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Child Health Nursing Research

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Korean Academy of Child Health Nursing

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About the Journal

Child Health Nursing Research (CHNR) is the official peer-reviewed research journal of the Korean Academy of Child Health Nursing. CHNR is a multidisciplinary, double-blind peer-reviewed, open-access journal that publishes original research, theory, and review papers on health care and nursing from the beginning of life to young adulthood, including both children and their families. It is devoted to all fields of child health, including global and cultural issues, aimed at both domestic and international healthcare professionals. The journal is published quarterly (Jan 31, Apr 30, July 31, and Oct 31) in English. The journal welcomes submissions from healthcare professionals around the world, and encourages the submission of papers dealing with cultural issues and those studied by international research teams.

- Indexed in major databases: PubMed Central, PubMed, Scopus, CINAHL, DOAJ, Crossref Metadata, Google Scholar, ScienceCentral, KCI (Korea Citation Index), RISS, KoreaMed, and KoMCI.
- Its abbreviated title is Child Health Nurs Res.
- Open access: All articles published in the journal are freely available with an open access license for everyone to read and download from the CHNR website (http://www.e-chnr.org/) immediately and permanently after publication.

Aims and Scope

Child Health Nursing Research aims to promote the health, development, and well-being of children and their families in Korea and all over the world by providing research on evidence-based practices.
Its scope includes the most recent clinically and academically relevant topics in health care and nursing from the beginning of life to young adulthood, including both children and their families. The journal deals with articles that address research, theory, and practice in a wide range of child health nursing areas and relevant cultural issues. Its regional scope is mainly Korea, but it welcomes submissions from researchers and nurses worldwide.
The primary readers of this journal are healthcare professionals, administrators and scientists serving newborns, infants, children, adolescents, young adults, and their families, including nurses, midwives, physicians, developmental specialists, public health workers, scientists, educators, epidemiologists, and other health caregivers.
The ultimate goal of *Child Health Nursing Research* is to develop a body of knowledge on the health of newborns, infants, children, adolescents, young adults, and their families while improving the clinical field and community with evidence-based practices to promote the health of children and families all over the world.

Manuscripts should be submitted via the online Manuscript Central website (http://www.e-chnr.org). Other correspondences can be sent by an e-mail to the Editor, Dr. YeoJin Im, College of Nursing Science & Graduate School of Nursing, Kyung Hee University, Korea (Tel: +82-2-961-9424, e-mail: imyj@khu.ac.kr).

Correspondence concerning business matters should be addressed to Treasurer, Yoo-Jin Heo, College of Nursing, Dankook University, Korea (Tel: +82-41-550-1456, e-mail: yoojin.heo@dankook.ac.kr). The subscription price of this journal is Korean Won, 200,000 (US$ 187.00 or equivalent) annually.
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College of Nursing, Korea University, Korea
Tel:+82-2-3290-4034, Fax: +82-2-928-9107, e-mail: childnursing@childnursing.or.kr, office@e-chnr.org

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Child Health Nursing Research in 2026: 3 decades of growth, poised for a global leap

YeoJin Im[1,2]

[1]Editor-in-Chief, Child Health Nursing Research, Seoul, Korea
[2]Professor, College of Nursing Science & Graduate School of Nursing, Kyung Hee University, Seoul, Korea

Corresponding author
YeoJin Im
College of Nursing Science, Kyung Hee University, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea
Tel: +82-2-961-9424
Fax: +82-2-961-9398
E-mail: imyj@khu.ac.kr

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Child Health Nursing Research (CHNR), the official journal of the Korean Academy of Child Health Nursing, has published continuously since 1995. This editorial reviews its history, current standing, and strategy for international indexing. CHNR adopted its present title in 2013, moved to English-only publication in 2020, and is indexed in CINAHL, Scopus, DOAJ, and PubMed Central. Its Scopus CiteScore rose every year, from 0.9 in 2021 to 2.5 in 2025, and SCImago placed it in the second quartile in both of its subject categories in 2025. Volume 32 (2026) comprises 42 articles, up from 28 in 2025; 24% involved authors from outside Korea. Building on these gains, CHNR aims for inclusion in the Web of Science Core Collection and, ultimately, MEDLINE. Four strategies will guide this effort: broadening author diversity, strengthening the international editorial board, publishing work that is read and cited, and upholding publication ethics. The 2026 revision of the Instructions for Authors supports these goals. Editors, reviewers, and authors share responsibility for the journal's next leap.

Keywords: Bibliometrics; Editorial policies; Internationality; Pediatric nursing; Periodicals as topic

1. Introduction

I took on the role of Editor-in-Chief of *Child Health Nursing Research* (CHNR) in January 2026, and this October issue closes Volume 32 and my first year in that role. The journal we have today was built by many hands: the authors who entrusted their work to us, the reviewers who gave their time and expertise, the editors, and everyone who supported the journal behind the scenes. I am deeply grateful to all of them. Building on what they made, CHNR must now take its next leap. This is a fitting moment to look back on how the journal grew, to take honest stock of where it stands today, and to set out where we intend to take it next.

Our next goal is clear: to have CHNR accepted into the Web of Science Core Collection, beginning with the Emerging Sources Citation Index (ESCI), and in the longer term to be indexed in MEDLINE. In this editorial, I share the evidence on which that goal rests and the concrete steps the editorial board will take to reach it. I also set out what editors, reviewers, and authors can each contribute to this next chapter.

2. A History of Steady Growth

CHNR has published without interruption since its first issue in 1995. It is the official journal of the *Korean Academy of Child Health Nursing*. It began as the Korean Journal of Child Health Nursing, a venue for Korean nurses to share research

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on the health of children, adolescents, and their families. In April 2006, it was renamed the *Journal of Korean Academy of Child Health Nursing*.

Over 3 decades, the journal has changed in 3 main ways. First, in 2013 it took a new name, *Child Health Nursing Research*, which signaled a scope beyond national borders. Second, in July 2020, beginning with Volume 26, Issue 3, it moved to English-only publication, so that its findings could reach a global readership. Third, it became fully open access under a CC BY-NC-ND 4.0 license, and it now publishes 4 issues each year, on January 31, April 30, July 31, and October 31.

As the journal matured, it was accepted into major databases in turn. Cumulative Index to Nursing and Allied Health Literature(CINAHL) Complete indexes the journal from 2011, under its former title, and has carried its full text since 2013. Scopus accepted CHNR in February 2018, and the Directory of Open Access Journals (DOAJ) followed in July 2019. In October 2021, CHNR passed the scientific evaluation for PubMed Central (PMC), and its articles became available in PMC in January 2022. PMC now provides its articles from Volume 25, Issue 1 (January 2019) onward and makes them searchable through PubMed. It is also indexed in Korea Citation Index (KCI), KoreaMed, and Google Scholar, among others.

The most recent chapter of this history was written under the previous Editor-in-Chief (2022–2025) [1]. In 2022, through an internationalization consulting program supported by the Korean Federation of Science and Technology Societies, the journal reorganized its editorial system and revised its instructions for authors and editorial workflows to meet global standards. From 2023, it actively invited editorials, review articles, and methodologically diverse studies on pressing issues in child health nursing. As a member of that editorial board, I will carry these policies forward without a break.

3. Where We Stand Today

CHNR's Scopus CiteScore has risen every year since 2021, from 0.9 to 2.5 in 2025 (Table 1). Over the same period, both its Source Normalized Impact per Paper (SNIP) (0.412 to 0.865) and its SCImago Journal Rank (SJR) (0.238 to 0.488) more than doubled [1-3]. In 2025, the journal ranked 148th of 351 journals in Pediatrics, Perinatology and Child Health (57th percentile), and SCImago placed it in Q2 in both of its subject categories, including Nursing (Pediatrics) for the first time [2,3]. Its 2026 CiteScoreTracker already stands at 2.6 [2]. These gains are notable for a specialized journal of CHNR's size.

Table 1. Scopus metrics of *Child Health Nursing Research*, 2021–2025

Metric	Year				
	2021	2022	2023	2024	2025
CiteScore	0.9	1.3	1.7	2.1	2.5
Percentile in category	33rd	37th	41st	51st	57th
Quartile	Q3	Q3	Q3	Q2	Q2
SJR	0.238	0.261	0.358	0.401	0.488
SNIP	0.412	0.392	0.415	0.634	0.865

Values for 2021–2024 are from the 2026 editor's report [1]; values for 2025 are from Scopus (CiteScore calculated May 5, 2026) and SCImago [2,3]. The 2025 percentile is for Pediatrics, Perinatology and Child Health (rank 148/351); in Nursing: Pediatrics, CHNR ranked 15th of 28 (48th percentile). The 2025 quartile is the SJR quartile, Q2 in both categories.
CHNR, Child Health Nursing Research; Q, quartile; SJR, SCImago Journal Rank; SNIP, Source Normalized Impact per Paper.

Volume 32 has also been our most productive year so far. The first 3 issues of 2026 carried 31 articles, more than the 28 articles published in all of 2025. With the 11 articles in this October issue, including this editorial, Volume 32 comprises 42 articles, up from 28 in 2025. Three of them are review articles, a type of paper the journal had lacked.

The journal has also become more international, though not in a straight line. The share of authors affiliated outside Korea rose from 7.3% in 2023 to 14.6% in 2024, then fell to 3.1% in 2025 [1]. In 2026, 4 articles in the first 3 issues came from teams in Indonesia, Vietnam, and the United States. One of these, a study of the intergenerational transmission of child maltreatment, was our first Korea–US collaboration of this kind. This October issue goes further: 6 of its 10 articles have corresponding authors based in Thailand, Indonesia, and Oman, including a scoping review from Thailand. Across Volume 32, 10 of 42 articles (24%) involved authors from outside Korea, and we estimate that at least 1 in 6 authors were affiliated with institutions abroad.

The research we publish is also better supported and more clearly focused. In 2025, 42.8% of articles were externally funded, up 9.5 percentage points from the year before [1]. Our articles cluster around 5 themes: child and adolescent mental health, family-centered care for chronic and complex conditions, neonatal and neonatal intensive care unit nursing, nursing education, and digital health technologies [1].

We have also strengthened research transparency. Since 2025, CHNR has required data sharing statements and dis-

closure of the use of artificial intelligence (AI) tools, in line with the latest recommendations of the International Committee of Medical Journal Editors (ICMJE) [4].

4. Our Vision: An International Hub for Child Health Nursing in the Asia-Pacific Region

Our vision is for CHNR to become the leading international venue for child health nursing research from the Asia-Pacific region, read and cited around the world. Inclusion in the Web of Science Core Collection is a key step toward that vision. Clarivate evaluates journals against 24 quality criteria and 4 impact criteria [5]. CHNR already meets the formal requirements, such as English-language full text, ISSN and DOI registration, and clear ethics policies. The remaining criteria concern the international reach of the journal and its influence in the field. We will focus on 4 strategies.

1) Broaden the diversity of our authors

We will invite submissions and review articles from researchers outside Korea, especially from North America, Europe, and the rest of Asia. Our goal is for at least 15% of authors to be affiliated with institutions outside Korea each year. We will also build on the partnerships begun this year with colleagues in Indonesia, Vietnam, Thailand, Oman, and the United States.

2) Strengthen an active international editorial board

Our board already includes members from the United Kingdom, the United States, and Japan. We will invite more active researchers, including several of this year's international authors and experts in statistics and research methods. Each member will take part in reviewing, soliciting, and writing for the journal, not in name only.

3) Publish work that is read and cited

We will commission more review articles and give priority to topics of global interest, such as digital health and AI in pediatric care, patient safety, and child maltreatment. We will also promote published articles more actively so that they reach the readers who need them.

4) Uphold publication ethics and timeliness

We will continue to publish every issue on schedule. We will follow the ICMJE recommendations and the Code of Conduct of the Committee on Publication Ethics (COPE), and we will keep our peer review rigorous and fair [4,6].

These strategies build directly on the roadmap my predecessor set out in January, which named MEDLINE and ESCI as the journal's next milestones [1]. With Volume 32 complete, the editorial board plans to submit CHNR for evaluation by Clarivate. ESCI is our immediate goal; our long-term aim is inclusion in MEDLINE.

5. Shared Roles: Editors, Reviewers, and Authors

Indexing evaluators judge a journal by what it publishes and by how it handles every manuscript. That record is written jointly by editors, reviewers, and authors, so each has a part in CHNR's next step.

1) Editors

The editorial board must make sure that our published policies match our daily practice, because evaluators check both. We will screen every submission for research ethics, plagiarism, and adherence to reporting guidelines. We will aim for prompt first decisions and clear reasons for every decision. International board members will review, solicit manuscripts, and write for the journal. Editors will never ask authors to cite CHNR as a condition of acceptance; citation practices that inflate a journal's metrics can lead to its suppression from indexes.

In 2026, we have already begun this work by reorganizing the editorial system. We appointed additional international editorial board members and reviewers, and we reappointed current board members in Korea and added new ones. We also introduced 2 Associate Editors. The Editor-in-Chief now assigns each manuscript to herself or to one of the Associate Editors as handling editor. Handling editors have strengthened the initial screening of their manuscripts, checking and supplementing the items reviewed by the editorial office at check-in. Board members follow an editorial review manual at both the check-in and the initial review stages. During peer review, handling editors actively provide their own editorial comments alongside those of the reviewers. In addition, the journal now provides English editing of abstracts and has revised its Instructions for Authors in line with current guidelines.

2) Reviewers

Peer review is the core of a journal's credibility. We ask reviewers to return reports on time and to make them specific,

constructive, and grounded in evidence. We ask them to assess methods and reporting against the relevant guidelines, such as CONSORT (Consolidated Standards of Reporting Trials), Strengthening the Reporting of Observational Studies in Epidemiology (STROBE), Consolidated Criteria for Reporting Qualitative Research (COREQ), and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), and to declare any conflict of interest. We especially welcome reviewers from outside Korea, whose perspectives help our articles speak to an international readership. We will acknowledge our reviewers each year and encourage them to record their review activity in Open Researcher and Contributor ID (ORCID).

3) Authors

Authors shape the journal most directly. We ask them to follow reporting guidelines, to document ethical approval, and to comply with our data sharing and AI disclosure policies. We encourage them to write for an international audience, placing Korean findings in a global context and stating their relevance beyond Korea. We also welcome review articles and multinational collaborations, and we encourage authors to cite earlier CHNR studies where they are genuinely relevant and to share their published work widely.

4) The 2026 Instructions for Authors

In May 2026, CHNR revised its Instructions for Authors to reflect what international indexing databases expect of a journal; the revision applies from Volume 32, Issue 3 (July 2026). It now requires ORCID for all authors and a full description of any use of generative AI, which cannot be listed as an author. For secondary data analyses, authors must report the Institutional Review Board (IRB) approval of the original data collection, and we recommend that the new analysis also undergo an IRB exemption review. The revision also adds an image integrity policy, strongly recommends age-appropriate assent from child participants, recommends design-specific reporting checklists such as PRISMA, STROBE, and COREQ, and sets out recusal procedures for editors and reviewers with conflicts of interest.

To put the revision into practice, we revised the author submission forms. We shared the new instructions by email with all editorial board members and reviewers in Korea and abroad, and posted them for all members of the Korean Academy of Child Health Nursing on the Academy's website notice board and on the CHNR online submission system. Editors now check 4 points in every manuscript: the reporting of statistics, the reporting of sex and gender, the disclosure of AI use, and IRB approval or exemption review. We ask reviewers to check the same 4 points. These rules are not formalities; they are the evidence evaluators look for when they assess a journal's quality and integrity. I therefore ask every author, reviewer, and editor to read the revised instructions, available at https://www.e-chnr.org/authors/authors.php, and to apply them to every manuscript.

6. Conclusion: An Invitation

International indexing is not an end in itself. It is a way to make sure that what nurses learn about caring for children and families reaches the people who can use it, wherever they are. Over 31 years, CHNR has grown from a national journal into a regional one. We now have the evidence and the plan to take the next step.

No editorial board can do this alone. I invite researchers in every country to send us their best work on child, adolescent, and family health, and to join us as reviewers. With your help, I am confident that CHNR will become a true international home for child health nursing research.

ARTICLE INFORMATION

Authors' contribution

All the work (Conceptualization; Writing–original draft; Writing–review & editing) was done by YeoJin Im.

Conflict of interest

YeoJin Im has been the Editor-in-Chief of *Child Health Nursing Research* since January 2026. She was not involved in the review process of this editorial. Otherwise, no existing or potential conflict of interest relevant to this article was reported.

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Data availability

All data analyzed in this editorial are included in this article or are publicly available from the cited sources.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author used Claude Opus 5.5 (Anthropic) to draft and edit the English text and to organize the journal's bibliometric data. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

ORCID and ResearcherID

YeoJin Im https://orcid.org/0000-0001-7054-0713
https://researcherid.com/rid/ABF-3113-2020

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Caregiver self-monitoring strategies in early childhood health care interventions: a scoping review

Chakkrich Pidjadee[1], Kim Lam Soh[2], Hasni Idayu Saidi[3], Tassanee Attharos[4], Kim Geok Soh[5], Kanjana Siricharoenwong[4]

[1]Lecturer, College of Nursing and Health, Suan Sunandha Rajabhat University, Bangkok, Thailand
[2]Professor, Department of Nursing, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
[3]Lecturer, Department of Biomedical Sciences, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Malaysia
[4]Assistant Professor, College of Nursing and Health, Suan Sunandha Rajabhat University, Bangkok, Thailand
[5]Professor, Department of Sport Studies, Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Malaysia

Corresponding author
Chakkrich Pidjadee
College of Nursing and Health, Suan Sunandha Rajabhat University, 75000 Samut Songkhram, Thailand
Tel: +66-34-773-907
Fax: +66-2-160-1204
E-mail: chakkrich.pi@ssru.ac.th

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Purpose: This study mapped and described evidence on self-monitoring strategies used by caregivers in early childhood health care interventions, focusing on their characteristics, purposes, supporting materials, implementation approaches, and reported challenges.

Methods: A scoping review was conducted in accordance with the JBI Manual for Evidence Synthesis. Six databases—MEDLINE, CINAHL, PsycINFO, Scopus, the Cochrane Library, and the WHO Global Index Medicus—were searched with no date limits through April 23, 2026. Two reviewers independently screened studies and extracted data. The data were analyzed descriptively and synthesized narratively, distinguishing self-monitoring from proxy monitoring.

Results: Thirty-seven studies met the inclusion criteria. Most used randomized controlled trial designs (62.2%). Target populations included parents, preschool teachers, and childcare workers. Interventions primarily addressed health promotion (75.7%) and chronic disease management (24.3%). Supporting skill practice and reinforcement was the most common purpose of caregiver self-monitoring (29.7%), whereas monitoring symptoms and treatment adherence was the most common purpose of caregiver proxy monitoring (24.3%). Self-monitoring recording tools, such as checklists, diaries, and logbooks, were the most frequently used tools for recording self-monitoring activities. Implementation typically involved caregiver training, application of self-monitoring tools, and review with feedback. Reported challenges included reliance on self-reported data, technical difficulties, and caregiver burden.

Conclusion: Caregiver self-monitoring and proxy monitoring are distinct but complementary strategies in early childhood health care interventions, supporting both health promotion and chronic disease management. Future studies should integrate self-monitoring by developing user-friendly tools, reducing caregiver burden, and testing hybrid parent-teacher or childcare-worker delivery models to improve sustainability and long-term child health outcomes.

Keywords: Caregivers; Child care; Early childhood; Review; Self-monitoring

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INTRODUCTION

Early childhood—commonly defined as birth to 8 years, and especially under 6—is a critical period for health, cognitive, and socio-emotional development. Rapid brain growth during the first 6 years of life establishes the foundation for lifelong learning, behavior, and health, strongly influenced by early experiences [1,2]. The World Health Organization (WHO) and United Nations Children's Fund (UNICEF) emphasize that the early years are a sensitive period during which nurturing care—including health, nutrition, responsive caregiving, and early learning—is essential for optimal child development [3]. Health care interventions at this time are essential for promoting healthy behaviors, preventing injuries, and delivering preventive and treatment services [4].

Because young children under 6 years of age depend on adults in both home and early childhood care settings, such interventions necessarily involve parents, guardians, preschool teachers, and childcare workers, whose knowledge and practices shape child health outcomes [5-7]. Accordingly, the focus on children under 6 years reflects their greater developmental dependency on caregivers for health-related behaviors, decision-making, and daily care, as highlighted in global early childhood development frameworks, and underscores the relevance of caregiver-mediated strategies in this age group [8].

Children in early childhood remain vulnerable to preventable health problems. Infectious diseases such as pneumonia, diarrhea, and malaria continue to cause significant under-5 mortality globally [9]. This developmental stage also establishes patterns that influence future noncommunicable disease risks, including poor diet, physical inactivity, excessive screen time, and inadequate sleep [10]. Without timely action, these factors can undermine physical, cognitive, and psychosocial well-being. Early detection and caregiver-driven responses are therefore essential to intervention effectiveness [10,11].

Self-monitoring (SM)—systematic observation, measurement, and documentation of symptoms, behaviors, or bodily signals—is a key behavioral strategy to enhance self-management [12]. It overlaps with self-management, self-care, and self-regulation [12,13] and is grounded in behavior change theories such as Social cognitive theory [14]. Traditionally using diaries, checklists, and logs, SM increasingly incorporates digital tools such as mobile apps and wearables [15,16].

In early childhood contexts, however, SM requires careful conceptualization. Young children are generally unable to perform SM independently due to their developmental stage. Instead, caregivers often act as proxy agents who observe, record, and evaluate information related to caregiving practices and children's health behaviors or symptoms [17,18]. Within the literature on early childhood health care (ECHC) interventions, SM may therefore be conceptualized as comprising 2 distinct but related forms of monitoring: (1) caregiver SM, which refers to caregivers observing and evaluating their own caregiving behaviors (e.g., parenting practices and implementation of intervention activities) [19,20]; and (2) caregiver proxy monitoring, which refers to caregivers observing and recording children's behaviors, symptoms, or health indicators [21-23]. Both forms of monitoring can function as mechanisms to reinforce behavior change, support intervention implementation, and improve child health outcomes [17]. As a result, caregivers, who play a pivotal role in shaping and sustaining children's health behaviors [24,25], utilize SM in various situations, including supporting adherence to health recommendations [21,26], fostering healthy habits in children [27], improving communication with health professionals, and enabling timely care-plan adjustments [20,28]. Examples include checklists to track parenting practices, daily physical activity (PA) logs in preschools, and progress reports used to reinforce healthy eating behaviors [29,30].

Despite its potential, no comprehensive synthesis exists on how SM strategies are used and adapted in ECHC interventions targeting caregivers of young children. A preliminary search conducted in July 2025 across MEDLINE, CINAHL, Joanna Briggs Institute (JBI) Evidence Synthesis, and the Cochrane Database of Systematic Reviews found no scoping or systematic reviews specifically addressing this topic. Most existing literature focuses on adult or general populations [15,31-33], leaving a clear gap for early childhood contexts. To address this gap, we aimed to map and describe the evidence on SM strategies used by caregivers—including parents, guardians, preschool teachers, and childcare workers—within ECHC interventions, focusing on their characteristics, purposes, supporting materials, implementation approaches, and reported challenges. This review seeks to inform intervention design, guide policy development, and identify research priorities for integrating SM into ECHC practices.

METHODS

Ethical statements: This study is a literature review of previously published studies and was therefore exempt from Institutional Review Board (IRB) approval (IRB exemption number: COE. 2-061/2026).

1. Study Design

This scoping review was conducted in accordance with the JBI Manual for Evidence Synthesis [34] and utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram during the study selection process [35]. The review is reported following the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist [36]. In line with the research objective, the Population–Concept–Context (PCC) framework was applied: (1) Population—caregivers of children aged below 6 years; (2) Concept—SM strategies; and (3) Context—interventions for ECHC. Additionally, the protocol was registered in the Open Science Framework (OSF) registry on August 14, 2025 (https://osf.io/wvsa3). A Transparent Changes Statement documenting post-protocol analytical refinements is available on the OSF project page (https://osf.io/p7zjs/files/78u3k).

2. Study Process

The study process included the following steps [34]: (1) defining the research questions, (2) developing the inclusion criteria, (3) searching for relevant studies, (4) selecting eligible studies, (5) extracting the data, (6) analyzing the data, (7) presenting the results, and (8) summarizing the findings, drawing conclusions, and noting any implications.

3. Research Question

The research question was "What SM strategies are used by caregivers in ECHC interventions?" Sub-questions include: (1) What are the key characteristics of the interventions incorporating SM strategies? (2) For what purposes are SM strategies used within these interventions? (3) What materials, tools, or resources support SM? (4) How are SM strategies operationalized and delivered in the interventions? and (5) What challenges, barriers, or limitations were reported regarding the use of SM?

4. Inclusion and Exclusion Criteria

Primary studies were included if the intervention (1) involved caregivers—such as parents, guardians, preschool teachers, or childcare workers—directly engaged in delivering or supporting ECHC for children under 6 years; (2) incorporated caregiver-mediated monitoring strategies, defined as structured approaches enabling caregivers to observe, record, or evaluate their own caregiving behaviors or children's health-related behaviors or symptoms; (3) was delivered in any setting, including homes, childcare centers, preschools, health clinics, community centers, or hospitals; (4) used an experimental design (e.g., randomized controlled trials [RCTs], quasi-experiments, or pretest–posttest studies with or without control groups) or was a study protocol or conference paper reporting sufficient methodological and outcome details; (5) included study protocols for the extraction of planned intervention characteristics (e.g., design, materials, and intended implementation) and any anticipated or planned challenges described in the protocols. However, protocols were excluded from the analysis of actual reported challenges, barriers, and outcomes, as these data were not available from protocol publications and (6) was published in English (all publication years were eligible).

Exclusion criteria comprised (1) studies involving caregivers of children over 6 years; (2) interventions focused exclusively on health professionals; (3) interventions unrelated to ECHC; (4) interventions without an SM component; and (5) studies that were purely descriptive, observational, or qualitative, as well as reports, commentaries, reviews, or conference abstracts lacking sufficient methodological detail for data extraction.

Although scoping reviews often include a broad range of study designs, this review focused on intervention-based evidence to map how SM strategies were implemented within ECHC interventions. Experimental studies and study protocols were therefore included because they provide detailed information on intervention components, delivery, and implementation. As a result, the findings represent a mapping of intervention-related evidence rather than all perspectives on caregiver monitoring practices.

5. Search Strategy

The search strategy followed the 3-step approach recommended by JBI [34]. First, an initial search of MEDLINE and

CINAHL using the PCC framework helped identify relevant keywords and index terms by reviewing titles, abstracts, and subject headings. Key terms included "caregiver," "parent," "educator," "teacher," "self-monitoring," "self-assessment," "self-observation," "child care," "day care," "parenting," "health education," and "health promotion." Second, a comprehensive search of primary studies was conducted across 6 databases with no date limits up to August 18, 2025 in MEDLINE (via PubMed), CINAHL (EBSCOhost), PsycINFO, Scopus, the Cochrane Library (CENTRAL), and WHO Global Index Medicus. Search strategies were tailored to each database, using MeSH terms, subject headings, and free-text keywords. Boolean operators ('OR' within concepts and 'AND' between concepts) and language/source filters were applied.

To ensure currency, an updated search was conducted on April 23, 2026, across the same databases using identical search strategies. In addition, citation searching of the reference lists of included studies and relevant grey literature sources were conducted during both the primary and updated searches. Grey literature sources included Google Scholar (first 200 results screened) and organizational websites such as WHO, UNICEF, and national public health agencies. Eligible articles were retrieved in full for review. Full search strategies and results are presented in Supplement 1.

6. Study Selection

All search results from the primary and updated searches were exported, managed, and de-duplicated using Rayyan Systematic Review Software (Rayyan) by 1 reviewer (C.P.). Duplicates between the primary and updated searches were removed prior to screening. The selection process involved 2 phases: title and abstract screening, followed by full-text screening. Two reviewers (C.P. and K.L.S.) independently screened titles and abstracts to assess eligibility, then independently reviewed the full texts of potentially relevant articles against the pre-established inclusion criteria. Lists of included and excluded studies, along with reasons for exclusion, were documented. Any discrepancies between reviewers were resolved through discussion, and if agreement could not be reached, a third reviewer (H.I.S.) made the final judgment.

7. Data Extraction and Analysis

Data extraction and synthesis distinguished between caregiver SM and caregiver proxy monitoring. These forms were analyzed separately to maintain conceptual clarity, given their different underlying mechanisms. Additionally, intervention types were further categorized and analyzed separately in the synthesis due to differences in monitoring targets and purposes.

A standardized data extraction form was developed and piloted on at least 2 studies by 2 members of the review team during the protocol stage to ensure clarity, comprehensiveness, and consistency. Extracted data included source details, population and setting, intervention characteristics, purpose of SM, materials used, implementation procedures, and reported challenges, barriers, or limitations. Data were analyzed descriptively and presented narratively, supported by tables and figures aligned with the review objectives. Frequency counts were used to summarize intervention characteristics, settings, target populations, and SM strategies. Descriptive content analysis was applied to categorize the purposes, supporting materials, implementation procedures, and reported challenges related to SM.

The distinction between caregiver SM and caregiver proxy monitoring was not explicitly prespecified in the registered protocol and was introduced as a post-hoc analytical refinement during data synthesis. This refinement did not affect the review objectives, eligibility criteria, search strategy, study selection process, or extracted data. Further details are provided in the Transparent Changes Statement available on the OSF project page (https://osf.io/p7zjs/files/78u3k).

RESULTS

1. Search Results

Figure 1 shows the PRISMA flow diagram of the study selection process. Across the primary and updated searches, a total of 16,013 records were identified from 6 databases. After duplicate removal, 12,165 records remained. Title and abstract screening excluded 12,029 records, leaving 136 records for full-text review. Of these, 109 records were excluded for not meeting the eligibility criteria, resulting in 27 included studies. In the primary search, 12 records were identified through Google Scholar screening (Google LLC) and 35 through citation searching. In the updated search, 5 records were identified through Google Scholar screening and 3 through citation searching. Across both searches, supplementary searching yielded 55 records (17 from Google Scholar

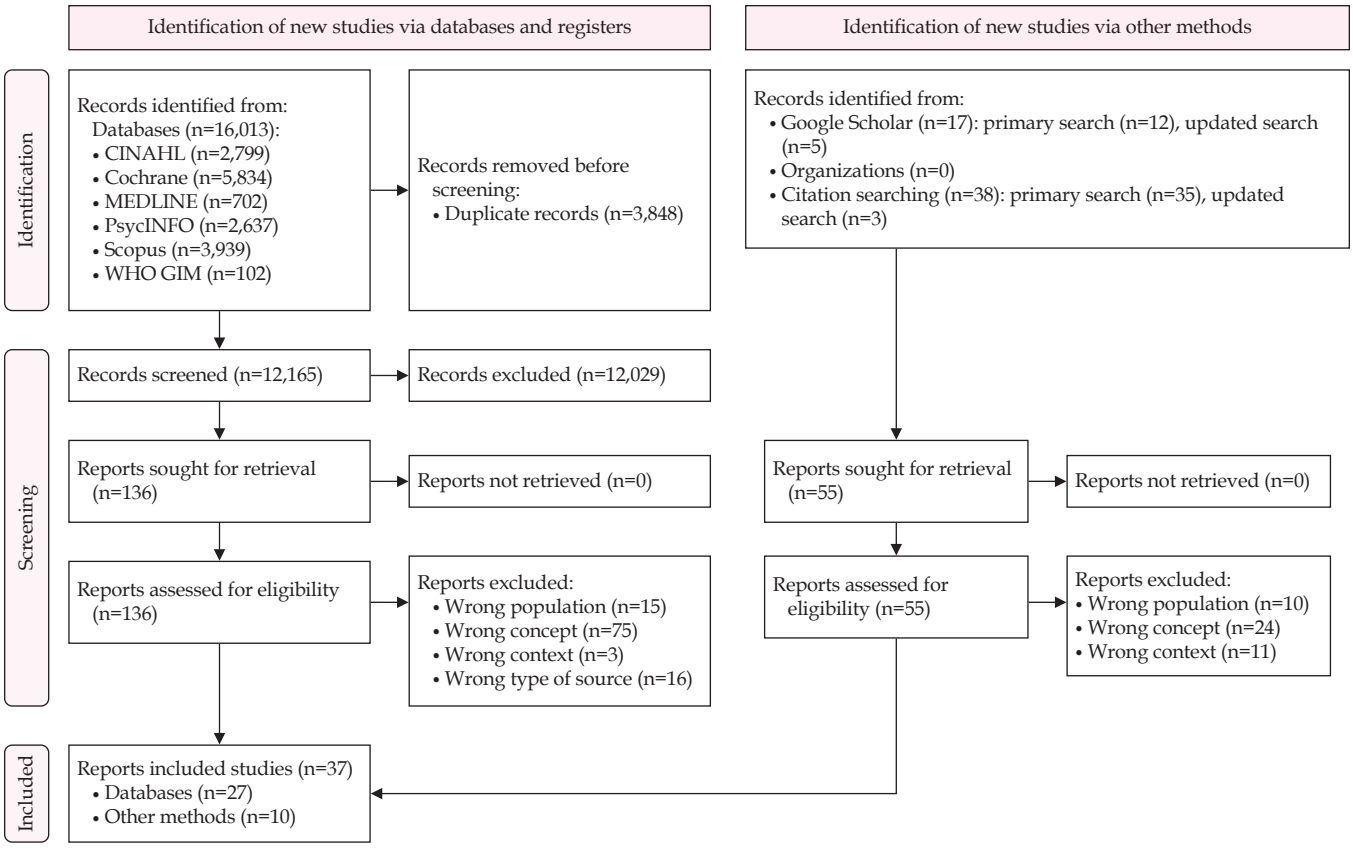

Figure 1. The study selection process: PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

and 38 from citation searching). After eligibility assessment, 10 studies met the inclusion criteria and were added to the final synthesis. In total, 37 studies were included [19-23,26,28-30,37-64]. Exclusion reasons included wrong population (no caregivers, n=6; caregivers of children aged over 6 years, n=19), wrong concept (no SM component) (n=99), wrong context (not an ECHC intervention) (n=14), and wrong type of source (non-experimental study, n=1; protocol registration with abstract only, n=11; study protocol of an included study, n=2; and non-English publications [Arabic and Korean], n=2).

2. Study Characteristics

Table 1 presents the intervention characteristics in ECHC, whereas Table 2 summarizes the key characteristics of the 37 included studies published between 1993 and 2026 and conducted across 19 countries. Most were from the UK and European countries (n=14; 37.8%), the United States (n=10; 27.0%), and Australia (n=7; 18.9%). Most used RCT designs (n=23; 62.2%), including cluster and pilot trials, 9 were RCT protocols (24.3%), 2 were quasi-experimental (5.4%), and 3 employed one-group pretest–posttest designs (8.1%). Target populations included parents (n=23; 62.2%), preschool teachers or childcare workers (n=10; 27.0%), and mixed caregiver groups (n=4; 10.8%), caring for children aged birth to 6 years in home, primary care, or childcare settings. Interventions were mainly health promotion (n=28; 75.7%)—notably obesity prevention (n=17), infant care (n=5), parenting support (n=4), oral health (n=1), and bullying/negative behavior prevention (n=1)—or chronic disease management (n=9; 24.3%), including asthma (n=4), eczema (n=3), type 1 diabetes (n=1), and hydrocephalus (n=1). Duration ranged from a single 45-minute session to 2-year programs. Among the included studies, 9 (24.3%) explicitly reported a theoretical or conceptual basis. Social cognitive theory was most common (n=6), followed by the socio-ecological framework (n=2). Other frameworks were each reported once, including self-efficacy theory, self-regulation theory, operant conditioning, and the PRECEDE-PROCEED model.

Table 1. Intervention characteristics in early childhood health care

No.	Author (year)	Country	Study design	Population & setting	Intervention type	Intervention details
1.	Annesi et al. [29] (2013)	USA	RCT	98 preschool teachers of children aged 5 years	Health promotion: obesity prevention	Start For Life: a preschool-based, teacher-delivered program with 30-minute structured PA sessions daily, based on SCT and Self-Efficacy Theory, to increase PA and reduce BMI.
2.	Bergmo et al. [37] (2009)	Norway	RCT	98 parents of children <6 years with eczema in hospitals	Chronic disease management: eczema	One-year remote dermatology consultations via secure web-based communication to improve parents' management skills, child health outcomes, and cost-effectiveness.
3.	Breitenstein et al. [26] (2020)	USA	RCT	287 parents of children aged 2–5 years in primary care	Health promotion: parenting	ezParent Program: a digital adaptation of the Chicago Parent Program; 6 self-paced modules over 12 weeks to teach behavioral parenting skills.
4.	Butz et al. [38] (2005)	USA	RCT	210 parents of children aged 2–8 years with asthma at home	Chronic disease management: asthma	Symptom and Nebulizer Education Intervention: 6 home visits over 6 months to teach symptom recognition and proper nebulizer use.
5.	Cheng et al. [19] (2018)	Taiwan	Quasi-experimental	52 mothers of preterm infants in neonatal intermediate unit	Health promotion: infant care	Preterm Infant Care Learning Portfolio: a semi-structured learning portfolio provided by nurses to improve infant care knowledge, skills, and maternal confidence.
6.	Day & Sanders [39] (2018)	Australia	RCT	Parents of children aged 2–8 years in primary care	Health promotion: parenting	Triple P Online: 8 self-paced online modules over 4 months, based on SCT and Behavioral Principles, to enhance parenting skills and confidence.
7.	De Craemer et al. [40] (2017)	Six European countries	Cluster RCT	Preschool teachers and parents of 2,438 children aged 4–6 years in preschools	Health promotion: obesity prevention	ToyBox Intervention: an evidence-based kindergarten program implemented over 6 weeks to promote healthy energy balance behaviors.
8.	Dimeglio et al. [22] (2021)	USA	RCT	143 parents of young children with type 1 diabetes at home	Chronic disease management: type 1 diabetes	Compared CGM+Family Behavioral Intervention, CGM alone, and BGM over 6 months to improve glycemic control and parental quality of life.
9.	Do et al. [21] (2024)	Germany, UK, Turkey	RCT	167 parents of children aged 4–84 months with asthma at home	Chronic disease management: asthma	Digital Wheeze Detector (WheezeScan): used over 120 days to monitor respiratory symptoms and support asthma management.
10.	Downing et al. [41] (2017)	Australia	RCT (protocol)	100 parents and children aged 2–4 years at home	Health promotion: sedentary behavior reduction	Mini Movers: 6-week mobile-based program using SCT and CALO-RE taxonomy to reduce screen time and sitting duration.
11.	Dramburg et al. [23] (2021)	Germany	One-group pretest–posttest	20 parents of children aged 9–72 months with asthma, home care	Chronic disease management: asthma	A digital wheeze detector (WheezeScan, Omron) integrated with an electronic diary (eDiary) app to record respiratory symptoms, wheeze detection, and medication use twice daily for 30 days.

(Continued on the next page)

Table 1. Continued

No.	Author (year)	Country	Study design	Population & setting	Intervention type	Intervention details
12.	Gomes et al. [20] (2021)	Portugal	RCT (protocol)	Parents of children aged 2–6 years, home care	Health promotion: obesity prevention	SmartFeeding4Kids: a web-based, self-guided parenting program promoting positive feeding practices and healthy eating. Parents completed 7 online sessions over 6 months.
13.	Hammersley et al. [42] (2017)	Australia	RCT (protocol)	160 parents of children aged 2–5 years in childcare settings	Health promotion: obesity prevention	Time2bHealthy: an online healthy lifestyle program for parents to prevent and manage childhood obesity. The program comprised 6 modules over 11 weeks.
14.	Hauck et al. [43] (2012)	Australia	Quasi-experimental	178 mothers of infants aged 4–6 months in early parenting centers	Health promotion: infant care	A 6-hour center-based visit designed to enhance parental confidence and competence by providing guidance on infant sleep behaviors.
15.	Henriksson et al. [28] (2020)	Sweden	RCT (protocol)	500 parents of children aged 2.5–3 years attending 20 primary child health care centers	Health promotion: obesity prevention	MINISTOP 2.0: a 6-month smartphone-based intervention supporting parents in promoting healthy diet and PA behaviors in young children.
16.	Hoffman et al. [44] (2020)	USA	Cluster RCT (pilot)	Preschool teachers in 6 childcare centers	Health promotion: obesity prevention	WE PLAY: a 4-week online training program for preschool teachers to increase children's moderate-to-vigorous PA.
17.	Hollar et al. [45] (2017)	USA	One-group pretest–posttest	Directors and staff in childcare centers	Health promotion: obesity prevention	A 12-month training and technical assistance program for childcare directors and staff to implement evidence-based nutrition strategies and improve policies for centers serving low-income, ethnically diverse children.
18.	Jones et al. [30] (2015)	Australia	RCT	Staff in 128 childcare services	Health promotion: obesity prevention	A 12-month intervention to increase implementation of healthy eating and PA policies and practices in center-based childcare services.
19.	Kipping et al. [46] (2023)	UK (England & Scotland)	Cluster RCT (protocol)	Nursery managers, staff, parents, and children aged 2–5 years in 56 early years settings	Health promotion: obesity prevention	NAP SACC UK: a 12-month intervention with workshops and ongoing support based on SCT and socio-ecological frameworks to improve nutrition and PA environments.
20.	Kvestad et al. [47] (2024)	Norway	Cluster RCT (protocol)	Preschool teachers in 52 childcare centers	Health promotion: bullying prevention	Be-Prox: a 9-month program delivered through 6 modules to systematically prevent and address bullying among children in Norwegian childcare centers.
21.	McGowan et al. [48] (2013)	UK	Cluster RCT	126 parents of children aged 2–6 years in childcare centers	Health promotion: obesity prevention	Four home visits over 8 weeks promoting habit formation for 3 feeding behaviors: serving fruits/vegetables, healthy snacks, and unsweetened drinks.

(Continued on the next page)

Table 1. Continued

No.	Author (year)	Country	Study design	Population & setting	Intervention type	Intervention details
22.	McSweeney et al. [49] (2017)	UK (England)	Cluster RCT	121 parents of children aged 3–5 years in home settings	Health promotion: obesity prevention	A preschool practitioner-led program comprising 5 monthly modules based on SCT and Operant Conditioning. Included family-based tasks and preschool activities to prevent obesity.
23.	Mesters et al. [50] (1993)	Netherlands	RCT (pilot)	50 parents of children aged 0–4 years with asthma in home settings	Chronic disease management: asthma	Five sessions over 3 weeks of a structured self-management education program to improve parents' knowledge, attitudes, and self-efficacy in managing asthma, including symptom prevention and response.
24.	Nezami et al. [51] (2018)	USA	RCT	51 mother–child dyads (children aged 3–5 years) in home settings	Health promotion: obesity prevention	Smart Moms: a 6-month smartphone-delivered program based on SCT to reduce children's intake of sugar-sweetened beverages and juices through parental behavior change.
25.	Pakarinen et al. [52] (2018)	Finland	Cluster RCT (protocol)	200 parents of children aged 1–4 years in 15 child health clinics	Health promotion: healthy behavior promotion	WellWe: a smartphone-based intervention supporting families in promoting healthy behaviors and psychosocial development in young children.
26.	Santer et al. [53] (2014)	UK (England)	RCT	148 parents of children aged ≤5 years with eczema in home settings	Chronic disease management: eczema	SpaCE: a 14-module web-based program over 12 weeks, developed using the PRECEDE-PROCEED model to improve quality of life through better eczema control and parental self-management.
27.	Santos et al. [54] (2019)	Brazil	RCT	586 mothers of infants aged 3 months in home settings	Health promotion: infant care	Home-based counseling sessions to improve infants' sleep quality and duration through parental behavior change strategies.
28.	Salvy et al. [55] (2018)	USA	RCT (protocol)	30 mother–child dyads (children aged 3–5 years) in home settings	Health promotion: obesity prevention	HABITS curriculum: a 12-month home-visitation program based on self-regulation theory, aiming to promote healthy behaviors and prevent obesity in early childhood.
29.	Singla et al. [56] (2015)	Uganda	Cluster RCT	291 mother–child dyads (children aged 12–36 months) in community settings	Health promotion: parenting	Twelve biweekly sessions of an integrated, community-based parenting intervention targeting child development and maternal well-being.
30.	Slining et al. [57] (2021)	USA	One-group pretest–posttest	Childcare workers in 10 childcare settings	Health promotion: obesity prevention	LiveWell Greenville ECE intervention: 8 sessions over 2 years based on a socio-ecological framework, supporting directors and caregivers in implementing healthy eating and PA practices.
31.	Stremler et al. [58] (2013)	Canada	RCT	246 primiparous women and their infants in hospital settings	Health promotion: infant care	A behavioral-educational sleep intervention delivered in a 1-hour session during early postpartum to improve maternal and infant sleep.

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Table 1. Continued

No.	Author (year)	Country	Study design	Population & setting	Intervention type	Intervention details
32.	Symon et al. [59] (2005)	Australia	RCT	268 parents of infants in community settings	Health promotion: infant care	A single 45-minute session of a behavior modification program for parents to enhance newborn sleep performance.
33.	Tran et al. [60] (2025)	Australia	RCT	22 childcare workers in 12 family day care centers	Health promotion: obesity prevention	Family Day Care Quality Improvement Toolkit: a 6-month web-based tool designed to support service providers in reviewing QIPs and integrating nutrition and PA practices.
34.	Yusof et al. [61] (2021)	Malaysia	Cluster RCT	Preschool teachers in 53 preschools and parents of children aged 5–6 years	Health promotion: oral health care	Beautiful Smile for All Program: a 6-month social media–based oral health education initiative delivered by dentists, involving teachers' and parents' active participation.
35.	Düzgün et al. [62] (2025)	Turkey	RCT	Parents of children with hydrocephalus; hospital setting	Chronic disease management	Avatar-based education program to improve parental knowledge and care skills; includes follow-up of shunt complications and self-assessment.
36.	Yang et al. [63] (2026)	China	RCT	Children (0–6 years) with atopic dermatitis and caregivers; hospital/outpatient	Chronic disease management	Smartphone-based digital eczema education via WeChat platform with structured modules, interactive materials, and dynamic action plan
37.	Hales et al. [64] (2026)	USA	Cluster RCT (protocol)	ECE staff in childcare centers; workplace setting	Health promotion: mental health/resilience	OnWARD: remote workplace resilience intervention delivered via webinars, digital lessons, text/email prompts, coaching calls, and resource library; includes goal setting, self-regulation strategies, and behavior change techniques such as SM and daily practice.

Study no. 1–34 from primary search and no. 35-37 from updated search.
BGM, blood glucose monitoring; BMI, body mass index; CALO-RE, Coventry, Aberdeen, and London–Refined; CGM, continuous glucose monitoring; ECE, early childhood education; PA, physical activity; QIPs, quality improvement plans; RCT, randomized controlled trial; SCT, social cognitive theory; SM, self-monitoring.

3. Purpose of Self-Monitoring

Six main purposes were identified and analyzed separately across 2 conceptually distinct forms: caregiver SM (n=25; 67.6%) and caregiver proxy monitoring (n=12; 32.4%) (Table 3).

For caregiver SM, the most common purpose was (1) supporting skill practice and reinforcement (n=11; 29.7%), strengthening parenting, feeding, and caregiving competencies in areas such as infant care, nutrition, sleep, and behavior management. This was followed by (2) monitoring implementation progress (n=7; 18.9%), primarily among preschool teachers and childcare workers delivering PA or healthy eating programs, as well as parents managing conditions such as eczema. Four studies (10.8%) addressed (3) behavior change and habit formation, supporting the establishment of consistent health-promoting routines. Three interventions (8.1%) used SM to (4) ensure fidelity and support quality improvement, with childcare workers completing structured self-assessments and action plans for nutrition and PA environments.

For caregiver proxy monitoring, 2 purposes were identified: (5) tracking child health behaviors (n=3; 8.1%) and (6) monitoring symptoms and treatment adherence (n=9, 24.3%). These included dietary intake, PA, screen time, oral health, sleep, body weight, and chronic conditions (e.g., asthma, eczema, diabetes, and hydrocephalus).

