOR reporting guidelines checklist should be submitted by submission system.
☐ Institutional review board (IRB) approval institution and number:

2. Title page

☐ Please follow the title page template available online.

3. Manuscript preparation

3.1. General guidelines

☐ A4 paper size, 12-point font Times New Roman in MS Word file.
☐ Line space: double spacing / Margins of 30 mm on the top and 25 mm on the bottom, left, and right.
☐ Page numbers at the bottom of each page.
☐ Subheadings of abstract, text, references, and tables and figures.
☐ Original article should be no more than 6,000 words; a review article should not exceed 8,000 words; and an editorial should be no longer than 2,500 words.

3.2. Abstract and Keywords

☐ 250 words or fewer in the abstract.
☐ Subheadings of Purpose, Methods, Results, and Conclusion.
☐ Three to five keywords from MeSH terms.

3.3. Main Text

☐ The main text consists of introduction, methods, results, discussion, conclusion, and references.

3.4. References

☐ The number of references should be 35 or fewer (50 or fewer for model construction).
☐ References follow NLM style.
☐ All references are written with DOIs.
☐ All citations in the paper should have a complete and accurate corresponding reference in the reference list.
☐ Present recent (within 5 years) articles to the extent possible.

3.5. Tables and Figures

☐ The total number of tables and figures should be 5 or fewer.
☐ All abbreviations should be described below the tables or figures.
☐ When numbers are used, the units of the numbers should also be given.
☐ All table and figure numbers should be mentioned in the text.
☐ Tables and figures are presented on separate pages after the references, with one table and figure per page.

Manuscripts submitted to KJAN will be returned if they do not conform to the submission guidelines of KJAN. The authors of this article understand and confirm the above instructions.

Name of corresponding author: _____ Date: _____/_____/_____ (Signature)

Copyright Transfer Agreement

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