Table 2. Summary characteristics of the included studies (N=37)

Characteristic	Category	No. (%)
Country/region	United Kingdom and European countries[a]	14 (37.8)
	United States	10 (27.0)
	Australia	7 (18.9)
	Taiwan	1 (2.7)
	Brazil	1 (2.7)
	Uganda	1 (2.7)
	Canada	1 (2.7)
	Malaysia	1 (2.7)
	China	1 (2.7)
Study design	RCT[b]	23 (62.2)
	RCT protocol	9 (24.3)
	Quasi-experimental	2 (5.4)
	One-group pretest–posttest	3 (8.1)
Target population	Parents	23 (62.2)
	Preschool teachers/childcare workers	10 (27.0)
	Mixed caregiver groups	4 (10.8)
Intervention category	Health promotion	28 (75.7)
	• Obesity prevention	17
	• Infant care	5
	• Parenting support	4
	• Oral health	1
	• Bullying/negative behavior prevention	1
	Chronic disease management	9 (24.3)
	• Asthma	4
	• Eczema	3
	• Type 1 diabetes	1
	• Hydrocephalus	1
Theoretical/conceptual framework	Reported[c]	9 (24.3)
	Social cognitive theory	6
	Socio-ecological framework	2
	Self-efficacy theory	1
	Self-regulation theory	1
	Operant conditioning	1
	PRECEDE–PROCEED model	1

RCT, randomized controlled trial.
[a]European countries include Finland, Germany, Netherlands, Norway, Portugal, Scotland, Sweden, Turkey, and multinational European studies. [b]Includes cluster RCTs and pilot RCTs. [c]Some studies incorporated 2 theoretical frameworks.

4. Supporting Materials and Resources

To categorize supporting materials and resources, multiple coding was permitted because individual interventions frequently incorporated more than 1 type of SM support. Categories were not intended to be mutually exclusive and were developed descriptively based on the primary function of each resource. Materials were grouped into 4 categories, including paper-based and digital: (1) SM recording tools; (2) self-assessment and action-oriented tools; (3) digital monitoring technologies; and (4) supplementary implementation supports (Table 3). Consequently, a single study could contribute to more than 1 category.

1) Self-monitoring recording tools

The most frequently reported resources were SM recording tools, including checklists (n=10), diaries (n=5), and logbooks (n=5). These tools were primarily used to document health status and behaviors, symptoms, caregiving practices, and intervention implementation over time. For example, parents logged their child's diet, PA, and screen time using a smartphone-based checklist [28], identified asthma symptoms using a paper-based checklist [38], and recorded infant care activities using structured learning portfolios [19]. Teachers also used checklists to monitor and guide the delivery of PA sessions [40]. Diaries and logbooks were commonly used to record infant sleep–wake cycles and crying patterns [59], wheezing episodes

Table 3. Self-monitoring strategies in early childhood health care interventions

No.	Author (year)	Monitoring type and purpose	Supporting materials and resources	Implementation procedure	Challenges
1	Annesi et al. [29] (2013)	CSM: Support teachers in tracking the delivery and progression of daily PA sessions.	• Supplementary implementation supports: achievement chart, certificate, lesson plans • SM recording tools: daily log (paper-based)	Teachers led 30-minute daily PA sessions; session delivery and progress were monitored using achievement charts and daily logs.	No issues reported related to the SM strategies used.
2	Bergmo et al. [37] (2009)	CPM: Enable parents to self-monitor and communicate their child's eczema symptoms.	• Digital monitoring technologies: secure web-based messaging system, digital camera • SM recording tools: symptom checklist (severity rating form) (digital-based) • Supplementary implementation supports: educational session	Parents photographed eczema areas, completed the checklist, and sent via secure system; specialists responded within 24 hours. Parents also received a 30-minute educational session with a specialist nurse.	Low adherence; technical difficulties with login and system use.
3	Breitenstein et al. [26] (2020)	CSM: Strengthen parenting skills, promote behavior management, and support SM of parenting practices.	• Digital monitoring technologies: 6-module mobile program, automated text reminders • Self-assessment and action-oriented tools: practice assignment checklists (digital-based)	Parents completed modules sequentially; each ended with a practice assignment, unlocking the next module upon checklist completion.	Reliance on self-reported outcomes (potential bias).
4	Butz et al. [38] (2005)	CPM: Improve parents' ability to identify asthma symptoms and manage care at home, including nebulizer use.	• Self-assessment and action-oriented tools: asthma action plan (paper-based) • SM recording tools: SM checklists (paper-based) • Supplementary implementation supports: nebulizer kit	Six nurse-led home visits provided education; parents practiced symptom recognition and nebulizer use with checklists; action plans verified with primary care providers when possible.	Reliance on parent self-report (potential bias, possible underestimation of symptoms and care utilization).
5	Cheng et al. [19] (2018)	CSM: Track and evaluate infant care skills, support reflection, reinforce maternal confidence, and encourage practice.	• SM recording tools: SM checklist (10 infant care tasks), self-recorded test results, baby health documentation (paper-based) • Self-assessment and action-oriented tools: self-assessment forms (paper-based) • Supplementary implementation supports: learning portfolio, brochures, notes, instructional videos	Mothers used the portfolio to self-record scores, assess practice outcomes, and document learning progress; practice frequency adjusted to individual needs.	Reliance on self-reported data (potential bias).
6	Day & Sanders [39] (2018)	CSM: Track parenting skill acquisition, support goal setting and reflection, and encourage application in high-risk situations.	• Digital monitoring technologies: online modules • Supplementary implementation supports: dynamically generated workbook, weekly text/email reminders	Parents completed 8 modules, set goals, tracked progress, and practiced tasks weekly.	Reliance on self-reported data (potential bias).
7	De Craemer et al. [40] (2017)	CSM: Support teachers in tracking daily PA implementation for preschoolers.	• SM recording tools: ToyBox with SM checklists (paper-based) • Supplementary implementation supports: classroom guides, hand puppet, newsletters, tip cards, posters, active play equipment	Teachers trained, implemented activities with guides and checklists; parents engaged through take-home materials.	No issues reported related to the SM strategies used.
8	Dimeglio et al. [22] (2021)	CPM: Support parents in monitoring child's glucose control and addressing behavioral barriers to CGM use.	• Digital monitoring technologies: Dexcom G5 CGM system • Supplementary implementation supports: training curriculum, educational/safety materials	Parents received interactive training and used CGM data for daily monitoring and insulin dosing.	No issues reported related to the SM strategies used.

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Table 3. Continued

No.	Author (year)	Monitoring type and purpose	Supporting materials and resources	Implementation procedure	Challenges
9	Do et al. [21] (2024)	CPM: Support parents in early detection/monitoring of wheezing, enhance self-efficacy, and guide treatment adaptations.	• Digital monitoring technologies: WheezeScan device, WheezeMonitor mobile application	Parents trained in device use, completed daily app checklists for 120 days, and used device during suspected respiratory distress.	No issues reported related to the SM strategies used.
10	Downing et al. [41] (2017)	CSM: Support parents in tracking activities to reduce sedentary behavior and increase active play.	• SM recording tools: goal-checking log (paper-based) • Supplementary implementation supports: booklet, brochure, interactive text messages	Parents set 2 SMART goals during a discussion, received materials, and tracked progress using the log/magnet.	No issues reported related to the SM strategies used.
11	Dramburg et al. [23] (2021)	CPM: Support parents in detecting and monitoring wheezing episodes, improve accuracy of symptom tracking, and enhance self-efficacy in home management.	• Digital monitoring technologies: WheezeScan device, WheezeMonitor mobile application, automated reminders	Parents used the detector twice daily and during suspected exacerbations for 30 days; results auto-synced to the app with parent-reported data; reminders sent to prompt entries.	Low adherence to twice-daily use (45.8%); some difficulty keeping children calm during measurement (approximately 37%); delayed data entries (recall bias).
12	Gomes et al. [20] (2021)	CSM: Track progress in promoting healthy eating habits, improve parental feeding practices, and support self-regulation.	• Digital monitoring technologies: SmartFeeding4Kids web/application platform, email notifications • SM recording tools: 24-hour food recall log (digital-based) • Supplementary implementation supports: personalized feedback reports, progress monitoring charts	Parents completed sessions sequentially, logged child's food intake and feeding practices, received feedback via reports, automated messages, and avatar interaction, and monitored progress through charts.	High parental burden from frequent recalls and monitoring tasks.
13	Hammersley et al. [42] (2017)	CSM: Support parents in tracking activities to promote healthy eating, PA, sleep, and reduce screen time.	• Digital monitoring technologies: interactive website, email reminders • Self-assessment and action-oriented tools: goal-setting forms, action plans (digital-based) • Supplementary implementation supports: online modules, progress monitoring charts	Parents completed modules biweekly, set/revised SMART goals, and tracked progress using charts and activities.	Engagement risk due to reliance on digital delivery and online community.
14	Hauck et al. [43] (2012)	CPM: Strengthen maternal competence and confidence in infant sleep management.	• SM recording tools: sleep–feed diary (paper-based) • Supplementary implementation supports: "About Sleep" resource	Mothers attended a 6-hour Day Stay with one-on-one support, recorded infant sleep–feed patterns, set goals, and trialed settling techniques.	Reliance on self-reported data (potential bias).
15	Henriksson et al. [28] (2020)	CPM: Support parents in monitoring their child's diet, PA, and screen time.	• Digital monitoring technologies: MINISTOP 2.0 smartphone application	Parents logged child's diet, activity, and screen time; the app provided weekly traffic-light feedback and daily reminders/tips.	Reliance on self-reported data (potential bias).
16	Hoffman et al. [44] (2020)	CSM: Support teachers in tracking progression of preschoolers' PA.	• SM recording tools: teacher SM checklist (paper-based) • Digital monitoring technologies: online training modules • Supplementary implementation supports: downloadable game	Teachers completed modules, led 1 structured and 1 unstructured play session, and recorded reflections in checklists.	No issues reported related to the SM strategies used.

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Table 3. Continued

No.	Author (year)	Monitoring type and purpose	Supporting materials and resources	Implementation procedure	Challenges
17	Hollar et al. [45] (2017)	CSM: Assess childcare settings alignment with Caring for Our Children standards and promote staff role modeling in nutrition education.	• Self-assessment and action-oriented tools: Health Environment Rating Scale (paper-based) • Supplementary implementation supports: training materials, nutrition handouts, policy/practice manuals, technical assistance resources	Childcare workers completed self-assessment, received tiered training, technical assistance, and follow-up.	No issues reported related to the SM strategies used.
18	Jones et al. [30] (2015)	CSM: Support childcare staff in tracking implementation of healthy eating and PA policies/practices.	• Supplementary implementation supports: guidelines, resource package, training materials, communication resources, written progress reports, follow-up calls/visits • SM recording tools: monitoring instruments (paper-based)	Staff attended training workshops and submitted written progress reports with follow-up monitoring.	Reliance on self-reported data (potential bias).
19	Kipping et al. [46] (2023)	CSM: Strengthen caregivers' skills in improving childcare nutrition and PA environments.	• Self-assessment and action-oriented tools: "Review & Reflect" self-assessment checklist, action plans (paper-based) • Supplementary implementation supports: workshops, manuals/resources	Caregivers completed self-assessment, set goals, attended training, and received tailored support.	No issues reported related to the SM strategies used.
20	Kvestad et al. [47] (2024)	CSM: Support childcare workers in preventing and reducing bullying and negative behaviors.	• Digital monitoring technologies: online materials • Self-assessment and action-oriented tools: practice assignments, checklists, sustainability plan (paper-based) • Supplementary implementation supports: Be-Prox training modules	Staff attended training, completed practice assignments, self-monitored with checklists, and integrated strategies into leadership practices.	No issues reported related to the SM strategies used.
21	McGowan et al. [48] (2013)	CSM: Support parents in developing automatic healthy feeding routines (fruit/vegetable serving, healthy snacks, healthy drinks) to improve children's dietary intake.	• SM recording tools: detachable SM checklists (paper-based) • Supplementary implementation supports: intervention booklet	Delivered via home visits; parents set goals, tracked feeding behaviors with checklists, and reviewed progress.	Reliance on self-reported data (potential bias).
22	McSweeney et al. [49] (2017)	CSM: Strengthen parental engagement in promoting healthy behaviors for their child.	• SM recording tools: SM checklists (paper-based) • Self-assessment and action-oriented tools: goal-setting templates, action plans (paper-based) • Supplementary implementation supports: intervention manual, preschool activity modules, newsletters, activity equipment, rewards	Parents set, tracked, and reviewed family health goals using newsletter checklists, with reinforcement and support.	No issues reported related to the SM strategies used.
23	Mesters et al. [50] (1993)	CPM: Promote parental SM of asthma symptoms and treatment adherence.	• SM recording tools: symptom/episode logs (paper-based) • Supplementary implementation supports: discipline-specific manuals, parent booklet, visual step-by-step guides	Parents attended training, tracked asthma episodes and triggers, reviewed data, and adjusted management with provider reinforcement.	No issues reported related to the SM strategies used.

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Table 3. Continued

No.	Author (year)	Monitoring type and purpose	Supporting materials and resources	Implementation procedure	Challenges
24	Nezami et al. [51] (2018)	CPM: Support parents in monitoring child's beverage intake and body weight.	• SM recording tools: diary (paper-based) • Digital monitoring technologies: smartphone option, personalized feedback emails • Supplementary implementation supports: Traffic Light Diet food list	Mothers attended one 75-minute session, self-monitored daily weight and intake, submitted weekly totals via text, and received feedback, education, and reinforcement.	Reliance on self-reported data (potential bias).
25	Pakarinen et al. [52] (2018)	CPM: Strengthen parental participation in child health promotion.	• Digital monitoring technologies: WellWe application • SM recording tools: SM checklists (digital-based)	Parents completed checklists in the app before clinic visits (30–40 minutes) and received immediate feedback.	Technical issues
26	Santer et al. [53] (2014)	CPM: Support parents in tracking eczema management for their child.	• Digital monitoring technologies: SPaCE website, SMS/email reminders • Self-assessment and action-oriented tools: action plan (paper-based) • Supplementary implementation supports: instructional videos, printable progress charts	Parents completed modules, created action plans, and tracked progress using tick/star charts.	No issues reported related to the SM strategies used.
27	Santos et al. [54] (2019)	CPM: Support mothers in tracking infant sleep patterns and caregiving strategies, with reinforcement to encourage adherence.	• SM recording tools: SM checklist, maternal sleep diary (paper-based) • Supplementary implementation supports: counselling booklet with tailored recommendations	Mothers recorded infant sleep/wake patterns during home visits, with reinforcement via follow-up calls.	Parental diaries may overestimate sleep duration and miss quiet wakefulness.
28	Salvy et al. [55] (2018)	CSM: Support maternal SM of weight and diet/activity behaviors.	• SM recording tools: food/activity SM records (paper-based) • Supplementary implementation supports: HABITS curriculum, weighing tools, training manuals, culturally tailored materials	Mothers regularly weighed themselves, recorded food and activity behaviors, and practiced healthy feeding strategies (structured meals, non-food soothing, repeated exposure).	Dietary recalls considered burdensome.
29	Singla et al. [56] (2015)	CSM: Encourage parents to track, practice, and reflect on parenting behaviors and coping strategies.	• SM recording tools: SM checklists (paper-based) • Self-assessment and action-oriented tools: practice assignments (paper-based) • Supplementary implementation supports: posters, activity booklet	Parents practiced target behaviors with children, spouses, or peers and completed SM assignments.	No issues reported related to the SM strategies used.
30	Slining et al. [57] (2021)	CSM: Support childcare workers in assessing and improving nutrition and PA policies/environments.	• Self-assessment and action-oriented tools: Go NAP SACC online self-assessment tool	Baseline self-assessment, tailored goal setting and action planning with health educator support, and technical assistance.	No issues reported related to the SM strategies used.
31	Stremler et al. [58] (2013)	CPM: Support mothers in reflecting on and adjusting maternal/infant sleep practices.	• SM recording tools: sleep diary (paper-based) • Supplementary implementation supports: 20-page booklet	In-hospital session, take-home booklet for self-learning, follow-up calls, and diary-based SM.	No issues reported related to the SM strategies used.
32	Symon et al. [59] (2005)	CPM: Enable parents to reflect on infant sleep strategies through diary tracking.	• SM recording tools: sleep diary (paper-based) • Supplementary implementation supports: 50-page booklet	One 45-minute consultation; infants checked for feeding adequacy; parents recorded sleep/wake cycles and crying in diaries.	Self-report limitations (recall bias, record-keeping burden).

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Table 3. Continued

No.	Author (year)	Monitoring type and purpose	Supporting materials and resources	Implementation procedure	Challenges
33	Tran et al. [60] (2025)	CSM: Support childcare workers in self-assessing nutrition/PA practices and developing QIPs.	• Self-assessment and action-oriented tools: self-assessment checklists with reflection prompts (digital-based) • Digital monitoring technologies: Family Day Care QI Toolkit web platform, email reminders	Educators completed self-assessments; service providers reviewed dashboards, identified priorities, and developed QIPs with action plans.	Reliance on self-reported data (potential bias).
34	Yusof et al. [61] (2021)	CSM: Encourage shared responsibility of preschool teachers and parents in promoting children's oral health behaviors.	• SM recording tools: toothbrushing diary, lesson log (paper-based) • Supplementary implementation supports: teacher OHE booklet, toothbrushing kits, parent resources	Teachers recorded daily school brushing; parents supervised and logged nighttime brushing.	Parental non-compliance risk.
35	Düzgün et al. [62] (2025)	CPM: Monitor shunt complications and self-assessment of care skills.	• Self-assessment and action-oriented tools: follow-up list, assessment tools (paper-based) • Digital monitoring technologies: avatar modules	Parents tracked complications over time and evaluated their caregiving skills at multiple follow-ups (1, 3, 6 months).	No issues reported related to the SM strategies used.
36	Yang et al. [63] (2026)	CPM: Monitor eczema symptoms, relapse, and treatment adherence.	• Digital monitoring technologies: WeChat-based smartphone application • Self-assessment and action-oriented tools: electronic action plan	Caregivers used digital tools to follow action plans and likely record symptoms and disease progression.	No issues reported related to the SM strategies used.
37	Hales et al. [64] (2026)	CSM: Support self-regulation and behavior change by monitoring personal behaviors related to resilience and health practices.	• SM recording tools: journal (paper-based) • Digital monitoring technologies: digital prompts, online modules	Participants engaged in goal setting, daily practice, and SM of behaviors as part of intervention activities; supported by reminders and coaching	No issues reported related to the SM strategies used.

Supporting materials and resources were categorized according to their primary function as self-monitoring recording tools, self-assessment and action-oriented tools, digital monitoring technologies, and supplementary implementation supports. Categories were not mutually exclusive; therefore, a single intervention could include materials from more than 1 category.
CGM, continuous glucose monitoring; CPM, caregiver proxy monitoring; CSM, caregiver self-monitoring; OHE, oral health education; PA, physical activity; QIPs, quality improvement plans; SM, self-monitoring.

through smartphone-based e-diaries [23], 24-hour dietary intake [20], and progress toward reducing sedentary behavior using goal-checking logbooks [41].

2) Self-assessment and action-oriented tools

Several interventions incorporated self-assessment tools (n=6), action plans (n=6), and practice checklists (n=3) to support reflection, goal-setting, behavior modification, and intervention fidelity. For example, childcare workers completed online self-assessments to evaluate and improve nutrition and PA environments within childcare settings [57]. Parents used asthma action plans and behavior-prevention checklists to guide decision-making and reinforce recommended caregiving practices [38,47].

3) Digital monitoring technologies

Digital monitoring technologies were used in 18 studies to facilitate monitoring and support caregiving practices. These included wheeze-detection devices linked to mobile applications [21,23], continuous glucose monitoring (CGM) systems for children with type 1 diabetes [22], and digital photography systems used to monitor eczema severity remotely [37,63]. These technologies enabled real-time or near real-time monitoring and often supported communication between caregivers and healthcare providers.

4) Supplementary implementation supports

Additional resources were used to reinforce monitoring activities and facilitate intervention implementation. These included workbooks (n=13), progress charts (n=4) for tracking achievements over time, goal-setting templates (n=2),

self-record forms (n=2), and written progress reports (n=1). Across interventions, SM was also supported by complementary strategies such as face-to-face or online education, counselling, training sessions, text-message reminders, instructional videos, manuals, and newsletters.

5. Implementation Approaches

Across studies, SM strategies were typically embedded in multi-component interventions for health promotion or chronic disease management (Table 3). Five main approaches were identified.

1) Implementation pattern

Most interventions followed a structured sequence: caregiver training, use of monitoring tools, and review with feedback. For example, parents attended training, tracked asthma triggers, and adjusted management with provider support [50]. Some offered training and monitoring without feedback (e.g., parents completing daily app checklists) [21], while others combined monitoring with feedback but no formal training, especially in professional development settings (e.g., childcare worker self-assessments with goal setting and technical assistance) [57,64].

2) Monitoring frequency

Daily monitoring was most common for diet, sleep, PA, or symptoms [21,22,29,40,61]. Some interventions required twice-daily logging, such as morning and evening symptom checks [23], while others used weekly/fortnightly summaries to track progress [39,51]. A few relied on one-time diaries to prepare for consultations [52].

3) Integration with training and supervision

SM was often introduced during nurse-led home visits, workshops, or hospital sessions, where participants practiced logging and set goals [38,43,58]. Childcare worker interventions combined training with checklists and supervisory review [57], while digital programs embedded monitoring into sequential modules that unlocked new content after completion [26].

4) Incorporation of feedback and reinforcement

Feedback was often integrated into SM and delivered through both automated and provider-mediated systems. Digital platforms generated immediate visual or numerical feedback (e.g., CGM data, WheezeScan results, MINISTOP traffic-light coding) [21-23,28], while providers reviewed logs, diaries, or photographs (e.g., eczema images reviewed within 24 hours) [37]. Reinforcement strategies included text or email reminders, which were widely used to sustain engagement [20,23,26,39,41,42,53,60].

5) Hybrid parent–teacher models

Several interventions distributed SM responsibilities between parents and preschool teachers, extending tracking across home and institutional settings. Teachers documented school-based activities such as structured play sessions or toothbrushing, while parents supervised and recorded complementary home routines [40,61].

6. Challenges and Limitations

Although 14 of 28 studies (50.0%), excluding study protocols, did not report specific issues related to the SM strategies used (Table 3), several challenges and limitations were noted:

1) Reliance on self-reported data

A common limitation was the reliance on self-reported outcomes, particularly from parents. This raised concerns about recall bias, under- or overestimation of symptoms, care utilization, and record-keeping accuracy [26,28,30,38,39,43,48,51,54,60].

2) Technical difficulties

Digital and app-based interventions occasionally encountered technical problems, including login difficulties and challenges maintaining system use [37,52]. Some studies also reported risks to participant engagement due to reliance on digital delivery and online community platforms [42].

3) Low adherence and compliance

Several interventions reported reduced adherence to prescribed monitoring routines. For example, fewer than half of participants (45.8%) completed twice-daily measurements, with delayed entries introducing recall bias [23]. Parental non-compliance was also noted as a risk, such as difficulties maintaining consistency with nightly toothbrushing at home [61].

4) Burden on caregivers

The intensity of monitoring tasks—such as frequent recalls,

daily diaries, or repeated dietary reporting—was perceived as burdensome by some parents [20]. Additional challenges included keeping children calm during monitoring procedures (reported by approximately 37.0% of parents) [23] and risks of overestimating outcomes, such as diaries overstating sleep duration or missing episodes of quiet wakefulness [54].

DISCUSSION

1. Summary of Evidence

This scoping review mapped and described evidence on SM strategies used by caregivers in ECHC interventions. Across the 37 included studies, monitoring was a common and integral component embedded within multi-component interventions targeting children under 6 years of age. Importantly, the findings demonstrate that what is often collectively described as "self-monitoring" in the literature comprises 2 conceptually distinct forms: caregiver SM and caregiver proxy monitoring. Distinguishing these forms is essential for clarifying their underlying mechanisms, purposes, and roles within interventions.

Caregiver SM refers to caregivers observing and evaluating their own behaviors, such as parenting practices [26], delivery of intervention activities [29], or adherence to recommended routines [40]. This form aligns with self-regulation processes, whereby individuals monitor their actions to guide behavior change [12]. In contrast, caregiver proxy monitoring involves observing and recording children's behaviors, symptoms, or health indicators [21-23]. This form does not involve self-regulation of the caregiver's behavior per se but rather supports caregiving decisions through awareness of the child's condition or behavior [65]. Although both forms are frequently implemented together within interventions, they serve different functions and should not be considered analytically equivalent.

When examined separately, caregiver SM primarily supported skill development, reinforcement of caregiving practices, and implementation monitoring, particularly among preschool teachers and childcare workers [47,60], whereas caregiver proxy monitoring focused on tracking children's behaviors and clinical indicators (e.g., diet, PA, sleep, and symptoms), most commonly among parents in home settings [20,21,54]. These differences reflect variations in caregiver roles, training, and context, and suggest that monitoring strategies should be tailored accordingly [66].

In addition to differences between monitoring forms, the findings highlight important distinctions between intervention types, particularly between health promotion and chronic disease management. These domains involve different monitoring targets, purposes, and mechanisms, and therefore should not be interpreted as directly comparable.

In health promotion interventions, monitoring most often involved caregiver SM and focused on establishing and maintaining health-promoting routines, such as healthy eating, PA, sleep, and oral hygiene. These approaches aimed to reinforce positive caregiving practices and support the development of healthy habits in early childhood [67]. Among these interventions, obesity prevention was the most common focus in the included studies. Positive parenting practices contribute to the establishment and reinforcement of beneficial health behaviors, including the provision of healthy foods and support for healthy eating [68]. Monitoring tools enabled caregivers to track children's body weight, diet, and PA to prevent excess weight gain and promote healthy development [69]. Overall, the emphasis was on routine behaviors and preventive care, with monitoring integrated into daily caregiving practices.

In contrast, in chronic disease management interventions, monitoring primarily involved caregiver proxy monitoring and focused on the observation and recording of symptoms, physiological indicators, or treatment adherence. Examples included tracking respiratory symptoms in asthma, skin condition in eczema, or glucose levels in type 1 diabetes. In these contexts, monitoring functioned as a mechanism for early detection, clinical decision-making, and adherence to treatment plans, often supported by digital devices or medical technologies [12,70,71]. Thus, while both intervention types incorporate monitoring, the underlying purposes and mechanisms differ substantially.

A wide range of supporting materials and resources were used to facilitate caregiver SM, including recording tools, self-assessment and action-oriented tools, digital monitoring technologies, and supplementary implementation supports. Checklists, diaries, and logbooks were the most commonly used resources, likely reflecting their low cost, ease of use, and adaptability across diverse settings [72,73]. These tools provided caregivers with structured ways to monitor children's health, behaviors, and caregiving practices while promoting active engagement in interventions [74].

Digital technologies, such as CGM systems, wheeze-detection devices, and smartphone-based applications, enabled

more timely and accurate monitoring and, in some cases, facilitated communication with healthcare professionals [23,38,75]. However, challenges related to technology access, usability, and caregiver burden highlight the need for adequate training and support [72]. Overall, these findings suggest that supporting materials and resources—whether paper-based or digital—play an important role in reinforcing SM behaviors and supporting the implementation of ECHC interventions [76].

SM in ECHC interventions was not an isolated activity but part of structured, multi-component delivery processes. Most programs combined caregiver training or orientation with daily or periodic logging, scheduled review, and feedback, enabling parents and educators to integrate monitoring into their routines and link data to actionable decisions. Embedding SM within training, supervision, and digital platforms provided timely feedback, reminders, and reinforcement, helping sustain engagement and behavior change [77]. Hybrid parent–educator models further extended monitoring across home and institutional settings, improving continuity of care and intervention reach [40,61]. These approaches highlight that effective SM depends not only on the tools used but also on deliberate implementation strategies—training, feedback, and ongoing support—that transform tracking into a mechanism for improving caregiver skills, child outcomes, and intervention sustainability [78].

In addition to the challenges posed by digital platforms and device-based tools, reliance on self-reported data was a common limitation across interventions. Self-report raised concerns about recall bias, over- or underestimation of symptoms, and incomplete or inaccurate record-keeping, particularly among parents. Other challenges included low adherence, technical problems, and caregiver burden arising from frequent or complex monitoring tasks. These findings underscore the importance of providing clear guidance, simplified tools, and ongoing support to minimize participant burden, sustain adherence, and improve data reliability in childcare settings [79].

2. Practical Implications

This review has several implications. For research, future studies should clearly distinguish between caregiver SM and proxy monitoring in both design and analysis to improve conceptual clarity and comparability across studies. There is also a need to reduce reliance on self-reported data by incorporating objective measures where feasible, and to evaluate the effectiveness and usability of digital monitoring tools across diverse populations and settings.

For practice, SM strategies should be tailored to caregiver roles and intervention contexts. For example, tools designed for parents in home settings may prioritize proxy monitoring of child behaviors and symptoms, whereas tools for educators may focus on SM of program delivery and environmental practices. Ensuring that monitoring tools are practical, minimally burdensome, and supported by feedback mechanisms is essential for sustained use.

For policy, integrating SM strategies into ECHC intervention programs may enhance caregiver engagement and support the implementation of both health promotion and disease management initiatives. Providing resources, training, and infrastructure—particularly in ECEC settings—may facilitate the effective use of SM strategies at scale.

3. Strengths and Limitations

A key strength of this review is its broad scope, enabling comparison of SM strategies across diverse health conditions, populations, and contexts. The inclusion of both paper-based and digital approaches highlights the evolving nature of SM practices in ECHC. However, several limitations should be acknowledged. First, despite a comprehensive search, only English-language studies were included, which may have introduced language bias. Second, the predominance of studies from high-income countries limits the generalizability of findings to low- and middle-income settings, where caregiver resources, health systems, and cultural norms may differ. Third, some included studies involved caregivers of children both under and over 6 years of age, which did not fully align with the predefined eligibility criterion of caring for children under 6 years. In some studies, insufficient information was provided to determine whether all children were within the specified age range. However, these studies were retained because they included caregivers of children under 6 years and provided relevant evidence to address the review objectives. Therefore, the findings should be interpreted with caution, particularly when generalizing the results specifically to caregivers of children under 6 years. Finally, as a scoping review, this study provides a descriptive overview of existing evidence and should be interpreted with caution, without drawing conclusions regarding the effectiveness or impact of the identified strategies.

CONCLUSION

This scoping review shows that caregiver SM and proxy monitoring are distinct but complementary strategies in ECHC interventions, supporting both health promotion and chronic disease management. By combining traditional tools with digital technologies and embedding them within training and feedback systems, SM strengthens caregiver engagement, skill development, and intervention fidelity. However, challenges such as reliance on self-reported data, technical issues, and caregiver burden remain. Future work should focus on developing user-friendly tools, reducing burden, and testing hybrid delivery models to improve sustainability and long-term outcomes for children's health and well-being.

ARTICLE INFORMATION

Authors' contribution

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Supplementary material

Supplement 1. Search strategy.

ORCID and ResearcherID

Chakkrich Pidjadee
https://orcid.org/0000-0001-9116-9116
https://researcherid.com/rid/LXW-5376-2024
Kim Lam Soh https://orcid.org/0000-0003-2404-828X
https://researcherid.com/rid/NZO-2679-2025
Hasni Idayu Saidi https://orcid.org/0000-0002-6262-5634
https://researcherid.com/rid/AHE-0160-2022
Tassanee Attharos https://orcid.org/0009-0003-5122-6480
https://researcherid.com/rid/QYQ-2332-2026
Kim Geok Soh https://orcid.org/0000-0001-5835-9460
https://researcherid.com/rid/QWB-7709-2026
Kanjana Siricharoenwong
https://orcid.org/0009-0002-7016-2294
https://researcherid.com/rid/QYQ-2268-2026

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Pediatric oncology nurses' experiences with trauma-informed care in South Korea: a qualitative study

Kyung-Sook Bang[1], Yeseul Jeong[2], Ji-Hye Choe[3], Sinyoung Choi[4]

[1]Professor, The Research Institute of Nursing Science, College of Nursing, Seoul National University, Seoul, Korea
[2]Assistant Professor, Research Institute of Nursing Science, College of Nursing, Keimyung University, Daegu, Korea
[3]Ph.D. Candidate, College of Nursing, Seoul National University, Seoul, Korea
[4]Postdoctoral Researcher, Center for World-leading Human-care Nurse Leaders for the Future by Brain Korea 21 (BK 21) Four Project, College of Nursing, Seoul National University, Seoul, Korea

Corresponding author
Yeseul Jeong
College of Nursing, Keimyung University, 1095 Dalgubeol-daero, Dalseo-gu, Daegu 42601, Korea
Tel: +82-53-258-7659
Fax: +82-53-258-7616
E-mail: yeseuljeong@kmu.ac.kr

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Purpose: Trauma-informed care (TIC) provides a framework for recognizing and responding to trauma in healthcare settings. However, little is known about how pediatric oncology nurses in South Korea understand and practice TIC, which has not yet been systematically implemented in pediatric oncology wards. This study explored pediatric oncology nurses' perceptions and experiences of TIC through individual in-depth interviews.

Methods: This descriptive qualitative study used purposive sampling. Eight female nurses from tertiary hospitals in the capital region, each with at least 1 year of experience caring for children with cancer, participated in individual in-depth interviews. Data were collected from January to March 2024 and analyzed using thematic analysis guided by the conceptual framework of trauma-informed nursing care.

Results: Four major themes emerged: (1) trauma-uninformed care emerging within constrained environments, (2) emergent trauma-informed strategies aligned with core principles, (3) emotional burdens and tensions endured under structural constraints, and (4) bearing fruit of the partial enactment of TIC through mutual trust building.

Conclusion: Despite structural limitations, pediatric oncology nurses recognized the presence and effects of trauma and implemented informal trauma-informed practices. System-level adoption of TIC, including universal trauma precautions, screening protocols, and staff-support systems, is needed to provide TIC for both patients and healthcare professionals.

Keywords: Adverse childhood experiences; Health facility environment; Oncology nursing; Pediatric nursing; Qualitative research

INTRODUCTION

Serious childhood illnesses and their associated diagnostic procedures, hospitalizations, and treatments can be profoundly distressing. Among these illnesses, childhood cancer imposes a particularly heavy burden on patients due to its frequent invasive interventions and prolonged, intensive treatment regimens [1]. Although advancements in treatment have improved survival rates, the diagnosis and treatment processes of childhood cancer remain highly stressful, with psychological sequelae persisting for years after completion of therapy [2]. During treatment, affected children often face

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delays in developmental milestones, psychosocial difficulties, and impaired adaptation [2]. Furthermore, the impact of the illness extends beyond the patient, resulting in psychological distress for parents and siblings [3,4].

Pediatric oncology nurses are often the frontline professionals who recognize and respond to trauma-related reactions in children with cancer and their families. Nurses working in pediatric oncology settings are inevitably exposed to high levels of occupational stress [5]. Compared to adult nursing, pediatric nursing involves managing not only the child's stress but also that of their families, making even routine procedures potentially highly distressing for all involved. Pediatric oncology nurses encounter additional stressors such as patient deaths, witnessing suffering, end-of-life care challenges, conflicts regarding treatment limitations, and resource- and workplace-related strain, including high workload, inadequate staffing, limited resources, and team conflict—factors that themselves may contribute to secondary traumatic stress [5]. In such emotionally demanding settings, a systematic trauma-informed care (TIC) approach is needed to recognize trauma-related responses, prevent retraumatization, and support nurses in providing sensitive care to children and families.

Although post-traumatic stress disorder (PTSD) is relatively well recognized in Korea, the concept and practice of TIC remain emergent. TIC is a comprehensive framework grounded in the recognition that trauma affects not only individuals but also the service delivery environment, organizational systems, and the outcomes and well-being of staff working within those systems [6]. It encompasses trauma-specific interventions—such as assessment, treatment, and recovery support—while simultaneously seeking to integrate its core principles into organizational policies, procedures, and overall operations [6]. TIC advocates for a holistic understanding of patients' physical, psychological, and behavioral responses as potential manifestations of trauma, with the goals of minimizing trauma exposure, preventing retraumatization, and enhancing care outcomes [7]. To this end, all service systems adopt as the key assumptions of a trauma-informed approach—the 4Rs—the recognition of the widespread impact of trauma (realize), the identification of its signs and symptoms (recognize), the implementation of appropriate responses (respond), and the prevention of retraumatization (resist retraumatization) [6]. A trauma-informed approach begins with adherence to 6 core principles: safety; trustworthiness and transparency; peer support; collaboration and mutuality; empowerment, voice, and choice; and attention to cultural, historical, and gender issues (Figure 1) [8]. Despite the increasing prevalence of PTSD, healthcare providers' knowledge and application of trauma-informed principles are limited [9]. Moreover, research focusing on trauma experiences among healthcare professionals such as nurses and social workers in Korea is scarce. Notably, no prior study has investigated trauma experiences or TIC practices specifically among pediatric oncology nurses, who are uniquely positioned at the intersection of caring for traumatized patients while themselves being susceptible to cumulative occupational trauma.

Given these gaps, the present study aimed to explore pediatric oncology nurses' perceptions and experiences of TIC through one-on-one, in-depth interviews, with the goal of elucidating current practices, challenges, and support needs within this specialized context.

METHODS

Ethical statements: This study was approved by the Institutional Review Board (IRB) of Seoul National University (IRB No. 2402/002-005).Written informed consent was obtained from all participants, including those who participated in online interviews and returned their signed consent forms by mail.

1. Study Design

This descriptive qualitative study explored pediatric oncology nurses' perceptions of TIC and their clinical practices relevant to TIC principles. The study was reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [10].

2. Participants

To obtain rich accounts of the phenomenon of interest, participants were recruited using purposive sampling. Inclusion criteria were: (1) at least 1 year of experience caring for pediatric oncology patients in an oncology ward, either currently or in the past, and (2) voluntary consent to participate. There were no exclusion criteria. Recruitment began with the researcher's acquaintances and was expanded through snowball sampling; no participants withdrew after enrollment. The final sample comprised 8 nurses who self-reported their gender as female and were working at tertiary hospitals in

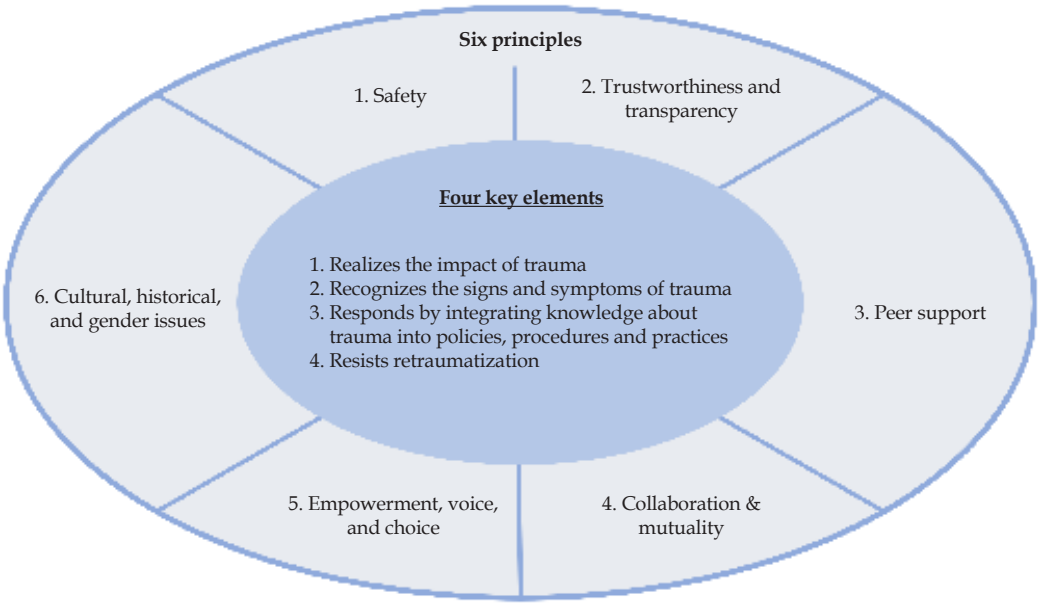

Figure 1. Substance Abuse and Mental Health Services Administration (SAMHSA)'s trauma-informed approach. From Lang JM, Campbell K, Vanderploeg J. Advancing trauma-informed systems for children [Internet]. Child Health and Development Institute of Connecticut; 2015 [cited 2026 Feb 2]. Available from: https://cwlibrary.childwelfare.gov/discovery/fulldisplay/alma9910011318097076 51/01CWIG_INST:01CWIG [8].

the capital region, with a mean of 8.6 years of pediatric oncology nursing experience (range, 4–30 years). There were no refusals to participate or withdrawals from the study. Their mean age was 33.3 years (range, 28–53 years), and their mean total clinical experience was 9.8 years (range, 4.5–30 years). The sample included 1 charge nurse, 1 head nurse, and 1 advanced practice nurse, with the remainder being staff nurses. None had previous psychiatric or emergency department experience, and only 1 participant had children (Table 1).

3. Data Collection

Data were collected through one-on-one in-depth interviews conducted both online and in person between January 19 and March 20, 2024. Interviews continued until data saturation was reached, that is, until no new information was identified and additional interviews no longer provided further insight into the research questions. Interviews were conducted online (n=3) and in person (n=5), with in-person interviews held at locations chosen by participants for comfort and convenience, including seminar rooms or the researcher's office. The interviewers comprised 2 female professors with doctoral degrees in pediatric nursing and 2 female doctoral candidates in pediatric nursing, all of whom had prior qualitative research experience or had attended related courses or seminars. Each interviewer conducted interviews with 1 to 4 participants, lasting between 1 and 2.5 hours.

For remote interviews, participants who expressed their willingness to participate were first contacted by phone and provided with information about the purpose and procedures of the study. Subsequently, documents including the informed consent form, the study information sheet, and the questionnaire were sent by mail. On the day of the interview, for both in-person and remote interviews, rapport was established through brief ice-breaking, after which the researcher provided a detailed explanation of the study, answered participants' questions, confirmed voluntary informed consent, and administered the questionnaire on general characteristics. In remote interviews, the screen-sharing function of an online conferencing platform was used at this stage to review the documents together and provide explanations. Interviews followed a semi-structured guide, which included a brief explanation of trauma and TIC to aid participant understanding. Sample questions included: "How do you perceive the impact of trauma on pediatric oncology patients?", "Have you encountered situations in which a patient appeared to be traumatized? How did you respond?", "What nursing interventions have you used to reduce trauma-related distress in pediatric oncology patients and their families?", "Have you personally experienced trauma while caring for pediatric oncology patients?", and "How did you, your colleagues, or your organization respond to trauma experienced by patients, fam-

Table 1. Participants' demographic and clinical characteristics

Characteristic	Participant							
	1	2	3	4	5	6	7	8
Age (yr)	31	31	28	29	37	28	53	29
Sex	Female	Female	Female	Female	Female	Female	Female	Female
Education level	Doctoral[a)]	Doctoral[a)]	Bachelor's	Bachelor's	Doctoral[a)]	Bachelor's	Doctoral[a)]	Master's[a)]
Pediatric oncology clinical experience (yr)	7	8	4.5	6	4	4	30	5
Total clinical experience (yr)	7	8	4.5	6	13	5	30	5
Emergency room/psychiatric department experience	None	None	None	None	None	None	None	None
Position	Staff nurse	Staff nurse	Charge nurse	Staff nurse	Head nurse	Staff nurse	Advanced practice nurse	Staff nurse
Having children	No	No	No	No	No	No	Yes	No
Affiliated hospital	A	A	B	C	A	D	D	A

[a)]Includes individuals currently enrolled.

ilies, nurses, or other staff in the pediatric oncology ward?"

Interviewers employed empathetic listening to create a comfortable atmosphere for open discussion. All interviews were audio- or video-recorded, and the interviewers transcribed the recordings verbatim. During interviews, researchers used follow-up questions and summaries to confirm and explore participants' statements and maintained field notes. The final dataset comprised 244 pages of A4-size transcribed text and field notes. Two participants reviewed their interview transcripts and the study findings for member checking.

4. Data Analysis

Thematic analysis was conducted following the procedures outlined by Braun and Clarke [11] to identify, analyze, and report patterns of participants' experiences and perceptions. Initially, 2 researchers independently read and reread the data to become familiar with the content and documented preliminary analytic insights. Based on these initial observations, each researcher independently generated initial codes across the dataset. Through collaborative discussion, the researchers then organized and consolidated related codes to search for and develop candidate themes. The research team subsequently reviewed the fit of the candidate themes in relation to the coded data extracts and the entire dataset, generated a thematic map, defined and named the themes, and produced the final analytic report.

5. Rigor

This study sought to ensure rigor in accordance with the criteria proposed by Sandelowski [12], namely credibility, fittingness, auditability, and confirmability.

To enhance credibility, 2 researchers independently analyzed the data and reached consensus through iterative team discussions. In addition, member checking was conducted with 2 participants, who confirmed that the findings accurately reflected their experiences.

To strengthen both credibility and fittingness, purposive sampling was employed to ensure variation in workplace settings, clinical experience, professional position, and educational background. The findings were supported by thick descriptions and verbatim participant quotations, and detailed participant characteristics were presented to enable readers to assess their applicability.

To establish auditability, all procedures, including participant selection, data collection, field notes, coding, and analytic decisions, were systematically documented to maintain a clear audit trail.

To enhance confirmability, the researchers engaged in ongoing reflexivity. They maintained reflexive notes and critically examined whether the themes were grounded in participants' narratives rather than in their pre-existing assumptions about TIC in Korean clinical settings.

Furthermore, to prevent perceived coercion, voluntary participation was emphasized, and interviews were conducted by a researcher with no prior hierarchical relationship with the participant.

6. Researcher Preparation

The all-female research team had clinical, academic, and qualitative research expertise relevant to exploring pediatric oncology nurses' experiences with TIC. All researchers had clinical experience in pediatric nursing, which facilitated empathic engagement and in-depth data collection. The team had prior experience conducting TIC-related studies and demonstrated a strong understanding of the concept and its relevance to the Korean healthcare context, supported by a critical review of relevant national and international literature.

The first and corresponding authors are nursing professors who have published multiple studies in qualitative research and pediatric nursing, while the remaining authors are doctoral-level and doctoral candidate researchers trained in qualitative research methods.

RESULTS

This qualitative study identified 4 overarching themes in pediatric oncology nurses' experiences with TIC: trauma-uninformed care emerging within constrained environments; emergent trauma-informed strategies aligned with core principles; emotional burdens and tensions endured under structural constraints; and bearing fruit of the partial enactment of TIC through mutual trust building (Table 2).

1. Theme 1. Trauma-Uninformed Care Emerging within Constrained Environments

Participants reported that TIC remains relatively unfamiliar in Korea, and their institutions lacked the prerequisites for its full implementation. Although formal TIC-specific policies or protocols were absent, some psychosocial support services for patients and families were available. Nurses used these resources to provide psychosocial care; however, the lack of structured guidelines limited comprehensive TIC practice. This gap created difficulties and exposed nurses to challenging situations.

1) Sub-theme 1.1. Assessment rendered hazy in the absence of the concept of TIC

In settings where TIC is not formally introduced, a universal precaution approach—assuming all patients may have trauma histories and assessing accordingly—is lacking. Participants reported that trauma histories were rarely assessed systematically; nurses instead learned about them indirectly through word of mouth or observations of atypical patient or caregiver responses.

Some trauma-related information could be obtained through psychosocial consult notes or prescriptions, but communication between nursing staff and psychosocial services was limited and unidirectional, hindering holistic care coordination.

Table 2. Themes and sub-themes of pediatric oncology nurses' experiences with trauma-informed care

Level	Theme and sub-theme
Theme 1.	Trauma-uninformed care emerging within constrained environments
Sub-theme 1.1.	Assessment rendered hazy in the absence of the concept of TIC
Sub-theme 1.2.	Providing patchwork TIC in the absence of structured education
Sub-theme 1.3.	A rigid ward culture undermining psychological safety
Theme 2.	Emergent trauma-informed strategies aligned with core principles
Sub-theme 2.1.	Realizing the impact of trauma on the emotional responses of patients and their parents
Sub-theme 2.2.	Recognizing signs of trauma through compassionate and attentive assessment
Sub-theme 2.3.	Responding collaboratively to minimize trauma triggers
Sub-theme 2.4.	Resisting retraumatization by respecting patients' autonomy
Theme 3.	Emotional burdens and tensions endured under structural constraints
Sub-theme 3.1.	Being traumatized by patients' and parents' unscreened trauma
Sub-theme 3.2.	Deepening grief through a family-like bond
Sub-theme 3.3.	Becoming mutually burned out in a high-stress, high-intensity environment
Theme 4.	Bearing fruit of the partial enactment of TIC through mutual trust building
Sub-theme 4.1.	Witnessing patient growth through empowerment
Sub-theme 4.2.	Gaining strong allies in the treatment process by building partnerships with parents
Sub-theme 4.3.	Restoring resilience through peer support
Sub-theme 4.4.	Experiencing fulfillment as nursing challenges ease with patients' positive engagement

TIC, trauma-informed care.

"Sometimes, by looking at palliative care consult notes, we can see parts of what they experienced before. That's how I learned about it." (Participant 3)

"I don't think there's a direct channel for us to communicate with the emotional support center. Other than reporting back in writing (…) I wish our opinions could be reflected too, because we see things from a third-party perspective outside the parent–child dynamic." (Participant 1)

2) Sub-theme 1.2. Providing patchwork TIC in the absence of structured education

An environment conducive to TIC includes physical safety for patients, trauma-aware staff, protocols to avoid retraumatization, organizational support, and committed leadership [6]. However, participants indicated that Korean hospitals, including tertiary hospitals, largely lacked these conditions. The most accessible institutional resources were psychosocial support programs for patients and families, which nurses actively recommended when they detected signs of emotional distress. Participants relied on undergraduate knowledge and ad hoc hospital training (e.g., palliative care, communication workshops) to recognize trauma symptoms and prevent retraumatization. In the absence of formal TIC education, more systematic TIC practice was limited. As a result, participants expressed a strong need for systematic TIC training.

"When I see a child looking very anxious—more than normal for them—I worry they might become severely depressed later. So, if they seem down, talk less, or act differently, I suggest consulting the emotional support center." (Participant 1)

"We need to make efforts to reduce trauma for children because parents' trauma ultimately affects the child. We should keep studying interventions and I think it would be great if nurses could receive such education." (Participant 5)

3) Sub-theme 1.3. A rigid ward culture undermining psychological safety

Because a trauma-informed organizational culture had not yet been established, nurses had limited opportunities to express or share the grief and sense of loss they experienced following patient deaths. Expressing grief at work was often perceived as unprofessional, and open emotional sharing among colleagues was rare. As a result, unresolved grief tended to accumulate privately.

"I thought I had to maintain professionalism—to stay objective and not be swayed by emotions." (Participant 1)

"Even among peers, we don't actively talk about feelings. If I cry, I just cry alone." (Participant 3)

2. Theme 2. Emergent Trauma-Informed Strategies Aligned with Core Principles

Even without an explicit conceptual understanding or formal TIC training, participants recognized the impact of trauma on pediatric patients and their caregivers. They employed their own strategies to sensitively identify trauma-related cues and provided TIC accordingly. Participants observed that pediatric oncology patients and caregivers often experienced complex trauma, manifesting as fear, anxiety, and treatment resistance. Nurses recognized the importance of understanding these emotional responses, which helped them tailor care strategies to individual needs and improve therapeutic relationships.

1) Sub-theme 2.1. Realizing the impact of trauma on the emotional responses of patients and their parents

Nurses noted that many pediatric patients resisted treatment or showed distress due to previous traumatic experiences related to hospitalization or invasive procedures. Recognizing these reactions as trauma-related responses rather than mere noncompliance enabled them to approach patients with greater empathy and patience.

Caregivers also exhibited trauma responses, including heightened anxiety and overprotection, which sometimes complicated care. Nurses recognized that these responses stemmed from prior traumatic experiences, such as distressing treatment processes or diagnoses. Rather than pathologizing these responses, they sought to respond with patience and understanding.

"Because the treatment process is so difficult, children tend to dislike coming to the hospital. In particular, there is a separate room for invasive procedures, and regardless of age, they all resist entering that room." (Participant 1)

"A child's cancer diagnosis is an extremely significant event for parents as well. At times, parents appear overwhelmed and seem to struggle to fully support their child's emotional needs." (Participant 5)

2) Sub-theme 2.2. Recognizing signs of trauma through compassionate and attentive assessment

Participants' recognition of the impact of trauma heightened their sensitivity to trauma-related responses. They carefully monitored and responded to subtle changes in the children's behavior or daily routines beyond obvious signs such as crying or complaints.

"In the morning, I ask, 'Did you sleep well overnight?' When it's evening, I ask, 'Did you eat well? How was your breakfast and lunch today?' And if I notice that the child has difficulty sleeping at night, I ask the next morning why they couldn't sleep." (Participant 1)

3) Sub-theme 2.3. Responding collaboratively to minimize trauma triggers

Despite poor ward environments, nurses endeavored to minimize trauma triggers, especially regarding patient deterioration, death, or painful procedures witnessed by others. They developed their own unit-level strategies, such as relocating critical patients to single rooms, to reduce distress in other patients and families.

"For critical patients, if treated in a shared room, other patients might witness everything and become anxious. So we move them to a treatment room to avoid triggering anxiety in others." (Participant 3)

"When we receive a DNR [do-not-resuscitate] order, we move the patient to a single room so the family can spend time together." (Participant 6)

4) Sub-theme 2.4. Resisting retraumatization by respecting patients' autonomy

Pediatric oncology nurses experientially understood the power of a strengths-based approach and applied it in their practice, placing a particular emphasis on respecting the patients' autonomy. From the nurses' experience, a coercive approach that relies on restraint to push through treatment often leads to greater fear and more severe refusal behaviors during subsequent readmissions and repeated procedures. Consequently, pediatric oncology nurses invested significant time and effort in explaining procedures to children in a developmentally appropriate manner from the earliest possible age, and they worked to build trusting relationships.

"For example, if a painful injection is scheduled, we start talking with the child from the morning. We say, 'We're going to do this today. It will probably hurt, but if you help us, we can make it less painful and less scary.' (…) If we give the child enough time and talk it through with them, things go much better. (…) Then, the next time they get an injection, it becomes a little less scary, and then the next time, a little less scary again. (…) Although medication can be administered by physically holding the child and forcing it in once, this approach cannot be sustained on a daily basis." (Participant 5)

3. Theme 3. Emotional Burdens and Tensions Endured under Structural Constraints

In the absence of an organizational system supporting TIC, participants struggled to provide TIC in their own ways and experienced considerable psychological burdens and tensions.

1) Sub-theme 3.1. Being traumatized by patients' and parents' unscreened trauma

Due to the absence of systematic trauma screening, nurses frequently became the first to encounter aggressive or challenging behaviors linked to unresolved trauma, often without preparation or institutional support. Being subjected to aggression in the absence of prior information or contextual explanation resulted in trauma responses among participants.

"We didn't know at the first admission. (…) Chemotherapy takes precedence, and psychiatric symptoms sometimes appear later. (…) When the patient threatened staff with a box cutter, all medical staff were terrified because no one knew what they might do. None of us had experienced such a psychiatric emergency before, so it became a trauma for many of us." (Participant 2)

2) Sub-theme 3.2. Deepening grief through a family-like bond

The therapeutic relationships with patients and caregivers also had profound effects on nurses. Repeated exposure to loss and suffering sometimes led to feelings of meaninglessness and emotional exhaustion.

Participants also developed close relationships with the parents. Seeing parents struggle with their child's worsening condition was painful, yet the participants found it difficult

to offer comfort because they felt unable to fully comprehend the devastation of having a seriously ill child or losing a child.

"When I was new, what was most difficult was the fear of facing a situation I had never seen before. But after 1 or 2 years, when I had seen more than 10 babies I cared for pass away, I didn't want to get close to them anymore. The very act of having to let them go became such a heartbreaking experience that I didn't want to form close bonds." (Participant 4)

"I often thought that my words might end up causing more hurt. I wondered if I might not be able to choose the right words." (Participant 2)

3) Sub-theme 3.3. Becoming mutually burned out in a high-stress, high-intensity environment

The pediatric oncology ward's demanding environment, characterized by the need for constant vigilance and detailed patient monitoring, contributed to a perfectionistic culture that precipitated burnout. In the environment where mistakes were not tolerated and the resulting pressure was intense, many nurses unable to cope left the unit.

"We can be excessively obsessive. The whole staff believes we must not miss even the smallest lab result, and those who don't share this mindset feel guilty. Many who can't handle it resign, transfer, or take leave." (Participant 5)

4. Theme 4. Bearing Fruit of the Partial Enactment of TIC through Mutual Trust Building

Participants affirmed their confidence in TIC based on witnessing patient and caregiver growth through autonomy support and empathic nursing care. They described how TIC practices helped patients adapt to difficult treatments, reduced stress, and improved cooperation, ultimately contributing to better clinical outcomes.

1) Sub-theme 4.1. Witnessing patient growth through empowerment

Nurses observed that granting patients, even as young as 6 or 7, opportunities for autonomous decision-making fostered cooperation and reduced resistance to treatment. By engaging directly with the child and allowing sufficient preparation time, participants noted improved patient tolerance of procedures and greater caregiver collaboration. These changes reduced patient stress, facilitated smoother nursing care, and reinforced nurses' confidence in the effectiveness of TIC, while active family engagement reflected greater trust in healthcare providers.

"Some children were afraid and refused treatment at first, but when we gave them time and supported their autonomy, they gradually became more cooperative." (Participant 6)

2) Sub-theme 4.2. Gaining strong allies in the treatment process by building partnerships with parents

While parents experience their child's cancer diagnosis as a traumatic and painful event, they are ultimately the most dedicated treatment partners, desperately wanting their child to heal and putting in the greatest effort to make that happen. The nurses in this study fostered the partnership by demonstrating professionalism and trustworthiness, motivating and supporting parents to maximize their strengths. This strong partnership also strengthened nurses' confidence in their care.

"I tell the mothers a lot, like, 'You really need to help a lot here. (…) Please say some encouraging words to your child first.' Then, even mothers who had been really struggling and almost falling apart would go in and say things like, 'You can do this. You'll be able to get through the treatment, and we'll go home soon. Let's do this together with Mom.' I think they often shift into a much more positive mindset. (…) As I had many good experiences in the hospital through that kind of partnership with mothers, I was able to speak to them more sincerely and give them words of hope." (Participant 4)

"In these situations, we lay out all the information in advance, even something like, 'With this treatment, a certain survival rate is guaranteed.' When the diagnosis is confirmed later, the parents are much more prepared, which is helpful. We don't just give them good news, though. We also talk about the less favorable outcomes, but we also emphasize that treatment is possible." (Participant 7)

3) Sub-theme 4.3. Restoring resilience through peer support

Most hospitals offered psychosocial support programs for staff, with participation often voluntary and variable in for-

mat. Some participants found counseling accessible and beneficial. In addition, support and understanding from fellow nurses facing similar challenges served as a vital source of renewed strength.

In some wards where peer support was actively practiced, a culture of openly expressing and sharing emotions with colleagues was evident. Such environments facilitated healthier grief processing among staff and helped nurses recover from traumatic experiences related to patient loss.

"I've seen many people benefit. Counseling is more casual than psychiatry clinics, so it's accessible and less intimidating. Many staff benefit." (Participant 5)

"When new nurses lost their first patient, we would all go out to eat after work. We didn't want to let her go straight home feeling sad, so we'd have chicken and beer, talk about happy things, and then go home. (…) Saying goodbye properly to patients and sharing grief with colleagues helped resolve our trauma and prevented painful memories from becoming the last impression." (Participant 4)

4) Sub-theme 4.4. Experiencing fulfillment as nursing challenges ease with patients' positive engagement

The application of TIC helped patients gradually adapt to challenging treatments, which reduced nurses' psychological burden related to patient distress. Nurses felt motivated to continue TIC practices despite the additional time and effort required. Moments of gratitude from patients and caregivers, as well as witnessing recovery, also restored nurses' sense of purpose.

"Though it's sometimes inconvenient to follow patients to school or other settings, these efforts help children forget their pain and experience normalcy." (Participant 4)

"There's an event where patients who have been cured and their families come and share their stories. I've never been to one myself, but a colleague who attended said that such events make her think, 'Ah, I really am doing something meaningful.' In the hospital, we mostly see patients who relapse, so I think it's good to have events that remind us, 'There are patients and families who go on to live healthy lives because we treated them well.'" (Participant 3)

DISCUSSION

This study explored pediatric oncology nurses' experiences and perceptions of TIC in Korean clinical settings, highlighting challenges, nursing practices, and outcomes associated with TIC implementation. The findings revealed systemic gaps in applying TIC principles within Korean clinical settings.

The first theme of this study, 'trauma-uninformed care emerging within constrained environments' was consistent with international research [13]. Our findings indicate that TIC remains an emerging concept in Korean healthcare. Despite being large tertiary hospitals, the institutions where the participants worked had not institutionalized TIC or adopted routine trauma screening protocols.

In this study, nurses' accounts suggest that the lack of formalized TIC implementation created significant challenges in pediatric oncology settings. Participants described working without structured policies, protocols, or training, often relying on indirect and informal information about patients' trauma histories. This gap appeared to limit universal trauma precautions, leaving trauma reactions unrecognized. In some cases, these reactions escalated into aggressive incidents, risking retraumatizing of patients and exposing nurses to traumatic experiences they felt inadequately prepared to manage.

The absence of a trauma-informed organizational culture has profound effects on nurses, leading to emotional isolation, unresolved grief, and eventual burnout. These results align with international literature emphasizing institutional readiness—including policy frameworks, environmental safety, and leadership commitment—for TIC implementation [14]. As trauma symptoms in children can be subtle and easily overlooked [13], systematic trauma screening is essential [15]. Proactive screening and staff support are needed to identify trauma-related needs early, prevent secondary trauma among healthcare providers, and improve care quality.

The second theme of this study was 'emergent trauma-informed strategies aligned with core principles.' Although TIC had not been formally implemented at the participants' institutions, pediatric palliative care (PPC) was provided. In Korea, PPC began as a government-led pilot project in 2018 and has expanded to several tertiary hospitals [16]. PPC addresses the physical, psychological, and social suffering of children and their families throughout the disease trajectory [17]. Pediatric cancer diagnosis and treatment can be trau-

matic because of repeated invasive procedures, prognostic uncertainty, and fear of recurrence. TIC emphasizes recognizing trauma and ensuring safety, trust, collaboration, empowerment, and minimization of retraumatization. Because PPC encompasses symptom management, psychosocial support, and family-centered care (FCC), it shares common ground with TIC [6]. Participants' practices—such as emotional support, facilitating child and family participation, and coordinating care to alleviate suffering—can therefore be understood as trauma-sensitive practices grounded in PPC or aligned with TIC principles rather than formal TIC implementation. However, TIC extends beyond individual practice to organizational approaches such as trauma awareness, screening, education, protocols, environmental modifications, and support systems for healthcare providers. Therefore, PPC may serve as a starting point for implementing TIC in Korean pediatric oncology settings but should be expanded into a system-level, institutionalized TIC approach.

Meanwhile, implementing TIC requires sensitivity to patients' trauma histories, emotional responses, strengths, and readiness for care. The American Academy of Pediatrics recommends trauma screening that avoids retraumatization and identifies protective and risk factors to guide intervention [18]. A study that applied a TIC screening tool in a pediatric oncology ward found that education on TIC basics and the child trauma screening tool improved nurses' attitudes, knowledge, compliance, self-reported competence, as well as the use of the tool [1]. Therefore, encouraging the use of appropriate screening tools in Korea is necessary to support objective trauma assessment. Positive effects of TIC training for nurses have also been reported [1], suggesting that structured TIC training should be considered.

Even without institutional support, nurses demonstrated proactive strategies to minimize trauma triggers. They relocated critically ill patients to private rooms and recommended psychosocial support services. Their efforts to support patient autonomy and empower caregivers were linked to improved cooperation, reduced distress, and smoother treatment processes. These behaviors align with the TIC principles of safety, trustworthiness, collaboration, and empowerment [6] .

The third theme of this study was 'emotional burdens and tensions endured under structural constraints.' Nurses experienced profound grief and emotional exhaustion from patient loss and repeated exposure to suffering, intensified by deep, family-like bonds with their young patients. However, compassion satisfaction arose from positive patient interactions, expressions of gratitude, and witnessing the recovery of survivors. This emotional duality aligns with research on compassion fatigue and satisfaction in oncology nursing [19].

The narratives emphasize the need for organizational support systems that normalize emotional expression and grief processing. Without such support, nurses face burnout, turnover, and reduced care quality. Reliance on individual knowledge and ad hoc learning highlights a critical gap in training. Hospitals should therefore establish formalized organizational frameworks for TIC education, communication, and staff support [20]. Dawson-Rose et al. [21] also emphasized that a trauma-informed organizational climate is critical for reducing nurse burnout and enhancing well-being.

The fourth theme of this study, 'bearing fruit of the partial enactment of TIC through mutual trust building' explores the positive experiences of pediatric oncology nurses in their relationships with patients and parents, as well as how they navigate difficulties through peer support. This theme offers insight into the crucial elements that enable nurses to overcome emotional and professional challenges and build resilience.

Nurses found great fulfillment in supporting patient autonomy and witnessing children's growth as they became active participants in their treatment. When children understand their condition and proactively engage in decisions about their care, they feel respected as individuals, not just patients [22]. Respecting children's participation and autonomy is considered a way of respecting their dignity [23].

This experience reinforces for nurses that their role extends beyond simple medical procedures; it is about supporting a child's holistic development. This finding suggests that nurses act as collaborative partners and facilitators of growth, not just caregivers [24]. Such autonomy-supportive care requires nurses to communicate sensitively with children while considering their developmental level and emotional readiness. At the same time, because children's participation in treatment in pediatric nursing occurs within the context of parents' understanding and cooperation, nurses also need to build collaborative relationships with parents while supporting children's autonomy. It has been reported that nurses' emotional intelligence is significantly correlated not only with communication skills and nurse-parent partnerships but also with job satisfaction [25]. The subdomains of the partnership between child health nurses and parents include reciprocity, carefulness, collaboration, sensitivity, information sharing, communication, and professional knowledge

and skills [26]. Therefore, emotional intelligence can be understood as a relational competency required to respect children's autonomy while maintaining collaborative relationships with parents. Such positive relationship-building not only facilitates children's engagement in treatment but also helps nurses experience their care as meaningful professional practice, thereby mitigating emotional burnout and strengthening intrinsic motivation [27].

In pediatric nursing, collaboration with parents is essential for successful treatment. Nurses in this study emphasized that a trust-based partnership with parents supports both the child's recovery and the parents' well-being. FCC, which promotes family involvement in pediatric settings, has been associated with improvements in parents' knowledge, participation, and psychosocial well-being [28]. Through information sharing, family involvement in care, respect and dignity, and family support, nurses and healthcare teams can strengthen caregiver-provider relationships and support caregivers' active involvement in patient care [28,29]. Beyond these benefits for patients and families, FCC may also benefit nurses by improving job satisfaction, confidence, and quality of care while reducing stress and burnout, thereby helping nurses experience care as more collaborative and professionally meaningful [29].

Pediatric oncology is an emotionally demanding field, and this study underscores the crucial role of peer support in fostering nurses' resilience. By sharing challenging experiences and offering mutual support, nurses were able to cope more effectively with work-related stress and prevent burnout. Similarly, a study involving pediatric intensive care unit nurses who participated in an intervention to share experiences of caring for terminally ill children found that such exchanges helped them regain strength through mutual understanding and self-reflection [30]. Bonds formed with colleagues who had undergone similar experiences created a sense of psychological safety grounded in empathy and trust. Beyond emotional support, these peer relationships also provided a valuable space for exchanging practical knowledge and coping strategies. Altogether, peer support proved vital for sustaining the professionalism and long-term well-being of pediatric oncology nurses.

These findings suggest that pediatric oncology nurses achieve professional growth and emotional stability through their interactions with patients and parents, as well as through their relationships with colleagues. These experiences empower nurses to overcome challenges and continue providing care aligned with TIC principles, even in the absence of formal organizational systems.

The findings underscore several practical and policy implications. First, healthcare institutions should prioritize the integration of TIC principles into organizational policies, staff training, and environmental design to foster safer and more supportive care settings for pediatric oncology patients and their families. Second, routine trauma screening and improved interdisciplinary communication channels are essential to identify and address patients' psychosocial needs effectively. The findings also suggest the need for organizational support for nurses who provide care in emotionally demanding pediatric oncology settings. Third, establishing structured psychosocial support programs for nursing staff—including grief counseling and peer support—may help mitigate burnout and sustain workforce well-being. Lastly, nurse-led initiatives demonstrated in this study indicate the potential for grassroots change, but systemic efforts are required to ensure sustainable and equitable TIC implementation across pediatric oncology services in Korea.

This study has several limitations. Its findings are based on in-depth interviews with a small sample of nurses from tertiary hospitals in the capital region of South Korea, which may limit transferability to other settings or regions. All participants were women, reflecting the female-dominated nursing workforce in Korea; thus, male nurses' perspectives were not represented, potentially limiting transferability across genders. Moreover, while rich qualitative data were obtained, perspectives from other healthcare professionals, patients, or families were not included.

Despite these limitations, the findings contribute important insights into the current state of TIC in pediatric oncology wards and underscore the critical need for systemic support to enhance trauma-informed nursing care. Future research should explore multi-professional perspectives on TIC in pediatric oncology and assess the outcomes of TIC implementation on patient satisfaction, provider well-being, and care quality. Quantitative studies evaluating the effectiveness of trauma screening tools and TIC interventions in pediatric populations would also contribute to the evidence-based integration of trauma-informed practices in clinical settings.

CONCLUSION

This study highlighted the lived experiences of pediatric oncology nurses providing TIC in clinical environments

where formal TIC structures were absent. Despite these structural limitations, nurses actively recognized the traumatic nature of childhood cancer and attempted to advocate for patient well-being within constrained systems. Findings emphasized the critical need for institutional-level trauma awareness, routine trauma screening, and interprofessional support systems to mitigate trauma exposure in both patients and healthcare providers. Without such efforts, trauma responses remain unrecognized, and both children and staff are placed at increased psychological risk.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: all authors. Methodology: KB, YJ. Software: none. Validation: all authors. Formal analysis: KB, YJ. Investigation: all authors. Resources: KB. Data curation: all authors. Writing–original draft: KB, YJ. Writing–review & editing: all authors. Visualization: none. Supervision: KB. Project administration: KB. Funding acquisition: none. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

The dataset generated and analyzed during the current study are not publicly available due to confidentiality; de-identified excerpts may be available from the corresponding author upon reasonable request, subject to IRB approval.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this manuscript, the authors used ChatGPT (OpenAI, GPT-5.6 Sol version) for English language editing and grammar checking. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

ORCID and ResearcherID

Kyung-Sook Bang https://orcid.org/0000-0001-9902-9716
https://researcherid.com/rid/D-5780-2012
Yeseul Jeong https://orcid.org/0000-0003-4369-0446
https://researcherid.com/rid/JHT-8886-2023
Ji-Hye Choe https://orcid.org/0000-0002-8229-4086
https://researcherid.com/rid/KZU-5098-2024
Sinyoung Choi https://orcid.org/0000-0001-6539-4475
https://researcherid.com/rid/LNQ-8163-2024

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Caregivers' experiences of PM2.5 prevention for preschool children in Thailand: a qualitative study with focus group interviews

Kesinee Imman[1], Jutamas Ponmark[2], Surachai Wongcharee[3], Saksit Imman[4]

[1]Lecturer, Department of Nursing, School of Nursing, University of Phayao, Phayao, Thailand
[2]Assistant Professor, Department of Nursing, School of Nursing, University of Phayao, Phayao, Thailand
[3]Assistant Professor, Field of Environmental Engineering, Faculty of Engineering, Mahasarakham University, Maha Sarakham, Thailand
[4]Associate Professor, School of Energy and Environment, University of Phayao, Phayao, Thailand

Corresponding author
Kesinee Imman
Department of Nursing, School of Nursing, University of Phayao, Phayao 56000, Thailand
Tel: +66-54-466-666 (Ext. 3126)
Fax: +66-54-466-313
E-mail: kesinee.kh@up.ac.th

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Purpose: This study explored caregivers' lived experiences and everyday practices related to preventing exposure to particulate matter ≤2.5 μm (PM2.5) among preschool children in a rural community in northern Thailand. Recurring haze and limited local resources create distinct challenges in this setting, making it important to understand how caregivers perceive air-quality risks and manage children's exposure in daily life.
Methods: This qualitative descriptive study used focus group interview supplemented by in-depth interviews. Twenty primary caregivers of preschool-aged children (14 females and 6 males) participated. Data were collected with a semi-structured interview guide and analyzed using qualitative content analysis based on the approach described by Graneheim and Lundman.
Results: Three major themes emerged from the analysis: (1) barriers in environmental awareness and responsibility, reflecting tensions between pervasive local pollution sources and caregivers' sense of helplessness; (2) individual efforts for disease prevention, describing caregivers' limited resources and reliance on visible symptoms rather than proactive prevention; and (3) building empathy and social support, indicating a shift from individual coping toward collective efforts to pursue education and structural change.
Conclusion: Reliance on reactive coping strategies highlights the limitations of individual-level prevention when infrastructure gaps remain. Effective interventions should therefore combine caregiver health literacy with advocacy for improved waste management policies. These findings underscore the need to move beyond placing responsibility primarily on families and toward strengthening community-level structural support for sustainable child protection.

Keywords: Air pollution; Caregivers; Focus groups; Particulate matter; Preschool child

INTRODUCTION

The health effects of fine particulate matter (PM2.5), airborne particles with an aerodynamic diameter of ≤2.5 μm, are a major global environmental health issue, with strong scientific evidence showing that they can cause both short- and long-term problems [1,2]. The World Health Organization (WHO) states that PM2.5 is a group 1 carcinogen [3]. More than 99% of the global population live in places where PM2.5 levels are higher than the recommended air quality

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standards. Air pollution causes more than 4.2 million deaths annually, including approximately 700,000 deaths among children aged <5 [2,4], making it one of the major environmental risk factors for diseases worldwide.

Northern Thailand has had a long history of poor air quality [5]. The primary sources of this pollution include regional open burning of agricultural wastes [6] and emissions from household activities [7]. Prolonged exposure to PM2.5 concentrations that significantly surpass the safe annual limit set by the WHO [2] creates a very unhealthy environment. This scenario is particularly dangerous for vulnerable groups, including young children, as it increases their risk of adverse respiratory and other health effects [1,4,8]. Children are at higher risk because they breathe more rapidly relative to their body weight, their immune systems are still developing, and their thin skin facilitates the absorption of pollutants. These factors hinder the development of the lungs [9], brains, and immune system [10], with both immediate and long-term health consequences [2].

Preschool-aged children who are exposed to PM2.5 are more likely to develop asthma, acute respiratory infections, and allergies [1,2,9]. A review emphasized the adverse effects of air pollution on brain development [11], and Sun et al. [12] discovered that PM2.5 exposure adversely affects physical growth of children aged 1–6 years. Long-term exposure has also been linked to cognitive deficits, neurological conditions, and increased risk of cancer. Exposure to high PM2.5 levels was linked to lower IQs (intelligence quotients) and higher risks of depression and anxiety in children [13] and suicidal thoughts in school-aged children and adolescents. Prenatal exposure to PM2.5 was found to be associated with an increase in immunoglobulin E levels and allergy susceptibility in progeny [14].

Despite reports of the health effects of PM2.5 exposure in children, relatively little is known about caregivers' experiences and perceptions regarding PM2.5 exposure prevention, particularly for preschool-aged children who rely on adults for daily care and protection. Caregivers are key in shaping children's health-related practices, such as decisions regarding outdoor activities, use of protective measures, interpretation of air quality information, and modifications to the home environment. Previous studies have highlighted the importance of environmental health literacy and preventive behaviors among caregivers [15-17]. However, factors that influence these behaviors, such as knowledge, risk perception, and contextual barriers, remain insufficiently understood in the Thai context, where recurrent PM2.5 pollution continues to pose a significant public health challenge [18,19].

A study in a northern Thai community found that caregivers demonstrated moderate levels of environmental health literacy and PM2.5 preventive behaviors. The study revealed that high educational attainment correlated positively with both literacy and protective behaviors. However, caregivers of healthy children were less likely to take preventive steps, suggesting that their actions were more often a response to visible health problems than a proactive awareness of risks [15]. Although these findings provide significant statistical insights, they do not capture the underlying motivations, contextual limitations, or complex experiences that influence caregivers' behavior in daily life.

This study was conducted specifically to explore the lived experiences, motivations, and contextual barriers of caregivers in preventing PM2.5 exposure among preschool-aged children—nuances that quantitative measures, such as environmental health literacy scores, cannot capture. A qualitative approach is essential because numerical data provide statistical associations but do not reveal the subjective meanings, daily decision-making processes, and cultural influences shaping behaviors in the context of pollution in northern Thailand. Grounded in interpretivism, this study posits that caregivers' realities are constructed socially, aligning with our goal of exploring their unique perceptions to inform tailored interventions.

METHODS

Ethical statements: This study was approved by the University of Phayao Human Ethics Committee (approval no. UP-HEC 1.2/060/65). Written informed consent was obtained from all participants prior to data collection.

1. Study Design

A qualitative descriptive approach was employed to capture caregivers' experiences. This study was reported in accordance with the Consolidated Criteria for Reporting Qualitative Research reporting guidelines. This approach was selected because it facilitates straightforward, low-interpretive exploration of experiences and perspectives while providing sufficient depth to understand how caregivers make sense of PM2.5 in their daily lives. This design was also appropriate because caregivers' accounts were expected to be practical,

context-bound, and closely tied to everyday routines rather than deeply abstract narratives.

To guide the analytical process, qualitative content analysis following the approach described by Graneheim and Lundman [20] was adopted, which allows for both manifest content (what was said directly) and latent content (underlying meanings inferred from the data). This analytic framework aligned with the study's goal of understanding caregivers' lived experiences in a nuanced yet accessible way.

2. Setting and Participants

The study was conducted in a rural community in northern Thailand that experiences recurring seasonal haze. This setting was selected because prolonged exposure to PM2.5 is a well-recognized issue in the area, and families with young children face ongoing challenges in managing air-quality risks.

Purposeful sampling was employed to recruit primary caregivers of preschool-aged children from a local childcare center. Eligible participants were responsible for the children's daily care and health-related decision-making. The goal was not to achieve demographic representation but to gather information-rich participants who regularly cared for preschool children during haze periods.

Twenty caregivers participated in the study. Participants varied in age, education, occupation, household structure, and previous encounters with pollution-related illness. Caregivers aged ≥18 years who could communicate in Thai and were responsible for the daily care and decision-making related to the health and well-being of preschool children were included. No participants withdrew from the study. Caregivers who did not provide direct care or had limited involvement in children's daily routines were excluded. Participant recruitment and data analysis occurred concurrently. Recruitment continued until data saturation was achieved. No new categories or themes emerged after the third focus group discussion and supplementary individual interviews, resulting in a final sample of 20 caregivers.

3. Data Collection

Data were collected between February and April 2023 through semi-structured focus group interviews (FGIs), supplemented by brief follow-up individual interviews. Three FGIs were conducted, each consisting of 6–7 participants. To encourage open discussion, groups were organized based on caregiving roles, such as parents and grandparents. Each session lasted approximately 40–60 minutes and was held in a private room at a childcare center.

The interview guide was developed to explore caregivers' experiences with preventing exposure to PM2.5 in everyday life. The questions were informed by the concept of environmental health literacy and focused on caregivers' perceptions of air pollution, access to information, and practices for protecting children from PM2.5 exposure. The interview questions were reviewed by experts to ensure clarity and relevance.

Examples of guiding questions included the following: (1) How do you perceive the PM2.5 situation in your community, and how does it affect your children? (2) What do you usually do to protect your child during periods of high PM2.5 levels? (3) How do you access information about PM2.5, and which sources do you rely on? (4) How do you decide what actions to take when PM2.5 levels are high? (5) What challenges do you face in preventing exposure?

To deepen the understanding of emerging insights, follow-up individual interviews (10–15 minutes each) were conducted with selected participants after the FGIs. These interviews provided an opportunity to explore sensitive experiences or clarify points that were touched upon only briefly during the FGIs. All interviews were audio-recorded, conducted in Thai, and supported by field notes capturing nonverbal expressions and contextual observations. Data collection continued until no new themes emerged, indicating data saturation.

Participants were informed of their right to withdraw from the study at any time without consequence. All procedures were conducted following the principles of the Declaration of Helsinki.

4. Data Analysis

Data analysis was conducted using qualitative content analysis according to the approach by Graneheim and Lundman [20]. Audio recordings were transcribed verbatim in Thai, and the researchers read each transcript repeatedly to obtain a sense of the whole. Meaning units relevant to the research question were then identified, condensed, and coded manually to allow close engagement with the data. Codes with similar content were grouped into preliminary categories. Categories with related meanings were organized into

subthemes, and these subthemes were further abstracted into overarching themes that captured both manifest and latent meanings in participants' accounts. Throughout the analysis, the research team met regularly to discuss and refine codes, categories, and themes to ensure that they accurately reflected the participants' experiences.

5. Trustworthiness

Trustworthiness was strengthened through several strategies aligned with the criteria proposed by Lincoln and Guba [21]. Credibility was enhanced through the triangulation of data from the FGIs, individual interviews, and field notes. In addition, participants were invited to confirm the accuracy of preliminary interpretations during informal follow-up conversations, supporting member checking.

Transferability was facilitated by providing "thick descriptions" of the research context and participants, enabling readers to assess the applicability of the findings to other contexts.

Dependability was established through a comprehensive audit trail documenting interview guides, coding records, and key analytical decisions.

Confirmability was strengthened through regular reflexive team meetings to mitigate researcher bias, alongside an external audit of the analytic process by an experienced qualitative researcher.

RESULTS

1. Participant Characteristics

The study comprised 20 primary caregivers of preschool children residing in northern Thailand; 14 were female (70%), and 6 were male (30%). All participants were Thai, aged 19–67 years (mean age, 41.15 years). Half of the participants identified themselves as either fathers or mothers. Among these participants, only 5 possessed a bachelor's degree or a higher level of education (Table 1).

Table 1. General characteristics of the study participants (N=20)

Characteristic	Value
Age (yr)	41.15±14.86 (19–67)
Sex	
Female	14 (70.0)
Male	6 (30.0)
Relationship to the child	
Parents	10 (50.0)
Grandparents	6 (30.0)
Other relatives	4 (20.0)
Educational attainment	
Primary	3 (15.0)
Secondary/vocational	12 (60.0)
Bachelor's degree or higher	5 (25.0)

Values are presented as mean±standard deviation (range) or number (%).

2. Data Analysis Results

Analysis of focus group dialogues and in-depth interviews was conducted using the qualitative content analysis approach described by Graneheim and Lundman [20], which led to the identification of 3 key themes that capture the latent meanings embedded in caregivers' lived experiences. The results delineate a spectrum from the identification of environmental deficiencies (barriers), negotiation of personal behaviors (attempts), and pursuit of community-based solidarity (social support). The 3 themes included (1) barriers in environmental awareness and responsibility, (2) individual efforts for disease prevention, and (3) building empathy and social support. The contents of the themes and subthemes are shown in Table 2.

1) Theme 1: Barriers in environmental awareness and responsibility

This theme identifies the tension of caring for vulnerable children within a deteriorating environment while lacking the tools to manage it. It bridges the manifest content of waste-burning practices with the latent feeling of helplessness, in which caregivers struggle to understand how to effectively prevent exposure.

(1) Subtheme 1.1: Neglecting community eco-responsibility

Respondents described a community with local lifestyle habits that amplify air pollution. Given the lack of infrastructure, the latent meaning implies an "unavoidable exposure." Caregivers described how the absence of municipal waste collection forces neighbors to burn garbage openly. "There is no garbage truck collection. Almost every house burns or buries their trash," as one grandfather put it (ID16). Similarly, a relative (ID5) explained, "I think a lot of dust comes from open burning of waste because there aren't any factories in close proximity." In this view, caregivers do not see pollution as a distant industrial problem but as a local com-

Table 2. Caregivers' perspectives and experiences on PM2.5 prevention for preschool children

Theme	Subthemes
Barriers in environmental awareness and responsibility	- Neglecting community eco-responsibility
	- Lack of knowledge regarding prevention methods
Individual efforts for disease prevention	- Acquisition of knowledge about air pollution
	- Management of children's health practices
Building empathy and social support	- Education for fostering community cooperation
	- Policy changes for environmental improvement

PM2.5, particulate matter ≤2.5 μm.

munity failure—one not within their individual ability to change.

(2) Subtheme 1.2: Lack of knowledge regarding prevention methods

This subtheme recasts caregivers' reactiveness as a fundamental gap in preventive knowledge. Initially appearing simply "reactive," the analysis reveals that caregivers often lacked the knowledge to prevent harm before it happened. Actions were frequently driven by symptoms, based on the misconception that "no symptoms" meant "no danger": "When the dust is down... the kids had no symptoms, and [so] they got on with their lives as usual," a grandfather remarked (ID17). Action was taken only when symptoms became severe: "My child… had burning eyes… I had to take them down to stay at their grandparents' home" (father, ID14). This points to a critical cognitive gap: prevention was understood as symptom management rather than avoiding exposure entirely.

2) Theme 2: Individual efforts for disease prevention

Transitioning from the external environment to the 'self,' this theme represents the struggling agency of the caregivers. It depicts how parents and relatives navigate information barriers and convert limited knowledge into everyday health behaviors for their children.

(1) Subtheme 2.1: acquisition of knowledge about air pollution

Caregivers employed various methods of collecting information, many of which were passive. The experience described was one of "waiting for authority." Although few used digital tools (Air4Thai), many of them were dependent on village broadcasts or public knowledge, suggesting that their attempt to learn is not of a free and independent nature: "The best news is waiting for it to be announced on TV… getting to rural populations like us well is through Village Health Volunteers," a grandfather declared (ID16). This need for external reminders indicates that individual actions tend to occur only when supported by cultural or media cues, which may delay timely preventive intervention.

(2) Subtheme 2.2: Management of children's health practices

This subtheme encompasses the everyday, practical "lived experience" of handling a child's health during pollution. It exposes the tradeoffs that caregivers make between health preservation, economic cost, and security for children. Closing windows, utilizing fans instead of expensive air purifiers, and the struggle to enforce mask-wearing were among the various interventions. A mother (ID19) reported her intensive management schedule for a fragile child: "I have to keep my child in a room… where they eat, sleep, and play." However, for many participants, economic concerns hampered such attempts: "The price of masks is an issue... so I shut the doors and let them play indoors with a fan" (mother, ID10). This highlights that "management" extends beyond making health-related decisions.

3) Theme 3: Building empathy and social support

The final theme describes caregivers' latent yearning for sustainable solutions. It extends beyond individual coping toward a collective desire for efficacy and systemic support.

(1) Subtheme 3.1: Education for fostering community cooperation

The analysis revealed that participants aspired to be more than passive learners; they sought an active role in shaping the direction of education to foster community collaboration from the ground up. Caregivers emphasized the need to integrate environmental responsibility into early childhood development. Invoking a traditional proverb, one mother pleaded, "As the twig is bent, so grows the tree… Teachers must teach and guide the children" (mother, ID18). The same participant further added, "We can disseminate accurate knowledge to the community… ensuring it is based on cor-

rect information" (mother, ID18). This illustrates caregivers' perspective that knowledge is a vital tool for fostering community engagement, serving as a catalyst to transform future behaviors.

(2) Subtheme 3.2: Policy changes for environmental improvement

Ultimately, individual empathy translated into a prescription for policy reform. Caregivers articulated that without structural changes—specifically regarding waste management infrastructure—empathy alone remains insufficient. Participants distinguished between interpersonal conflict (blaming neighbors) and the systemic failure of public services: "I want to see waste management like many other communities have," a relative stated (ID5). While acknowledging the economic barriers to policy implementation, such as collection fees, the consensus was unequivocal: "Local agencies should use relevant policy measures" (mother, ID13). This subtheme highlights a critical shift: moving away from solitary coping mechanisms toward a collective demand for political and structural accountability.

DISCUSSION

This study provides insights into how caregivers in rural settings manage PM2.5 exposure as part of their everyday lives. Rather than focusing only on knowledge, caregivers continually make practical decisions under uncertain conditions, often with limited control over their surrounding environment. Although many expressed a desire to protect their children, they were unsure about when and how to act. Their responses reflect a balance between awareness, available resources, and structural constraints that shape daily caregiving practices.

One clear pattern was that caregivers relied on visible signs, such as haze or children's symptoms, to decide when to take action. This "wait-and-see" approach has been widely reported, as people respond more strongly to observable cues than to abstract risk information [22]. However, in this study, the reliance on visible cues also reflected a perceived mismatch between available air quality data and the conditions in their immediate environment. Consequently, caregivers were less confident in using available information when making decisions. From the perspective of the health belief model, perceived susceptibility remains limited when risks are not experienced as immediate or relevant [23].

Compared with studies in urban settings, where digital tools and real-time air quality monitoring are more accessible, respondents of the present study relied more on informal communication channels, such as community announcements and interpersonal exchanges. These differences highlight how access to information influences preventive behavior. Similar patterns have been observed in studies of environmental health literacy in which trust in information sources plays a key role in shaping responses to air pollution [16,17]. This finding suggests that effective communication strategies should focus on not only providing data but also ensuring that the information is locally meaningful and trusted.

The respondents had already adopted various coping strategies, such as keeping children indoors, adjusting daily routines, and modifying home environments to reduce exposure. However, these measures were often limited by financial constraints, housing conditions, and children's comfort. Similar challenges were reported in a previous study, which showed that individual-level strategies are constrained by environmental and structural factors [24]. Within the health belief model, these findings reflect a gap between perceived benefits and self-efficacy. Although caregivers understand the risks, they may find it difficult to implement the recommended measures consistently. This highlights the need for practical, low-cost interventions that are feasible in resource-limited settings. Differences in caregiving roles and resource availability may also influence how these strategies are applied in practice.

The findings also suggest that caregivers increasingly view PM2.5 as a shared community problem rather than an individual issue. Many participants felt that their efforts would have limited impact if others in the community continued activities such as open burning. This finding reflects broader evidence that household and community practices contribute significantly to ambient air pollution [7]. Studies in Thailand have also demonstrated that community networks and local health volunteers play important roles in supporting environmental health behaviors [16,17]. Our findings extend this by showing that caregivers view community spaces, such as childcare settings, as potential entry points for building shared awareness and cooperative action.

Moreover, structural constraints were repeatedly emphasized, particularly the lack of effective waste management systems. Several participants explained that open burning was often unavoidable because of limited alternatives. This finding is consistent with regional evidence showing that ag-

ricultural burning and household waste practices are major contributors to air pollution in northern Thailand [6]. Policy-level responses, particularly improvements in waste management and air quality control, have been identified as essential in previous studies [25,26] and are strongly supported by the experiences described by participants in this study. This highlights how structural constraints limit the effectiveness of individual-level prevention efforts.

Overall, these findings provide a context-specific understanding of how caregivers in rural and resource-limited settings interpret and respond to PM2.5 risks in their daily lives. Although previous research has often focused on health outcomes or individual-level behaviors [15], the present study highlights how caregivers' decisions are shaped by the interaction between knowledge, available resources, and community conditions. These results underscore the importance of integrating health education with practical support and community engagement to improve PM2.5 exposure prevention among young children.

Future research could further explore how caregivers' responses vary across different household conditions or caregiving roles and how daily routines influence exposure management. In addition, intervention studies that integrate localized air quality information with community-based strategies may help identify more effective approaches to reducing children's exposure.

This study has some limitations. The findings are based on a specific rural context and participants were recruited from a single childcare center, which may limit the transferability of the findings to other settings. Although the center serves families from multiple surrounding communities, the perspectives captured may not represent all caregiver experiences in different contexts. The study focused on primary caregivers of preschool children and did not include perspectives of other family members or stakeholders who may also influence child health practices. In addition, the reliance on self-reported experiences may not fully reflect actual practices. Future research involving multiple sites and incorporating objective environmental measurements may provide a more comprehensive understanding of PM2.5 exposure and prevention behaviors.

CONCLUSION

The findings highlight that caregivers in rural and resource-limited settings often rely on symptom-based responses rather than take proactive prevention measures when managing PM2.5 exposure in preschool children. Their actions were shaped by limited resources, incomplete knowledge, and environmental constraints. These findings suggest the need for practical and context-appropriate strategies, such as accessible information and feasible daily practices. Community cooperation may also support behavioral change. At the policy level, improving waste management systems is essential, as structural limitations directly affect caregivers' ability to reduce exposure to PM2.5.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: KI. Methodology: KI. Software: none. Validation: SW. Formal analysis: KI. Investigation: KI, JP. Resources: SW. Data curation: JP. Writing–original draft: KI. Writing–review & editing: KI, JP. Visualization: none. Supervision: SI. Project administration: SI. Funding acquisition: none. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

Please contact the corresponding author for data availability.

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Microsoft Copilot (Microsoft Corporation, web-based version) was used to assist with English language editing, grammar checking, and improvement of manuscript readability

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Microsoft Copilot (Microsoft Corporation, web-based version) and Grammarly for language editing and manuscript refinement. After using these tools, the authors carefully reviewed and edited the manuscript as needed and assumed full responsibility for the content of the published article.

ORCID and ResearcherID

Kesinee Imman https://orcid.org/0000-0002-1476-4728
https://researcherid.com/rid/IUM-8936-2023
Jutamas Ponmark https://orcid.org/0000-0002-7135-1233
https://researcherid.com/rid/LUY-7113-2024
Surachai Wongcharee
https://orcid.org/0000-0002-5687-4562
https://researcherid.com/rid/AAP-4334-2021
Saksit Imman https://orcid.org/0000-0002-1149-1277
https://researcherid.com/rid/QWD-6036-2026

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Effects of nursing work environment, professional autonomy, and organizational commitment on retention intention among pediatric inpatient unit nurses in South Korea: a descriptive cross-sectional study

Heejin Han[1], Hyewon Shin[2]

[1]Graduate Student, College of Nursing, Ewha Womans University, Seoul, Korea
[2]Associate Professor, College of Nursing, Ewha Womans University, Seoul, Korea

Corresponding author
Hyewon Shin
College of Nursing, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul 03760, Korea
Tel: +82-2-3277-3305
E-mail: hyeshin@ewha.ac.kr

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Purpose: Nurse retention remains a critical workforce challenge; however, evidence on retention intention among pediatric nurses remains limited. This study examined the levels of nursing work environment, professional autonomy, and organizational commitment among pediatric inpatient unit nurses and assessed their effects on retention intention.

Methods: This descriptive cross-sectional study included 50 pediatric nurses from a tertiary hospital in South Korea. Data were collected through an online survey between November 2025 and January 2026. Nursing work environment, professional autonomy, organizational commitment, and retention intention were measured using validated instruments. Data were analyzed using descriptive statistics, the t-test, analysis of variance, Pearson correlation coefficients, and bootstrap multiple linear regression in IBM SPSS ver. 29.0.

Results: The mean scores were 2.24±0.48 for nursing work environment, 3.64±0.44 for professional autonomy, 2.91±0.64 for organizational commitment, and 5.03±1.49 for retention intention. Organizational commitment showed a moderate positive correlation with retention intention. The regression model including organizational commitment explained 37% of the variance in retention intention (adjusted R^2=.37). Organizational commitment was the strongest predictor, followed by educational level; nurses with master's degrees had lower retention intention than those with bachelor's degrees.

Conclusion: Organizational commitment was the strongest predictor of retention intention among pediatric inpatient unit nurses. Organizational strategies that strengthen commitment may help improve pediatric nurse retention. In addition, a clinical ladder system for highly educated and experienced nurses, together with policies reflecting the distinctive demands of pediatric care, may be needed to support a sustainable nursing workforce.

Keywords: Nurses; Pediatric nursing; Personnel turnover

INTRODUCTION

As health systems worldwide face difficulties in securing and retaining a skilled workforce, stabilizing the nursing workforce is essential and a top priority for meeting healthcare demands [1]. In Korea, the resignation rate within the first year among newly hired nurses was high at 52.4% in 2023 [2]. This figure indicates that securing nursing person-

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nel alone is insufficient to resolve workforce shortages in clinical settings. A high resignation rate among newly hired nurses not only results in a loss of personnel but also hinders the progression of new nurses into experienced roles, thereby threatening the sustainability of nursing services [3]. This instability adversely affects patient safety, quality of nursing services, and organizational efficiency [4]. Thus, there is an urgent need for strategies to enhance nurse retention and increase nurses' retention intention.

This instability in the nursing workforce is more pronounced in pediatric inpatient units. A domestic study revealed that pediatric unit nurses exhibited a higher turnover intention compared to their counterparts in adult units, although this difference did not achieve statistical significance [5]. In China, over 36% of pediatric nurses exhibited a low level of retention intention [6]. Even among those with moderate or higher retention intention, there was a significant inclination to consider resignation if alternative job opportunities arose, indicating that the retention status of the pediatric nursing workforce is potentially vulnerable and unstable [6].

This vulnerability is fundamentally rooted in the distinctive nature of pediatric nursing, which is characterized by 'dual care' [5,7]. Unlike adult nursing, pediatric care involves guardians as both the focus and partners of care, deeply engaged in the treatment planning process [8]. Consequently, professional autonomy for nurses in pediatric inpatient units should extend beyond simple clinical judgment to include the ability to negotiate and coordinate therapeutic interventions based on trust with parents [9]. In their role, nurses must manage the emotions of both children and guardians, even during routine procedures [5]. Establishing nurse-parent partnerships is thus a critical factor that alleviates nurses' stress and enhances their intention to remain in their positions [6].

In this context, the nursing work environment emerges as a crucial indicator of pediatric nursing quality, extending beyond mere work convenience [8]. The work environment in pediatric inpatient units is often perceived as inadequate due to the dual care demands and high workloads, which significantly undermine nurses' retention intentions [5,7,9]. Specifically, within the unique setting where guardians are present 24 hours a day as partners in care [7], insufficient staffing shifts the professional nursing responsibilities to parents, resulting in guardians' dissatisfaction and complaints [8]. This situation places nurses at the center of conflict, leading to emotional exhaustion and increased turnover intention [7,8].

Along with the institutional environment, professional autonomy constitutes another critical factor essential for sustaining pediatric nursing work. The essence of pediatric nursing lies in the advocate role, which entails choosing interventions suitable for the patient's developmental stage and offering education and counseling in collaboration with parents [9]. However, when an overwhelming workload compels nurses to focus on functional tasks [10], it restricts their ability to apply judgment, creating professional skepticism that ultimately threatens retention [7,10].

Furthermore, organizational commitment serves as a core determinant of workforce stability. A profound conflict between the core philosophy of family-centered care and harsh organizational realities often diminishes this commitment [10]. When organizational support falls short of upholding professional values, nurses struggle to identify with the organization, leading to a decline in commitment that ultimately becomes a critical barrier to workforce retention [11]. Therefore, understanding the factors that influence pediatric inpatient nurses' retention intentions, while considering the unique aspects of pediatric units, is crucial for enhancing the health of pediatric patients and advancing the professional competence of pediatric nursing.

To establish a clear conceptual foundation for evaluating these relationships, the major variables in this study are defined within the specific context of pediatric nursing. First, the nursing work environment refers to the organizational and environmental factors that are adjustable at the unit level to facilitate professional practice. Professional autonomy denotes the nurses' independent judgment and practice behaviors based on their specialized knowledge. Furthermore, organizational commitment reflects the nurses' professional attitude of dedication and their psychological intention to remain with their current institution. Ultimately, these organizational and professional factors are anticipated to be closely linked to retention intention, which is defined as the conscious intention and deliberate plan of nurses to continue working.

Previous studies concerning pediatric inpatient unit nurses have predominantly examined negative outcomes such as burnout, job stress, or turnover intention in relation to individual factors [5,7]. To date, however, few studies have directly investigated the predictors of retention intention among pediatric nurses. In contrast, research in adult inpatient settings has consistently demonstrated that a favorable nursing work environment, higher professional autonomy,

and stronger organizational commitment serve as crucial positive determinants that significantly increase nurses' retention intention [12,13]. While these adult-focused studies have firmly established these positive relationships, there remains limited understanding of the specific individual influences of these 3 critical factors within the unique context of pediatric units, where dual care is crucial and guardians actively participate in care. Addressing this gap, the present study examined the individual influences of the nursing work environment, professional autonomy, and organizational commitment on retention intention among nurses in pediatric inpatient units and proposed a model to clarify retention intention. The findings lay the groundwork for practical workforce retention strategies that take into account the specific characteristics of pediatric inpatient units and their relational and emotional demands.

METHODS

Ethical statement: This study was approved by the Institutional Review Board (IRB) of Seoul National University Hospital (IRB No. 2510-059-1681). Informed consent was obtained from all participants.

1. Study Design

This descriptive cross-sectional study was conducted to identify the individual effects of nursing work environment, professional autonomy, and organizational commitment on retention intention among nurses in a pediatric inpatient unit. The reported study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines [14].

2. Participants

Participants were recruited through convenience sampling at Seoul National University Hospital. Eligible participants were nurses who (1) had at least 6 months of clinical practice in pediatric inpatient units (pediatric wards, pediatric medical respite care wards, neonatal, and pediatric intensive care units), (2) provided direct nursing care to pediatric patients, and (3) provided informed consent to participate in the study. Personnel without direct patient care, such as nurses in dedicated non-bedside roles (e.g., physician assistant roles) and nurse managers, were excluded. The employment criterion was set at 6 months in accordance with previous studies that regarded 6 months as the minimum period for adaptation and stabilization [7,15].

To estimate the minimum sample size, G*Power ver. 3.1.9.7 (Heinrich-Heine-Universität Düsseldorf) was utilized. Based on a multiple linear regression analysis (fixed model, R^2 deviation from zero) and considering the nurse staffing dynamics and the specialized clinical environment of pediatric inpatient units at the participating institution, the parameters were set at a significance level (α) of .05, a statistical power (1–β) of .70, and an effect size (f^2) of .20. Using 8 predictive variables (age, educational level, marital status, total clinical experience, work type, nursing work environment, professional autonomy, and organizational commitment), the minimum required sample size was 70. However, this study was limited to nurses in a specific specialty, and practical constraints existed, such as the participation burden owing to previous studies conducted within the same institution. To optimize model stability within a feasible sample size, 3 separate regression models were specified a priori using 4 predictors per model: 3 general characteristics (total clinical experience, marital status, and educational level) and 1 of the 3 primary research variables (nursing work environment, professional autonomy, and organizational commitment). The minimum sample size required for this study was 54.

Although 55 participants were initially recruited, a total of 50 pediatric nurses were included in the analysis after excluding cases with insincere responses (n=1), duplicate responses (n=1), and ineligibility based on the inclusion criteria (n=3). Given the specialized nature and relatively limited staffing pool of pediatric inpatient nurses in the participating institution, every effort was made to recruit the largest possible sample within practical constraints, despite not reaching the initial target size.

All instruments used in this study were used with prior permission.

3. Variables and Measurement Instruments

1) General characteristics

Data on participants' age, educational level, total clinical experience, marital status, work type, and work unit were collected. Sex data were not collected in this study as the research focused on organizational and work environment factors among pediatric nurses within specific units, where gender-based subgroup analysis was not a primary research ob-

jective. Consequently, sex-disaggregated analyses were not performed.

2) Nursing work environment

In this study, the nursing work environment referred to organizational and environmental factors that were adjustable at the unit. The participants' perceptions of the nursing work environment were evaluated using the Korean version of the Practice Environment Scale of the Nursing Work Index, which was adapted to the Korean context and validated for reliability and validity [16,17]. The instrument comprises 29 items scored on a 4-point Likert scale. Higher item-mean scores indicate a more favorable perception of the nursing work environment. The original instrument demonstrated internal consistency of Cronbach's α=.82 [16], and the Korean adaptation reported Cronbach's α=.93 [17]. The reliability in this study was confirmed with Cronbach's α=.94.

3) Professional autonomy

Professional autonomy in this study denotes independent judgment and practice behaviors grounded in professional knowledge. The participants' perceptions of professional autonomy were assessed using the Korean version of the Dempster Practice Behavior Scale. This instrument was initially developed by Dempster [18] and translated into Korean by Kim and Ha [19]. The instrument consists of behavior-based items including responsibility, autonomous decision making, regulation of environment and situation, and the practical application of professionalism. The instrument comprises 30 items rated on a 5-point Likert scale. Higher item-mean scores indicate a higher level of professional autonomy. The original instrument demonstrated internal consistency of Cronbach's α=.95 [18], and the Korean version reported Cronbach's α=.92 [19]. The reliability of the instrument in this study was confirmed with Cronbach's α=.92.

4) Organizational commitment

In this study, organizational commitment is defined as the intention to remain with the organization and an attitude of dedication to it. Organizational commitment was evaluated using the Organizational Commitment Questionnaire originally developed by Mowday et al. [20], translated into Korean by Lee [21], and modified by Jang [22]. The instrument comprises 11 items rated on a 5-point Likert scale. Higher item-mean scores indicate a stronger level of organizational commitment. The original instrument demonstrated internal consistency of Cronbach's α=.90 [20], and the Korean version reported Cronbach's α=.89 [22]. The reliability of the instrument in this study was confirmed with Cronbach's α=.86.

5) Retention intention

Retention intention in this study refers to the intention and plan to continue working as a nurse. Retention intention was evaluated utilizing the Korean version of the Nurses' Retention Index [23,24]. The instrument comprises 6 items rated on an 8-point Likert scale. Higher item-mean scores represent greater retention intention in the present nursing position. Internal consistency has been reported as Cronbach's α=.97 for the original instrument [23] and Cronbach's α=.92 for the Korean version [24]. The reliability of the instrument in this study was confirmed with Cronbach's α=.92.

4. Data Collection

Data were collected from November 10, 2025, to January 31, 2026. After approval was obtained from the Institutional Review Board of Seoul National University Hospital, prior authorization was secured from the Nursing Department. A study announcement was posted on the hospital intranet board and staff breakrooms. The announcement described the study purpose, eligibility criteria, and participation procedures and provided an online survey link with a quick-response (QR) code.

Upon accessing the link, participants were first directed to a page containing a detailed study explanation, which outlined the research purpose, procedures, potential risks and benefits, and the freedom to withdraw from the study at any time without penalty. Participants were required to provide electronic informed consent by clicking an agreement button before they could proceed to the structured questionnaire. To guarantee the anonymity and privacy of the respondents, the online survey system was strictly configured not to collect any identifiable information (such as names or email addresses) or network Internet Protocol addresses.

As a token of appreciation, a small reward was offered, and mobile phone numbers for this purpose were collected at the end of the same online survey form. To strictly maintain participant anonymity, the collected phone numbers were immediately separated from the survey response dataset prior to data analysis. Furthermore, all collected phone numbers were permanently deleted immediately after the rewards were distributed. All remaining survey data were au-

tomatically assigned unique identification numbers, securely encrypted, and stored on a password-protected storage device accessible only to the primary researcher. Participation was entirely voluntary, and respondents were instructed to complete the survey during their off-duty hours.

5. Data Analysis

All statistical analyses were conducted utilizing IBM SPSS Statistics for Windows ver. 29.0 (IBM Corp.). The general characteristics of the participants and the primary variables were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. Differences in retention intention according to general characteristics were examined using independent t-tests or one-way analysis of variance. Specifically, the "work unit" variable was reclassified into 2 groups (general wards and intensive care units) to account for the sample distribution. The relationships between continuous variables (age and total clinical experience) and retention intention and the correlations among the primary variables were analyzed using Pearson's correlation coefficients. To identify the factors influencing retention intention, 3 separate multiple linear regression analyses were performed. Prior to running the regression analyses, the basic statistical assumptions–including normality, homoscedasticity, independence of residuals (Durbin-Watson test), and multicollinearity (tolerance and variance inflation factor)-were evaluated across all 3 regression models to ensure model validity. Categorical demographic variables (marital status and educational level) were dummy coded for inclusion in the regression models. To address the limitations posed by the relatively small sample size and to ensure the stability and robustness of the regression coefficients, bootstrapping with 5,000 resamples was employed.

All statistical tests were 2-tailed with a significance level of $\alpha = .05$. In accordance with reporting guidelines, unstandardized regression coefficients (B), standard errors (SE), 95% confidence intervals (CIs), standardized coefficients (β), and effect sizes (R^2, adjusted R^2) were reported.

RESULTS

1. General Characteristics of the Participants

The mean age of the participants was 32.7 years, and the mean total clinical experience was 9.5 years. Regarding marital status, 31 participants (62.0%) were single, which was more common than those who were married (n=19; 38.0%). In terms of educational level, 42 participants held a bachelor's degree (84.0%), whereas 8 participants (16.0%) held a master's degree. The most common work type was the 3-shift system (n=39; 78.0%), and most participants worked in general wards (pediatric ward and pediatric medical respite care ward; n=39, 78.0%) (Table 1).

2. Differences in Retention Intention according to the Participants' General Characteristics

The analysis of differences in retention intention according to the participants' general characteristics revealed that age (r=.31, $p=.026$) and total clinical experience (r=.32, $p=.023$) were significantly and positively correlated with retention intention. Meanwhile, retention intention was lower in participants who were unmarried (vs. married) (t=–1.91, $p=.063$), held a master's degree (vs. bachelor's degree) (t=0.79, $p=.436$), worked in 3-shift rotations (F=1.43, $p=.250$), and were assigned to intensive care units (vs. general wards) (t=0.29, $p=.770$). However, these differences were not statistically significant (Table 1).

3. Levels of Nursing Work Environment, Professional Autonomy, Organizational Commitment, and Retention Intention

Descriptive statistics for the primary variables (nursing work environment, professional autonomy, organizational commitment, and retention intention) are presented in Table 2. The mean score for the nursing work environment was 2.24±0.48. The mean scores for professional autonomy and organizational commitment were 3.64±0.44 and 2.91±0.64, respectively. The mean score for retention intention was 5.03±1.49.

4. Correlations among Nursing Work Environment, Professional Autonomy, Organizational Commitment, and Retention Intention

The analysis of correlations between retention intention and primary variables revealed that retention intention was significantly and positively correlated with organizational commitment (r=.55, $p<.001$), nursing work environment (r=.44, $p=.001$), and professional autonomy (r=.34, $p=.015$),

in descending order of correlation strength. These results indicate that higher levels of organizational commitment and professional autonomy and a more favorable perception of the nursing work environment are significantly associated with increased retention intention. Furthermore, the nursing work environment, professional autonomy, and organizational commitment were significantly and positively correlated ($p < .001$) (Table 3).

5. Predictors Influencing Retention Intention

To identify the predictors influencing retention intention, 3 separate multiple linear regression models were constructed by incorporating general characteristics and each primary research variable. Prior to analysis, the basic assumptions of the regression were evaluated. The Durbin-Watson statistics ranged from 1.46 to 1.57, confirming that there were no autocorrelation issues. Additionally, the normality of residuals was supported by Shapiro-Wilk tests ($p > .05$), and homoscedasticity was confirmed via Breusch-Pagan tests ($p > .05$). Influential outliers were ruled out as all Cook's distance values remained below 0.20. However, in the initial multicollinearity assessment, age and total clinical experience showed high collinearity (variance inflation factor >10). Therefore, age was excluded from the final regression models, and total clinical experience was retained based on theoretical relevance. Total clinical experience was selected over age because most of the reviewed literature reported that nursing

Table 1. Descriptive statistics of general characteristics and differences in retention intention (N=50)

Characteristic	Mean±SD or no. (%)	Retention intention (mean±SD)	r/t/F (*p*)
Age (yr)	32.7±6.5		.31 (.026)
Total clinical experience (yr)	9.5±6.8		.32 (.023)
Marital status			–1.91 (.063)
Unmarried	31 (62.0)	4.72±1.50	
Married	19 (38.0)	5.53±1.37	
Educational level			0.79 (.436)
Bachelor's	42 (84.0)	5.10±1.52	
Master's	8 (16.0)	4.65±1.34	
Work type			1.43 (.250)
Three-shift rotating (day/evening/night)	39 (78.0)	4.88±1.56	
Two-shift rotating	8 (16.0)	5.23±0.84	
Day-only (non-rotating)	3 (6.0)	6.33±1.59	
Work unit			0.29 (.770)
General wards (pediatric ward & pediatric medical respite care ward)	39 (78.0)	5.06±1.58	
Intensive care units (NICU & PICU)	11 (22.0)	4.91±1.24	

NICU, neonatal intensive care unit; PICU, pediatric intensive care unit; SD, standard deviation.

Table 2. Descriptive statistics of nursing work environment, professional autonomy, organizational commitment, and retention intention

Variable	Scale range	Mean±SD	Min	Max
Nursing work environment	1–4	2.24±0.48	1.31	3.48
Professional autonomy	1–5	3.64±0.44	2.63	4.43
Organizational commitment	1–5	2.91±0.64	1.27	4.18
Retention intention	1–8	5.03±1.49	2.17	8.00

SD, standard deviation.

Table 3. Correlations among nursing work environment, professional autonomy, organizational commitment, and retention intention

Variable	1	2	3	4
1. Nursing work environment	1			
2. Professional autonomy	.51 (<.001)	1		
3. Organizational commitment	.66 (<.001)	.51 (<.001)	1	
4. Retention intention	.44 (.001)	.34 (.015)	.55 (<.001)	1

Values are presented as r (*p*).

retention intention significantly increased with clinical experience [13,15,25]. Similarly, marital status and educational level, which have been established as significant predictors of retention intention in previous literature [4,15], were selected and treated as dummy variables, whereas "work type" and "work unit" were excluded to ensure a parsimonious and statistically stable model.

To control general characteristics and compare the individual explanatory power of each primary variable, regression analyses were performed by constructing 3 separate models, each incorporating general characteristics (total clinical experience, marital status, and educational level) along with 1 of the primary variables: nursing work environment (Model 1), professional autonomy (Model 2), and organizational commitment (Model 3) (Table 4). This strategy was utilized to precisely clarify the individual predictive contribution on retention intention; however, joint effects remain unexamined.

Given the small sample size (N=50), a bootstrap multiple linear regression analysis with 5,000 resamples was performed to ensure the robustness of the estimates. In Model 1, nursing work environment (B=1.16, β=.37; 95% CI, 0.13 to 2.06; p=.006) and educational level (p=.020) were significant predictors. In Model 2, professional autonomy (B=1.29, β=.38; 95% CI, 0.25 to 2.34; p=.003), educational level (p=.005), and total clinical experience (p=.010) were significant predictors.

Model 3, which included organizational commitment, demonstrated the highest explanatory power (adjusted R^2=.37), compared to Model 1 (adjusted R^2=.27) and Model 2 (adjusted R^2=.29). Model 3 was statistically significant (F=8.17, p<.001), and the significant predictors of retention intention were organizational commitment (p<.001; 95% CI, 0.55 to 1.73) and educational level (p=.008; 95% CI, –2.44 to –0.39). Specifically, participants holding a master's degree exhibited lower retention intention compared with those holding a bachelor's degree (B=–1.43, β=–.36), and higher levels of organizational commitment were associated with increased retention intention (B=1.19, β=.51).

DISCUSSION

This study explored the effects of the nursing work environment, professional autonomy, and organizational commitment on the retention intention of pediatric inpatient unit nurses. Reflecting on the outcomes of this study, the levels of each variable and factors influencing retention intentions are discussed below.

1. Levels of Primary Variables (Nursing Work Environment, Professional Autonomy, Organizational Commitment, and Retention Intention)

The mean value for the nursing work environment was 2.24±0.48 (out of 4). According to Lake's criteria [16], a score >2.5 indicates a favorable perception of the work environment; thus, the participants in this study did not perceive their environment positively. This score is lower than those report-

Table 4. Bootstrap multiple linear regression predicting retention intention[a)]

Predictor	Model 1					Model 2					Model 3				
	B	SE	β	t (p)	95% CI	B	SE	β	t (p)	95% CI	B	SE	β	t (p)	95% CI
Intercept	0.89	1.16		0.76 (.449)	–1.54 to 3.41	–1.74	1.82		–0.96 (.344)	–5.94 to 2.54	–0.02	1.10		–0.02 (.985)	–2.12 to 2.29
Total clinical experience (yr)	0.07	0.04	.30	1.86 (.070)	–0.01 to 0.14	0.09	0.04	.42	2.68 (.010)	0.02 to 0.16	0.06	0.03	.25	1.67 (.104)	–0.01 to 0.12
Marital status[b)]	–0.35	0.46	–.11	–0.76 (.452)	–1.15 to 0.49	–0.36	0.45	–.12	–0.78 (.437)	–1.24 to 0.37	–0.23	0.43	–.08	–0.53 (.596)	–1.03 to 0.49
Educational level[b)]	–1.34	0.56	–.33	–2.41 (.020)	–2.57 to –0.18	–1.66	0.56	–.41	–2.98 (.005)	–2.62 to –0.61	–1.43	0.52	–.36	–2.77 (.008)	–2.44 to –0.39
Nursing work environment	1.16	0.40	.37	2.88 (.006)	0.13 to 2.06										
Professional autonomy						1.29	0.42	.38	3.09 (.003)	0.25 to 2.34					
Organizational commitment											1.19	0.29	.51	4.10 (<.001)	0.55 to 1.73
F (p)	5.50 (.001)					5.88 (<.001)					8.17 (<.001)				
R^2	.33					.34					.42				
Adjusted R^2	.27					.29					.37				
Durbin-Watson	1.49					1.57					1.46				

Across all 3 models, tolerance ranged from .56 to .96, and VIF ranged from 1.04 to 1.79, indicating no multicollinearity issues (all VIF <10, tolerance >.10).
CI, confidence interval; Ref, reference; SE, standard error; VIF, variance inflation factor.
[a)]95% CIs are based on bootstrapping with 5,000 resamples (bias-corrected and accelerated). [b)]Educational level (Ref: bachelor's degree) and marital status (Ref: married) were dummy coded.

ed in previous studies using the same instrument, such as 3.19 for general hospital nurses [26]. Although hospital size and nursing staffing grades are positively correlated with work environment [25], the low score in this study, despite being conducted in a tertiary hospital, likely reflects the unique challenges faced by pediatric nursing settings. Pediatric care involves high emotional demands and intense workloads [5,7], and most nursing interventions for pediatric patients require more time than those for adults [7,8]. However, the Korean nursing staffing standards do not differentiate between adult and pediatric wards [8], which may lead to a poorer perception of the work environment among pediatric nurses [5,7,9].

Under the California Nurse-to-Patient Ratio Law, general pediatric units are legally required to maintain a ratio of 1:4 or fewer, unlike the 1:5 ratio mandated for adult medical-surgical units [27]. In contrast, South Korea's current nursing staffing regulations do not explicitly distinguish between adult and pediatric inpatient units [8]. Notably, the national health insurance fee schedule imposes a pediatric surcharge on nursing management and inpatient care fees [8]. When these surcharges are translated into staffing terms, caring for 1 infant under the age of 1 equates to caring for 1.3 adult patients, while caring for a child aged 1 to 7 equates to 1.1 adult patients [8]. These figures suggest that pediatric nursing requires a higher density of nursing resources compared to adult care. Therefore, future nursing policies in Korea should go beyond mere financial compensation and aim to address pediatric staffing standards within legal and institutional frameworks. Such measures could help reduce the workload and create an environment conducive to professional autonomy, enhancing the retention intention.

The mean score for professional autonomy was 3.64±0.44 (out of 5), which is higher than the 3.36 reported in a study of general hospital nurses using the same instrument [28]. This finding suggests that pediatric inpatient unit nurses perceive a relatively high level of professional autonomy, emphasizing their autonomous judgment and responsibility for pediatric patients. Pediatric units are characterized by intense interactions with caregivers regarding education and counseling [9]. It was inferred that these characteristics foster an environment conducive to independent and proactive nursing practices, thereby enhancing nurses' professional autonomy.

The mean score for organizational commitment was 2.91±0.64 (out of 5), which was lower than the scores reported in previous studies of 3.22 for general hospital nurses [26] and 3.37 for public hospital nurses [13]. This disparity may be partly attributable to the unique clinical characteristics of pediatric settings, where family-centered care is the foundational philosophy [5]. In pediatric units, where most patients are minors, parents serve as both partners and focal points of care, actively engaging in clinical processes such as informed consent and medication [8]. However, when organizational environments fail to provide the necessary resources to support this philosophy, nurses experience a significant gap between their professional values and organizational reality [10]. This conflict in values results in a decrease in organizational commitment, as nurses find it challenging to align with an organization that does not uphold their fundamental professional mission [10]. Additionally, the focus on extensive family involvement can ironically heighten nurses' exposure to incivility from patients' families [7]. This exposure not only reduces organizational commitment but also leads to emotional exhaustion, ultimately causing turnover [7].

These findings suggest that organizational commitment may act as a critical psychological mechanism linking the distinct environmental stressors of pediatric units to workforce retention. Since the heavy emotional workload and complex dynamics inherent in family-centered care cannot be easily eliminated at the unit level, institutions must provide macro-level strategic incentives to buffer these daily clinical stressors and rebuild nurses' organizational attachment. In this context, implementing a clinical ladder system (CLS) warrants cautious consideration as an overarching organizational strategy to enhance commitment. Rather than acting as a direct resolution for unit-specific stressors, a CLS targets a professional's intrinsic motivation by evaluating educational attainment and clinical experience to provide diverse professional roles, opportunities for self-development, and commensurate rewards [29]. Previous literature notes that organizational commitment levels are particularly enhanced when advancement is achieved through such active career development rather than automatic seniority-based promotion [29]. This approach can serve as an essential method for institutionalizing career trajectories that enable highly educated nurses with pediatric expertise to evolve into clinical experts within the hospital setting.

In this study, the mean score for retention intention was 5.03±1.49 (out of 8), which was lower than the 5.88 reported in a study of public hospital nurses [13] but similar to the 5.00 found among nurses in general and tertiary hospitals [15]. These variations across study settings underscore that retention intention can differ substantially depending on the spe-

cific clinical environment. Therefore, it is essential to identify the factors that determine the retention intention of pediatric inpatient unit nurses in order to establish strategies for the continuous cultivation and retention of specialized pediatric nursing personnel.

2. Predictors of Retention Intention

In this study, separate regression analyses were conducted to identify the independent predictors of retention intention after controlling for the participants' general characteristics. In Model 1, the nursing work environment was identified as a significant predictor, supported by literature demonstrating that a favorable, well-resourced work environment is a critical foundational element that enhances nurses' retention intention [12]. Concurrently, in Model 2, professional autonomy emerged as another vital predictor of retention intention. This finding closely aligns with a domestic study [13], which emphasizes that professional autonomy serves as a robust driving force significantly correlating with a nurse's decision to stay. Therefore, administrative efforts must be 2-pronged—ensuring systemic resource allocation while protecting autonomous clinical judgment—to effectively mitigate occupational burnout and sustain a stable, specialized nursing workforce.

Furthermore, in Model 3, which evaluated organizational commitment alongside controlled general characteristics, this psychosocial factor emerged as the most powerful determinant of retention ($\beta = .51$, $p < .001$), which is consistent with previous research findings [13]. A comparative analysis of all 3 regression models revealed that Model 3 possessed the highest explanatory power at 37% (adjusted R^2), and within Model 3, organizational commitment and educational level ($p = .008$) were significant predictors of retention intention.

Although the total clinical experience correlated with retention intention in the bivariate analysis, it lost its significance when entered into the regression model along with organizational commitment. This attenuation may suggest that organizational commitment shares variance with clinical experience; however, mediation was not tested and the cross-sectional design precludes such inference. High organizational commitment is achieved by aligning personal and organizational goals through the provision of a clear vision and professional support [20]. Therefore, improving retention intention requires mechanisms that allow nurses to experience professional growth and build deeper organizational commitment throughout their career trajectories, rather than relying on seniority-based retention. In this regard, the systematic operation of a CLS can enhance retention intention [29].

Correlation analysis showed that the nursing work environment, professional autonomy, and organizational commitment were significantly correlated with retention intention, and this trend remained consistent across individual regression models. However, a comparison of the 3 models revealed that Model 3, which included organizational commitment, had the highest explanatory power (37%, adjusted R^2) and the largest standardized coefficient. These results suggest that although the practice environment and autonomy are important, organizational commitment may play a particularly important role in driving the retention intention. Consequently, retaining pediatric nursing staff requires the establishment of practical foundations, such as adequate staffing and respect for autonomy, alongside meticulous organizational management.

Regarding educational level, nurses holding a master's degree showed lower retention intention than those holding a bachelor's degree ($B = -1.434$, $\beta = -.36$, $p = .008$), which contradicts previous literature [15]. Notably, this difference was not significant in the bivariate analysis ($p = .436$) and emerged only after adjusting for clinical experience, suggesting a possible suppression effect. However, because this subgroup represents a very small sample ($n = 8$), this finding carries high uncertainty and must be interpreted strictly as an exploratory observation rather than a generalizable trend. Mechanistically, if such a tendency exists, it might reflect potential mismatches between advanced education and clinical opportunities for professional role expansion [29]. Systems that grant professional roles and decision-making authority to highly educated nurses significantly increase job satisfaction and retention, also reduce bedside nurses' burnout and elevate patient-reported experiences [30]. Thus, utilizing master's-prepared nurses in specialized roles, such as family-centered care coordinators, warrants consideration as a strategy to align advanced competencies with institutional needs. Specifically, assigning specialized roles to pediatric nurse specialists in complex care domains that require advanced clinical expertise and professional communication skills—such as discharge preparation and medication communication, where patient experience scores in pediatric wards have historically been low [8]—could serve as a supportive mechanism to streamline care delivery. While the direct impact of such roles requires further empirical valida-

tion, providing structured professional pathways may alleviate registered nurses' workloads and potentially enhance care experiences for children and guardians. Therefore, policy efforts are suggested to develop career pathways that help master's-prepared nurses establish their professional identity.

This study has some limitations. First, the use of convenience sampling at a single tertiary hospital and a final sample size below the minimum requirement limit the generalizability of the findings. Furthermore, due to the limited sample size, variables were prioritized based on theoretical relevance to pediatric nursing rather than including all potential confounders, which may increase the risk of model overfitting. Although bootstrapping with 5,000 resamples was employed to yield more stable parameter estimates and robust 95% CIs, this resampling technique does not inherently expand the sample size or eliminate the constraints of a small sample. Therefore, caution should be exercised when generalizing these results to all pediatric inpatient units or other institutional settings, and future replication studies with larger and more diverse samples are warranted to confirm the external validity of the model. Second, the initial sample size was determined based on a power threshold of .70, which is lower than the conventional standard of .80 and increases the risk of Type II errors. While post-hoc power analyses yielded values of .97 to .99 based on the observed R^2 values (.33 to .42), these high estimates stem from the large observed effect sizes rather than a robust initial design. Thus, these findings should be interpreted cautiously as preliminary exploration, and future studies with larger samples and a minimum power of .80 are warranted. Third, skewed response distributions led to the exclusion of work schedules and departments from the regression, limiting the investigation of retention intention across shifts or units. Additionally, a distinct limitation involves the sample imbalance within the educational level category. Statistically significant results derived from such an extremely small subgroup carry a substantial risk of statistical instability, as the estimates can be highly sensitive to minor individual variations within that tiny subset. Therefore, the finding that nurses with a master's degree exhibit lower retention intention than those with a bachelor's degree cannot be reliably generalized to the broader nursing population. This specific result must be interpreted with an appropriate degree of caution as a preliminary finding. Fourth, self-reported questionnaires may lead to subjective bias, and the cross-sectional design limits definitive causal inferences; thus, prospective longitudinal designs are needed. Finally, because this study focused on the individual contributions of each factor, further research is required to explore the complex interactions or mediating effects of these variables.

CONCLUSION

This study aimed to provide robust evidence to promote the retention intention of pediatric inpatient nurses by identifying the individual effects of the nursing work environment, professional autonomy, and organizational commitment. In conclusion, organizational commitment serves as a key factor influencing pediatric nurses' retention intention, emphasizing the need for targeting organizational support and career structure enhancements to improve retention.

Based on these findings, organizations must develop strategies to increase the organizational commitment of pediatric inpatient nurses, such as expanding opportunities for participation in decision-making and providing appropriate support. Notably, a clinical career management system is required for competent nurses. Assigning roles that match their competencies such as family-centered care coordinator and providing rewards may enhance pediatric nurses' expertise and motivate them to remain in the organization. Furthermore, policy support must reflect the unique characteristics of pediatric nursing with institutional improvements at the national level, such as formalizing pediatric staffing standards distinct from adult standards.

Despite the limitations of a localized sample from a single tertiary hospital, it is important to identify the importance of organizational commitment as a key mechanism in determining retention intention and derive implications for the management of highly educated personnel. Future studies should involve large-scale replication studies with representative samples and in-depth analyses to identify the complex interactions or mediating effects among variables to further clarify the mechanisms of pediatric nursing workforce retention.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: HH. Methodology: HH, HS. Software: HH. Validation: HH. Formal analysis: HH. Investigation: HH. Resources: HH. Data curation: HH. Writing–original draft: HH, HS. Writing–review & editing: HH, HS. Visualization: HH. Supervision: HS. Project administration: HS. Fund-

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Conflict of interest

The authors declare no conflict of interest.

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Data availability

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

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Google Gemini 3.6 Flash to proofread and edit the English language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

ORCID and ResearcherID

Heejin Han https://orcid.org/0009-0001-4175-7670
https://researcherid.com/rid/PNF-7186-2026
Hyewon Shin https://orcid.org/0000-0003-1831-3710
https://researcherid.com/rid/ITU-5631-2023

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Prevalence of and risk factors associated with growth and developmental delays among children in urban and suburban primary care settings in Indonesia: a cross-sectional study

Martira Maddeppungeng[1], Merlyn Meta Astari[1], Sri Ramadany[2], Shelly Salmah[3], Ainan Raena Nas[4], Zakiah[5]

[1]Lecturer, Department of Pediatrics, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[2]Lecturer, Department of Public Health and Preventive Medicine, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[3]Lecturer, Department of Histology, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[4]Lecturer, Department of Public Health Science-Community Medicine, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[5]Lecturer, Department of Public Health Science-Community Medicine, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

Corresponding author
Martira Maddeppungeng
Department of Pediatrics, Faculty of Medicine, Hasanuddin University, Makassar, 90245, Indonesia
Tel: +62-813-4290-3666
Fax: +62-813-1660-6884
E-mail: martira711@yahoo.com

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Purpose: This study aimed to estimate the prevalence of growth and developmental delays and identify associated risk factors among children living in urban and suburban areas.

Methods: This analytical cross-sectional study included 247 children aged 3–24 months from 2 health center catchment areas, 1 urban and 1 suburban. Anthropometric measurements and growth-monitoring records from January–December 2024 were collected. Development was screened using the Denver Developmental Screening Test II during field visits from January–March 2025. Interviews assessed demographics, parental education and occupation, breastfeeding, prenatal, perinatal, and postnatal histories, and digital media exposure. Bivariate analyses (chi-square or Fisher's exact test) and multivariable logistic regression were performed using IBM SPSS ver. 29.0.

Results: Short stature prevalence was 18.6% in the urban area and 26.6% in the suburban area. Suspected developmental delays were identified in 11.4% and 24.3% of children, respectively. Development status was associated with maternal education (p=.006), screen time exposure (p=.047), vaginal delivery (p=.039), and postnatal history (p=.034). multivariable analysis showed that higher maternal education (adjusted odds ratio, 0.22; 95% confidence interval, 0.08–0.56) and delivery method (0.46; 0.23–0.89) were associated with lower odds of suspected developmental delays. Longer screen time (1.92; 1.09–3.37) and postnatal complications (2.37; 1.09–5.15) were associated with higher odds.

Conclusion: Frequent growth monitoring was associated with better nutritional status and weight gain in both areas and increased body length in the suburban area. Lower odds of developmental delays were associated with maternal education and delivery method, whereas higher odds were associated with screen time duration and postnatal complications.

Keywords: Child development; Growth and development; Primary health care; Risk factors

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INTRODUCTION

Every child has the right to grow and develop to their full potential, as part of efforts to achieve sustainable development [1]. In the first 1,000 days of life, providing adequate and optimal nutrition is a factor that plays an important role in physical growth, brain development, immunity, and health status [2,3]. At the primary care level, growth monitoring frequency (GMF) conducted through integrated health posts (Posyandu) and community health centers (Puskesmas) is the main strategy for early detection of growth disorders and as a means to assist with proper feeding, caregiver education, and medical referral [4,5].

Globally, approximately 150.2 million children under the age of 5 experience stunting, 42.8 million experience wasting, and 35.5 million are overweight [6]. Meanwhile, the 2019 Global Burden of Disease report shows that 316.8 million children experience developmental disabilities, with a prevalence of around 7.5% in children under the age of 5 [7]. In Indonesia, in 2023, the prevalence of children under 5 experiencing stunting was recorded at 21.5%, wasting at 8.5%, and overweight at 4.2%. In addition, 56.8% of children have not been monitored for their development according to standards [8]. Despite the availability of growth monitoring programs through primary health care services, the coverage and quality of growth and developmental monitoring in Indonesia remain suboptimal. Gaps in routine monitoring, caregiver engagement, and early detection mechanisms at the community level may contribute to delayed identification and management of growth and developmental delays.

In developing countries, children can be exposed to various risk factors in the early years of life—including poor health, malnutrition, and low levels of stimulation at home. Risk factors vary, including biological determinants (prenatal, perinatal, and postnatal complications), socioeconomic conditions, caregiver education, quality of stimulation at home, exposure to modern environments such as screen time at an early age, and lack of access to and coordination of public health services [9-11].

Regional characteristics may further shape children's growth and developmental environments. Differences in access to health services, educational resources, socioeconomic conditions, and caregiving practices between urban and suburban settings may influence patterns of service utilization and child health outcomes [12-14]. This study aims to: (1) describe the prevalence of growth and developmental delays among children receiving primary health care services in urban and suburban areas; and (2) identify factors associated with growth and developmental delays among these children.

METHODS

Ethical statements: This study was approved by the Human Ethics Committee of Hasanuddin University, Indonesia (IRB No. 39/UN4.6.4.5.31/PP36/2025). Written informed consent was obtained from the parents or legal guardians of all participants, all of whom were infants and toddlers.

1. Study Design

This cross-sectional study aimed to determine the prevalence and risk factors of growth and suspected developmental delays among children living in urban and suburban areas. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.

2. Study Settings and Sample

Participants were recruited through integrated health posts (Posyandu) supervised by their respective primary health care centers. The study was conducted at 2 primary health care centers in Makassar, Indonesia: Kassi-Kassi Primary Health Care Center, representing an urban setting, and Tamangapa Primary Health Care Center, representing a suburban setting. The urban setting was characterized by a densely populated and highly developed residential area, whereas the suburban setting represented a peripheral community with lower population density and mixed residential characteristics. The study population consisted of children aged 3 to 24 months.

The sample size was calculated using the formula for estimating a population proportion. The calculation was based on a 95% confidence level ($Z\alpha = 1.96$), an assumed prevalence of 20% ($p = .20$; $q = .80$), and a precision level (d) of 5%, resulting in a minimum required sample size of 246 participants.

Participants were recruited using a consecutive sampling method, whereby all eligible children attending the selected Posyandu during the study period were invited to participate. Rather than limiting recruitment once the minimum sample size was reached, all eligible participants who met

the inclusion criteria during the predefined study period were enrolled. Consequently, the numbers of participants differed between the urban and suburban groups because recruitment reflected the actual attendance of eligible children at the participating Posyandu in each area.

Inclusion criteria included healthy children within the specified age range whose parents or legal guardians provided written informed consent. Children with congenital abnormalities or acute illnesses at the time of assessment were excluded. Recruitment from multiple Posyandu sites in each area was intended to improve representativeness and reduce potential selection bias.

3. Measurements

Anthropometric measurements consisted of body weight (BW), body length (BL), and head circumference (HC), assessed following World Health Organization (WHO) protocols. BW was measured using a calibrated digital scale (Seca 354; Seca GmbH, Hamburg, Germany; accuracy ± 10 g) with minimal clothing; BL using a Seca 417 length board with proper alignment, and HC with a non-stretchable measuring tape placed above the eyebrows and around the occipital prominence. Nutritional status was assessed using weight-for-age (WAZ), length-for-age (LAZ), and weight-for-length (WLZ) Z-scores based on the WHO Child Growth Standards. Children were categorized as underweight if WAZ < –2 standard deviation (SD), stunted if LAZ < –2 SD, and having malnutrition if WLZ indicated wasting (< –2 SD). Microcephaly was defined as head circumference below –2 SD for age and sex according to WHO standards. These variables were categorized into "yes/no" groups for analysis. The GMF from January to December 2024 was categorized as routine (≥8 visits per year or ≥4 visits in 6 months) or non-routine, in accordance with national guidelines. Developmental assessments were conducted using the Denver Developmental Screening Test II (Denver II), which includes assessments in 4 domains: gross motor skills, fine motor skills, language skills, and personal-social skills. All Denver II assessments were performed by a pediatrician with subspecialty expertise in child growth and development.

Additionally, data on demographic characteristics (child's age, parental age, parental education level, and parental occupation), health history, and caregiving practices were collected through structured interviews. Prenatal history included pregnancy intention, regular antenatal care attendance, maternal habits and maternal illnesses during pregnancy, contraceptive use, and psychological problems. Perinatal history included the delivery method. Postnatal history included neonatal jaundice, excessive sleepiness, history of neonatal intensive care unit admission, seizures, epilepsy, birth trauma, and other medical conditions after birth. Caregiving practices included exclusive breastfeeding, age at first screen exposure, and duration of screen time.

4. Data Collection

Data were collected from January to March 2025 at 2 primary health care center in urban and suburban areas in Indonesia during scheduled Posyandu sessions. Anthropometric measurements were performed by pediatricians experienced in standardized child growth assessment. Anthropometric measurements and Denver II screening were performed directly, while background information was collected through structured interviews with caregivers. To minimize selection bias, participants were recruited consecutively from eligible children attending the selected Posyandu during the study period. All data were checked for completeness and consistency on-site before processing.

5. Data Analysis

Data were processed through editing, coding, entry, and verification using Microsoft Excel (Microsoft Corp.), while statistical analysis was performed using IBM SPSS Statistics 29.0 (IBM Corp.). Univariate analysis was used to obtain a frequency distribution of child characteristics (age, GMF, nutritional status, prenatal history, perinatal history, postnatal history, breastfeeding history, age of screen exposure, and duration of screen time), parental characteristics (age, education, and occupation), growth (weight-for-age, length-for-age, and head circumference), and development (Denver II). Bivariate analysis was conducted to determine the association between growth status and GMF, as well as child development and risk factors. This analysis used cross tabulation with the chi-square test when expected cell counts were adequate. Otherwise, Fisher's exact test was used. Logistic regression was applied to identify independent risk factors.

Variables included in the multivariable logistic regression model were selected based on biological plausibility, previous evidence, and to minimize multicollinearity among closely related factors. Variables that were statistically signif-

icant in the bivariate analysis were considered for inclusion in the multivariable logistic regression model. When two or more variables represented similar or related constructs, only the variable considered to be the most clinically relevant was retained in the final model to reduce multicollinearity and improve model stability.

RESULTS

1. Participant Characteristics

Table 1 shows the growth and development characteristics of children in the urban and suburban areas. A total of 247 children aged 3 to 24 months were included, consisting of 70 (28.3%) from urban primary health care center and 177 (71.7%) from suburban primary health care center.

Children in both study areas were mostly aged ≤1 year. Routine growth monitoring was more common among children in the urban area than in the suburban area. Regarding parental socioeconomic characteristics, urban areas showed higher maternal education levels and a greater proportion of employed mothers compared to suburban areas. Data on other characteristics, including pregnancy, perinatal, postnatal, breastfeeding, and screen exposure histories, are detailed in Table 1.

2. Prevalence of Child Growth and Development Delays

Table 2 shows an overview of the prevalence of growth and development disorders between urban and suburban areas. Body weight and nutritional status of children were in the normal category, respectively, at 81.4% and 75.7% in the urban area and 81.9% and 76.8% in the suburban area. Nor-

Table 1. Participant characteristics (N=247)

Characteristic	Category	Urban area (n=70)	Suburban area (n=177)
Age (yr)	≤1	39 (55.7)	103 (58.2)
	>1	31 (44.3)	74 (41.8)
Growth monitoring frequency	Routine	56 (80.0)	108 (61.0)
	Not routine	14 (20.0)	69 (39.0)
Prenatal history	Present	14 (20.0)	43 (24.3)
	Absent	56 (80.0)	134 (75.7)
Delivery method	Vaginal delivery	31 (44.3)	88 (49.7)
	C-section	39 (55.7)	89 (50.3)
Postnatal history	Yes	12 (17.1)	31 (17.5)
	No	58 (82.9)	146 (82.5)
Breastfeeding history	Exclusive breastfeeding	50 (71.4)	106 (59.9)
	Non-exclusive breastfeeding	20 (28.6)	71 (40.1)
Age of screen exposure	No exposure	29 (41.4)	67 (37.9)
	<6 mo	13 (18.6)	18 (10.2)
	6 mo–1 yr	11 (15.7)	46 (26.0)
	>1 yr	17 (24.3)	46 (26.0)
Duration of screen time (hr/day)	No screen time	29 (41.4)	67 (37.9)
	<2	40 (57.1)	97 (54.8)
	≥2	2 (2.9)	13 (7.3)
Father's age (yr)	≤19	1 (1.4)	7 (4.0)
	>19	69 (98.6)	170 (96.0)
Mother's age (yr)	≤19	5 (7.1)	6 (3.4)
	>19	65 (92.9)	171 (96.6)
Father's education	Elementary/middle/high school	43 (61.4)	143 (80.8)
	Higher education	27 (38.6)	34 (19.2)
Mother's education	Elementary/middle/high school	41 (58.6)	139 (78.5)
	Higher education	29 (41.4)	38 (21.5)
Father's occupation	Irregular employment	55 (78.6)	156 (88.1)
	Regular employment	15 (21.4)	21 (11.9)
Mother's occupation	Housewife	37 (52.9)	145 (81.9)
	Employment	33 (47.1)	32 (18.1)

Values are presented as number (%).

mal length was observed in 81.4% of children in the urban area and 73.4% in the suburban area, while short stature was found in 18.6% of children in the urban area and 26.6% in the suburban area. Screening using the Denver II showed suspected developmental delays in 11.4% of children in the urban area and 24.3% in the suburban area (Table 2).

Table 2. Prevalence of child growth and development disorders by region

Variable	Category	Urban area (n=70)	Suburban area (n=177)
Growth			
Underweight	Yes	13 (18.6)	32 (18.1)
	No	57 (81.4)	145 (81.9)
Short stature	Yes	13 (18.6)	47 (26.6)
	No	57 (81.4)	130 (73.4)
Microcephaly	Yes	14 (20.0)	28 (15.8)
	No	56 (80.0)	149 (84.2)
Nutritional status	Normal	53 (75.7)	136 (76.8)
	Malnutrition	17 (24.3)	41 (23.2)
Development			
Denver II	Normal	62 (88.6)	134 (75.7)
	Suspect	8 (11.4)	43 (24.3)
Gross motor delay		2 (2.9)	13 (7.3)
Fine motor delay		2 (2.9)	16 (9.0)
Language delay		7 (10.0)	9 (5.1)
Personal social delay		1 (1.4)	11 (6.2)

Values are presented as number (%).
Denver II, Denver Developmental Screening Test II.

3. Risk Factors for Growth and Development Delays in Children

In the urban area, children who were monitored regularly had good nutritional status ($p=.001$) and weight gain ($p=.030$). The odds of good nutrition were nearly 7 times higher (odds ratio [OR], 6.96) and the odds of weight gain were nearly 4 times higher (OR, 3.86). The relationship between regular monitoring and length gain did not reach statistical significance ($p=.052$), but still showed a positive trend (Table 3).

In the suburban area, routine monitoring was significantly associated with good nutritional status, weight gain, and increased length ($p=.028$, $p=.001$, $p=.004$). Children who received regular monitoring were about twice as likely to have good nutrition (OR, 2.19) and 5 times more likely to gain weight (OR, 5.55) (Table 3).

Maternal education and occupation were significantly associated with the suspect category in developmental assessment. Children whose mothers had higher education had lower odds of being classified in the suspect category than those whose mothers had lower education (OR, 0.29; 95% confidence interval [CI], 0.12–0.72; $p=.006$). Maternal occupation was also significantly associated with developmental screening outcomes. Children of employed mothers had a lower proportion of suspect outcomes than children of mothers who were housewives ($p=.022$). The corresponding OR was 0.37 (95% CI, 0.16–0.89).

Table 3. Association between growth monitoring frequency and growth outcomes by area (N=247)

Variable	Category	Frequency of growth monitoring		p[a]	OR (95% CI)
		Routine (n=164)	Not routine (n=83)		
Urban area (Routine: 56/164, Not routine: 14/83)	Nutritional status			.001	6.96 (1.94–24.95)
	Normal	47 (83.9)	6 (42.9)		
	Malnutrition	9 (16.1)	8 (57.1)		
	Body weight			.030	3.86 (1.07–13.86)
	Increased	34 (60.7)	4 (28.6)		
	Not increased	22 (39.3)	10 (71.4)		
	Body length			.052	3.24 (0.95–10.99)
	Increased	36 (64.3)	5 (35.7)		
	Not increased	20 (35.7)	9 (64.3)		
Suburban area (Routine: 108/164, Not routine: 69/83)	Nutritional status			.028	2.19 (1.08–4.45)
	Normal	89 (82.4)	47 (68.1)		
	Malnutrition	19 (17.6)	22 (31.9)		
	Body weight			<.001	5.55 (2.86–10.73)
	Increased	82 (75.9)	25 (36.2)		
	Not increased	26 (24.1)	44 (63.8)		
	Body length			.004	2.53 (1.34–4.75)
	Increased	78 (72.2)	35 (50.7)		
	Not increased	30 (27.8)	34 (49.3)		

CI, confidence interval; OR, odds ratio.
Values are presented as number (%).
[a]By chi-square test.

Screen exposure duration and age at first screen exposure were associated with developmental screening outcomes (p=.047, p=.020). In addition, prenatal, perinatal, and postnatal history were significantly associated with the suspect category in the developmental assessment (p=.020, p=.039, p=.034). The father's education and occupation, as well as breastfeeding history, did not show a significant relationship with developmental status (Table 4).

The multivariable logistic regression model included maternal education, delivery method, daily screen time, and postnatal history as independent variables. All variables included in the final model are presented in Table 5. Maternal education was associated with lower odds of suspected developmental delay (adjusted OR, 0.21; 95% CI, 0.08–0.56; p=.002). Similarly, delivery method was also associated with lower odds of developmental problems (adjusted OR, 0.45; 95% CI, 0.23–0.89; p=.022) (Table 5).

Table 5. Logistic regression analysis of risk factors for suspected developmental delay in children (N=247)

Risk factors	B	Adjusted OR (95% CI)	p
Mother's education	–1.526	0.22 (0.08–0.56)	.002
Delivery method	–0.782	0.46 (0.23–0.89)	.022
Screen time	0.652	1.92 (1.09–3.37)	.023
Postnatal history	0.864	2.37 (1.09–5.15)	.029

B, regression coefficient; OR, odds ratio; CI, confidence interval. For delivery method, C-section was the reference category, and vaginal delivery was the comparison category. Screen time was analyzed as a categorical variable.

Table 4. Sociodemographic characteristics and developmental Denver II screening test (N=247)

Characteristic	Denver II		p	OR (95% CI)
	Normal (%) (n=196)	Suspect (%) (n=51)		
Father's education			.381	1.35 (0.68–2.70)
Elementary/middle/high school	150 (80.6)	36 (19.4)		
Higher education	46 (75.4)	15 (24.6)		
Mother's education			.006	0.29 (0.12–0.72)
Elementary/middle/high school	135 (75.0)	45 (25.0)		
Higher education	61 (91.0)	6 (9.0)		
Father's occupation			.278	0.57 (0.21–1.57)
Irregular employment	165 (78.2)	46 (21.8)		
Regular employment	31 (86.1)	5 (13.9)		
Mother's occupation			.022	0.37 (0.16–0.89)
Housewife	138 (75.8)	44 (24.2)		
Employment	58 (89.2)	7 (10.8)		
Screen time (hr/day)			.047	-
No screen time	78 (82.1)	17 (17.9)		
<2	110 (80.3)	27 (19.7)		
>2	8 (53.3)	7 (46.7)		
Age of screen exposure			.020	-
No exposure	79 (82.3)	17 (17.7)		
<6 mo	29 (93.5)	2 (6.5)		
6 mo–1 yr	38 (66.7)	19 (33.3)		
>1 yr	50 (79.4)	13 (20.6)		
Prenatal history			.020	2.19 (1.12–4.30)
Yes	39 (68.4)	18 (31.6)		
No	157 (82.6)	33 (17.4)		
Delivery method			.039	0.51 (0.27–0.97)
Vaginal delivery	101 (84.9)	18 (15.1)		
C-section	95 (74.2)	33 (25.8)		
Postnatal history			.034	2.17 (1.04–4.52)
Yes	29 (67.4)	14 (32.6)		
No	167 (81.9)	37 (18.1)		
Breastfeeding history			.560	1.21 (0.63–2.32)
Exclusive breastfeeding	122 (78.2)	34 (21.8)		
Non-exclusive breastfeeding	74 (81.3)	17 (18.7)		

CI, confidence interval; Denver II, Denver Developmental Screening Test II; OR, odds ratio.

Conversely, longer screen exposure duration and postnatal history were identified as significant risk factors for the suspected category in developmental assessments. Children with longer screen exposure had nearly twice the odds of being suspected in developmental assessments (adjusted OR, 1.92; 95% CI, 1.09–3.37; $p = .023$), while those with a postnatal history had more than twice the odds of a suspect Denver II result (adjusted OR, 2.37; 95% CI, 1.09–5.15; $p = .029$) (Table 5).

DISCUSSION

Growth and developmental delays in children remain a public health problem in many developing countries. In Indonesia, other risk factors that may have an impact include socioeconomic disparities between regions and the implementation of Child Growth and Development Monitoring programs that are not yet optimal and evenly distributed across all levels of society.

Wigati and Ekasari [15] demonstrated that routine monitoring can promote optimal growth, whereas Lumongga et al. [16] found a significant association between growth monitoring and the nutritional status of young children. In contrast, Taylor et al. [17] found no consistent evidence supporting the benefits of growth monitoring on the nutritional status of children in low- and middle-income countries. Research by Sinaga et al. [18] states that growth in body length slows down during the first 2 years of life, especially in children with suboptimal nutrition intake.

The effectiveness of GMF depends on the social and environmental context in which children grow, including family utilization of health posts and parental awareness of the importance of growth monitoring. One factor that may have an influence is the education level of parents, especially mothers. Higher education enhances families' ability to understand appropriate childcare practices. Through regular visits, growth and developmental delays can be detected earlier, allowing timely provision of education, counseling, and nutritional interventions.

Children from birth to 6 years of age are in a golden period of development, during which they are highly receptive to various forms of stimulation. During this stage, the brain develops rapidly through continuous interaction with the environment. The quality of early experiences, including adequate nutrition and stimulation, responsive caregiving, early learning opportunities, good health, and a safe environment, plays a critical role in establishing a strong foundation for lifelong learning, health, and behavior [19,20].

In the urban area, parents, particularly mothers, had higher levels of education compared with those in the suburban area. This finding is consistent with Rocha et al. [21], who reported that maternal education is associated with child development. Mothers with higher education levels tend to have better knowledge of nutrition, developmental stimulation, and the importance of immunization, thereby supporting more optimal child growth. Another study by Rezaeizadeh et al. [22] also demonstrated that maternal education plays a crucial role in children's growth during the first 2 years of life.

Maternal employment is also associated with the likelihood of developmental delays in children. A study by Dervisevic et al. [23] stated that maternal employment may provide economic benefits through increased household income, enabling better fulfillment of children's nutritional, health, and educational needs. However, maternal employment may also have potential negative effects by reducing the amount of direct caregiving time [23]. In the present study, although most mothers in the suburban area were housewives and therefore had more time available for childcare, their relatively low educational attainment may contribute to limited knowledge regarding child development [24].

In today's global era, children are exposed to screen time from a very early age. The findings of Supanitayanon et al. [10] and Gomes et al. [25] support this. Early exposure may replace stimulating activities (such as play, reading, and verbal interaction) and disrupt sleep patterns, which are essential for brain development. Excessive screen time can lead to several adverse effects, including reduced attention span, language delays, sleep disturbances, and decreased social interaction [26,27].

In addition, delivery method and postnatal history remained significantly associated with developmental screening outcomes, whereas prenatal history, which was significant in the bivariate analysis, was not included in the multivariable model. Vaginal delivery was associated with lower odds of being classified in the suspect category, while a history of postnatal complications was associated with higher odds. This finding is consistent with previous evidence indicating that prenatal stress, prematurity, asphyxia, and neonatal complications are associated with long-term neurocognitive impairments [28]. These results highlight the importance of strengthening high-quality antenatal, delivery, and neonatal care services within primary health care facilities.

Cesarean delivery has been associated with an increased risk of developmental delays in children at 3 years of age. Children born via cesarean section tend to have lower motor and language development scores at certain ages. The association between cesarean delivery and adverse neurodevelopmental outcomes may be explained by reduced early mother–infant physical contact and increased physiological stress experienced by both the mother and infant during the procedure [29].

Interestingly, a history of exclusive breastfeeding was not significantly associated with developmental delays in this study. The discrepancy with a previous study [30] may be explained by the influence of other, more dominant contextual factors such as socioeconomic status, parenting practices, and the level of environmental stimulation. Nevertheless, the promotion of exclusive breastfeeding remains relevant given its well-established benefits for child immunity and growth.

Overall, this study highlights the importance of strengthening growth and developmental monitoring programs, particularly in areas with low coverage such as the suburban area, to ensure early detection of growth and developmental problems. The findings indicate that higher maternal education and vaginal delivery were associated with lower odds of suspected developmental delay, whereas longer screen time and postnatal history were associated with higher odds of suspected developmental delays.

One strength of this study is the use of combined data from registration books and direct measurements, as well as analyses that encompass both growth and developmental dimensions. However, several limitations should be noted, including the cross-sectional design, which does not allow for causal inference, potential recall bias, and limited generalizability due to the study being conducted in only 2 locations. Furthermore, sex-related aspects should be interpreted with consideration of the Sex and Gender Equity in Research (SAGER) guidelines, as the study may not have fully addressed sex-related differences in growth and developmental outcomes. In addition, Denver II is a screening tool rather than a diagnostic instrument. Therefore, children classified as having suspected developmental delays require further comprehensive assessment to establish a diagnosis.

Longitudinal studies with interventional approaches, including the use of digital technologies for growth and developmental monitoring, may serve as future research directions to generate more measurable and integrated solutions. Despite these limitations, the findings of this study have important practical implications, as they support early detection and timely intervention for growth and developmental delays, while also encouraging parents to engage in continuous and integrated monitoring of their children's growth and development in collaboration with health care providers, ultimately contributing to the improvement of child health services.

CONCLUSION

Growth and developmental problems were more prominent in the suburban setting, and both biological and caregiving-related factors were associated with suspected developmental delay. Primary health care services should prioritize routine growth monitoring and developmental screening in suburban areas, with caregiver education on screen time. Longitudinal studies are needed to clarify causal pathways and to evaluate nurse-led monitoring interventions.

From a clinical standpoint, the results emphasize the crucial role of nursing practice in primary health care, particularly in conducting routine growth and developmental screening, educating parents on appropriate caregiving practices, and monitoring modifiable risk factors such as screen time. Strengthening nurses' involvement in early detection and continuous follow-up may facilitate timely interventions, enhance parent–healthcare collaboration, and ultimately improve the quality of child health services.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: MM, MMA, SR. Methodology: MM, SS, ARN, Z. Software: SR, MMA, SS. Validation: MM, MMA, SR. Formal analysis: SR, MMA, SS. Investigation: MM, MMA, SR. Resources: MMA, SS, ARN, Z. Data curation: MM, MMA. Writing–original draft: MM, MMA, SR, SS, ARN, Z. Writing–review & editing: MM, MMA, SR, SS, ARN, Z. Visualization: MM, MMA. Supervision: MM. Project administration: MMA, SR. Funding acquisition: MM, MMA. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

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

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

No generative AI tools were used for writing.

ORCID and ResearcherID

Martira Maddeppungeng https://orcid.org/0000-0001-6109-6024 https://researcherid.com/rid/RGK-5482-2026
Merlyn Meta Astari https://orcid.org/0000-0002-4775-9458
Sri Ramadany https://orcid.org/0009-0004-9321-7272
Shelly Salmah https://orcid.org/0009-0007-5859-7048
Ainan Raena Nas https://orcid.org/0009-0007-6752-4959
Zakiah https://orcid.org/0009-0008-4542-345X

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Effects of a quick response code–based caregiver video education program on peripheral intravenous catheter maintenance–related outcomes in hospitalized children in South Korea: a single-center quasi-experimental study

Yongju Been[1], Yun Mi Kim[2]

[1]Head Nurse, Department of Nursing, Presbyterian Medical Center–Jesus Hospital, Jeonju, Korea
[2]Assistant Professor, College of Nursing, Jesus University, Jeonju, Korea

Corresponding author
Yun Mi Kim
College of Nursing, Jesus University, 383 Seowon-ro, Wansan-gu, Jeonju, 54989, Korea
Tel: +82-63-230-7577
Fax: +82-63-230-7790
E-mail: anyway777@jesus.ac.kr

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Purpose: This study evaluated the effects of quick response (QR) code-based video education on caregivers' knowledge and attitudes regarding peripheral intravenous catheter (PIVC) maintenance in hospitalized children and on PIVC-related outcomes.
Methods: This quasi-experimental study used a nonequivalent control-group design. Participants were 62 caregivers of children aged ≤72 months receiving PIVC therapy in a pediatric ward in Jeonju, South Korea (31 caregivers per group). The groups were recruited sequentially, with a 2-week interval. The control group, recruited from October 17 to 31, 2025, received standard verbal and leaflet-based education. The experimental group, recruited from November 14 to 20, 2025, received the QR code–based video program plus standard education. Knowledge and attitudes were assessed at baseline and 1 and 3 days post-insertion. PIVC dwell time, flushing and dressing-change frequencies, and complications were obtained from observational records. Data were analyzed using repeated-measures analysis of variance, the Mann-Whitney U test, and the chi-square test.
Results: Knowledge showed a significant group-by-time interaction (p<.001). Attitudes changed significantly over time (p<.001), but the interaction and between-group difference were nonsignificant (p=.780 and p=.433, respectively). Dwell-time distributions differed significantly between groups (p=.033). The experimental group showed lower frequencies of flushing (p=.003), dressing changes (p<.001), and lower incidence of complications (16.1% vs. 45.2%; p=.013; odds ratio, 0.23; 95% confidence interval, 0.07–0.77).
Conclusion: QR code-based video education improved caregivers' knowledge and was associated with favorable short-term PIVC maintenance and clinical outcomes.

Keywords: Caregivers; Catheterization, peripheral; Health education; Multimedia; Pediatric nursing

INTRODUCTION

1. Background

Peripheral intravenous catheters (PIVCs) are commonly used in hospitalized children to administer medications and intravenous fluids [1,2]. However, PIVC insertion and maintenance can be particularly challenging in children because of their developmental and anatomical characteristics [3]. In addition, maintaining catheter securement is important in

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pediatric patients because dislodgement, infiltration, occlusion, phlebitis, and other complications can lead to premature PIVC failure [2,4]. Pediatric PIVC failure occurs frequently, with reported rates exceeding 30% [2]. Such failure may result in treatment interruption, repeated catheter insertion, additional pain and anxiety, and increased healthcare resource use [5]. Therefore, systematic and standardized PIVC management strategies are needed to minimize complications and premature catheter failure [6,7].

To address these challenges, patient- and family-centered care (PFCC), a core philosophy of contemporary pediatric nursing, recognizes caregivers as important partners in the care process rather than merely as visitors [8,9]. PFCC emphasizes collaboration, information sharing, and caregiver participation in the care of hospitalized children [8,10,11]. In the context of PIVC management, previous studies have reported that structured education and active caregiver participation can improve caregivers' PIVC-related knowledge and support catheter maintenance in hospitalized children [12-14]. These findings highlight the importance of providing caregivers with appropriate education to support their participation in PIVC maintenance.

However, conventional caregiver education is often delivered through verbal explanations or printed materials, which may provide limited opportunities for caregivers to revisit educational content when needed during hospitalization [14,15]. Previous caregiver education studies have demonstrated the value of structured PIVC education, while also suggesting the need for educational approaches that facilitate continued access to standardized information [12,14,15]. Providing caregivers with opportunities to review PIVC maintenance information as needed may therefore complement conventional education.

To address these limitations, digital and video-based educational approaches have increasingly been used to provide standardized health information in accessible formats [16,17]. Video-based education can integrate visual and auditory information, while digital delivery can facilitate access to educational content beyond a single educational encounter [16,17]. In particular, quick response (QR) code–based video education allows users to access standardized video content conveniently through mobile devices and has been applied in clinical education settings [15]. Such an approach may provide caregivers of hospitalized children with opportunities to review PIVC maintenance information on demand during the early hospitalization period.

Previous studies have reported that educational interventions for caregivers of hospitalized children can improve caregivers' PIVC-related knowledge and selected maintenance outcomes [12,14]. However, these studies primarily focused on outcomes assessed shortly after education, providing limited information on how caregivers' knowledge and attitudes change during the early hospitalization period. In addition, PIVC maintenance-related indicators and clinical outcomes, such as catheter dwell time and complication occurrence, have not been comprehensively examined alongside these caregiver outcomes. Video-based educational interventions have also shown potential to support knowledge acquisition and caregiver learning by providing standardized audiovisual information [16,18]. Nevertheless, evidence remains limited regarding whether a QR code–based video education program that enables repeated, on-demand access during hospitalization is associated with changes in caregivers' knowledge and attitudes over time and with short-term PIVC-related outcomes. Accordingly, the present study examined the effects of a QR code–based video education program on caregivers' knowledge and attitudes regarding PIVC maintenance, as well as PIVC maintenance-related indicators and clinical outcomes in hospitalized children.

This study was informed by an integrated framework incorporating multimedia learning theory, the Knowledge–Attitude–Practice (KAP) model by Mayer [19,20], and PFCC [8,10]. According to the multimedia learning theory Mayer [19], appropriately designed audiovisual materials can facilitate information processing and knowledge acquisition [19,20]. In this study, QR code–based video education was used to provide caregivers with standardized audiovisual information that could be accessed repeatedly during hospitalization. From the KAP perspective, knowledge and attitude are related but distinct domains that may contribute to health-related practices [20]. Accordingly, caregivers' knowledge and attitudes were examined as key educational outcomes rather than as direct measures of behavioral change. Within the PFCC framework, caregivers are recognized as important participants in the care of hospitalized children, and effective partnerships between caregivers and healthcare professionals are central to pediatric care [8-10]. Taken together, these perspectives provide a rationale for examining whether QR code–based video education can improve caregivers' knowledge and attitudes regarding PIVC maintenance and contribute to favorable PIVC maintenance-related and clinical outcomes in hospitalized children.

2. Purpose

Despite these theoretical assumptions, few studies have systematically examined how QR code–based video education designed to facilitate repeated and on-demand learning may be associated with caregivers' knowledge, attitudes, and clinical outcomes in hospitalized children. Therefore, this study aimed to apply a QR code–based video education program for caregivers of hospitalized children and to examine its effects on caregivers' knowledge and attitudes regarding PIVC maintenance, as well as on maintenance-related indicators and clinical outcomes, including PIVC dwell time and complication rates.

Hypothesis 1. Caregivers in the experimental group who receive the QR code–based video education program on PIVC maintenance are expected to show greater knowledge scores than those in the control group.

Hypothesis 2. Caregivers in the experimental group who receive the QR code–based video education program are expected to show more positive attitudes toward PIVC maintenance than those in the control group.

Hypothesis 3. Children in the experimental group whose caregivers receive the QR code–based video education program are expected to show longer PIVC dwell times, fewer maintenance-related interventions (e.g., flushing and dressing changes), and lower rates of PIVC-related complications than those in the control group.

METHODS

Ethical statements: This study was approved by the Institutional Review Board (IRB) of Presbyterian Medical Center, Jeonju, Korea (IRB No. PMC 2025-09-002-002). Written informed consent was obtained from the caregivers of hospitalized children prior to participation.

1. Study Design

This study used a quasi-experimental, non-equivalent control group pretest–posttest design with a time lag to evaluate the effects of a QR code–based video education program on caregivers' outcomes and PIVC maintenance among hospitalized children. This study was reported in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement [21].

2. Study Setting and Participants

The study was conducted in the pediatric ward of Presbyterian Medical Center, a general hospital located in Jeonju, Republic of Korea. Participants were caregivers of hospitalized children who required PIVC therapy and provided written informed consent after receiving an explanation of the study purpose and procedures.

Children aged 72 months or younger were selected to focus on infants, toddlers, and preschool-aged children who may have limited ability to understand the need for intravenous therapy, communicate PIVC-related discomfort, or independently protect and monitor the catheter site. Pediatric PIVC management requires particular attention to catheter stability and the prevention of complications [2,4]. Previous studies have also emphasized the importance of caregiver education and participation in PIVC maintenance among hospitalized children [12,13]. Accordingly, the age criterion of 72 months or younger was applied to focus on a pediatric population in which caregiver observation and participation were considered particularly relevant to PIVC maintenance.

The inclusion criteria were as follows: (1) caregivers of children aged 72 months or younger admitted through the outpatient clinic or emergency department; (2) children with a PIVC in place for intravenous therapy during hospitalization; and (3) caregivers who were able to understand the study procedures and complete the questionnaires and educational sessions. The exclusion criteria were as follows: (1) children in critical condition for whom caregiver participation in the educational intervention was not feasible; (2) children expected to be discharged or transferred before completion of the day 3 post-insertion assessment; and (3) caregivers with communication limitations that would impede participation in the study.

To promote consistency in PIVC management throughout the study, standardized ward procedures for PIVC insertion, site selection, securement, assessment, dressing changes, and documentation were applied to both groups. One week before data collection, the researcher and all 15 nurses working in the pediatric ward (100% participation) received standardized training on 24-gauge PIVC insertion, site selection, securement, and dressing protocols. The training was provided by a dedicated intravenous nurse from the same institution who held a master's degree and had more than 10 years of specialized experience in intravenous therapy. Standardized instruction and hands-on guidance were provided for ap-

proximately 1 hour per nurse. In addition, ward nurses serving as research assistants received a separate 1-hour pre-study orientation on the study purpose, observational indicators, and standardized recording procedures to promote consistency in documentation and outcome assessment.

3. Sample Size

The sample size was calculated using G*Power software ver. 3.1.9.4 (Heinrich-Heine-Universität Düsseldorf), developed by Faul et al. [22]. For repeated measures analysis of variance (ANOVA) with a within–between interaction, the required sample size was estimated using a significance level (α) of .05, statistical power (1−β) of .95, 2 groups, 3 repeated measurements, and a medium effect size (f = .25), and a correlation of .50 among repeated measures, based on Cohen's convention [23]. Because no previous study had examined the same QR code–based video education intervention using identical outcome variables, a medium effect size was applied for the sample size estimation.

The minimum required sample size was 44 participants (22 per group). Allowing for an anticipated attrition rate of approximately 20% due to unexpected early discharge or incomplete post-insertion assessments, the target sample size was set at 56 participants (28 per group). Participants were recruited using consecutive sampling during predefined, IRB-approved recruitment periods for each group. Recruitment continued throughout these periods rather than terminating when the target sample size was reached; therefore, all eligible caregivers who provided written informed consent were enrolled.

A total of 62 caregivers were assessed for eligibility, and all were enrolled (excluded, n = 0). Of these, 31 were assigned to the control group and 31 to the experimental group. The control group was recruited first, followed by the experimental group after a 2-week interval to minimize intervention diffusion. No participants were lost to follow-up because of early discharge, withdrawal, or incomplete post-insertion assessment (lost to follow-up, n = 0). Consequently, all 62 participants completed the 3 assessments and were included in the final analysis (31 per group) (Figure 1).

4. Variables and Measurements

1) General and PIVC-related characteristics

Data on participants' general characteristics were collected

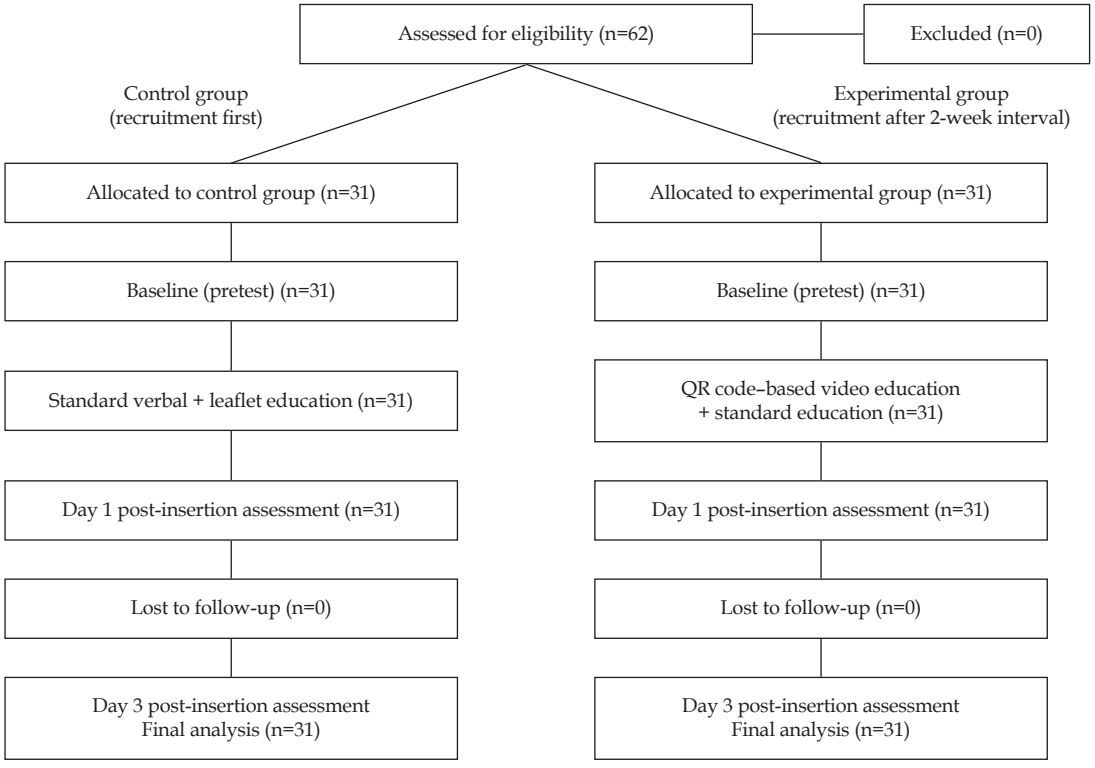

Figure 1. Study flowchart. All 62 participants completed all 3 assessments; no exclusions or losses to follow-up occurred.

using a structured questionnaire developed for this study. Caregiver characteristics included relationship to the child, gender, age, education level, occupation, prior hospitalization experience, prior experience with PIVC therapy, and prior experience with PIVC management education [12,14]. Children's characteristics included age, sex, weight, diagnosis, prior hospitalization, atopic dermatitis, adhesive allergy, and length of hospital stay [2,4,5]. In addition, PIVC-related characteristics included the type of intravenous fluid, infusion rate, infusion method, catheter insertion site, and antibiotic type [2,5].

2) Confirmation of video access

A simple self-reported confirmation record was developed for this study to document whether caregivers accessed the educational video during hospitalization. After accessing the educational content via the QR code, caregivers were asked to record the date of access. However, video viewing frequency and duration were not systematically quantified, analyzed, or used as outcome variables in this study. Therefore, the record was used solely to confirm access to the educational content rather than to objectively assess the extent of intervention exposure.

3) Knowledge of PIVC maintenance

The tool for measuring caregivers' knowledge of PIVC maintenance was adapted from the educational materials on intravenous management for caregivers of hospitalized children developed by Kim et al. [12]. It comprises 11 items across 6 subdomains: PIVC securement (1 item), flow rate control (2 items), connection status (3 items), backflow and leakage (2 items), relationship between insertion site and fluid flow (2 items), and the child's behavioral response to fluid infusion (1 item). Each item is scored as 1 point for a correct answer and 0 points for an incorrect or "I don't know" response. The total score ranges from 0 to 11, with higher scores indicating greater knowledge regarding PIVC maintenance. The tool primarily assessed caregivers' knowledge related to routine PIVC maintenance and observation during hospitalization. The reliability of the tool (Kuder–Richardson 20) was .91 at the time of development [12] and .79 in this study.

4) Attitude toward PIVC maintenance

Caregivers' attitudes toward PIVC maintenance were measured using a tool developed by Kim et al. [12] and used with permission. The instrument consists of 10 items across 2 subdomains: coping with PIVC (5 items) and perception of PIVC (5 items). In this study, "attitude" was defined not as the actual execution of PIVC maintenance behaviors, but as caregivers' cognitive appraisal (perception) and psychological readiness or behavioral intention toward engaging in PIVC care. Responses are rated on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), with total scores ranging from 10 to 50. Higher scores indicate a more positive and proactive attitude toward PIVC maintenance. Actual maintenance-related clinical indicators and outcomes were separately assessed using observational indicators recorded by trained research assistants. The internal consistency of the instrument was high, with Cronbach's α of .92 at the time of development [12], and .92 in the present study.

5) PIVC maintenance-related indicators and clinical outcomes

PIVC maintenance-related indicators and clinical outcomes were assessed using an observational checklist adapted from the tool developed by Kim et al. [12]. Caregivers' knowledge was assessed using a self-reported questionnaire, whereas PIVC-related outcomes were evaluated by trained research assistants through direct observation and medical record review. The checklist included general and PIVC-related characteristics, such as fluid type, infusion rate and method, insertion site, and antibiotic use, as well as maintenance-related indicators including flushing frequency for suspected occlusion, dressing change frequency related to catheter instability, unplanned PIVC changes, PIVC dwell time, and the frequency and incidence of PIVC-related complications [2,7].

PIVC-related complications were operationally defined as phlebitis, infiltration, occlusion, or accidental dislodgement that resulted in premature catheter removal before completion of the planned intravenous therapy or required additional clinical intervention. The content validity of the checklist was evaluated by 5 experts—1 nursing director, 1 nursing education manager, 2 pediatric ward nurses, and 1 professor of child health nursing—and the content validity index (CVI) was .80. All research assistants received pre-study training on standardized criteria for identifying PIVC-related complications and completing the observational checklist to promote consistency in outcome assessment. Although research assistants received pre-study training on standardized criteria for identifying PIVC-related complications, inter-rater

agreement was not formally assessed. In addition, outcome assessors may have been aware of group allocation during data collection. Therefore, the possibility of measurement or observer bias in the assessment of PIVC-related outcomes cannot be excluded.

5. Development of the Educational Video

The educational video for caregivers of hospitalized children was developed using an evidence-based approach. Relevant literature and clinical guidelines, including those from the Centers for Disease Control and Prevention [24] and the Korean Hospital Nurses Association [25], were reviewed to establish the educational content. In addition, semi-structured interviews were conducted with 10 caregivers of hospitalized children and 16 clinical nurses to identify practical educational needs in the clinical setting.

Based on the literature review and interviews, the educational content included maintaining appropriate fluid container height, managing intravenous lines, ensuring safe mobility of the child, monitoring infusion flow, recognizing signs of PIVC-related complications, and reporting abnormalities to healthcare providers. A storyboard was developed, and photographs and video recordings were used to demonstrate clinical situations such as catheter securement, alarm responses, and abnormal infusion conditions. Medical terminology was minimized, and simple language, subtitles, and narration were used to facilitate caregiver understanding. Background music was included, and the final video length was approximately 12 minutes.

Content validity was evaluated by a panel of 5 experts comprising 3 nursing professors, 1 nursing director, and 1 pediatric ward head nurse. Items with a CVI of .80 or higher were retained, and the overall CVI for clarity, delivery, and comprehensibility was .96. Expert feedback was incorporated into revisions of terminology, visual clarity, and presentation. A pilot test was then conducted with 5 caregivers of hospitalized children to assess feasibility and comprehensibility, and the video was finalized based on their feedback. The completed video was used as a core component of the intervention. The overall intervention structure, including standard education, video-based education, and repeated QR code–based access, is presented in Table 1.

6. Procedure

Data collection was conducted from October 17 to November 20, 2025, following IRB approval. To minimize intervention contamination between groups, recruitment, data collection, and intervention delivery were conducted sequentially with a 2-week interval. The control group was recruited from October 17 to October 31, 2025, and received standard verbal and leaflet-based education immediately after PIVC insertion during the same period. After a 2-week interval, the experimental group was recruited from November 14 to November 20, 2025, and received the QR code–based video education intervention, in addition to standard verbal and leaflet-based education, immediately after PIVC insertion during the same period. The 2-week interval was used to reduce the risk of intervention diffusion through informal information sharing among caregivers in the same pediatric ward and to allow most caregivers in the control group to be discharged before recruitment of the experimental group.

Before enrollment, eligible caregivers were informed of the study purpose and procedures, potential risks and benefits, the voluntary nature of participation, and their right to withdraw at any time without penalty or disadvantage. Written informed consent was obtained before data collection. To protect privacy and confidentiality, personally identifiable information was removed from the research data and replaced with unique study identification codes. Research data were securely stored with access restricted to the research team and were retained and disposed of in accordance with the IRB-approved procedures. Baseline (pretest) data were then collected, including general characteristics and caregivers' knowledge and attitudes regarding PIVC maintenance.

Immediately after PIVC insertion, caregivers in both groups received standardized verbal and leaflet-based education for approximately 5 minutes. To minimize the influence of external variables, all PIVC-related procedures, including insertion, securement, flushing, assessment, and dressing changes, were performed using standardized materials and hospital protocols applied consistently to both groups. All participating nurses also received pre-study orientation and training to promote consistent adherence to these protocols and minimize inter-provider variation in clinical practice and documentation.

In the experimental group, caregivers additionally watched a 12-minute educational video on PIVC maintenance using a tablet provided by the researcher, followed by a 5-minute

Table 1. Intervention protocol

Intervention component	Group	Timing	Duration	Provider	Delivery method	Key educational content	Repeated learning
Standard education	Con. & Exp.	Immediately after PIVC insertion	Approximately 5 min	Ward nurse (research assistant)	Verbal education using a leaflet	Maintaining the fluid container ≥1 m above the insertion site; preventing the child from pulling or removing the catheter line; using a stroller or wheelchair for mobility rather than carrying the child; charging the infusion pump and reporting alarms; checking securement tape for loosening or detachment; reporting wet or soiled dressings; and reporting signs of complications, such as swelling, pain, or leakage	No
Video education	Exp. only	Immediately after standard education	12 min	Researcher[a)]	Audiovisual education using a tablet provided by the researcher	Visual demonstration of PIVC maintenance procedures, key observation points, and responses to potential PIVC-related problems, consistent with the standard protocol	No
Question-and-answer session	Exp. only	Immediately after video viewing	5 min	Researcher[a)]	Face-to-face Q&A	Confirmation of caregivers' understanding of the video content and clarification of questions regarding PIVC maintenance	No
Repeated QR code–based access	Exp. only	From completion of the initial intervention until day 3 post-insertion	On demand	Caregiver	QR code linked to the same educational video, accessed using the caregiver's personal mobile device	Review of PIVC maintenance procedures, observation points, and responses to potential problems as needed during hospitalization	Yes

Cont., control group; Exp., experimental group; PIVC, peripheral intravenous catheter; Q&A, question and answer; QR, quick response. A simple viewing log was used only to confirm access to the educational video; viewing frequency and duration were not objectively measured or analyzed as outcome variables.

[a)]The researcher provided the video education and conducted the question-and-answer session.

question-and-answer session to confirm comprehension. To facilitate repeated learning, a QR code linked to the video was placed in the patient room, allowing caregivers to access the content on demand using their own mobile devices until day 3 post-insertion. Caregivers were encouraged to revisit the video as needed during hospitalization. A simple viewing log was used only to confirm access to the video; viewing frequency and duration were not quantified or analyzed as outcome variables. Because of the educational nature of the intervention, blinding of caregivers and intervention providers was not feasible. To minimize potential measurement bias, trained research assistants recorded PIVC maintenance-related indicators and clinical outcomes using standardized documentation procedures.

Data were collected at 3 time points: baseline (pretest), day 1 post-insertion, and day 3 post-insertion. Knowledge and attitude scores were assessed at all 3 time points, whereas maintenance-related indicators and clinical outcomes were collected cumulatively throughout the observation period. Day 3 (72 hours post-insertion) was selected as the final assessment point because it represents a clinically relevant period for PIVC survival, given that the average dwell time of pediatric PIVCs is approximately 47–53 hours and premature catheter failure before 72 hours is common. In addition, the mean length of hospital stay in this study was approximately 4.5 days; therefore, extending follow-up beyond day 3 was expected to increase attrition due to early discharge. The educational content of the intervention is presented in Table 1.

7. Data Analysis

Data were analyzed using IBM SPSS Statistics ver. 26.0 (IBM Corp.). The general and PIVC-related characteristics of caregivers and children were summarized using frequencies, percentages, means, and standard deviations. Baseline homogeneity between the experimental and control groups was assessed using independent t-tests for continuous variables and chi-square tests or Fisher's exact tests for categorical variables, as appropriate.

Caregivers' knowledge and attitudes regarding PIVC maintenance were assessed at 3 time points: baseline, day 1 post-insertion, and day 3 post-insertion. Changes in knowledge and attitude scores over time were analyzed using repeated measures ANOVA to examine the effects of group, time, and the group × time interaction.

Prior to the analysis, the assumptions of normality, homogeneity of variance, and sphericity were assessed. If the sphericity assumption was violated, multivariate tests using Wilks' Lambda were applied to evaluate within-subject effects. For statistically significant results, post-hoc comparisons were conducted using the Bonferroni correction.

For variables that did not meet the assumption of normality, including PIVC dwell time, flushing frequency, dressing change frequency, unplanned PIVC change frequency, and the frequency of PIVC-related complications, differences between the experimental and control groups were analyzed using the Mann-Whitney U test. The incidence of PIVC-related complications was analyzed using the chi-square test, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to quantify the difference between the groups.

Statistical significance was defined as $p < .05$ for 2-tailed tests. The reliability of the measurement instruments was assessed using Cronbach's α for Likert-type scales and the Kuder–Richardson Formula 20 for dichotomous items.

RESULTS

1. Homogeneity of General and PIVC-related Characteristics

A total of 62 caregivers and their hospitalized children (31 in the experimental group and 31 in the control group) were included in the analysis (Figure 1). The mean age of caregivers was 38.71±7.24 years in the experimental group and 37.10±6.05 years in the control group. Mothers represented the majority of caregivers in both groups (64.5% and 77.4%, respectively). The mean age of the children was 26.03±23.53 months in the experimental group and 19.16±23.89 months in the control group. No statistically significant differences were observed between the groups in caregiver characteristics, child characteristics, or PIVC-related characteristics (all $p > .05$) (Table 2).

2. Hypothesis Verification

1) Effects on caregivers' knowledge regarding PIVC maintenance

Repeated measures ANOVA revealed a significant group × time interaction for knowledge scores ($p < .001$), as well as significant main effects of time ($p < .001$) and group ($p = .030$). Bonferroni post-hoc analysis showed significant differences across all 3 time points. Therefore, Hypothesis 1 was supported (Table 3).

2) Effects on caregivers' attitude regarding PIVC maintenance

For attitude scores, a significant main effect of time was observed ($p < .001$), with Bonferroni post-hoc analysis showing significantly higher scores at 1 day and 3 days post-insertion than at baseline. However, neither the group × time interaction ($p = .780$) nor the main effect of group ($p = .433$) was statistically significant. Therefore, Hypothesis 2 was not supported (Table 3).

3) PIVC maintenance-related indicators and clinical outcomes

Compared with the control group, the experimental group showed lower flushing frequency ($p = .003$) and dressing change frequency ($p < .001$). PIVC dwell time differed significantly between the groups based on mean ranks ($p = .033$), although the median dwell time was 3 days in both groups. Unplanned PIVC changes showed a marginal difference between the groups ($p = .050$). The incidence of PIVC-related complications was significantly lower in the experimental group than in the control group (16.1% vs. 45.2%; $p = .013$; OR, 0.23; 95% CI, 0.07–0.77). Therefore, Hypothesis 3 was partially supported (Table 4).

DISCUSSION

This study evaluated the effects of a QR code–based video

Table 2. Homogeneity of caregiver, child, and PIVC-related characteristics between the experimental and control groups (N=62)

Characteristic	Cont. (n=31)	Exp. (n=31)	χ^2 or t	*p*
Caregiver characteristics				
Age (yr)	37.10±6.05	38.71±7.24	–0.952	.345
Relationship to the child			-	.135[a]
Father	5 (16.1)	8 (25.8)		
Mother	24 (77.4)	20 (64.5)		
Grandfather	2 (6.5)	0 (0.0)		
Grandmother	0 (0.0)	2 (6.5)		
Other	0 (0.0)	1 (3.2)		
Education level			-	.473[a]
High school or less	3 (9.7)	6 (19.4)		
College or above	28 (90.3)	25 (80.6)		
Occupation			-	.656[a]
None	9 (29.0)	9 (29.0)		
Self-employed	1 (3.2)	4 (12.9)		
Clerical	8 (25.8)	7 (22.6)		
Professional	8 (25.8)	6 (19.4)		
Service	2 (6.5)	1 (3.2)		
Education	1 (3.2)	0 (0.0)		
Other	2 (6.5)	4 (12.9)		
Prior hospitalization			0.265	.607
Yes	17 (54.8)	19 (61.3)		
No	14 (45.2)	12 (38.7)		
Prior PIVC education			-	.335[a]
Yes	4 (12.9)	8 (25.8)		
No	27 (87.1)	23 (74.2)		
Child and PIVC-related characteristics				
Age (mo)	19.16±23.89	26.03±23.53	–1.141	.258
Sex			-	.235[a]
Male	5 (16.1)	10 (32.3)		
Female	26 (83.9)	21 (67.7)		
Body weight (kg)	12.75±6.12	13.63±5.80	–0.584	.561
Atopic dermatitis			-	> .999[a]
Yes	1 (3.2)	0 (0.0)		
No	30 (96.8)	31 (100.0)		
Medical adhesive (plaster) allergy			-	> .999[a]
Yes	1 (3.2)	0 (0.0)		
No	30 (96.8)	31 (100.0)		
Length of hospital stay (day)	4.58±1.41	4.45±0.92	–0.426	.671
Type of intravenous fluid			-	> .999[a]
0.45 dextrose saline	0 (0.0)	1 (3.2)		
1:4 dextrose saline	1 (3.2)	0 (0.0)		
Dextrose saline	30 (96.8)	30 (96.8)		
Infusion rate (mL/hr)	30.00±14.08	30.32±11.61	–0.098	.922
Infusion method			-	> .999[a]
Dorsi flow	10 (32.3)	10 (32.3)		
Infusion pump	21 (67.7)	21 (67.7)		
Antibiotic class (IV)			-	> .999[a]
None	4 (12.9)	3 (9.7)		
Cephalosporins	7 (22.6)	7 (22.6)		
Penicillins	20 (64.5)	21 (67.7)		
PIVC insertion site			-	.742[a]
Hand dorsum	23 (74.2)	26 (83.9)		
Wrist	1 (3.2)	1 (3.2)		
Elbow	1 (3.2)	2 (6.5)		
Foot dorsum	5 (16.1)	2 (6.5)		
Ankle	1 (3.2)	0 (0.0)		

Values are presented as mean±standard deviation or number (%).
Cont., control group; Exp., experimental group; IV, intravenous; PIVC, peripheral intravenous catheter.
[a]Fisher's exact test was used due to small expected cell counts.

Table 3. Estimated marginal mean (±SE) and mean (±SD) of knowledge and attitude scores over time by group (N=62)

Group	Pretest[1]	Posttest[2]	Follow-up[3]	Group (G)		T×G[a)]		Time (T)[a)]	
				F	p	F	p	F	p
Knowledge				4.917	.030	8.890	<.001	27.760	<.001[2,3>1 b)]
Exp. (n=31)	6.26±0.45 (6.26±2.53)	8.97±0.38 (8.97±2.11)	9.77±0.27 (9.77±1.52)						
Cont. (n=31)	6.87±0.35 (6.87±1.96)	7.29±0.32 (7.29±1.79)	8.10±0.40 (8.10±2.21)						
Attitude				0.624	.433	0.249	.780	45.583	<.001[2,3>1 b)]
Exp. (n=31)	29.81±1.49 (29.81±8.31)	38.77±1.16 (38.77±6.48)	38.77±0.84 (38.77±4.66)						
Cont. (n=31)	29.52±1.41 (29.52±7.85)	37.29±1.30 (37.29±7.26)	37.13±1.07 (37.13±5.94)						

Values are presented as estimated marginal mean±SE (mean±SD) unless otherwise stated. Bonferroni-adjusted pairwise comparisons (p<.05): 1=pretest, 2=posttest, 3=day 3 post-insertion assessment.
Cont., control group (n=31); Exp., experimental group (n=31); SD, standard deviation; SE, standard error; T×G, time×group interaction.
[a)]Within-subject effects were verified using Wilks' Lambda (multivariate test). [b)]Bonferroni-adjusted post-hoc comparisons for the main effect of time (averaged across groups).

Table 4. Comparison of PIVC-related outcomes between the experimental and control groups (N=62)

Variable	Cont. (n=31)	Exp. (n=31)	U	z	χ^2	p	Exp./Cont. OR (95% CI)
PIVC dwell time (day)	3.00 [26.77]	3.00 [36.23]	334.000	2.135		.033	
PIVC site flushing (times)	1.00 [37.37]	0.00 [25.63]	298.500	2.938		.003	
Dressing changes (times)	2.00 [39.73]	0.00 [23.27]	225.500	3.741		<.001	
Unplanned PIVC changes (times)	0.00 [35.13]	0.00 [27.87]	368.000	1.957		.050	
PIVC-related complications (times)	0.00 [35.37]	0.00 [27.63]	360.500	2.074		.038	
Incidence of PIVC-related complications					6.147	.013	0.23 (0.07–0.77)
Yes	14 (45.2)	5 (16.1)					
No	17 (54.8)	26 (83.9)					

Values are presented as median [mean rank] or number (%) unless otherwise stated. The Mann-Whitney U test was used for continuous and frequency outcomes. Frequency refers to the number of complication events, whereas incidence refers to the occurrence of at least 1 complication during hospitalization. The 95% CI for the OR was estimated using the Wald method on the log scale.
CI, confidence interval; Cont., control group; Exp., experimental group; OR, odds ratio; PIVC, peripheral intravenous catheter.

education program for caregivers of hospitalized children on caregivers' knowledge and attitudes regarding PIVC maintenance and on PIVC-related outcomes. Caregivers in the experimental group showed a greater improvement in knowledge over time than those in the control group. Although attitude scores increased over time in both groups, no significant group×time interaction was observed. The experimental group also showed lower frequencies of flushing and dressing changes and fewer PIVC-related complications, suggesting favorable short-term PIVC maintenance-related and clinical outcomes.

An important aspect of this intervention was that caregivers could repeatedly review the educational video through a QR code during hospitalization. Unlike one-time verbal explanations or printed materials, the video allowed caregivers to revisit the information when needed. The educational content was developed through literature review, needs assessment, expert validation, and pilot testing, and was presented using simple language and visual demonstrations of common PIVC-related situations. These features may have contributed to the greater improvement in PIVC maintenance knowledge observed in the experimental group, consistent with previous studies of structured or video-based caregiver education [12,14,16]. This finding is also consistent with Mayer's multimedia learning theory [19] which suggests that appropriately designed audiovisual materials can facilitate information processing and knowledge acquisition. However, the improvement in knowledge cannot be attributed to the QR code alone because the intervention included a 12-minute video, a 5-minute question-and-answer session, and repeated access to the video. Therefore, the observed effect may reflect the combined influence of these educational components.

In contrast, attitude scores improved over time in both groups, but the group×time interaction was not statistically significant. This finding may be understood within the KAP framework, in which knowledge and attitude are related but

distinct domains [20]. An increase in knowledge may not necessarily be accompanied by an immediate change in attitude, and the 3-day observation period may have been too short for a between-group difference to emerge.

The absence of an additional intervention effect on attitude may also be considered in relation to PFCC [8]. Given the importance of partnership and communication between healthcare professionals and caregivers in family-centered pediatric care, the routine communication and support received by both groups during hospitalization may have contributed to the improvement in attitude over time [8-10]. In addition, the intervention focused primarily on PIVC education and did not include broader PFCC components such as shared decision-making or caregiver empowerment, which may have limited its additional effect on attitude.

Caregivers' actual PIVC maintenance behaviors were not directly measured in this study. Therefore, changes in attitude should not be interpreted as evidence of changes in caregiving behavior or as a direct explanation for the clinical outcomes. Attitude was interpreted as reflecting caregivers' perceptions and readiness regarding PIVC care rather than actual management behaviors [20].

Regarding PIVC-related outcomes, the experimental group showed fewer complications and differences in several maintenance-related indicators. These findings are generally consistent with previous studies emphasizing the importance of catheter stability, securement, and systematic management in reducing pediatric PIVC failure [4,6], as well as studies reporting beneficial effects of caregiver-focused education on PIVC maintenance [12,14].

The lower frequencies of flushing and dressing changes in the experimental group should be interpreted as differences in maintenance-related processes rather than as direct evidence of fewer complications. PIVC dwell time also differed significantly between groups, although the median dwell time was 3 days in both groups. Thus, the dwell-time finding is better interpreted as a difference in distribution rather than as a clear increase in the absolute duration of catheter use.

Unplanned PIVC changes showed only a borderline difference between groups ($p=.050$). Although the experimental group had fewer PIVC-related complications, this was not accompanied by a statistically significant reduction in unplanned catheter changes. This may reflect the fact that not all complications require immediate catheter replacement, as well as differences in clinical judgment regarding catheter removal.

Overall, these findings suggest that structured caregiver education may have a complementary role in pediatric PIVC management. Previous studies have also reported beneficial effects of caregiver-focused education on PIVC maintenance [12,14]. However, the present findings should be confirmed in larger and more diverse populations before broader clinical application is considered.

From a clinical perspective, structured caregiver education may complement standard PIVC education in pediatric settings. Previous studies have also reported beneficial effects of caregiver-focused education on PIVC maintenance [14,20], and QR code–based delivery may provide caregivers with convenient access to educational materials during hospitalization [15].

This study has several limitations. The non-equivalent control group design without randomization may have introduced selection bias and residual confounding, despite the absence of statistically significant baseline differences in measured characteristics. In addition, sequential recruitment may have resulted in period-related differences in ward conditions, staffing, patient characteristics, or clinical workload. Although a 2-week interval was used to reduce intervention diffusion, potential historical effects cannot be excluded.

The study was conducted at a single institution with a relatively small sample, which may limit the generalizability of the findings. Although children aged 72 months or younger were included, developmental differences in mobility, communication ability, and dependence on caregivers within this age range may have influenced PIVC-related outcomes. The exclusion of children expected to be discharged or transferred before the day 3 assessment may also have resulted in underrepresentation of children with shorter hospital stays.

The experimental group received a longer and more interactive educational intervention than the control group, including a 12-minute video, a 5-minute question-and-answer session, and repeated access through a QR code. Therefore, an attention effect cannot be excluded. Caregivers' actual PIVC maintenance behaviors were also not directly measured, limiting interpretation of the relationship between the educational intervention and clinical outcomes.

Intervention exposure was assessed using a self-reported viewing log, and the frequency and duration of video viewing were not objectively measured. In addition, the knowledge instrument focused mainly on routine PIVC maintenance and may not have fully assessed knowledge of complication-related signs and symptoms. Maintenance-related frequency outcomes were analyzed using nonparametric meth-

ods because of the small sample size and skewed distributions.

Future studies should include larger and more diverse samples, objective measures of video exposure, direct assessment of caregivers' PIVC maintenance behaviors, and instruments that more comprehensively assess both routine maintenance and complication-related knowledge. Randomized or multicenter studies would also help strengthen the evidence for the effectiveness of the intervention. The present findings should therefore be interpreted as preliminary evidence supporting the potential usefulness of structured QR code–based video education in pediatric PIVC care.

CONCLUSION

This study found that a QR code–based video education program was associated with greater improvement in caregivers' knowledge of PIVC, differences between groups in flushing and dressing change frequencies, and fewer PIVC-related complications. However, no additional effect on caregivers' attitudes was observed compared with standard education. These findings suggest that structured video education with repeated QR code–based access may be a useful complement to standard caregiver education in pediatric PIVC care. Further studies with larger and more diverse samples are needed to confirm these findings.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: YB, YMK. Methodology: YB, YMK. Data collection: YB. Formal analysis: YB, YMK. Supervision: YMK. Writing–original draft: YB. Writing–review and editing: YB, YMK. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

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

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

ChatGPT (OpenAI, 5 and 6 Version) were used to assist with reference organization and English-language writing and editing. All AI-assisted content was reviewed and verified by the authors, who take full responsibility for the final manuscript.

ORCID and ResearcherID

Yongju Been https://orcid.org/0009-0006-2837-8015
https://researcherid.com/rid/RFB-8165-2026
Yun Mi Kim https://orcid.org/0000-0002-2912-8927
https://researcherid.com/rid/NTQ-5147-2025

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Effects of mothers' perceptions of nurses' communication ability on perceived quality of nursing care: mediation by the mother–nurse partnership in a cross-sectional study in South Korea

Hyejin Wi[1], Hyeon Ok Kim[2], Ju-Hee Nho[2], Eun Jee Lee[3]

[1]Registered Nurse, Department of Nursing, Jeonbuk National University Hospital, Jeonju, Korea
[2]Professor, Department of Nursing, Research Institute of Nursing Science, Jeonbuk National University, Jeonju, Korea
[3]Associate Professor, Department of Nursing, Research Institute of Nursing Science, Jeonbuk National University, Jeonju, Korea

Corresponding author
Eun Jee Lee
Department of Nursing, Research Institute of Nursing Science, Jeonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju 54896, Korea
Tel: +82-63-270-3118
E-mail: ejlee@jbnu.ac.kr

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Purpose: This study examined the mediating role of the mother–nurse partnership in the relationship between mothers' perceptions of nurses' communication ability and perceived quality of nursing care.
Methods: Between August and November 2024, a questionnaire survey was administered to mothers whose preschool-aged children were hospitalized for 2–7 days at a tertiary hospital in South Korea. The data were summarized using descriptive statistics and analyzed using correlation analysis and the PROCESS macro.
Results: Mean scores for mothers' perceptions of nurses' communication ability, the mother–nurse partnership, and perceived quality of nursing care were 4.17, 4.23, and 8.97, respectively. The mother–nurse partnership mediated this relationship. Kinesics, proxemics, and paralanguage had indirect effects on perceived quality of nursing care through the mother–nurse partnership, and proxemics also had a direct effect.
Conclusion: The findings indicate a mediating role for the mother–nurse partnership in the relationship between mothers' perceptions of nurses' communication ability and perceived quality of nursing care. They also highlight the importance of nurses' nonverbal communication, particularly kinesics, proxemics, and paralanguage, within this mediating pathway.

Keywords: Child, preschool; Communication; Mothers; Nurse-patient relations; Nursing care

INTRODUCTION

Children differ from adults in that they are in the process of growth and development and have limited ability to express their condition or needs, which requires nursing care that takes both developmental stage and family context into account [1,2]. In Korean society, the maternal role in child-rearing and emotional support has traditionally been emphasized. Within this cultural context, Korean mothers serve as the primary caregivers of their children. They remain at the child's bedside throughout hospitalization, recognize subtle changes in the child's condition, and play a central role in recovery [3]. Mothers should therefore be regarded not merely as guardians but as active participants in nursing care, collaborating with nurses throughout the child's care process [2].

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In family-centered pediatric nursing, mothers' perceptions of nursing evaluation indicators are particularly important because hospitalized children cannot readily evaluate their own care experience. Among such indicators, perceived quality of nursing care refers to the degree of congruence between the care recipient's expectations and the care actually received [4]. A related but distinct concept is nursing satisfaction, which refers to the emotional response of patients or caregivers to the care provided [5]. Whereas satisfaction reflects an overall affective evaluation, perceived quality of nursing care captures the gap between expected and actual care. Moreover, when mothers perceive nursing care quality to be high, their anxiety decreases, their cooperation in the treatment process increases, and treatment outcomes for the child are ultimately enhanced [6].

Factors influencing perceived quality of nursing care include nurses' communication ability [7-9] and the mother–nurse partnership [6,10,11], along with anxiety [6], uncertainty [7], and nurse staffing [12]. The mother–nurse partnership refers to a collaborative relationship between mothers and nurses built on reciprocity, sensitivity, communication, and shared information, directed toward the shared goal of the child's recovery [11]. For mothers to perceive nursing care quality as high, both the quality of the mother–nurse relationship and the process of interaction directed toward the shared goal of the child's treatment and recovery are essential [13]. From this perspective, mother–nurse communication and partnership can be viewed as core factors that simultaneously reflect relational quality and interactional process.

When nurses demonstrate strong communication ability, mothers experience smoother information sharing, feel more comfortable, and place greater trust in the care provided [14]. In other words, nurses' communication translates into qualitative improvement of family-centered care through the formation of trusting, collaborative relationships with mothers [15]. From this perspective, the mother–nurse partnership can be viewed as the relational pathway through which nurses' communication leads to high-quality nursing care.

Although communication and partnership have each been reported as factors influencing nursing care quality, how these 2 variables are linked in shaping it has not been sufficiently examined. As noted above, nurses' communication contributes to the formation of partnerships with mothers through trust and collaboration, and these partnerships, in turn, lead to the provision of high-quality nursing care; this suggests a pathway in which communication influences nursing care quality through the mediating role of partnership. Communication is inherently bidirectional, comprising verbal and nonverbal elements, and different communication types influence partnerships with patients and caregivers, as well as nursing care quality, in distinct ways [16,17]. Nonverbal communication encompasses subdomains such as kinesics, proxemics, paralanguage, and physical appearance, each of which may convey distinct relational messages in nurse–patient interactions [18]. It is therefore necessary to examine the mediating pathway from communication to partnership to nursing care quality, by communication type.

Most prior research in South Korea has focused on how nurses perceive their own communication ability [19]. From a family-centered care perspective, however, the effectiveness of nurses' communication should be evaluated from the mothers' perspective, given that communication outcomes are determined not by the sender's intent but by what the recipient actually perceives [4]. A discrepancy may therefore exist between nurses' self-assessments and mothers' actual perceptions of care. To our knowledge, few studies have examined how specific communication subdomains influence the mother–nurse partnership and mothers' perceptions of nursing care quality, leaving a gap in evidence regarding which communicative behaviors are most influential in fostering effective mother–nurse partnerships and ultimately enhancing the quality of pediatric nursing care.

Therefore, this study aimed to examine the mediating role of the mother–nurse partnership in the relationship between mothers' perceptions of nurses' communication ability and perceived quality of nursing care, and to identify, by communication type, how these effects operate through this mediating pathway.

METHODS

Ethical statements: This study was approved by the Institutional Review Board (IRB) of Jeonbuk National University Hospital (IRB No. 2024-07-005-005) and conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants.

1. Study Design

This cross-sectional, predictive correlational study was designed to examine the mediating effect of the mother–nurse

partnership on the relationship between mothers' perceptions of nurses' communication ability and quality of care. It focused on mothers of preschool-aged children hospitalized with acute illness. This study was reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2. Participants

Mothers of hospitalized children were recruited through convenience sampling from a tertiary hospital in South Korea. The inclusion criteria were as follows: (1) Mothers of preschool-aged children who had been hospitalized for acute illness for at least 2 days and no longer than 7 days. (2) Mothers whose children were in the preschool developmental stage.

Mothers were excluded if their child had been admitted only 1 day earlier, as initial stress from adapting to the unfamiliar hospital environment may compromise the accuracy of their responses. Because the mother–nurse partnership develops through systematic and regular interactions [13], a minimum of 2 days was set to ensure sufficient exposure to routine nurse–mother interactions. The upper limit of 7 days was based on a population-based study that categorized pediatric length of stay of 2–7 days as a distinct short-stay group [20]. This criterion was applied to focus on the acute-care context and to exclude care dynamics associated with prolonged or chronic hospitalization.

The sample size for this study was calculated using G*POWER ver. 3.1.9.7 (Heinrich-Heine-Universität Düsseldorf). For a multiple regression analysis with a significance level of .05, statistical power (1–β) of .80, and a medium effect size of .15, a minimum of 127 participants was required. This sample size estimate considered 12 predictors, including 10 general characteristics and 2 independent variables. Considering an anticipated dropout rate of approximately 10%, a target of 140 participants was set, and data were collected from 141 mothers who consented to participate. After excluding 6 questionnaires with unanswered items or discontinued responses, data from 135 participants (95.74% of the collected questionnaires) were included in the final analysis. No missing data remained in the final dataset.

3. Instruments

1) Mothers' perceptions of nurses' communication ability

Nurses' communication ability, as perceived by mothers, was measured using a Korean-language instrument developed by Kim [18], which assesses both verbal and nonverbal communication. This self-report questionnaire consists of 13 items: 4 items assessing verbal communication and 9 items assessing nonverbal communication across 4 subdomains. These subdomains include kinesics (e.g., facial expressions, eye contact, and posture), proxemics (e.g., physical distance during interaction), paralanguage (e.g., tone, intonation, and speed of speech), and physical appearance (e.g., attire, grooming, and hairstyle). Each item is rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores indicating a more positive perception of nurses' communication ability.

In the original study of the instrument [18], the overall internal consistency reliability (Cronbach's α) was .93. Cronbach's α values for the subdomains were as follows: verbal communication (.81), kinesics (.85), proxemics (.61), paralanguage (.87), and physical appearance (.91). In this study, the overall Cronbach's α was .92, with subdomain values as follows: verbal communication (.92), kinesics (.83), proxemics (.79), paralanguage (.75), and physical appearance (.90).

2) Mother–nurse partnership

The mother–nurse partnership was measured using the parent version of the Pediatric Nurse–Parent Partnership Scale, a Korean-language instrument developed by Choi and Bang [11]. This self-report questionnaire assesses the partnership between nurses and parents caring for hospitalized children. It consists of 34 items rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher scores indicate a more positive relationship between the mother and the nurse. Cronbach's α was .96 in both the original study [11] and the present study.

3) Perceived quality of nursing care

The perceived quality of nursing care was measured using a Korean-language instrument developed by Cho et al. [4]. This self-report instrument was based on the Quality of Care Through Patients' Eyes (QUOTE) tool originally developed by van Campen et al. [21]. This consists of 19 items that assess nurses' care provided to their children. Each item includes 2 components, importance and performance, rated on a 4–point Likert scale.

Importance score ranges from 0–10 points and is rated as follows: "not important" (0 points), "somewhat important" (3 points), "important" (6 points), and "very important" (10

points). Performance ranges from 0–1 point and is rated as: "strongly disagree" (1 point), "disagree" (0.67 points), "somewhat agree" (0.33 points), and "agree" (0 points). The perceived quality of nursing care index was calculated as described below.

Quality of nursing care = 10–(Importance × Performance)

Cronbach's α of the importance and performance components of the instrument was .93 and .95, respectively, in the study by Cho et al. [4]. In this study, Cronbach's α was .87 for importance and .92 for performance.

4. Data Collection

Data were collected from mothers of preschool-aged children hospitalized for acute illnesses at a tertiary hospital between August 12, 2024, and November 2, 2024. The researcher explained the study purpose, procedures, and methods, clarifying that the collected data would be used solely for research purposes. A sealed collection box for responses was placed on the ward to minimize the possibility that the participants' responses would be influenced by the researcher or nurses. After completing the questionnaire, participants were instructed to deposit their response directly into the box.

5. Data Analysis

The collected data were analyzed using IBM SPSS/WIN ver. 27.0 (IBM Corp.). Descriptive statistics were used to summarize participants' general characteristics. Skewness and kurtosis were examined to assess the normality of the main study variables. Differences in the perceived quality of nursing care according to participant characteristics were analyzed using independent t-tests and one-way analysis of variance. Post-hoc comparisons used the Scheffé test. When the assumption of homogeneity of variance was not met, Welch's test was used. Post-hoc comparisons then used the Games-Howell test. Correlations between the study variables were analyzed using Pearson's correlation coefficients.

Model 4 of the PROCESS macro ver. 4.2 (https://afhayes.com/) was used to examine the mediating effect of the mother–nurse partnership on the relationship between mothers' perceptions of nurses' communication ability and quality of care. Prior to the analysis, multicollinearity was tested using tolerance and variance inflation factor, and autocorrelation was assessed using the Durbin-Watson statistic. Variables showing significant differences in perceived quality of nursing care (mother's marital status, child's age, gestational age at birth, and number of hospitalizations) were included as covariates in all mediation models (Table 1). In the subdomain analyses, the remaining 4 subdomains were additionally controlled. The significance of the mediating effect was tested using bootstrapping with 10,000 resamples to generate 95% confidence intervals (CIs) for the parameter estimates. In the mediation analysis of the communication subdomains, the /SEED option was applied in SPSS syntax to set the random number generator seed, ensuring consistency across bootstrapped samples. This enhances the validity of comparisons among the indirect effects of each subdomain.

RESULTS

1. Differences in Perceived Quality of Nursing Care according to Maternal and Child Characteristics

The largest age group of mothers was 30–34 years (31.9%), and most were married (94.8%) and university graduates (76.3%). The largest categories for religion, occupation, and monthly income were Protestant (35.6%), professional (33.3%), and Korean won 3,000,000–3,990,000 (37.0%), respectively. Among the children, 37.0% were 4 years old, 51.9% were firstborn, 77.8% were born at full term, and 38.5% had been hospitalized twice (Table 1).

Significant differences in the perceived quality of nursing care were found according to the mother's marital status ($t = -2.48$, $p = .036$), the child's age ($F = 9.30$, $p < .001$), the child's gestational age at birth ($t = -3.61$, $p < .001$), and the child's number of hospitalizations ($F = 3.88$, $p = .014$).

Perceived quality of nursing care was significantly higher among divorced mothers than married mothers and among mothers of children born preterm than those of children born at full term. Post-hoc comparisons showed significantly higher scores among mothers of 6-year-old children than those of 3- or 4-year-old children, and among mothers whose children had been hospitalized 3 times than those whose children had been hospitalized twice. No statistically significant differences were observed according to the mother's age, religion, occupation, education, monthly income, or the child's birth order ($p > .05$) (Table 1).

Table 1. Differences in mothers' perceived quality of nursing care according to participants' characteristics (N=135)

Characteristic	No. (%)	Mean±SD	t/F (*p*)	Post-hoc
Mother				
Age (yr)			0.72 (.545)	
<30	28 (20.7)	9.11±0.65		
30–34	43 (31.9)	8.86±0.91		
35–39	33 (24.4)	9.05±0.82		
≥40	31 (23.0)	8.89±0.88		
Marital status			–2.48[a] (.036)	
Married	128 (94.8)	8.94±0.84		
Divorced	7 (5.2)	9.40±0.44		
Religion			0.74 (.566)	
Protestant	48 (35.6)	8.86±0.79		
Buddhist	20 (14.8)	8.69±0.88		
Catholic	27 (20.0)	8.97±0.81		
None	33 (24.4)	9.10±0.94		
Other	7 (5.2)	8.96±0.80		
Occupation			0.26 (.903)	
Homemaker	26 (19.3)	9.11±1.03		
Public servant	15 (11.1)	9.01±0.59		
Office worker	33 (24.4)	8.96±0.83		
Professional	45 (33.3)	8.89±0.76		
Self-employed	16 (11.9)	9.12±0.93		
Education			1.91 (.153)	
≤High school	16 (11.9)	9.17±0.81		
University	103 (76.3)	8.94±0.80		
≥Graduate school	16 (11.9)	8.52±1.07		
Monthly income (10,000 KRW)			1.47[a] (.233)	
≤199	30 (22.2)	9.24±0.92		
200–299	29 (21.5)	8.98±0.75		
300–399	50 (37.0)	8.83±0.68		
≥400	26 (19.3)	8.89±1.00		
Child				
Child's age (yr)			9.30[a] (<.001)	(A,B<D)[b]
3[A]	37 (27.4)	8.96±0.84		
4[B]	50 (37.0)	8.87±0.79		
5[C]	26 (19.3)	8.68±0.96		
6[D]	22 (16.3)	9.53±0.47		
Birth order			0.41 (.662)	
1st	70 (51.9)	8.91±0.78		
2nd	49 (36.2)	8.87±0.94		
≥3rd	16 (11.9)	9.11±0.87		
Gestational age at birth			–3.61 (<.001)	
Full-term	105 (77.8)	8.86±0.87		
Preterm	30 (22.2)	9.33±0.56		
No. of hospitalizations			3.88[a] (.014)	(B<C)[b]
1[A]	39 (28.9)	8.89±0.92		
2[B]	52 (38.5)	8.81±0.79		
3[C]	29 (21.5)	9.31±0.57		
≥4[D]	15 (11.1)	8.97±0.83		

Percentages may not total 100% because of rounding. A–D indicate the groups compared in the post-hoc tests.
KRW, Korean won; SD, standard deviation.
[a]By Welch test. [b]By Games-Howell test.

2. Mothers' Perceptions of Nurses' Communication Ability, the Mother–Nurse Partnership, and Perceived Quality of Nursing Care

Normality was confirmed for all variables based on the skewness and kurtosis values, indicating that the data followed a normal distribution. The mean score for mothers' perceptions of nurses' communication ability was 4.17±0.53. Furthermore, the mean score for the mother–nurse partnership was 4.23±0.43, and the perceived quality of nursing care was 8.97±0.83. The mean score for verbal communication was 4.23±0.65, whereas nonverbal communication averaged 4.14±0.54. Among the subdomains of nonverbal communication, the mean scores were as follows: kinesics (4.07±0.64), proxemics (4.20±0.67), paralanguage (3.90±0.69), and physical appearance (4.44±0.64) (Table 2).

3. Relationships among Mothers' Perceptions of Nurses' Communication Ability, the Mother–Nurse Partnership, and Perceived Quality of Nursing Care

Perceived quality of nursing care was strongly correlated with both mothers' perceptions of nurses' communication ability (r=.62, p<.001) and the mother–nurse partnership (r=.64, p<.001). Nonverbal communication (r=.60, p<.001) showed a stronger correlation with perceived quality of nursing care than verbal communication (r=.51, p<.001). Regarding the subdomains of nonverbal communication, kinesics (r=.56, p<.001), proxemics (r=.56, p<.001), and physical appearance (r=.45, p<.001) demonstrated moderate correlations with the perceived quality of nursing care, whereas paralanguage showed a relatively weak correlation (r=.37, p<.001) (Table 3).

4. Effects of Mothers' Perceptions of Nurses' Communication Ability on Perceived Quality of Nursing Care: The Mediating Effect of the Mother–Nurse Partnership

Mothers' perceptions of nurses' communication ability significantly predicted both the mother–nurse partnership (B=0.54, p<.001) and the perceived quality of nursing care (B=0.53, p<.001). The mother–nurse partnership also had a strong and statistically significant impact on the perceived quality of nursing care (B=0.80, p<.001). The indirect effect of mothers' perceptions of nurses' communication ability on

Table 2. Mothers' perceptions of nurses' communication ability, the mother–nurse partnership, and perceived quality of nursing care (N=135)

Variable	Mean±SD	Possible range	Actual range	Skewness	Kurtosis
Perceived quality of nursing care	8.97±0.83	0–10	7.01–10.00	–0.40	–0.89
Mother–nurse partnership	4.23±0.43	1–5	3.12–5.00	–0.07	–0.19
Mothers' perceptions of nurses' communication ability	4.17±0.53	1–5	3.00–5.00	–0.15	–0.58
Verbal communication	4.23±0.65	1–5	3.00–5.00	–0.25	–0.99
Nonverbal communication	4.14±0.54	1–5	3.00–5.00	–0.14	–0.58
Kinesics	4.07±0.64	1–5	2.67–5.00	–0.23	–0.74
Proxemics	4.20±0.67	1–5	2.50–5.00	–0.43	–0.77
Paralanguage	3.90±0.69	1–5	2.50–5.00	0.26	–0.94
Physical appearance	4.44±0.64	1–5	3.00–5.00	–0.77	–0.47

SD, standard deviation.

Table 3. Correlations among mothers' perceptions of nurses' communication ability, the mother–nurse partnership, and perceived quality of nursing care (N=135)

Variable	Perceived quality of nursing care
Mother–nurse partnership	.64 (<.001)
Mothers' perceptions of nurses' communication ability	.62 (<.001)
Verbal communication	.51 (<.001)
Nonverbal communication	.60 (<.001)
Kinesics	.56 (<.001)
Proxemics	.56 (<.001)
Paralanguage	.37 (<.001)
Physical appearance	.45 (<.001)

Values are presented as r (p).

perceived quality of nursing care via the mother–nurse partnership was significant (B=0.43; 95% CI, 0.22–0.67). This indicates that the mother–nurse partnership significantly mediates this relationship.

Further analysis of communication ability subdomains revealed that 3 subdomains of nonverbal communication had significant indirect effects: Kinesics significantly influenced the mother–nurse partnership (B=0.23, p=.001), and its indirect effect on perceived quality of nursing care through the mother–nurse partnership was significant (B=0.18; 95% CI, 0.06–0.35). Proxemics had a significant indirect effect (B=0.14; 95% CI, 0.02–0.29) through the mother–nurse partnership. Paralanguage also showed a significant mediating effect (B=0.11; 95% CI, 0.03–0.22). Verbal communication and physical appearance did not demonstrate significant indirect effects (Table 4, Figure 1).

DISCUSSION

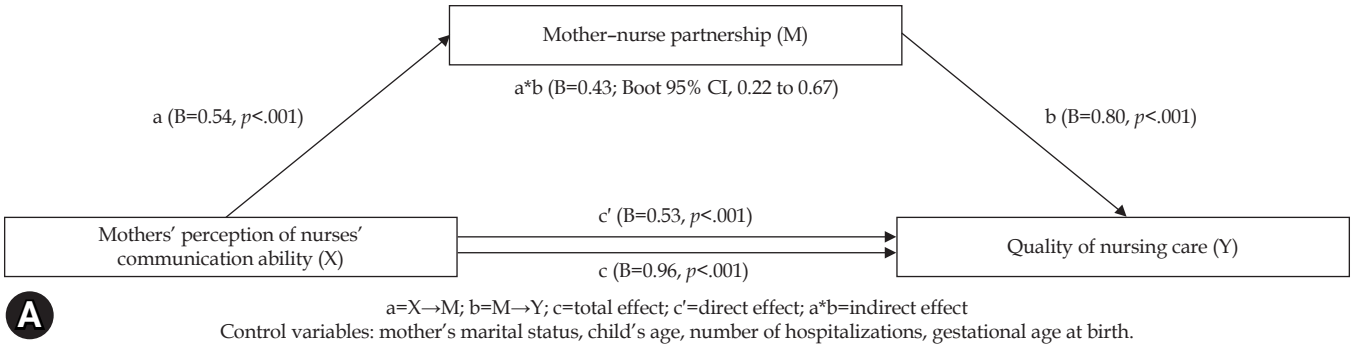
In this study, mothers' perceptions of nurses' communication ability were found to influence the mother–nurse partnership, which in turn had an indirect effect on the perceived quality of nursing care. Higher perceived communication ability corresponded with more positive mother–nurse partnerships, ultimately contributing to higher perceived quality of nursing care. These findings are consistent with previous studies [19,22].

One possible explanation for these findings lies in the con-

Table 4. Bootstrap analysis of the mediating effect of the mother–nurse partnership on the relationship between mothers' perceptions of nurses' communication ability and perceived quality of nursing care (N=135)

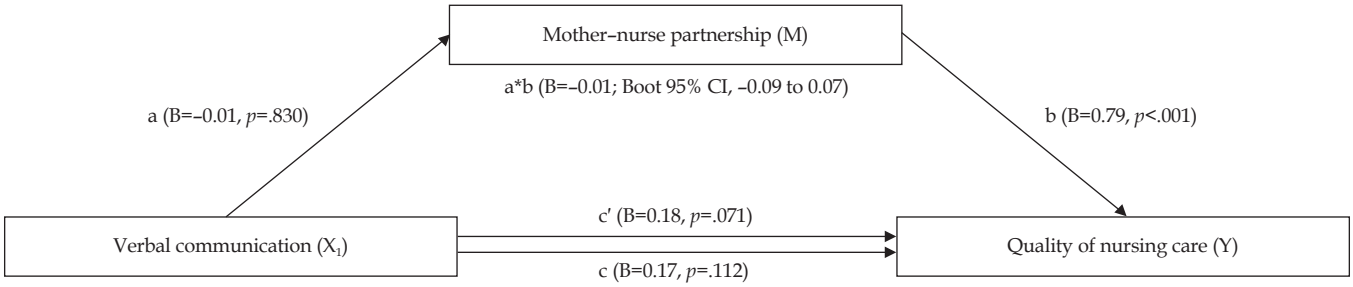
Variable	Category	B	SE	t	p	R^2	F (p)	Boot B	Boot SE	Boot 95% CI
Step 1	X → M	0.54	0.05	10.03	<.001	.53	15.46 (<.001)			
Step 2	X → Y	0.53	0.13	3.99	<.001					
	M → Y	0.80	0.16	4.94	<.001	.50	13.92 (<.001)			
Total effect		0.96	0.11	8.99	<.001					
Indirect effect										
X → M → Y								0.43	0.12	0.22 to 0.67
Step 1	X_1 → M	–0.01	0.05	–0.22	.830	.58	12.79 (<.001)			
Step 2	X_1 → Y	0.18	0.10	1.82	.071					
	M → Y	0.79	0.17	4.65	<.001	.60	13.05 (<.001)			
Total effect		0.17	0.11	1.60	.112					
X1 → M → Y								–0.01	0.04	–0.09 to 0.07
Step 1	X_2 → M	0.23	0.07	3.30	.001	.58	12.79 (<.001)			
Step 2	X_2 → Y	0.18	0.13	1.33	.185					
	M → Y	0.79	0.17	4.65	<.001	.60	13.05 (<.001)			
Total effect		0.36	0.14	2.57	.011					
X2 → M → Y								0.18	0.07	0.06 to 0.35
Step 1	X_3 → M	0.18	0.06	2.87	.005	.58	12.79 (<.001)			
Step 2	X_3 → Y	0.25	0.12	2.03	.045					
	M → Y	0.79	0.17	4.65	<.001	.60	13.05 (<.001)			
Total effect		0.39	0.13	3.06	.003					
X3 → M → Y								0.14	0.07	0.02 to 0.29
Step 1	X_4 → M	0.14	0.05	2.68	.009	.58	12.79 (<.001)			
Step 2	X_4 → Y	–0.07	0.10	–0.71	.477					
	M → Y	0.79	0.17	4.65	<.001	.60	13.05 (<.001)			
Total effect		0.04	0.11	0.37	.713					
X4 → M → Y								0.11	0.05	0.03 to 0.22
Step 1	X_5 → M	0.00	0.06	0.06	.956	.58	12.79 (<.001)			
Step 2	X_5 → Y	–0.05	0.11	–0.51	.612					
	M → Y	0.79	0.17	4.65	<.001	.60	13.05 (<.001)			
Total effect		–0.05	0.11	–0.45	.654					
X5 → M → Y								0.00	0.06	–0.11 to 0.11

This independent variable (X) is divided into verbal communication (X_1) and nonverbal communication, which has 4 subscales: kinesics (X_2), proxemics (X_3), paralanguage (X_4), and physical appearance (X_5).
CI, confidence interval; M, mother–nurse partnership; SE, standard error; X, mothers' perceptions of nurses' communication ability; Y, perceived quality of nursing care.



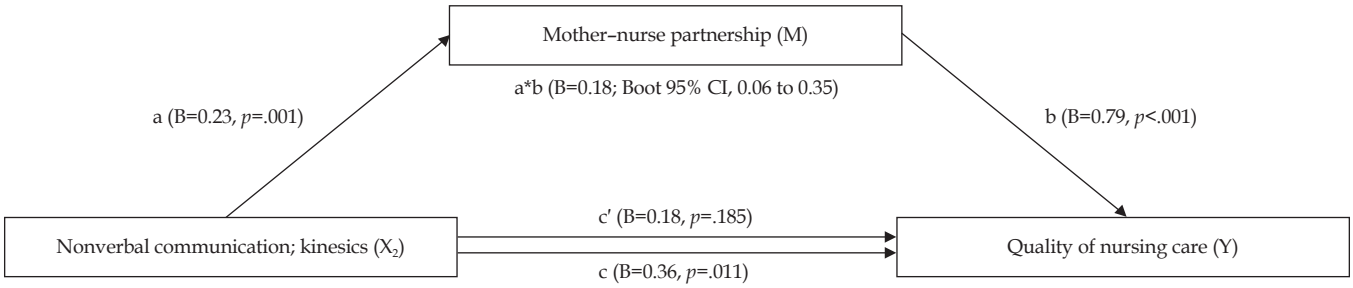
A

a=X→M; b=M→Y; c=total effect; c'=direct effect; a*b=indirect effect
Control variables: mother's marital status, child's age, number of hospitalizations, gestational age at birth.



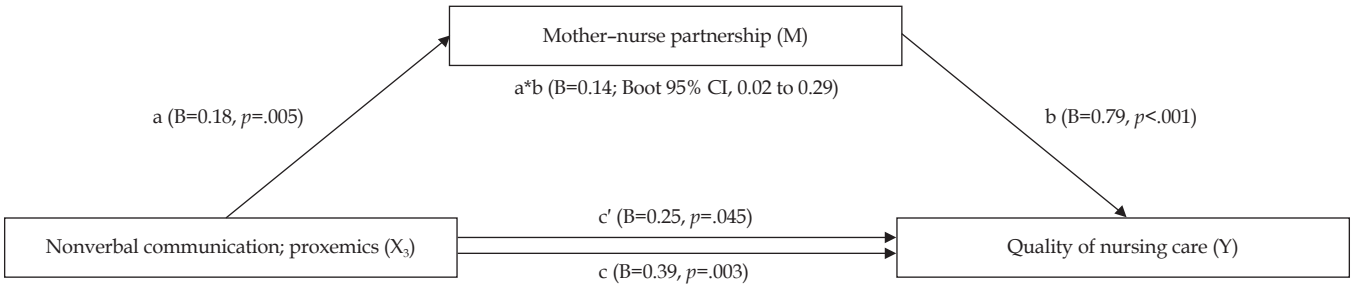
B

a=X→M; b=M→Y; c=total effect; c'=direct effect; a*b=indirect effect
Control variables: mother's marital status, child's age, number of hospitalizations, gestational age at birth, nonverbal communication (kinesics, proxemics, paralanguage, physical appearance)



C

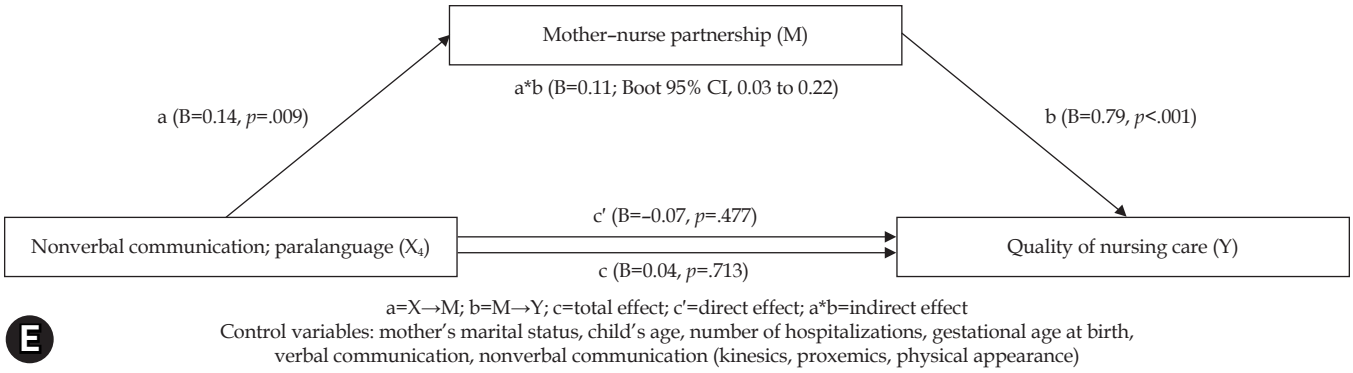
a=X→M; b=M→Y; c=total effect; c'=direct effect; a*b=indirect effect
Control variables: mother's marital status, child's age, number of hospitalizations, gestational age at birth, verbal communication, nonverbal communication (proxemics, paralanguage, physical appearance)



D

a=X→M; b=M→Y; c=total effect; c'=direct effect; a*b=indirect effect
Control variables: mother's marital status, child's age, number of hospitalizations, gestational age at birth, verbal communication, nonverbal communication (kinesics, paralanguage, physical appearance)

Figure 1. (A–F) Mediating effect of mother–nurse partnership on the relationship between mothers' perception of nurses' communication ability and quality of nursing care. CI, confidence interval. (Continued on the next page.)



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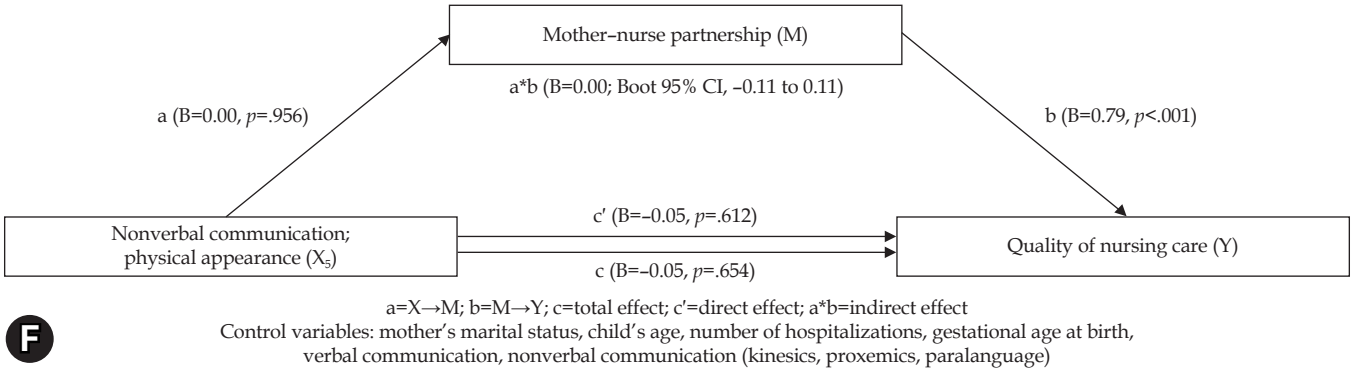

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Figure 1. (Continued; caption shown on previous page).

text of pediatric nursing, in which communication often occurs through caregivers rather than directly with the patient [23]. Because preschool-aged children may have limited ability to express their needs clearly, mothers play a central role in interpreting and communicating the child's condition [1]. In this context, nurses' communication behaviors may be evaluated not only in terms of information exchange but also in terms of relational signals that convey empathy, attentiveness, and trust [10,11]. This may explain why communication ability was strongly associated with both the mother–nurse partnership and perceived quality of nursing care in this study.

This study also examined how different types of communication influence the mother–nurse partnership and perceived quality of nursing care. The results showed that nurses' verbal communication had no significant direct effect on either the perceived quality of nursing care or the mother–nurse partnership. Moreover, nurses' verbal communication had no indirect effect on either outcome through the mother–nurse partnership. In pediatric settings involving preschool-aged children, verbal communication between nurses and mothers may perform a different function than in adult care contexts [18]. Because preschool-aged children have limited expressive language ability, nurses primarily address mothers rather than children directly, with mothers serving as information brokers who relay information to the child in age-appropriate ways [24]. In such nurse–mother exchanges, communication is often embedded in ongoing caregiving rather than formal information transfer, and mothers may evaluate nurses' communication less by what is said than by relational signals—empathy, attentiveness, and trust—that are conveyed largely through nonverbal cues [16,17]. Further research is required to understand better the role and impact of verbal communication in pediatric nursing.

Among the subdomains of nonverbal communication, kinesics (body language), proxemics (spatial behavior), and paralanguage were found to have mediating effects on the perceived quality of nursing care through the mother–nurse partnership. This suggests that nonverbal communication plays a crucial role in pediatric nursing care [25]. The following sections discuss each subdomain of nonverbal communication in detail.

1. Kinesics

Kinesics did not have a direct effect on the perceived quality of nursing care but indirectly influenced it through the mother–nurse partnership. As a subdomain of nonverbal communication, kinesics refers to the physical movements observed in interpersonal interactions, such as facial expressions, eye contact, posture, gestures, and nodding [18]. A recent scoping review of pediatric inpatient settings reported that nurses' communication strategies were among the most frequently identified facilitators of trust, with eye contact and smiling specifically noted as important for developing trusting nurse–child relationships [26]. Although evidence on kinesics in nurse–parent interactions remains limited, broader studies in adult care contexts have similarly shown that clinicians' kinesic behaviors, such as posture, support trust building and positive perceptions of communication [16,17]. Pediatric nursing requires continuous communication and collaboration with mothers during the child's hospitalization. It is therefore essential for nurses to recognize the importance of kinesics, actively apply it when caring for children, and enhance their competence in this area.

2. Proxemics

Proxemics had a direct effect on the perceived quality of nursing care, with the mother–nurse partnership showing a mediating effect in this relationship. Proxemics refers to the behavior of recognizing and regulating relationships through physical distance in interpersonal interactions, including the maintenance of appropriate personal space and physical contact [18]. Through spatial behavior, healthcare providers can convey relational messages such as attentiveness, empathy, and trust, which may influence patient and caregiver perceptions of care quality [16,17,22]. Therefore, to strengthen the mother–nurse partnership and improve perceived quality of nursing care, it is necessary to enhance nurses' knowledge and skills related to proxemics through targeted education and training.

3. Paralanguage

Paralanguage was found to have no direct effect on the perceived quality of nursing care, but it had an indirect effect on this outcome mediated by the mother–nurse partnership. As a subdomain of nonverbal communication, paralanguage includes elements such as the tone of voice, speech rate, volume, and pitch [18]. These elements add meaning and emotion to speech, and they can stimulate the listener's interest and desire to engage [17,22]. Previous studies have also reported that paralanguage positively influences customer satisfaction by eliciting positive emotional responses from clients [27], which is consistent with the findings of this study. In addition, paralanguage enables emotional connection and trust building, which may positively affect the formation of the mother–nurse partnership, which is based on trust [28]. Therefore, enhancing nurses' paralanguage skills in clinical practice should be considered an important strategy for strengthening the mother–nurse partnership and ultimately improving the perceived quality of nursing care.

4. Physical Appearance

Physical appearance was found to have neither a direct effect on the perceived quality of nursing care nor an indirect effect on the outcome through the mother–nurse partnership. As a subdomain of nonverbal communication, physical appearance includes physical attractiveness, attire, and overall impression [18]. This finding differs from those of previous studies that reported that first impressions influenced perceptions of care, anxiety, trust, and comfort [29]. This result may be attributed to several factors. First, the participants were mothers whose children had been hospitalized for at least 2 days. As the perceived quality of nursing care is assessed based on the congruence between expectations and actual nursing performance [4], the impact of initial impressions may not have been captured. Second, nurses generally wear similar uniforms and follow standardized grooming policies. There may be limited observable differences in nurses' physical appearance.

One limitation of this study is its cross-sectional design, which limits the ability to draw causal inferences. Although the mediation model suggests that mothers' perceptions of nurses' communication ability influence perceived quality of nursing care through the mother–nurse partnership, longitudinal or interventional studies are required to establish temporal and causal relationships. In addition, the use of convenience sampling from a single hospital setting may limit the generalizability of the findings to other family contexts, clinical settings, or pediatric populations and may have introduced selection bias.

Despite these limitations, the findings of this study extend

understanding of how nurses' communication ability is linked to mothers' perceptions of nursing care quality through the mother–nurse partnership. Specifically, the findings highlight the central role of the mother–nurse partnership as a key relational process linking communication to care quality within a family-centered pediatric context. By examining specific subdomains of nurses' communication, this study provides nuanced evidence regarding which communicative behaviors may be most influential in fostering effective partnerships with mothers. Strengthening communication competencies may be a practical approach to enhancing the mother–nurse partnership and perceived quality of nursing care. Future studies should examine additional factors influencing these relationships using longitudinal and multi-site designs.

From a clinical perspective, these findings suggest that strengthening nonverbal communication competencies may be an important strategy for enhancing the mother–nurse partnership and improving perceived quality of pediatric nursing care [17,22]. Communication training programs for pediatric nurses may benefit from incorporating structured education on nonverbal communication, including kinesics, proxemics, and paralanguage, within the framework of family-centered care [11]. Such training may target specific behaviors—eye contact and supportive posture (kinesics), appropriate physical distance (proxemics), and gentle tone and moderated speech rate (paralanguage)—and be reinforced through simulation or role-play with standardized mothers as feedback partners [30], along with ward-level policies that allow unhurried bedside interactions.

CONCLUSION

This study examined the mediating effect of the mother–nurse partnership on the relationship between mothers' perceptions of nurses' communication ability and perceived quality of nursing care, focusing on mothers of preschool-aged children hospitalized with acute illness. The findings revealed that the mother–nurse partnership plays a key mediating role in this relationship, particularly in nonverbal communication subdomains, such as kinesics, proxemics, and paralanguage. These results extend current understanding of communication in pediatric nursing by highlighting the relational significance of nonverbal communication within family-centered care.

Based on these findings, the following recommendations are proposed:

First, targeted training programs on nonverbal communication (kinesics, proxemics, paralanguage) should be developed for pediatric nurses, supported by simulation-based learning and ward-level policies that enable unhurried bedside interactions.

Second, future research should be expanded to include mothers of children with chronic or severe illnesses and those from multicultural families to validate and generalize the present findings.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: all authors. Methodology: all authors. Validation: all authors. Formal analysis: HW, EJL. Investigation: all authors. Data curation: HW, EJL. Writing–original draft: HW, EJL. Writing–review & editing: all authors. Visualization: all authors. Supervision: EJL. Project administration: HW, EJL. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

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

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used Grammarly and ChatGPT (OpenAI, GPT-5.6 Version) for grammar and language editing. After using these tool/service, the authors reviewed and edited the content as needed and take full responsibility for the published article.

ORCID and ResearcherID

Hyejin Wi https://orcid.org/0009-0002-1270-9941
https://researcherid.com/rid/RFB-6419-2026
Hyeon Ok Kim https://orcid.org/0000-0002-1385-8087
https://researcherid.com/rid/RFB-9396-2026
Ju-Hee Nho https://orcid.org/0000-0002-5260-5605
https://researcherid.com/rid/AAT-6962-2021
Eun Jee Lee https://orcid.org/0000-0001-6774-8011
https://researcherid.com/rid/ADV-5498-2022

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Predictors of family quality of life among Omani families of children with sickle cell disease: maternal stress and family structure in a cross-sectional study

Wafa Al Jabri

Assistant Professor, College of Nursing, Sultan Qaboos University, Muscat, Oman

Corresponding author
Wafa Al Jabri
College of Nursing, Sultan Qaboos University, P.O. Box 35, Postal Code 123, Al Khoudh, Muscat, Oman
Tel: +968-2414-5416
Fax: +968-2441-3536
E-mail: wafah@squ.edu.om

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Purpose: Children with chronic health conditions such as sickle cell disease (SCD) often have a reduced quality of life, with consequences for their families. This study examined predictors of family quality of life (FQOL) among Omani families of children with SCD.
Methods: In this cross-sectional study, a convenience sample of 103 mothers completed validated measures of maternal perceived stress and FQOL. Multiple regression analyses examined the effects of individual- and family-level factors on FQOL, with family income and family structure entered as categorical variables.
Results: Maternal perceived stress (β=–.46, p<.001) and family structure (β=–.212, p=.023) significantly predicted FQOL. FQOL was higher in nuclear families (mean=3.63, standard deviation=0.39) than in other family types (extended, single-parent, and polygamous) (mean=3.34, standard deviation=0.47; t(101)=–3.50, p=.001). The overall regression model explained 30.9% of the variance in family quality of life (R^2=.309).
Conclusion: Maternal perceived stress and family composition both were significantly associated with FQOL. These findings support the need for culturally responsive, family-centered interventions and can inform clinical and policy strategies to improve family functioning and overall well-being among families of children with SCD.

Keywords: Anemia, sickle cell; Family; Oman; Quality of life; Stress, psychological

INTRODUCTION

Sickle cell disease (SCD) is a chronic, hereditary blood disorder caused by the presence of abnormal hemoglobin, which leads to painful vaso-occlusive crises (VOCs), chronic anemia, and cumulative organ damage [1]. Globally, SCD represents a significant public health burden, with an estimated 7.7 million people living with the disease as of 2021, and approximately 515,000 affected births annually, reflecting a steady increase due to population growth [2]. The disease contributes substantially to childhood mortality, mainly in low- to middle-income countries, where it continues to be among the leading causes of death in children under 5 [2]. In Oman, SCD is one of the most prevalent genetic conditions, posing both medical and psychosocial challenges for affected families [3]. While considerable attention has been given to the clinical management of SCD, its broader impact on family systems has received less empirical focus.

Families of children with SCD often experience ongoing caregiving demands, hospitalizations, financial burdens, and emotional strain [4,5]. The unpredictable and recurring nature of SCD exacerbates parental anxiety and disrupts family routines, ultimately affecting family cohesion and overall well-being. These stressors are particularly intensified for mothers, who often serve as the primary caregivers in many cultural contexts, including Oman [6,7].

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The family quality of life (FQOL) concept provides a comprehensive lens for understanding how chronic pediatric conditions like SCD affect not only the individual child but also the entire family unit. FQOL is defined as the collective well-being of a family in areas such as emotional health, family interaction, financial stability, and access to social support [8]. Several studies across chronic illness populations have identified key predictors of FQOL.

Parental stress has repeatedly been identified as a strong negative predictor of FQOL. In studies of families of children with autism, higher maternal stress levels were significantly associated with poorer FQOL [9,10]. Similar findings were reported in families of children diagnosed with attention deficit hyperactivity disorder (ADHD) and other developmental disabilities [11]. Although SCD differs in its symptom profile, the emotional and practical burdens placed on caregivers can mirror those of other chronic conditions.

Family structure also plays a significant role in predicting FQOL. Research shows that nuclear families often report higher levels of cohesion and lower stress compared to single-parent or polygamous families [12,13]. Polygamous households, in particular, have been associated with marital conflict, reduced emotional support, and increased psychological distress, especially among first wives [14]. These family dynamics may diminish parents' coping capacity and contribute to lower perceptions of FQOL.

Socioeconomic status is another possible influential factor. Low family income, unemployment, and limited access to healthcare resources have all been linked to reduced FQOL in various populations [5,15]. Financial insecurity can increase the psychological burden on parents and constrain their ability to meet the complex care needs of their child with a chronic condition. Additionally, family size and caregiving burden have been associated with reduced FQOL. Larger families often experience stretched resources, divided attention, and increased parental burnout, especially when more than 1 child is affected by a chronic illness [16]. In such contexts, caregiving demands can limit opportunities for family leisure, social interaction, and emotional bonding, all important dimensions of FQOL.

Although previous studies have highlighted the substantial psychosocial impact of SCD on families and caregivers, research examining FQOL in Oman remains limited and relatively recent. Existing evidence suggests that caregiving demands disproportionately affect mothers and may negatively influence family well-being, while emerging local findings indicate that family structure may also play an important role in shaping FQOL [3]. FQOL among families of children with chronic health conditions, particularly SCD, remains an underexplored area in both global and regional contexts. Despite the clinical focus on disease management and child health outcomes, less attention has been given to the broader psychosocial and family-level consequences of chronic illness. In the Omani context, there is limited evidence on how chronic pediatric conditions affect overall family functioning, caregiver well-being, and perceived FQOL. This is particularly important given the persistent caregiving demands associated with SCD, including recurrent VOCs, frequent hospitalizations, and long-term treatment needs, all of which contribute to emotional, psychological, and financial strain on families. Nevertheless, few studies have adopted an integrative approach to examining how maternal stress and family structure jointly predict FQOL, particularly within the unique sociocultural context of Oman. Addressing this gap is essential to inform culturally appropriate, family-centered interventions and healthcare policies aimed at improving both caregiver well-being and overall family functioning.

Understanding FQOL in families of children with SCD provides critical insight for designing culturally sensitive support programs. In Oman, where family structure and gender roles may differ from Western models, maternal perceived stress and polygamy could uniquely influence family well-being. Additionally, cultural expectations surrounding caregiving, social support, and family cohesion can shape how families cope with the long-term demands of managing chronic illness. Identifying these contextual and sociocultural factors is essential for developing effective, family-centered care interventions that are responsive to the specific needs of Omani families and that promote both caregiver resilience and improved quality of life for children with SCD and their families.

This study aims to examine predictors of FQOL among Omani families of children with SCD, with a specific focus on individual factors (such as the age of the child, maternal age, and maternal perceived stress) and family factors (such as number of children, family structure, and income). By identifying key determinants of FQOL in this context, the findings can inform family-centered, culturally relevant care strategies that support the well-being of caregivers and promote optimal outcomes for children with SCD.

1. Conceptual Framework

The present study was underpinned by the unified theory of family quality of life (UTFQOL), which integrates individual, family, and systemic influences on FQOL. The model emphasizes interactions among health status, family dynamics, resources, and perceived stress as key determinants [8]. Grounded in the framework, this study adopts a comprehensive, multilevel perspective to examine the determinants of FQOL. At the individual level, factors such as the child's health condition, developmental needs, and the mother's psychological state (including perceived stress, coping capacity, and emotional well-being) directly shape daily caregiving experiences and overall subjective well-being. Maternal perceived stress, in particular, is viewed as a proximal mechanism that influences how caregivers perceive, interpret, and respond to caregiving demands. At the family level, structural and resource-based factors such as family income, family structure, and number of children determine the availability and distribution of material, social, and emotional resources required to manage chronic illness. These factors also influence caregiving roles, family cohesion, and internal support systems. Consistent with the UTFQOL framework, the study further examines the combined predictive influence of individual-level and family-level variables on FQOL outcomes through multivariate analysis. This integrated approach recognizes that FQOL is not determined by a single factor, but rather emerges through the interaction of personal experiences, caregiving stressors, family relationships, and available resources. By incorporating these interconnected levels of influence, the framework provides a strong theoretical basis for addressing the study's research questions and for understanding how child-related, maternal, and family factors jointly contribute to variations in family well-being.

2. Research Questions

- What are the associations between individual-level factors (e.g., child gender, VOCs frequency, maternal perceived stress) and FQOL?
- Are family-level factors (e.g., number of children, family structure, income) associated with FQOL?
- Do individual and family-level factors predict FQOL in families of children with SCD?

METHODS

Ethical statements: This study was approved by the Medical Research Ethics Committee of the Sultan Qaboos University Hospital (SQU-EC/ 546/2021). Written informed consent was obtained from all participants before data collection.

1. Study Design

The study used a cross-sectional design to examine factors associated with FQOL among Omani families of children affected by SCD. A cross-sectional design was appropriate because it allowed the researchers to assess the relationships between individual and family-level factors and FQOL at a single point in time in an efficient and practical manner. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [17].

2. Participants

Data were collected from mothers of children affected by SCD in Oman, with the setting being the Pediatric Hematology Clinic (PHC) at Sultan Qaboos University Hospital. Sample size estimation was conducted using Cohen's power analysis with a significance level of $\alpha = .05$, power = .80, and medium effect sizes based on prior related studies [18]. For bivariate correlations (research question 1 and 2), an effect size of .30 indicated a required sample of 84 participants, while regression (research question 3) with 6 predictors and an effect size of .15 required 98 participants. Therefore, the largest estimated sample size (N = 98) was adopted to ensure adequate statistical power across all research questions. A total of 106 mothers were approached using the convenience sampling technique with the help of the hematology nurse in the PHC clinic. Only 103 mothers agreed to participate in the study. The participants met the inclusion criteria of adult Omani mothers of children who were diagnosed with SCD (6–13 years). Mothers of children who were treated by bone marrow transplant, or have a sibling already participated in this study were excluded. Moreover, mothers of children experiencing severe pain episodes were not approached for participation.

3. Measurements

The Beach Center Family Quality of Life (BC-FQOL) Scale was used to assess family quality of life. The original scale developed by Hoffman et al. [19] (2006) consists of 25 items across 5 domains, which are: (1) family interaction, (2) parenting, (3) emotional well-being, (4) physical/material well-being, and (5) disability-related support. In this study, the modified 21-item version was used, excluding the disability-related support domain because the study involved families of children with sickle cell disease rather than children with physical or intellectual disabilities, consistent with the modification described by Zuna et al. [20] in 2009. Items are rated on a 5-point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied). Zuna et al. [20] in 2009 reported good reliability for the modified scale (Cronbach's α=.90; subscale α=.77–.85). The Arabic version was translated by the international dictionary for legal translation office following World Health Organization guidelines. In the current study, Cronbach's α of the scale was .91.

The Perceived Stress Scale (PSS-10) was also used to assess maternal perceived stress. Responses are rated on a 5-point Likert scale, ranging from 0 (never) to 4 (very often), using the Arabic version of the PSS-10 that showed good reliability with Cronbach's alpha coefficients ranging from .71 to .82 [21]. Items 4, 5, 7, and 8 are reverse-coded before summing the responses. The total score ranges from 0 to 40, with higher scores indicating greater perceived stress [21]. In the current study, the Cronbach's alpha value was .81, indicating a good level of internal consistency. The participants also completed demographic data to capture details such as age, gender, family structure, family income, parents' level of education, parents' employment status, and healthcare events related to SCD.

4. Data Collection

After obtaining ethical approvals to conduct the study, the researchers contacted the head nurse of the clinic to explain the study's aim and data collection procedures. The participants were approached during their children's appointments. Informed consent was obtained from all participants. The data were collected from participants between October and December 2021. Mothers who agreed to take part in the study were given comprehensive information including a study information form, consent form, and study questionnaire. The participant information form outlined the study's objectives, potential risks and benefits, and clearly stated that participation was voluntary. The questionnaires were distributed to the mothers during the waiting time before meeting with the physician. The principal investigator was the one who administered the questionnaires to the participants and provided them with clarification as needed.

5. Data Analysis

Data analysis, conducted using IBM SPSS Statistics ver. 23.0 (IBM Corp.), involved descriptive statistics and frequency distributions for general participant characteristics.

To address the first and second research questions, independent-samples t-tests and one-way analysis of variance, followed by Bonferroni-adjusted post-hoc test were used to compare FQOL scores across groups and identify pairwise differences. Moreover, correlation analyses were used to examine the associations between individual-level factors (child gender, VOCs frequency, and maternal perceived stress) and FQOL, as well as between family-level factors (number of children, family structure, and family income) and FQOL.

Furthermore, to answer the third research question, a multiple regression analysis was used to determine the extent to which individual-level and family-level factors predict FQOL in families of children with SCD. This approach was chosen because the study aimed to examine the independent effects of all predictors on FQOL at a single analytical level rather than testing stepwise theoretical layers, therefore, the present analysis focused on assessing the overall contribution of all variables simultaneously while controlling for interrelationships among predictors within a single conceptual model. Family income was categorized into low, middle, and high income groups and coded as 0, 1, and 2, respectively. Family structure was dichotomized into nuclear families (coded 0) and other family types (coded 1) including extended, single-parent, and polygamous families. All relevant variables were entered simultaneously to assess their unique associations with FQOL while controlling for the other variables in the model. All relevant variables were entered into the model to examine their unique and combined effects on FQOL, while accounting for potential confounding influences and thereby enhancing the study's internal validity.

Prior to analysis, key statistical assumptions for both tests were assessed, including normality, linearity, homoscedasticity, independence of observations, and absence of multicol-

linearity and influential outliers to ensure the validity and reliability of the results. The assumption of multicollinearity was satisfied, as none of the predictors were highly correlated with one another. All variance inflation factor (VIF) values were below 10, and tolerance values exceeded 0.20. All statistical tests were 2-tailed, with statistical significance established at $p < .05$. Additionally, 95% confidence intervals (CIs) were reported where applicable.

All missing data were examined to determine the pattern and proportion of missing values for each study variable. The results indicated that the missing data were randomly distributed. For the scale items, the percentage of missing responses was less than 2.0%; therefore, missing values were replaced with each participant's mean scores of the subscale for each item.

RESULTS

1. General Characteristics of the Participants

The participants represented families from various regions of Oman, with the largest proportion coming from the Al Dakhilya region. Mothers ranged in age from 27 to 52 years, with a mean age of 38.75 years. Most mothers had some level of undergraduate or college education, and over half were unemployed. The vast majority of fathers were employed, with more than half having attained undergraduate education. Most participating families were nuclear and had between 1 and 5 children. Approximately two-thirds of the families lived in urban areas, and about 41% reported a monthly household income of 900 Omani rials (approximately US$2,329) or less. Children in the study averaged 4.3 clinic or emergency visits annually due to VOCs (Table 1).

2. FQOL and Family Characteristics

Descriptive statistics indicated that mothers reported a moderate to high satisfaction level with their FQOL (3.51±0.45). In contrast, they reported a moderate level of maternal perceived stress (2.37±0.54). Descriptive statistics for the key study variables are provided in Table 1. The study findings indicated that most participating mothers experienced moderate (60.2%) or high (35.9%) stress levels, whereas only 3.9% reported low levels of stress. The distribution of mothers according to their perceived stress level is presented in Table 2.

Overall, FQOL did not differ significantly by child gender, parents' employment status, family income, or parents' education level ($p > .05$). However, a significant difference was found by family structure ($F(3,99) = 5.69$, $p = .001$). Levene's test was not significant ($F(3,99) = 0.976$, $p = .41$), indicating that the homogeneity of variance assumption was met. Nuclear families reported the highest FQOL (3.63±0.39), followed by the extended families (3.40±0.46) and single-parent families (3.17±0.39) , whereas polygamous families reported the lowest FQOL (2.96±0.62) (Table 3). Bonferroni-adjusted post hoc comparisons revealed significantly higher FQOL among nuclear families than among single-parent and polygamous families ($p = .041$ and $p = .045$, respectively), with no other significant differences found. These findings should be interpreted cautiously because the single-parent (n=7) and polygamous (n=3) groups were small.

3. Correlation Analysis

The study used correlation and multiple regression analyses to explore factors predicting mothers' perceptions of FQOL. Pearson's correlation revealed a significant negative relationship between maternal perceived stress (MPS) and FQOL ($r = -.486$, $p < .001$) (Table 4). Additionally, a weak negative correlation was found between the number of children in the family and FQOL ($r = -.23$, $p = .020$) (Table 4). Other variables did not show significant correlations with FQOL.

4. Factors Influencing FQOL

A multiple regression analysis was performed using individual factors (child- and mother-related) and family factors, with categorical variables such as family income (coded 0=low, 1=medium, 2=high) and family structure was dichotomized into nuclear families (coded 0) and other family types (coded 1), including extended, single-parent, and polygamous families. Prior to conducting the multiple regression analysis, multicollinearity among the independent variables was assessed. The tolerance values ranged from 0.714 to 0.945, and VIF values ranged from 1.058 to 1.400, indicating no evidence of problematic multicollinearity among the predictors.

The overall regression model was significant, explaining 30.9% of the variance in FQOL ($R^2 = .309$, adjusted $R^2 = .264$). The final model identified 2 significant predictors of FQOL: family structure ($\beta = -.212$, $t = -2.31$, $p = .023$; 95% CI, −0.36 to

Table 1. General characteristics of study participants (N=103)

Characteristic	Category	Value
Child's gender (N=103)	Male	58 (56.3)
	Female	45 (43.7)
Family structure (N=103)	Nuclear	59 (57.3)
	Extended	34 (33.0)
	Single-parent	7 (6.8)
	Polygamous	3 (2.9)
District type (n=93)	Rural	35 (37.6)
	Urban	58 (62.4)
Mother's level of education (n=102)	Less than 9th grade	2 (2.0)
	Partial high school	4 (3.9)
	High school graduate	18 (17.6)
	Partial college	9 (8.8)
	Associate degree	28 (27.5)
	Baccalaureate degree	37 (36.3)
	Master's degree	4 (3.9)
Mother's employment status (n=101)	Employed	44 (43.6)
	Not employed	57 (56.4)
Father's level of education (n=96)	Less than 9th grade	4 (4.2)
	Partial high school	6 (6.3)
	High school graduate	18 (18.8)
	Partial college	17 (17.7)
	Associate degree	35 (36.5)
	Baccalaureate degree	14 (14.6)
	Master's degree	2 (2.1)
Father's employment status (n=96)	Employed	92 (95.8)
	Not employed	4 (4.2)
Family monthly income (n=99)	≤400 OMR ($1,035)	9 (9.1)
	401–900 OMR	32 (32.3)
	901–1,400 OMR	40 (40.4)
	1,401–1,900 OMR	16 (16.2)
	1,901–2,400 OMR	2 (2.0)
	>2,400 OMR ($6,210)	0 (0.0)
Presence of other health conditions (N=103)	Yes	20 (19.4)
	No	83 (80.6)
Family quality of life (N=103)	-	3.51±0.45 (2.11–4.86)
Maternal perceived stress (N=103)	-	2.37±0.54 (0.00–3.50)
Number of children (N=103)		5.28±1.82 (1–9)
VOCs frequency (N=103)		4.30±1.75 (0–8)

Values are presented as number (%) or mean±standard deviation (Min–Max).
OMR, Omani rial.

−0.03) and maternal perceived stress (β=–.38, t=–5.02, p<.001; 95% CI, −0.53 to −0.23) (Table 5). Family structure was a significant predictor with nuclear families reporting significantly higher FQOL scores (3.63±0.39) than other family types (3.34±0.47), confirmed by an independent t-test (t(101)=–3.50, p=.001) (Table 5). Maternal perceived stress was another significant predictor indicating that lower stress levels were associated with higher perceived FQOL. None of the other variables, including child gender, number of children, frequency of VOCs, or family income, were significant predictors of FQOL in the regression model (Table 5).

Table 2. Distribution of mothers according to perceived stress level (N=103)

Maternal perceived stress level	No. (%)
Low	4 (3.9)
Moderate	62 (60.2)
High	37 (35.9)
Total	103 (100.0)

PSS-10 scores: 0–13 (low), 14–26 (moderate), and 27–40 (high perceived stress).

DISCUSSION

Regarding the first research question, MPS was the only individual-level factor found to be associated with FQOL. This study showed that most mothers reported moderate or high stress, while only 3.9% reported low stress. On average, the mean stress levels observed among mothers in the present study were comparable to those reported in prior studies examining parental stress among families of children with SCD. For example, Moody [22] in 2021 investigated the relationship between parental stress and health-related quality of life among children with SCD. Moody [22] reported that most parents of children with SCD experienced moderate levels of stress. Consistent with these findings, previous studies have reported substantial stress among parents of children with SCD, stemming from the demands of managing their child's medical care, addressing emotional distress, and coping with recurrent VOCs and the unpredictable course of the disease [4-7]. Furthermore, higher levels of perceived stress among mothers were significantly associated with lower FQOL ratings. This association may indicate that elevated stress levels influence mothers' perceptions of their FQOL. Alternatively, the COVID-19 (coronavirus disease 2019) pandemic, which coincided with the data collection period, may have contributed to increased stress and potentially influenced mothers' perceptions of FQOL.

Although the association between maternal perceived stress and FQOL has not been specifically investigated among families of children with SCD, findings from studies involving families of children with other chronic and developmental conditions provide supporting evidence. For example, McStay et al. [9] conducted a study in Australia to examine the role of child age in maternal perceived stress and FQOL among families raising a child with autism. They found that mothers of children with autism reported significantly higher levels of stress and lower perceived FQOL [9]. Similarly, Wang et al. [10] investigated the effects of parenting stress on parental involvement and FQOL among families of children with autism in China, reporting a negative association between maternal perceived stress and FQOL. Moreover, Nuri et al. [12] examined the relationship between parental stress and FQOL among parents of children with ADHD. Their findings indicated that parents experienced high levels of stress, which were negatively associated with FQOL [12]. These findings are further supported by broader evidence across chronic illness populations. For instance, evidence comes from a comparative study involving families of children with autism, Down syndrome, cerebral palsy, and

Table 3. Mean FQOL scores and one-way ANOVA results by family structure (N=103)

Family structure	No. of participants	Mean±SD	F (3,99)	*p*
Nuclear family	59	3.63±0.39	5.69	.001
Extended family	34	3.40±0.46		
Single-parent family	7	3.17±0.39		
Polygamous family	3	2.96±0.62		
Total	103	3.51±0.45		

ANOVA, analysis of variance; FQOL, family quality of life; SD, standard deviation.

Table 4. Correlations between family quality of life, maternal stress, and number of children (N=103)

Variable	1	2	3
1. Family quality of life	1		
2. Maternal perceived stress	−.486 (*p*<.001)	1	
3. No. of children	−.230 (*p*=.020)	.120 (*p*=.226)	1

Table 5. Multiple regression analysis for variables predicting FQOL (N=103)

Predictor	B	β	t	*p*	R	R^2	Adjusted R^2	Durbin-Watson	No.	Mean±SD	t (101)
Multiple regression analysis											
Child's gender	–0.01	–.011	–0.127	.899							
No. of children	–0.09	–.032	–0.315	.754							
Total VOCs	0.03	.016	0.165	.869							
Family income	0.41	.180	2.02	.064							
Family structure	–0.19	–.212	–2.31	.023							
Maternal perceived stress	–0.38	–.461	–5.02	.001							
Model statistics					.556	.309	.264	1.814			
Family structure comparison											
Nuclear families				.001					59	3.63±0.39	–3.50
Other family types									44	3.34±0.47	

Family structure was coded as 0=nuclear family and 1=other family types (extended, single-parent, and polygamous families).
B, unstandardized regression coefficient; β, standardized regression coefficient; FQOL, family quality of life; SD, standard deviation; VOCs, vaso-occlusive crises.

type 1 diabetes, demonstrated a consistent negative association between perceived chronic stress and FQOL across all domains, irrespective of the child's diagnosis [23]. Despite the significant differences in the nature of SCD, autism, ADHD, Down syndrome, cerebral palsy, and type 1 diabetes, the findings across these studies suggest a recurring association between parental stress and lower FQOL in families caring for children with chronic or developmental conditions.

The second research question examined family-level factors associated with overall FQOL. The findings indicated that families with a greater number of children reported lower levels of FQOL. This finding is consistent with previous research suggesting that larger family size may increase the caregiving and financial burden on parents, which may, in turn, adversely affect overall family well-being [24]. Moreover, Chen et al. [17] reported that an increase in the number of family members may reduce the average income available per family member, potentially contributing to lower levels of satisfaction among family members. In addition, evidence from Oman supports these findings. A study examining caregiver burden has shown that increased caregiving demands, often intensified in extended family settings, are strongly associated with higher stress and reduced family well-being, particularly when formal support systems are limited [25].

Another notable finding of the present study was the significant variation in FQOL across different family structures. Mothers from nuclear families reported significantly higher levels of FQOL compared with mothers from single-parent and polygamous families. In contrast, mothers from polygamous families reported the lowest levels of FQOL. These findings are consistent with previous research indicating that 2-parent families tend to report higher overall FQOL than single-parent families [14]. Moreover, previous studies have reported that individuals in polygamous family structures may experience greater levels of marital conflict, family disruption, and family violence compared with those in monogamous families [3,13,15]. Such family-related challenges may place additional emotional, social, and practical demands on mothers and may contribute to poorer perceptions of overall FQOL.

The third research question was to identify the predictors of FQOL. The regression analysis included child's gender, family income, family structure, number of children in the family, frequency of VOCs, and the MPS. Of these variables, only MPS and family structure emerged as significant predictors of FQOL. Specifically, higher FQOL was associated with lower maternal perceived stress and a nuclear family structure. These findings are particularly noteworthy given the limited evidence regarding the predictive roles of maternal perceived stress and family structure in FQOL among families of children with SCD. Hsiao et al. [16] reported that parental stress was a significant predictor of FQOL among families of children with autism, suggesting that reducing parental stress may contribute to improvements in overall FQOL. With regard to family structures, many research studies have demonstrated that certain family structures, particularly single-parent and polygamous families, are associated with greater family dysfunction and lower FQOL [13,26,27]; however, these studies did not specifically examine family structure as a predictor of FQOL. Therefore, the present finding that family structure significantly predicted FQOL adds to the existing literature and highlights the potential importance of family context when examining quality of life among families caring for children with SCD and other chronic conditions.

Interestingly, family income and number of children were not significant predictors of FQOL in the final model. The lack of association between income and FQOL may reflect the buffering role of extended family support systems and shared caregiving responsibilities, which can reduce the direct influence of financial status on perceived family well-being. Similarly, although number of children was not a significant predictor in the final model, its potential influence may be indirect and shaped by cultural norms that value larger families and by the availability of informal support networks that help distribute caregiving demands. Overall, these results suggest that non-significant predictors should not be viewed as unimportant, but rather as context-sensitive factors whose effects may be mediated or moderated by family structure, cultural expectations, and available social support.

Notably, mothers from nuclear families reported higher FQOL scores compared with mothers from other family structures, which is consistent with the findings from the regression analysis. Differences in FQOL and maternal perceived stress across other characteristics highlight the multifactorial nature of family experiences when caring for a child with SCD. These findings reinforce the importance of considering the broader family context, social support systems, and caregiving demands when developing interventions aimed at improving FQOL.

In general, although numerous studies have examined the

associations between different factors and FQOL, research specifically examining its predictors among families of children with chronic conditions remains limited. Further research is therefore warranted to identify additional factors that may predict FQOL and to enhance understanding of the complex factors influencing family well-being. Moreover, the study has some other limitations, including reliance on self-reported data, that may have introduced recall and social desirability bias, and the use of only mothers' perspectives, which may not fully represent the collective family perceptions about FQOL. The use of convenience sampling and single-site data collection may also limit the generalizability of the findings to the broader population. In addition, the small numbers of participants in some family-structure subgroups, particularly polygamous families (n=3) and single-parent families (n=7), may have affected the stability of the subgroup comparisons; therefore, these findings should be interpreted cautiously. Finally, the cross-sectional design limits causal inferences, and unexpected situational factors during data collection (such as clinic noise and fathers' influence during survey completion) may have affected mothers' responses.

CONCLUSION

The findings indicate that both maternal perceived stress and family composition were significantly associated with FQOL, with lower maternal perceived stress associated with higher FQOL and mothers from nuclear families reporting higher FQOL than those from single-parent and polygamous families. The study underscores the necessity for family-centered healthcare models that address maternal perceived stress and the complexities of family structure in Oman. Healthcare providers should integrate psychosocial support and stress management programs into care plans, particularly targeting mothers in polygamous and single-parent families. Policy makers are encouraged to develop culturally responsive support services and allocate resources for caregiver support, including counseling and community-based networks. Educational programs focusing on stress reduction and resilience building for families managing chronic illnesses are recommended. Further research should investigate longitudinal family outcomes, paternal influences, sibling well-being, and healthcare access disparities to comprehensively understand factors shaping FQOL.

ARTICLE INFORMATION

Authors' contribution

Conceptualization, methodology, data collection, data analysis, interpretation, writing–original draft, writing–review & editing, and final approval of published version: WAJ.

Conflict of interest

The author declares no conflict of interest.

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Data availability

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

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author used ChatGPT (OpenAI, GPT-6 Version) to assist with language editing, summarization, and refinement of the manuscript. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

ORCID and ResearcherID

Wafa Al Jabri https://orcid.org/0009-0003-3566-3277
https://researcherid.com/rid/NWG-8176-2025

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Predictive value of birth weight and age for preliminary community-level stratification of undernutrition risk among children under 5: a cross-sectional study in rural Indonesia

Yani Maidelwita[1], Rini Rahmayanti[1], Sri Suciana[1], Rika Sarfika[2], Tukimin Bin Sansuwito[3]

[1]Lecturer, Faculty of Health and Science, Universitas Mercubaktijaya, Padang City, Indonesia
[2]Lecturer, Department of Mental Health and Community, Faculty of Nursing, Universitas Andalas, Padang City, Indonesia
[3]Lecturer, School of Nursing, Lincoln University College, Petaling Jaya, Malaysia

Corresponding author
Yani Maidelwita
Faculty of Health and Science, Universitas Mercubaktijaya, Jl. Jamal Jamil Pondok Kopi Surau Gadang, Nanggalo, Padang City, West Sumatra 25146, Indonesia
Tel: +62-75142295 (landline)
Fax: +62-751442286
E-mail: yanimaidelwita@mercubaktijaya.ac.id

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Purpose: We evaluated the predictive value of low birth weight (LBW), child age, and maternal education for stunting, wasting, and underweight among children aged 0–59 months.

Methods: We analyzed cross-sectional surveillance data from 394 children in Pesisir Selatan District, West Sumatra, Indonesia, and classified nutritional status according to the 2006 World Health Organization Child Growth Standards. For each outcome, we fitted a parsimonious logistic model (LBW, age, maternal education, and sex) and an expanded model incorporating 8 additional variables (9 regression coefficients). We assessed discrimination using the area under the receiver operating characteristic curve (AUROC) and calibration using the Hosmer-Lemeshow test and calibration slope.

Results: The prevalence of stunting, wasting, and underweight was 14.5%, 10.7%, and 17.3%, respectively. LBW was the strongest predictor in the parsimonious model for stunting (adjusted odds ratio [AOR], 4.85; 95% confidence interval [CI], 2.53–9.29), wasting (AOR, 2.88; 95% CI, 1.38–6.02), and underweight (AOR, 4.34; 95% CI, 2.30–8.19; $p \leq .005$). A lack of formal maternal education was independently associated with stunting and underweight. The optimism-corrected AUROCs were .706, .631, and .751, with calibration slopes of .88, .75, and .90, respectively. Adding variables in the expanded model did not improve fit (likelihood-ratio $p > .05$) and increased optimism.

Conclusion: The parsimonious model showed modest discrimination for stunting and underweight. Discrimination for wasting was inadequate. A predictive contribution from the added variables could not be demonstrated with the available number of events. These preliminary findings require external validation before community-level application.

Keywords: Birth weight; Child nutrition disorders; Community health services; Indonesia; Risk assessment

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INTRODUCTION

Undernutrition in early childhood remains one of the most consequential public health challenges worldwide, contributing to impaired physical growth, compromised neurocognitive development, weakened immune function, and diminished economic productivity across the life course [1,2]. The 2025 United Nations Children's Fund/World Health Organization (WHO)/World Bank Joint Child Malnutrition Estimates indicate that approximately 150.2 million children under 5 were stunted, 42.8 million were wasted, and 12.2 million suffered severe wasting globally, with the heaviest burden concentrated in low- and middle-income countries (LMICs) [3]. These indicators are core metrics for tracking progress toward Sustainable Development Goals (SDGs) 2 and 3, both of which aim to end preventable child malnutrition by 2030. Subnational mapping across 105 LMICs has revealed persistent geographical inequalities even within countries showing aggregate improvement [4].

Among the determinants of childhood undernutrition, low birth weight (LBW; <2,500 g) is a well-documented biological marker associated with 2- to 3-fold increases in subsequent stunting, wasting, and underweight across LMICs [5-8]. The biological pathways are well-established and involve intrauterine growth restriction, reduced lean body mass, altered hormonal signaling, and compromised gut and immune function [9,10]. Birth weight is routinely recorded in maternal-and-child-health (MCH) records throughout Indonesia and across most LMICs, making it a no-cost, universally accessible early-life data point with direct relevance for community-level risk stratification.

Child age modifies undernutrition risk through complementary biological and behavioral mechanisms. The 2023 WHO Guideline for Complementary Feeding identifies the 6–23-month period as coinciding with peak risk for growth faltering, when the transition from exclusive breastfeeding to complementary feeding exposes children to dietary inadequacies, micronutrient gaps, and heightened infection susceptibility [11,12]. Longitudinal cohorts across 21 populations have shown that wasting incidence peaks between birth and 3 months and remains recurrent through 24 months, with cross-sectional prevalence considerably understating cumulative exposure [13]. Indonesian and multi-country evidence further indicates that growth faltering accelerates during the second year of life and is only partially reversible thereafter [3,14]. Maternal education provides a third, more distal determinant, capturing health literacy, caregiver decision-making, and household resource allocation in ways that often outperform direct income measures [15,16].

Despite well-established independent associations of LBW, age, and maternal education with individual undernutrition indicators, limited evidence is available on the combined predictive performance of parsimonious early-life indicators across all 3 undernutrition outcomes within a unified risk-stratification framework suitable for routine community-level application. The existing evidence base remains predominantly descriptive, examining single outcomes in isolation or reporting risk-factor associations without quantifying predictive adequacy. Recent prediction work has employed machine-learning algorithms on Demographic and Health Survey datasets, yielding pooled accuracies of approximately 69% for stunting and 74% for underweight [17]. Outcome-specific prediction models have also been developed using more elaborate predictor sets, such as the model by Xiong et al. [18] for stunting in children under 3 years, that incorporate delivery mode, maternal education, and feeding practices. However, these models typically require extensive inputs (dietary diversity, sanitation, wealth indices) rarely available in routine LMIC surveillance, and have not been adapted for low-data community settings. A parsimonious model using only routinely recorded variables, with formal evaluation of discrimination and calibration, has not been reported for the Indonesian Posyandu (Integrated Community Health Posts) context, the principal delivery platform for preventive child health services nationally.

This gap has direct operational consequences. Posyandu currently operates under a largely reactive surveillance paradigm, detecting undernutrition only after anthropometric failure has occurred. The 2025 Joint Estimates Report explicitly urges high-burden countries to adopt preventive, early-warning strategies aligned with SDG monitoring [3]. A simple, validated predictive model using routinely recorded early-life variables could enable proactive triage within existing infrastructure, flagging children at risk before growth faltering becomes clinically established, shifting the paradigm from reactive detection toward preventive identification.

This study is framed explicitly as a prediction-modeling investigation rather than a risk-factor analysis. We evaluate the combined predictive value of LBW and child age, supplemented by maternal education and sex, for stunting, wasting, and underweight in a rural West Sumatran community, and we contrast this parsimonious specification against an ex-

panded model that adds dietary, behavioral, and environmental determinants. Our hypotheses are: (1) LBW and age 6–23 months are positively associated with all 3 undernutrition outcomes after adjustment for sociodemographic covariates; (2) the parsimonious multivariate model demonstrates acceptable discrimination (area under the receiver operating characteristic [ROC] curve [AUROC] ≥.70) and calibration for 2 or more outcomes; and (3) the expanded model does not yield clinically meaningful improvements in discrimination once internal-validation optimism is taken into account. The selection of LBW, age, and maternal education as primary predictors is grounded in 3 considerations: (1) biological plausibility, in that each variable maps to a validated mechanistic pathway; (2) practical accessibility, given that all 3 are routinely recorded in the Indonesian MCH booklet and Posyandu register; and (3) operational fit, since each can be ascertained by Posyandu cadres without specialized training, making them feasible for scaled community deployment.

METHODS

Ethical statements: This study was approved by the Ethics Committee of Awal Bros University (Protocol No. 0067/UAB1.20/SR/KEPK/06.25). Informed consent was obtained from the parents or legal guardians of all participating children.

1. Study Design and Setting

This study employed a cross-sectional, retrospective analytical design using data from the community-based nutritional surveillance system at Puskesmas Surantih (Community Health Center) in Pesisir Selatan District, West Sumatra, Indonesia. Surveillance activities were integrated into routine growth monitoring at Posyandu, community-led health units staffed by trained midwives and volunteers that serve as the primary entry point for preventive child health services, including anthropometric monitoring. Surveillance records collected between January and February 2025 served as the analytical dataset. Because the design is cross-sectional, the resulting prediction model estimates concurrent (not future) undernutrition risk; the temporal validity of model performance is therefore restricted to current risk stratification rather than to forecasting incident undernutrition trajectories. The study is reported in accordance with the TRIPOD (Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis) statement [19], supplemented by the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) recommendations for the observational (cross-sectional) design.

2. Population and Sampling Procedure

The target population comprised all children aged 0–59 months enrolled in the Puskesmas Surantih Posyandu monitoring network during January–February 2025 (active registry n=612). Sample size adequacy for multivariate logistic regression was determined using the Peduzzi minimum events-per-variable (EPV) approach, requiring ≥10 outcome events per predictor variable. Given that wasting had the lowest expected prevalence (approximately 10%) and the parsimonious model required up to 6 dummy-coded coefficients, a minimum of 600 children would have been required to satisfy the strict EPV ≥10 criterion. The final analytical sample of 394 children approached the EPV criterion for stunting (57 events/6 coefficients≈9.5), satisfied it for underweight (68/6≈11.3), but fell below the criterion for wasting (42/6=7.0). Because no penalized estimation was applied, internal validation through bootstrap optimism correction was used for all models to quantify, rather than remove, the resulting overfitting. The expanded model with 15 dummy-coded coefficients fell well below the strict EPV threshold and is therefore presented explicitly as an exploratory comparator.

A simple random sampling procedure was used. The full active registry was extracted to a digital list with anonymized identifiers. A computer-generated random number sequence was produced in R ver. 4.3.1 (The R Foundation for Statistical Computing) and applied to the registry IDs by a research nurse not otherwise involved in measurement or analysis. Random sampling of 420 children, rather than enrolment of the full registry of 612, reflected the additional data-collection burden of the expanded model: the dietary, behavioral, socioeconomic, and environmental variables required structured caregiver interviews, and interviewing the entire registry was not logistically feasible within the January to February 2025 surveillance window. The sampling fraction was therefore set to accommodate this interview workload while preserving equal-probability random selection. The smaller sample reduced the number of outcome events available for analysis, with consequences for statistical power, particularly for wasting, that are addressed in the Limitations. Because the analytical sample fell short of the 600 children required a

priori, a post-hoc calculation of the minimum detectable odds ratio at 80% power was performed and is reported with the Results section. The first 420 randomly drawn IDs were reviewed for eligibility; 26 were excluded due to incomplete birth-weight records, congenital anomaly, or acute illness at the time of measurement, yielding a final analytical sample of 394 children. Post-sampling comparison of selected versus non-selected children on age and sex showed no systematic differences, confirming balanced random selection. Eligibility criteria included: (1) age 0–59 months; (2) complete anthropometric and birth-weight records; and (3) residence within the Puskesmas Surantih service area. Children with congenital anomalies, chronic diseases, or acute illness at measurement were excluded to prevent confounding by non-nutritional anthropometric factors.

3. Variables and Operational Definitions

Nutritional outcomes were defined per the WHO 2006 Child Growth Standards [20]: stunting (height-for-age z < −2 standard deviation [SD]), wasting (weight-for-height z < −2 SD), and underweight (weight-for-age z < −2 SD). Although severity categories (moderate and severe) are reported descriptively, outcomes were dichotomized for predictive modeling to avoid sparse-cell instability.

The parsimonious model included 4 primary predictor variables (6 dummy-coded coefficients): birth weight (< 2,500 g vs. ≥ 2,500 g; verified from the MCH booklet); age category (0–5, 6–23, 24–59 months; reference, 0–5 months); maternal education (none, primary; reference, secondary/tertiary combined); and child sex. The expanded model added 8 further covariates (9 regression coefficients) representing dietary, behavioral, socioeconomic, and environmental domains: household income (low vs. middle/high); exclusive breastfeeding for the first 6 months; complementary feeding practice (poor/fair/good; entered as 2 dummy variables); dietary diversity score (1–7 food-group score); protein intake adequacy; improved sanitation; recent infection (past 2 weeks); and food security (4-level Household Food Insecurity Access Scale categorization, dichotomized as moderate/severe vs. secure/mild for primary analysis). Total breastfeeding duration, complete immunization, and clean water access were collected as candidate variables and assessed in bivariate analyses but were not entered into the multivariable expanded model owing to high collinearity with exclusive breastfeeding, maternal education, and improved sanitation, respectively. Additional covariates considered exploratorily included caregiver occupation, maternal age, parity, and family size.

4. Data Collection and Quality Assurance

Anthropometric measurements followed WHO standardized protocols. Recumbent length (< 24 months) or standing height (≥ 24 months) was measured to the nearest 0.1 cm using calibrated infantometers and stadiometers; weight was measured to the nearest 0.1 kg using digital scales. Calibration was verified daily with standard reference rods and weights. Anthropometric z-scores (height-for-age, weight-for-height, and weight-for-age) were computed against the WHO 2006 Child Growth Standards using the LMS method as implemented in the WHO Anthro software (igrowup macro); observations falling outside the WHO biologically plausible limits were flagged and excluded. Birth weight was abstracted from the national MCH booklet. Sociodemographic, dietary, behavioral, and environmental information was obtained via structured caregiver interviews using validated instruments adapted for the local context. All dietary, behavioral, socioeconomic, and environmental variables were collected at the same time as the anthropometric measurements during the same January to February 2025 surveillance window. Quality assurance procedures included: (1) double-entry data verification; (2) independent audit of 10% of anthropometric records; and (3) cross-validation between interview responses and MCH booklet documentation. Interviews were conducted by trained enumerators at the Posyandu session, after the purpose of the study had been explained to the caregiver and consent obtained, and all records were anonymized before analysis.

All 394 children in the analytical sample had complete data for every outcome, predictor, and interview-based covariate, because eligibility screening (complete anthropometric and birth-weight records) preceded the caregiver interview and enumerators verified each interview form for completeness before the family left the Posyandu session. No imputation was therefore required, and all analyses are complete-case analyses of the 394 children. Of the 26 children excluded before analysis, those excluded for incomplete birth-weight records could not be characterized on outcome status, and this exclusion may have introduced a small degree of selection bias, which is acknowledged in the Limitations.

5. Statistical Analysis

All analyses were performed in Python ver. 3.11 (Python Software Foundation) with statsmodels (logistic regression) and scikit-learn (cross-validation, ROC). All statistical tests were 2-tailed, and the alpha level for statistical significance was set at $\alpha = .05$. Descriptive statistics summarized participant characteristics. Bivariate associations were evaluated using Pearson's chi-square tests for categorical variables and independent-sample t-tests for continuous variables (child age, birth weight, breastfeeding duration, dietary diversity score, protein intake, maternal age, parity, birth order, and family size), applying the Welch correction where the Levene test indicated unequal variances; group means, SDs, test statistics, and standardized mean differences for these comparisons are reported in Supplement 1. Where the expected frequency in any cell of a contingency table fell below 5, Fisher's exact test (Freeman-Halton extension for tables larger than 2 by 2) was used in place of the chi-square test. This affected only a small number of sparse strata, such as the severe food-insecurity category, and did not change any of the bivariate conclusions.

Two multivariate logistic regression models were fitted for each of the 3 outcomes. Model 1 was the Parsimonious Risk-Stratification Model and included 4 predictor variables represented by 6 coefficients: LBW, age 6–23 months and 24–59 months as dummy variables, maternal education "none" and "primary" as dummy variables, and male sex. Its purpose was to assess whether routinely captured variables could support preliminary identification of children who may require follow-up assessment by community health workers within existing Posyandu workflows. The model was not intended to function as a stand-alone screening or diagnostic instrument.

Model 2 was the expanded fully adjusted model which added 8 further predictor variables represented by 9 coefficients (household income, exclusive breastfeeding, 2 complementary-feeding dummies, dietary diversity score, protein adequacy, improved sanitation, food insecurity moderate/severe, and recent infection). Its purpose was to serve as a fully adjusted predictive comparator against the parsimonious specification. Because its 15 coefficients were estimated from only 42 to 68 outcome events, the expanded model is presented as exploratory only.

Predictor inclusion followed a theory-driven approach rather than data-driven stepwise selection, to preserve generalizability. Multicollinearity was assessed using variance inflation factors (VIF threshold < 5; all values in our models were below 2.5).

Predictive performance was evaluated through: (1) apparent AUROC; (2) Hosmer-Lemeshow goodness-of-fit test for calibration; (3) Brier score for overall predictive accuracy; (4) stratified 10-fold cross-validation (random seed fixed for reproducibility); and (5) bootstrap optimism correction using 500 resamples. Optimism-corrected AUROC was treated as the primary performance metric for each model. Because the Hosmer-Lemeshow test has low power when outcome events are few, calibration was additionally summarized by the bootstrap-estimated calibration slope, obtained as the mean slope of the linear predictor when each bootstrap model was applied to the original data, with values below 1 indicating overfitting and the amount of shrinkage that would be needed [21], and was displayed graphically as calibration plots of observed against predicted probabilities across risk groups with a locally weighted (LOWESS) smoother (Supplement 2). Adjusted odds ratios (AORs) are reported with 95% confidence intervals (CIs) alongside every *p*-value. AUROC $\geq .70$ was treated as the threshold for acceptable discrimination, with values in the .70–.79 range interpreted as modest but acceptable rather than strong.

Direct model comparison employed: (1) likelihood-ratio testing of the parsimonious versus expanded models for each outcome; and (2) the Akaike (AIC) and Bayesian (BIC) information criteria, with lower values indicating better fit penalized for complexity.

Three sensitivity analyses addressed the limited number of outcome events. First, the parsimonious model for each outcome was re-estimated with Firth penalized logistic regression, which reduces the small-sample bias of maximum-likelihood estimates, with profile penalized-likelihood CIs and penalized likelihood-ratio *p*-values [22]; discrimination and the calibration slope of the penalized models were internally validated with the same bootstrap procedure. Second, age was modeled as a continuous variable (per 12 months) and as a restricted cubic spline with 3 knots placed at the 10th, 50th, and 90th percentiles, in place of the WHO-based categories, and non-linearity was tested with a likelihood-ratio test of the spline against the linear term. Third, because the analytical sample ($n = 394$) was smaller than the 600 required a priori, the minimum odds ratio detectable with 80% power at $\alpha = .05$ for a binary predictor was calculated post hoc with the method of Hsieh et al. [23], using the observed preva-

lence of each outcome and an exposure prevalence of 43% (equivalent to low household income); power for odds ratios of 1.5 to 3.0 was calculated in the same way. No adjustment was made for multiple testing; with 3 outcomes and several predictors, individual *p*-values, particularly those from the bivariate screening and the expanded model, are interpreted as exploratory rather than confirmatory.

RESULTS

1. Baseline Characteristics

A total of 394 children aged 0–59 months were included. The sample was distributed nearly equally by sex (52.0% male), with 17.8% born with low birth weight and 47.7% in the 6–23-month vulnerability window. Maternal education was distributed across no education (10.7%), primary (28.4%), secondary (36.8%), and tertiary (24.1%). Approximately 43.4% of households were classified as low-income; 62.2% of infants had been exclusively breastfed for their first 6 months; 28.7% had good complementary feeding practices; 71.3% had improved sanitation; and 77.9% had clean water access. Food insecurity (moderate or severe) was reported in 32.0% of households. Full baseline characteristics, including all dietary, behavioral, and environmental determinants, are presented in Table 1.

Table 1. Baseline characteristics of children aged 0–59 months (N=394)

Characteristic	Value
Sex	
Male	205 (52.0)
Female	189 (48.0)
Birth weight	
Low (<2,500 g)	70 (17.8)
Normal (≥2,500 g)	324 (82.2)
Mean birth weight (g)	3,144±681
Age group (mo)	
0–5	57 (14.5)
6–23	188 (47.7)
24–59	149 (37.8)
Mean age (mo)	22.6±16.3
Maternal education	
No formal education	42 (10.7)
Primary	112 (28.4)
Secondary	145 (36.8)
Tertiary	95 (24.1)
Household income	
Low income	171 (43.4)
Middle/high income	223 (56.6)
Maternal characteristics	
Maternal age (yr)	29.1±7.0
Parity	2.6±1.1
Family size	5.1±1.3
Feeding practices	
Exclusive breastfeeding (0–6 mo), yes	245 (62.2)
Breastfeeding duration (mo)	18.0±5.5
Complementary feeding	
Poor	78 (19.8)
Fair	203 (51.5)
Good	113 (28.7)
Dietary diversity score (1–7)	4.18±1.19
Protein intake (g/day)	27.6±6.3
Adequate protein intake	280 (71.1)
Environment and health services	
Complete immunization	300 (76.1)
Improved sanitation	281 (71.3)
Clean water access	307 (77.9)
Recent infection (past 2 wk)	116 (29.4)
Food security	
Secure	108 (27.4)
Mild insecurity	160 (40.6)
Moderate insecurity	95 (24.1)
Severe insecurity	31 (7.9)

Values are presented as number (%) for categorical variables and mean±standard deviation for continuous variables. Percentages may not total 100 because of rounding. Low-income households were defined using the national poverty threshold (IDR 2,994,197.47 per month).
IDR, Indonesian rupiah.

2. Prevalence and Severity of Undernutrition

Based on the WHO 2006 Child Growth Standards, 14.5% of children were stunted (8.9% moderate, 5.6% severe), 10.7% were wasted (6.6% moderate, 4.1% severe), and 17.3% were underweight (11.4% moderate, 5.8% severe). Severity distributions are presented in Supplement 3.

3. Bivariate Associations

Birth weight showed strong bivariate associations with all 3 outcomes (all $p < .001$ for stunting and underweight; $p = .001$ for wasting). Maternal education was significantly associated with stunting ($p < .001$) and underweight ($p < .001$), and showed a borderline, non-significant association with wasting (Fisher's exact test $p = .055$). Among children of mothers with no formal education, prevalence was markedly elevated (35.7% stunting, 23.8% wasting, and 47.6% underweight). Among the additional socioeconomic, dietary, behavioral, and environmental determinants, bivariate associations with the 3 outcomes were generally not significant (household income, complementary feeding, dietary diversity, protein ad-

equacy, sanitation, clean water access, immunization, food security, recent infection: all $p > .05$ in the bivariate analyses for at least 2 of 3 outcomes). Sex and age group were not significantly associated with any outcome bivariately. Detailed bivariate results for categorical predictors are presented in Table 2. For the continuous variables (Supplement 1), birth weight in grams was lower among affected children for all 3 outcomes (all $p \leq .004$), consistent with the categorical LBW results, whereas child age, dietary diversity score, protein intake, maternal age, parity, and family size did not differ between affected and unaffected children (all $p > .05$). Two continuous variables did differ. Total breastfeeding duration was longer among wasted than non-wasted children (20.3 months vs. 17.7 months, $p = .004$), and birth order was higher among underweight than non-underweight children (2.15 vs. 1.78, $p = .003$). Neither variable had been pre-specified for the expanded model (see Methods section), and both are discussed as exploratory bivariate findings.

4. Parsimonious Screening Model

In the parsimonious multivariate model, LBW had the largest AOR across all 3 outcomes: stunting (AOR, 4.85; 95% CI, 2.53–9.29; $p < .001$), wasting (AOR, 2.88; 95% CI, 1.38–6.02; $p = .005$), and underweight (AOR, 4.34; 95% CI, 2.30–8.19; $p < .001$). Children of mothers with no formal education had significantly elevated adjusted odds of stunting (AOR, 2.30; 95% CI, 1.01–5.23; $p = .047$) and underweight (AOR, 4.16; 95% CI, 1.88–9.21; $p < .001$), with a near-significant pattern for wasting (AOR, 2.23; 95% CI, 0.90–5.57; $p = .085$). The 6–23-month vulnerability window was associated with elevated odds of underweight (AOR, 2.66; 95% CI, 1.05–6.75; $p = .040$), but the associations with stunting and wasting were not statistically significant after adjustment. Sex was not associated with any outcome (all $p > .50$). AORs are visualized in Figure 1 and the full numeric estimates for the parsimonious model are provided in Supplement 4.

5. Expanded Fully Adjusted Model

In the expanded fully adjusted model, LBW remained the predictor with the largest AOR for all outcomes (stunting AOR, 5.25; wasting AOR, 3.89; underweight AOR, 4.44; all $p \leq .001$), and no formal maternal education remained significant for stunting (AOR, 2.50; $p = .034$) and underweight (AOR, 4.64; $p < .001$). None of the additional dietary, behavioral, or environmental determinants, including household income, exclusive breastfeeding, complementary feeding category, dietary diversity score, protein adequacy, improved sanitation, food insecurity, and recent infection, reached conventional statistical significance (all $p > .05$) after adjustment for the parsimonious predictors. VIFs were below 2.5 for all predictors, indicating no problematic multicollinearity. Detailed AORs are presented in Supplement 5.

6. Model Performance and Comparison

Apparent AUROCs for the parsimonious model were .740 for stunting, .691 for wasting, and .772 for underweight. Hosmer-Lemeshow tests did not indicate statistically significant lack of fit for any of the 3 outcomes ($p = .063$, .161, and .394, respectively). However, the calibration slope of .75 and the calibration plot indicated suboptimal calibration and overestimation of risk for wasting. Apparent AUROCs for the expanded model were .759, .748, and .772. Likelihood-ratio testing of the parsimonious-versus-expanded comparison was non-significant for all 3 outcomes (stunting LR χ^2 (9) = 8.30, $p = .505$; wasting LR χ^2 (9) = 13.22, $p = .153$; underweight LR χ^2 (9) = 2.96, $p = .966$). AIC was lower for the parsimonious model across all 3 outcomes; BIC, with its stronger complexity penalty, favored the parsimonious model decisively.

Internal validation revealed important differences between the 2 specifications. After bootstrap optimism correction (500 resamples), the parsimonious model retained AUROCs of .706 (stunting), .631 (wasting), and .751 (underweight). The expanded model showed greater optimism (.070, .097, and .064 for the 3 outcomes, respectively, compared with .034, .059, and .022 for the parsimonious model), resulting in corrected AUROCs of .689, .651, and .708, which were lower than the parsimonious model for stunting and underweight. Stratified 10-fold cross-validation yielded the same pattern. Brier scores were comparable between the 2 models, indicating no overall accuracy advantage from added complexity. Bootstrap calibration slopes for the parsimonious model were .88 for stunting, .75 for wasting, and .90 for underweight, compared with .71, .60, and .74 for the expanded model, indicating that the expanded specification would require substantially more shrinkage. The calibration plots showed close agreement between predicted and observed risk for underweight across the full range, overestimation of risk in the highest-risk group for stunting, and clear overesti-

Table 2. Bivariate associations between candidate predictors and nutritional status (N=394)

Predictor	Total	Stunting		Wasting		Underweight	
		No. (%)	*p*	No. (%)	*p*	No. (%)	*p*
Birth weight			< .001		.001		< .001
Normal (≥2,500 g)	324	31 (9.6)		26 (8.0)		39 (12.0)	
LBW (<2,500 g)	70	26 (37.1)		16 (22.9)		29 (41.4)	
Age group (mo)			.974		.786		.217
0–5	57	8 (14.0)		5 (8.8)		8 (14.0)	
6–23	188	28 (14.9)		22 (11.7)		39 (20.7)	
24–59	149	21 (14.1)		15 (10.1)		21 (14.1)	
Sex			.597		.590		.405
Female	189	25 (13.2)		18 (9.5)		29 (15.3)	
Male	205	32 (15.6)		24 (11.7)		39 (19.0)	
Maternal education			< .001		.055		< .001
No education	42	15 (35.7)		10 (23.8)		20 (47.6)	
Primary	112	11 (9.8)		10 (8.9)		13 (11.6)	
Secondary	145	20 (13.8)		12 (8.3)		22 (15.2)	
Tertiary	95	11 (11.6)		10 (10.5)		13 (13.7)	
Household income			.277		.119		.422
Middle/high	223	28 (12.6)		29 (13.0)		35 (15.7)	
Low income	171	29 (17.0)		13 (7.6)		33 (19.3)	
Caregiver occupation			.111		.700		.437
Unemployed	133	18 (13.5)		11 (8.3)		18 (13.5)	
Informal	159	19 (11.9)		19 (11.9)		33 (20.8)	
Formal	80	13 (16.2)		10 (12.5)		13 (16.2)	
Other	22	7 (31.8)		2 (9.1)		4 (18.2)	
Exclusive breastfeeding			.144		.140		.624
No	149	27 (18.1)		11 (7.4)		28 (18.8)	
Yes	245	30 (12.2)		31 (12.7)		40 (16.3)	
Complementary feeding			.121		.604		.761
Poor	78	17 (21.8)		6 (7.7)		14 (17.9)	
Fair	203	26 (12.8)		24 (11.8)		37 (18.2)	
Good	113	14 (12.4)		12 (10.6)		17 (15.0)	
Protein intake			.342		> .999		> .999
Inadequate	114	20 (17.5)		12 (10.5)		20 (17.5)	
Adequate	280	37 (13.2)		30 (10.7)		48 (17.1)	
Immunization			.712		.842		.590
Incomplete	94	12 (12.8)		9 (9.6)		14 (14.9)	
Complete	300	45 (15.0)		33 (11.0)		54 (18.0)	
Sanitation			.962		> .999		.555
Unimproved	113	17 (15.0)		12 (10.6)		17 (15.0)	
Improved	281	40 (14.2)		30 (10.7)		51 (18.1)	
Clean water			> .999		> .999		.263
No	87	13 (14.9)		9 (10.3)		19 (21.8)	
Yes	307	44 (14.3)		33 (10.7)		49 (16.0)	
Recent infection			.687		.166		> .999
No	278	42 (15.1)		34 (12.2)		48 (17.3)	
Yes	116	15 (12.9)		8 (6.9)		20 (17.2)	
Food security			.175		.802		.073
Secure	108	16 (14.8)		13 (12.0)		13 (12.0)	
Mild insecurity	160	18 (11.2)		17 (10.6)		28 (17.5)	
Moderate insecurity	95	20 (21.1)		8 (8.4)		17 (17.9)	
Severe insecurity	31	3 (9.7)		4 (12.9)		10 (32.3)	

p-values are from Pearson's chi-square test or from Fisher's exact test (Freeman-Halton extension for tables larger than 2 by 2) where any expected cell frequency was below 5. All tests were 2-tailed with $\alpha = .05$. *p*-values are reported without a leading 0 and to 3 decimal places, and $p > .999$ denotes an exact *p*-value of 1.000.
LBW, low birth weight.

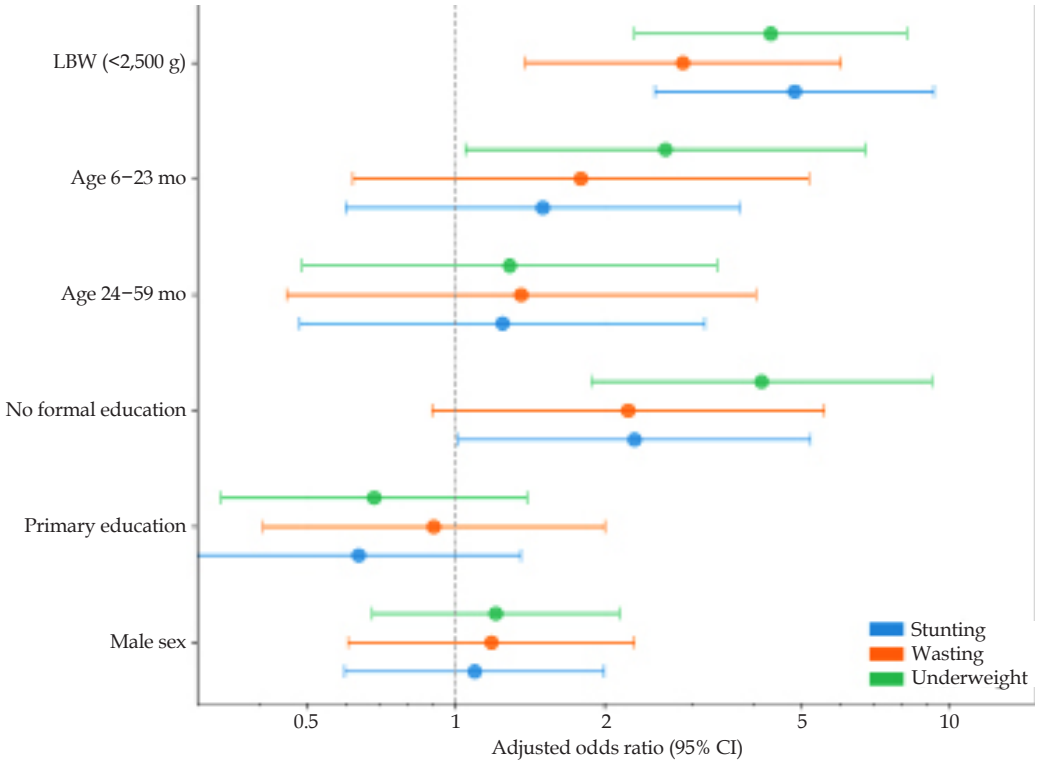

Figure 1. Forest plot of adjusted odds ratios (95% confidence interval [CI]) from the parsimonious screening model for stunting, wasting, and underweight. The dashed vertical line indicates the null value (adjusted odds ratio [AOR], 1.0). Reference categories are normal birth weight (≥2,500 g), age 0–5 months, secondary or tertiary maternal education, and female sex. Numeric estimates are provided in Supplement 4. LBW, low birth weight (<2,500 g).

mation of risk above a predicted probability of about .20 for wasting (Supplement 2). Comprehensive performance metrics are presented in Table 3 and Figure 2, and the formal model comparison is provided in Supplement 6.

Sensitivity analyses supported these conclusions. Firth penalized estimates for the parsimonious model were close to the maximum-likelihood estimates, with slightly narrower CIs (LBW AOR, 4.68, 2.85, and 4.20 for stunting, wasting, and underweight; no formal maternal education AOR, 2.28, 2.23, and 4.02), and penalization did not rescue the wasting model, whose optimism-corrected AUROC remained below the acceptable threshold (.637) (Supplement 7). Modeling age as a continuous or spline term did not improve discrimination for any outcome, the odds ratio per 12 months of age was close to 1 (0.93 to 1.03; all $p > .50$), and the test for non-linearity was not significant ($p = .204$, .088, and .291), so the pre-specified WHO-based categories were retained (Supplement 8). The post-hoc power calculation indicated that, for a binary predictor with 43% prevalence, the minimum odds ratio detectable with 80% power was 2.25 for stunting, 2.55 for wasting, and 2.13 for underweight; power to detect an odds ratio of 2.0 was .67, .56, and .73, and power to detect an odds ratio of 1.5 was only .30, .24, and .33, respectively.

Taken together, these results indicate that the expanded model did not provide measurable additional predictive value in the present dataset: it did not improve model fit, it was penalized by both AIC and BIC, and it carried greater optimism on internal validation, while requiring 8 additional variables that are not routinely captured in community surveillance. Given the events-per-variable limitations acknowledged above for the 15-coefficient specification and the limited power to detect odds ratios below about 2, we do not read this as evidence that the additional determinants are unimportant or that the parsimonious model is superior in general; the more accurate statement is that the additional predictive contribution of these variables could not be demonstrated given the current number of events and sample size. The wasting model showed optimism-corrected AUROC below the .70 threshold for acceptable discrimination in both specifications and with penalized estimation, and it is therefore reported as exploratory only; the current variables are inadequate for predicting acute wasting in this population.

Table 3. Model performance and internal validation of the parsimonious and expanded models (N=394)

Outcome	Model	Apparent AUROC	10-fold CV AUROC ± SD	Bootstrap optimism	Optimism-corrected AUROC	Calibration slope	Brier score	HL *p*
Stunting	Parsimonious (6 coefficients)	.740	.680 ± .108	.034	.706	.88	.117	.063
Stunting	Expanded (15 coefficients)	.759	.645 ± .091	.070	.689	.71	.122	.839
Wasting[a)]	Parsimonious (6 coefficients)	.691	.647 ± .106	.059	.631	.75	.095	.161
Wasting[a)]	Expanded (15 coefficients)	.748	.588 ± .129	.097	.651	.60	.100	.677
Underweight	Parsimonious (6 coefficients)	.772	.752 ± .097	.022	.751	.90	.127	.394
Underweight	Expanded (15 coefficients)	.772	.680 ± .093	.064	.708	.74	.136	.495

The parsimonious model contains 4 predictor variables represented by 6 regression coefficients (low birth weight, 2 age dummies, 2 maternal education dummies, and sex); the expanded model adds 8 socioeconomic, dietary, and environmental variables represented by 9 coefficients (12 variables and 15 coefficients in total). Internal validation used stratified 10-fold cross-validation (random seed=2026) and bootstrap optimism correction (500 resamples, Harrell's method). Bootstrap optimism is the difference between the apparent and the bootstrap-corrected AUROC; the optimism-corrected AUROC is the primary performance metric. Optimism-corrected AUROCs were calculated from unrounded estimates and may therefore differ by .001 from the difference between the rounded values shown. The calibration slope is the bootstrap-estimated slope of the linear predictor when each bootstrap model is applied to the original data; a value of 1 indicates ideal calibration and values below 1 indicate overfitting (calibration plots are shown in Supplement 2). A lower Brier score indicates better overall accuracy. A non-significant HL *p*-value ($p>.05$) indicates no statistically significant lack of fit. All tests were 2-tailed with $\alpha=.05$. AUROC, calibration slope, Brier score, and *p*-values are reported without a leading 0.

AUROC, area under the receiver operating characteristic curve; CV, cross-validation; HL, Hosmer-Lemeshow; SD, standard deviation.

[a)]The wasting model did not reach acceptable discrimination (optimism-corrected AUROC <.70) under either specification or with Firth penalized estimation (Supplement 7) and is presented as exploratory only.

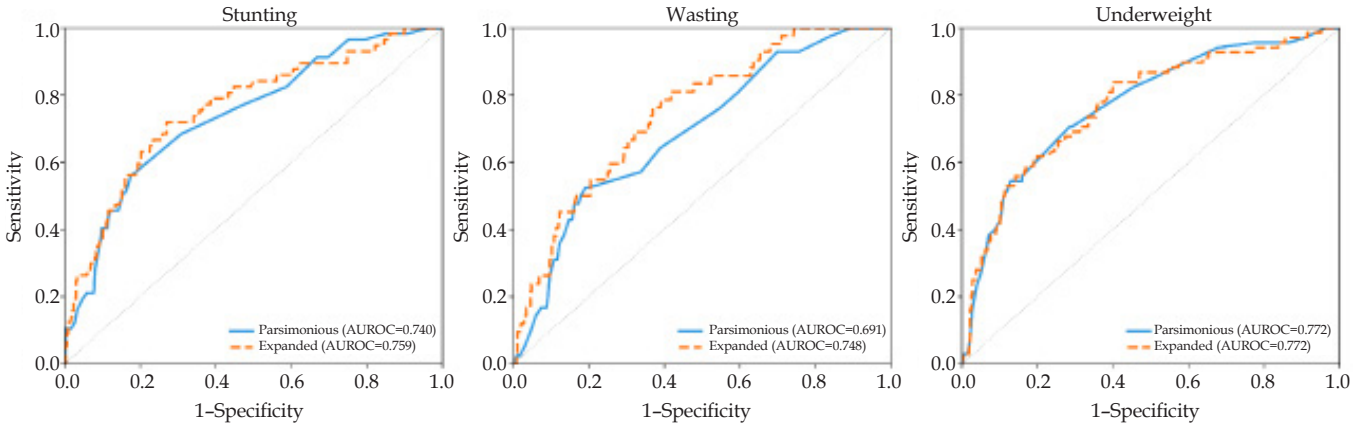

Figure 2. Receiver operating characteristic (ROC) curves comparing the parsimonious (6-coefficient) and expanded (15-coefficient) models for each of the 3 undernutrition outcomes. Area under the ROC curve (AUROC) values shown are apparent (uncorrected); optimism-corrected AUROCs and calibration slopes are reported in Table 3.

DISCUSSION

This study evaluated whether a parsimonious model combining birth weight, child age, and maternal education achieves predictive performance suitable for community-level undernutrition screening, and whether adding dietary, behavioral, and environmental determinants meaningfully improves performance. In a rural West Sumatran sample, the parsimonious model achieved optimism-corrected AUROCs of .706 for stunting and .751 for underweight, values in the low .70s that represent modest but acceptable rather than strong discrimination, with calibration slopes of .88 and .90, and .631 for wasting, which fell below the acceptable threshold. The expanded model, despite incorporating 8 additional socioeconomic, dietary, and environmental determinants, did not significantly improve fit and showed lower opti-

mism-adjusted discrimination for stunting and underweight; at the number of events available, its additional predictive contribution could not be demonstrated. These findings constitute preliminary risk-stratification evidence rather than a validated screening tool, and they require external validation before any consideration of operational deployment.

1. Low Birth Weight as the Predominant Early-Life Marker

Low birth weight was the predictor with the largest AOR across all 3 outcomes in both the parsimonious and expanded models. The magnitude of the associations is consistent with multi-country evidence indicating that small-for-gestational-age and preterm births confer 2- to 5-fold increases in subsequent undernutrition risk [5-8]. The underlying biological pathways, including intrauterine growth restriction, reduced lean mass, altered insulin-like growth factor signaling, and compromised gut and immune function, are well characterized and were summarized in our Introduction; we therefore do not repeat them in detail here [9,10]. The point relevant to this prediction-focused study is that this established mechanistic basis, combined with the universal recording of birth weight in the Indonesian MCH booklet, makes LBW an exceptionally promising candidate variable for community-level risk stratification. Earlier work from the same provincial context in West Sumatra similarly identified LBW as the most dominant biological predictor of malnutrition irrespective of maternal knowledge or healthcare access [24], suggesting a persistent regional vulnerability that national-level analyses may dilute. The findings should be interpreted as predictive associations rather than as evidence of causal effects given the cross-sectional design.

2. The Limited Independent Contribution of Additional Determinants

The most operationally important finding of this study is that 8 additional behavioral, dietary, and environmental determinants, including household income, complementary feeding, dietary diversity, protein adequacy, sanitation, food security, and recent infection, did not significantly improve predictive performance over the parsimonious model. Three interpretations are warranted. First, much of the variance attributable to upstream socioeconomic and environmental factors may already be captured by maternal education, which is a robust composite proxy for household resources and health literacy in this setting. Second, the cross-sectional design with modest sample size has limited statistical power to detect modest independent effects after adjustment for strong upstream predictors. Third, the dietary and feeding measures available in our surveillance dataset, while comprehensive in coverage, may lack the precision required to capture true exposure variability; longitudinal designs using validated 24-hour recalls or food-frequency questionnaires would likely refine these estimates [12]. We therefore do not interpret the absence of independent associations as evidence that these factors are unimportant, only that their predictive contribution beyond LBW, age, and maternal education in this sample is limited. This caution applies with particular force because several of these determinants, including household income, dietary diversity, sanitation, and food security, were not associated with any outcome even in the unadjusted bivariate analyses. Because these factors are well established as determinants of child undernutrition in the wider literature, their flat associations in this dataset are at least as likely to reflect an under-powered single-site sample and surveillance-grade measurement instruments, for example a single-window dietary assessment and a categorical food-insecurity scale, as a genuine absence of effect. We therefore explicitly caution against reading the present null findings as evidence that income, diet, sanitation, or food security are unimportant for child undernutrition; the more conservative interpretation is that this study was neither designed nor powered to detect their independent contributions. This nuance is critical for downstream policy interpretation. The post hoc power calculation makes the point concrete. With 42 to 68 events, the study had roughly 80% power to detect only odds ratios of about 2.1 to 2.6 for a moderately prevalent binary predictor, and less than one-third power for an odds ratio of 1.5, which is the order of magnitude commonly reported for dietary and environmental determinants in larger surveys. The 2 continuous variables that did differ bivariately, longer breastfeeding duration among wasted children and higher birth order among underweight children, also warrant caution: neither was pre-specified for the expanded model, no multiplicity adjustment was applied, and the direction of the breastfeeding association may reflect prolonged breastfeeding of children perceived as thin rather than a protective or harmful effect, a possibility that cross-sectional data cannot resolve.

3. Maternal Education and Its Operational Value

No formal maternal education emerged as a strong independent predictor of stunting and underweight, with AORs of 2.30 and 4.16, respectively. This finding is consistent with the broader global evidence that maternal education provides a composite signal of health literacy, healthcare utilization, and household resource allocation [15,16]. The differential association, significant for chronic indicators but weaker for acute wasting, is biologically coherent, as stunting and underweight accumulate over time and are more sensitive to sustained caregiving behaviors, whereas wasting reflects acute caloric deficit and infection [25]. Importantly, even among mothers with limited formal education, participatory community-based interventions grounded in local cultural contexts can effectively modify feeding behaviors and improve nutritional knowledge [26], suggesting that educational disadvantage at the household level is partially modifiable through accessible health promotion within existing Posyandu infrastructure.

A further consideration concerns child age. Although the Introduction emphasizes the 6–23-month window as the period of greatest nutritional vulnerability, age contributed little to the adjusted models and reached significance only for underweight. This apparent tension is consistent with the dynamic and recurrent nature of early-childhood growth faltering noted earlier [13]: a single cross-sectional snapshot records a child's status at 1 point in time and cannot capture the cumulative and episodic exposure that accrues across the 6–23-month period, so a cross-sectional age category is a comparatively weak proxy for this longitudinal risk. The limited adjusted age effect should therefore not be read as evidence that the 6–23-month window is unimportant; rather, prospective longitudinal designs would be required to recover its full predictive value.

4. Parsimonious versus Expanded Models

The likelihood-ratio test indicated that adding 8 determinants to the parsimonious model did not significantly improve model fit for any outcome (all $p > .05$), and AIC and BIC both penalized the expanded specification. Critically, optimism-corrected AUROCs were lower in the expanded model for 2 of 3 outcomes, indicating that the additional complexity introduced overfitting rather than genuine improvement. This pattern is methodologically expected given the Peduzzi events-per-variable framework: when outcome events are limited (42 for wasting, 57 for stunting, 68 for underweight) and predictors are correlated, adding variables increases apparent fit while degrading internally validated performance. We emphasize that the bootstrap procedure quantifies the degree of this optimism; it does not correct or remove the overfitting, and we did not apply penalized estimation, such as ridge or lasso regression, to shrink the coefficients. The expanded model should therefore be read as an exploratory comparator whose apparent performance is inflated by overfitting that cannot be excluded at this number of events per variable, rather than as a remedied or shrinkage-adjusted specification. The practical implication is that, in this dataset, the 8 additional determinants conferred no measurable predictive gain, so a parsimonious model built from routinely captured variables was not disadvantaged relative to a more complex specification for community-level risk screening in resource-constrained Indonesian settings. We are careful not to generalize this into a claim that fewer variables are inherently better. At the number of events available here, the expanded specification simply could not demonstrate added value, and a larger and better-measured sample might yet show that it does. The bootstrap calibration slopes quantify this directly: the expanded model would require its coefficients to be shrunk by roughly 26% to 40% (slopes of .60 to .74) to be calibrated in new data, compared with 10% to 25% for the parsimonious model, and the small number of events per coefficient in the expanded model is the most plausible source of this difference.

5. Predictive Performance in Context

Our optimism-corrected AUROCs (.71 for stunting, .75 for underweight, .63 for wasting) are broadly consistent with the published literature on parsimonious prediction models in LMIC settings. A 2025 meta-analysis of machine-learning models predicting childhood malnutrition using Demographic and Health Survey data reported pooled accuracies of approximately 69% for stunting and 74% for underweight, with substantial heterogeneity across algorithms [17]. More complex models using extensive dietary, environmental, and socioeconomic inputs can achieve higher accuracy [27,28], and outcome-specific models such as the stunting prediction algorithm by Xiong et al. [18] similarly achieved improved performance through inclusion of delivery mode and detailed feeding variables, but they require data collection ca-

pacity that is rarely feasible at the Posyandu level. Our findings suggest that for community-level screening, parsimony imposes minimal performance cost relative to data-intensive alternatives. The wasting model, however, with optimism-corrected AUROC below .70 under maximum-likelihood and Firth penalized estimation alike, is inadequate for operational use and requires methodological refinement, likely incorporation of acute-illness markers, longitudinal design, and validated infection screening, before any clinical application can be contemplated.

6. Implications for Risk-Stratified Community Surveillance

If externally validated, a parsimonious model using LBW, age, and maternal education could support proactive risk stratification within existing Posyandu infrastructure: priority-based follow-up for high-risk children, targeted caregiver counseling, early referral for supplemental nutrition programs, and focused monitoring during the 6–23-month vulnerability window. We emphasize, however, that the screening function is conceptually distinct from the intervention function. The model is designed to identify which children to flag for closer attention; deciding what to offer them must be guided by a separate behavioral, dietary, and environmental assessment of the modifiable factors specific to each child and household. Modifiable behavioral and environmental factors remain critical intervention targets even where they do not improve prediction. At the policy level, our findings reinforce the importance of multisectoral strategies that strengthen antenatal nutrition to reduce LBW prevalence and expand maternal education, in addition to ongoing complementary feeding interventions during the critical transition period [12].

7. Limitations and Future Directions

Several limitations warrant emphasis. First, the cross-sectional design precludes causal inference and limits temporal predictive validity. The model predicts concurrent risk, not future trajectories. Second, single-site sampling from 1 rural West Sumatran district limits the generalizability of our findings to other Indonesian regions with different socioeconomic, dietary, and environmental conditions. Third, the dietary, breastfeeding, and feeding measures used here, although covering the principal behavioral and environmental domains, may lack the precision of gold-standard instruments (24-hour recall, food-frequency questionnaires) and could have underestimated true exposure variability. Fourth, the wasting model showed inadequate optimism-corrected discrimination (AUROC = .63, unchanged by Firth penalization) and a calibration slope of .75, and it is reported as exploratory only; it should not be used for operational screening. Fifth, the model has not yet been externally validated in independent populations, which is a prerequisite for any recommendation regarding implementation. Sixth, residual confounding by unmeasured determinants (e.g., paternal involvement, environmental enteric dysfunction, gestational age) remains possible. Seventh, the analytical sample of 394 children, drawn from a registry of 612, yielded a limited number of outcome events (42 for wasting), which constrained statistical power; the post-hoc calculation shows that only odds ratios of roughly 2.1 to 2.6 were detectable with 80% power, so the non-significance of several established determinants should be read as an effect that could not be demonstrated rather than as evidence of no effect. This limitation also most plausibly underlies the instability of the wasting model, and it means the 15-coefficient expanded model was fitted well below the recommended events-per-variable threshold and remains susceptible to overfitting that internal validation can measure but not remove. Eighth, calibration evidence rests on the Hosmer-Lemeshow test, which has low power with few events, supplemented by bootstrap calibration slopes and plots; calibration-in-the-large cannot be assessed meaningfully in the development sample and must await external validation. Ninth, no adjustment was made for multiple testing across 3 outcomes and many predictors, so isolated significant findings, particularly in the bivariate screening, may be chance findings. Tenth, combining secondary and tertiary maternal education into a single reference category, a pragmatic choice given the number of events, may have obscured differences between primary and secondary education. Finally, the exclusion of children with incomplete birth-weight records may have introduced a small degree of selection bias if record completeness was related to nutritional status. We therefore frame the findings as preliminary risk-stratification evidence requiring further development and validation. Future work should pursue: (1) prospective longitudinal validation in multiple Indonesian provinces; (2) external validation in other LMIC settings; (3) implementation studies evaluating operational feasibility within Posyandu workflows; and (4) refinement of the wasting model with acute-illness

markers and validated dietary instruments, using penalized or shrinkage estimation and a substantially larger number of events.

CONCLUSION

In this cross-sectional sample of 394 rural Indonesian children, a parsimonious multivariate model incorporating low birth weight, child age, and maternal education achieved modest but acceptable predictive performance for stunting (optimism-corrected AUROC = .706) and underweight (.751), and inadequate performance for wasting (.631). Adding 8 behavioral, dietary, and environmental determinants did not significantly improve model fit and did not provide measurable additional predictive value in this dataset, with lower optimism-adjusted discrimination and calibration slopes for the expanded model; the parsimonious specification was therefore retained, on operational grounds and because the additional predictive contribution of the added variables could not be demonstrated given the current number of events and sample size.

These findings constitute preliminary risk-stratification evidence and should not yet be translated into routine practice. Before consideration for operational deployment within Posyandu and similar community health platforms, the model requires external validation in independent Indonesian populations, prospective longitudinal evaluation, and refinement, particularly for the wasting outcome. The wasting model in particular, with an optimism-corrected AUROC of .631, did not reach acceptable discrimination, is reported here as exploratory only, and should not be used for screening until it has been substantially refined and revalidated. Pending such validation, the findings nevertheless underscore the strategic value of routinely captured early-life indicators (birth weight, age, maternal education) as candidates for proactive risk identification in resource-constrained settings, complementing rather than replacing existing growth-monitoring systems.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: YM. Methodology: YM, RS. Validation: RS, TBS. Formal analysis: RR. Investigation: YM, RR, SS. Resources: SS. Data curation: YM. Writing–original draft: YM. Writing–review & editing: RR, SS, RS, TBS. Supervision: RS, TBS. Project administration: YM. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

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

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI, GPT-5.6 Sol version) to refine the language, structure, and clarity of the manuscript text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Supplementary material

Supplement 1. Bivariate comparisons of continuous variables by nutritional status.
Supplement 2. Calibration plots for the parsimonious model.
Supplement 3. Prevalence and severity of stunting, wasting, and underweight.
Supplement 4. Adjusted odds ratios from the parsimonious screening model.
Supplement 5. Adjusted odds ratios from the expanded fully adjusted model.
Supplement 6. Likelihood-ratio test, AIC, and BIC comparing the parsimonious and expanded models.
Supplement 7. Firth penalized logistic regression estimates and internal validation for the parsimonious model.

Supplement 8. Sensitivity analysis of alternative age specifications.

ORCID and ResearcherID

Yani Maidelwita https://orcid.org/0000-0001-7973-9948
https://researcherid.com/rid/GNP-6922-2022
Rini Rahmayanti https://orcid.org/0009-0003-6142-5811
https://researcherid.com/rid/ADR-8461-2022
Sri Suciana https://orcid.org/0009-0005-5918-5294
https://researcherid.com/rid/RJB-4760-2026
Rika Sarfika https://orcid.org/0000-0001-7066-568X
https://researcherid.com/rid/ACZ-8059-2022
Tukimin Bin Sansuwito
https://orcid.org/0000-0001-7323-4308
https://researcherid.com/rid/AAE-6942-2022

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Association between general self-efficacy and social media addiction among young adult nursing students in Indonesia: a cross-sectional study

Sugeng Mashudi[1], Lukman Handoko[2], Nurul Syameera Aduka[3]

[1]Associate Professor, Nursing Sciences, Universitas Muhammadiyah Ponorogo, Ponorogo, Indonesia
[2]Associate Professor, Occupational Health and Safety Engineering, Politeknik Perkapalan Negeri Surabaya, Surabaya, Indonesia
[3]Senior Lecturer, Faculty of Health and Life Sciences, INTI International University, Nilai, Malaysia

Corresponding author
Sugeng Mashudi
Universitas Muhammadiyah Ponorogo,
10 Budi Utomo Street, Ponorogo 63471,
East Java, Indonesia
Tel: +62-352-481124 (landline)
Fax: +62-352-461796
E-mail: sugengmashudi@umpo.ac.id

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Purpose: This study examined the association between general self-efficacy and social media addiction among young adult undergraduate nursing students in Indonesia.
Methods: This cross-sectional study included 120 Indonesian undergraduate nursing students aged 21–23 years. Social media addiction and self-efficacy were assessed using the Bergen Social Media Addiction Scale and the General Self-Efficacy Scale, respectively. Data were analyzed using hierarchical multiple linear regression.
Results: The mean social media addiction score was 19.11 (standard deviation=2.11), and the mean self-efficacy score was 24.60 (standard deviation=4.20). Self-efficacy showed a weak but statistically significant negative correlation with social media addiction (r=−.21, p=.022). Sociodemographic predictors entered in Step 1 of the hierarchical regression analysis explained 7.3% of the variance in social media addiction (R^2=.073). Sex was a significant predictor (β=−0.19, p=.038), with male students reporting lower scores than female reference group. The final model explained 10.8% of the variance in social media addiction (R^2=.108; F(5, 114)=2.77, p=.021).
Conclusion: Higher self-efficacy was weakly associated with lower social media addiction. Given the limited variance explained and the omission of other well-established correlates of social media addiction, these findings do not support general self-efficacy as a standalone protective mechanism.

Keywords: Internet addiction disorder; Mental health; Psychiatric nursing; Self-efficacy; Young adult

INTRODUCTION

In recent years, social media use has become an increasingly integral part of university students' lives. This is primarily because digital environments facilitate communication, information sharing, and social interaction in both academic and non-academic settings [1]. However, problematic social media use has been associated with academic difficulties, sleep disturbance, emotional dysregulation, and reduced quality of life in young adults [2]. More specifically, the increasing level of social media use among nursing students has become a significant public health concern and an emerging issue in nursing practice settings. Problematic use has been associated with reduced attention during clinical training, impaired academic performance, sleep disturbances, and emotional dysregulation [3]. These behavioral consequences may interfere with clinical judgment, professional concentration, and safe patient care during clinical placements. Therefore, understanding the factors associated with problematic social media use is important for developing preventive and

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health-promoting strategies in nursing education and practice settings. In this study, the term "problematic social media use" is adopted as the primary construct label. Related expressions such as "social media addiction and excessive social media use" are retained only when quoting instrument names (Bergen Social Media Addiction Scale) or the terminology used in the original cited studies, and should be considered as referring to the same underlying construct. In addition to its academic and clinical implications, problematic social media use during young adulthood also intersects with core developmental tasks, making it a relevant focus for health-promoting and preventive nursing interventions aimed at safeguarding psychological well-being during this transitional life stage.

According to previous studies, young adulthood is a developmental phase characterized by greater independence, identity exploration, and digital engagement. During this phase, young adults experience educational stress, changing social roles, and increasing personal responsibilities. These overlapping academic, social, and personal challenges may increase dependence on the Internet for communication, coping, and social interaction. Therefore, problematic social media use may be common among this demographic. Identifying the factors associated with problematic use is important for developing targeted preventive and health-promoting nursing interventions [4]. In this developmental period, self-efficacy may serve as a psychological resource that supports adaptive coping, adjustment, and well-being. Its association with problematic social media use is hence relevant to both academic functioning and broader preventive and developmental nursing practice.

Previous studies have identified several psychological, social, and environmental correlates of social media addiction [5]. These findings suggest that complex interrelationships between personal and situational factors influence problematic social media use [6]. Self-efficacy, defined as an individual's belief in their ability to manage actions and challenges, has also been suggested as a potential correlate of digital self-regulation. However, social media behavior is multidimensional and cannot be explained by a single psychological factor [7]. In a different study, Bandura emphasized that self-efficacy beliefs are domain-specific [8]. Accordingly, the General Self-Efficacy Scale (GSES) assesses perceived capability across situations rather than self-efficacy specific to social media use. The construct reflects an individual's perceived ability to cope with stressful or demanding situations [9] and may represent a broader psychological resource relevant to behavioral regulation [9]. The present results show an association between generalized self-efficacy and social media addiction, not the effect of domain-specific self-efficacy on digital regulation.

Most studies on social media addiction have been conducted among Western or East Asian participants, with only a few involving Indonesian university students. This gap in the literature raises questions about the extent to which previous findings apply across diverse cultural contexts. The sociocultural environment in Indonesia, characterized by strong peer connectedness, collectivist social values, and widespread smartphone use, may influence social media engagement differently compared with other regions. The country's collectivist orientation is rooted in longstanding sociocultural and religious traditions, including the philosophy of *gotong royong* (mutual cooperation), strong extended-family and communal structures, and religious and customary (*adat*) values that emphasize interdependence and communal harmony. These traditions continue to shape interpersonal expectations, socialization patterns, and normative behavior among young Indonesians, including modes of engagement with social media within peer and family networks. Available Indonesian studies have primarily examined the prevalence and socio-ecological correlates of social media use and related disorders among students, with limited attention to generalized self-efficacy as a psychological correlate [1]. The influence of cultural and technological contexts suggests that factors associated with social media addiction may vary across populations. Therefore, a theoretically grounded study within the Indonesian sociocultural context is required to identify relevant psychological correlates [10]. In collectivist societies, social expectations, peer influence, and group norms can shape individual behavior. These influences may also contribute to beliefs about one's ability to regulate behavior, including digital media use. From a social cognitive perspective, self-efficacy develops through personal experiences as well as social modeling and interpersonal interactions. This shows that strong peer connectedness and collectivist norms may influence young adults' perceptions of their ability to regulate social media engagement, providing a potential link between sociocultural context and individual self-efficacy beliefs.

Accordingly, the present study addressed the following questions: (1) Do social media addiction scores differ according to sex, age, and educational level? (2) What are the levels

of self-efficacy and social media addiction among Indonesian university students? (3) Is self-efficacy correlated with social media addiction? (4) Is self-efficacy independently associated with social media addiction after adjusting for sex, age, and educational level?

METHODS

Ethical statements: This study was approved by the Health Research Ethics Committee of Universitas Muhammadiyah Ponorogo (Protocol No. 643/ER/KEPK/2025) and conducted in accordance with the Declaration of Helsinki. Electronic consent was obtained from all participants aged 20 years or older before enrollment. Participation was voluntary, and anonymity and confidentiality were maintained throughout the study.

1. Study Design

This study used a cross-sectional correlational design to investigate the relationship between self-efficacy and social media addiction in young Indonesian adults. The study was reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guideline for cross-sectional studies [11].

2. Population and Sample Size

Participants were undergraduate nursing students aged 21–23 years recruited from 9 universities in East Java province, Indonesia. Eligibility criteria included current enrollment in a nursing program, active social media use, and the ability to complete an online questionnaire. Students who reported psychiatric or neurological conditions or were unable to complete the questionnaire appropriately were excluded. A total of 120 participants with complete data were included in the final analysis. Sample-size adequacy for the hierarchical multiple regression was evaluated using both predictor-based heuristics and formal power analysis. Conventional rules of thumb recommended the use of 10–15 observations per predictor. Educational level was represented by 2 dummy variables, resulting in 5 predictors in the final model: sex, age, 2 educational-level dummy variables, and self-efficacy. The recommended minimum sample size was 50–75 participants [12], while the final sample comprised 120 participants. A sensitivity analysis was performed using G*Power ver. 3.1 (Heinrich-Heine-Universität Düsseldorf) for linear multiple regression with fixed effects and an R^2 increase. Using N = 120, $\alpha = .05$, and 1 tested predictor among 5, the analysis provided 80% power to detect an incremental effect of $f^2 = 0.07$ for self-efficacy beyond the covariates. The observed incremental effect was smaller ($f^2 = 0.04$), corresponding to an achieved power of approximately .58. The sample size was sufficient to detect incremental effects of approximately $f^2 = 0.07$ but provided limited power to detect the smaller effect observed in the study.

3. Measurements

1) Social media addiction

Social media addiction was assessed using the Bergen Social Media Addiction Scale (BSMAS) [13]. The instrument comprised 6 items scored on a 5-point Likert scale ranging from 1 (very rarely) to 5 (very often), yielding total scores of 6–30 [14]. Higher scores indicated more problematic social media use. The total BSMAS score was used as a continuous variable in the statistical models. In the original validation study, the scale showed good internal consistency (Cronbach's $\alpha = .88$) [13]. A reliability generalization meta-analysis reported a pooled α of .84 (95% confidence interval [CI], .83–.85) across BFAS/BSMAS studies [14]. In the present study, Cronbach's α for BSMAS was recorded at .84.

2) Self-efficacy

Self-efficacy was assessed using the 10-item GSES developed by Schwarzer and Jerusalem [15]. Each item was scored on a 4-point Likert scale ranging from 1 (not at all true) to 4 (exactly true), yielding total scores of 10–40. This scale measured self-efficacy across a wide range of challenging situations, with higher scores signifying greater perceived capabilities. The GSES was used to assess generalized rather than social media-specific self-efficacy. The original validation showed good internal consistency, with Cronbach's α ranging from .76 to .90 across samples from 23 nations (most values in the high .80s) [15]. The Indonesian version of the GSES demonstrated sound, unidimensional construct validity among university students [16]. In the present study, GSES showed good internal consistency (Cronbach's $\alpha = .81$).

3) Sociodemographic characteristics

Sociodemographic characteristics included sex, age, and educational level, which were treated as covariates in the analysis. A dummy variable was created for sex (0 = female,

1=male), and age was entered as a continuous variable. Academic enrollment was classified according to the current educational level of the participants. These covariates were selected on conceptual and empirical grounds rather than arbitrarily. Problematic social media use is multifactorial and has been shown to vary with demographic and academic characteristics in student populations [6,17,18]. Sex, age, and educational level were included as covariates to account for potential demographic confounding. In line with social cognitive theory [19], self-efficacy was designated as the primary personal-level predictor, while the sociodemographic variables served as adjustment factors.

4. Data Collection

The questionnaire was developed using Google Forms (Google LLC) for self-administered data collection. The survey was disseminated through official university communication channels, campus student organization networks, and academic servers. Before participation, prospective participants were shown an information page outlining the study aims and data protection measures, and only those who provided electronic consent could proceed to the questionnaire. Data were collected from February to June 2025, and responses were simultaneously transferred to a secure, password-protected database accessible only to members of the study team.

5. Data Analysis

Statistical analyses were conducted using IBM SPSS ver. 26.0 (IBM Corp.). Descriptive statistics were used to summarize participants' sociodemographic characteristics and the main study variables. Independent-samples t-tests and one-way analysis of variance were used to examine differences in social media addiction across sociodemographic categories. Pearson's correlation coefficient was used to assess the association between self-efficacy and social media addiction. The homogeneity-of-variance assumption for the independent-samples t-test was evaluated using Levene's test ($F(1, 118)=0.37$, $p=.547$) indicating that the equal-variance assumption was met.

A hierarchical multiple linear regression analysis was used to explore the predictors of social media addiction. Step 1 included the control variables—sex, age, and educational level—while Step 2 added the pivotal independent variable (self-efficacy). Changes in the proportion of explained variance (ΔR^2) were tested to determine whether self-efficacy still contributed independently after controlling for sociodemographic variables. Tests for normality, linearity, homoscedasticity, and multicollinearity were conducted before the regression analysis, and all assumptions were met, with statistical significance set at $p<.05$.

RESULTS

1. General Characteristics of Participants

A total of 120 respondents were included in the analysis, the majority of whom were women (90.8%), as detailed in Table 1. In terms of educational level, 51.7% were in their third year, 29.2% were in their fourth year, and 19.2% had been enrolled for more than 4 years. Meanwhile, 45%, 27.5%, and 27.5% of participants were 22, 21, and 23 years old, respectively.

2. Differences in Social Media Addiction by General Characteristics

No statistically significant differences in total BSMAS scores were observed by age or educational level (both $p>.05$), whereas a significant difference was observed by sex. Female participants had higher mean±standard deviation (SD) BSMAS scores (19.25±2.09) than males (17.80±1.89), and the difference was significant ($t(118)=2.20$, $p=.029$) (Table 2). Mean social media addiction scores did not differ by age group (21-year-olds: 18.40±2.19; 22-year-olds: 19.50±1.98; 23-year-olds: 19.19±2.10) ($F(2, 117)=2.90$, $p=.059$). Similarly, educational level did not significantly contribute to the variance in social media addiction ($F(2, 117)=1.01$, $p=.368$), and the mean scores were 19.13±2.11,

Table 1. Distribution of the demographic characteristics of the participants (N=120)

Characteristic	Category	No. (%)
Sex	Female	109 (90.8)
	Male	11 (9.2)
Educational level	Third-year student	62 (51.7)
	Fourth-year student	35 (29.2)
	Extended senior student	23 (19.2)
Age (yr)	21	33 (27.5)
	22	54 (45.0)
	23	33 (27.5)

Percentages may not total 100 due to rounding.

Table 2. Differences in BSMAS scores according to general characteristics (N=120)

Characteristic	No. of participants	Mean BSMAS score±SD	t/F	*p*
Sex			2.20[a]	.029
Female	109	19.25±2.09		
Male	11	17.80±1.89		
Age (yr)			2.90[b]	.059
21	33	18.40±2.19		
22	54	19.50±1.98		
23	33	19.19±2.10		
Educational level			1.01[b]	.368
Third-year student	62	19.13±2.11		
Fourth-year student	35	19.41±2.02		
Extended senior student	23	18.61±2.21		

BSMAS, Bergen Social Media Addiction Scale; SD, standard deviation.
[a]By independent t-test. [b]By one-way analysis of variance.

19.41±2.02, and 18.61±2.21 for third-year, fourth-year, and extended senior students, respectively. Given the pronounced sex imbalance in this sample (90.8% female vs. 9.2% male, n=11), the observed difference should be interpreted with caution. The small male subgroup may generate an unstable and imprecise estimate of the sex difference, so this finding should not be given undue weight until it is replicated in samples with a more balanced sex distribution.

3. Levels of Self-efficacy and Social Media Addiction

The mean±SD social media addiction score was 19.11±2.11 out of a possible range of 6–30. As shown in Table 3, the mean self-efficacy score was 24.60±4.20 out of a possible range of 10–40.

Table 3. Descriptive statistics of the primary variables (N=120)

Variable	Scale range	Mean±SD
Social media addiction	6–30	19.11±2.11
Self-efficacy	10–40	24.60±4.20

SD, standard deviation.

4. Correlation between Self-efficacy and Social Media Addiction

Self-efficacy had a weak negative correlation with social media addiction (r=–.21, *p*=.022), as detailed in Table 4. This indicated that higher self-efficacy was associated with lower social media addiction.

Table 4. Correlation between self-efficacy and social media addiction (N=120)

Variable	Self-efficacy (GSES)	Social media addiction (BSMAS)
Self-efficacy (GSES)	1	
Social media addiction (BSMAS)	–.21*	1

BSMAS, Bergen Social Media Addiction Scale; GSES, General Self-Efficacy Scale.
*p=.022.

5. Hierarchical Regression Predicting Social Media Addiction

Hierarchical multiple linear regression was used to determine whether self-efficacy was independently associated with social media addiction after adjustment for demographic characteristics, including sex, age, and educational level (Table 5). In Step 1, sex, age, and educational level accounted for 7.3% of the variance (R^2=.073), but the overall model did not reach statistical significance (F(4, 115)=2.26, p=.066). Among the control variables, sex was a significant individual predictor (β=–.19, p=.038), indicating that female students reported higher addiction scores after adjusting for age and educational level. Notably, neither age nor educational level was significantly associated with social media addiction.

In Step 2, self-efficacy was added to the model and proved to be a significant negative predictor of social media addiction (β=–.19, p=.036). Sex also remained a significant predictor (β=–.18, p=.047). Moreover, the addition of self-efficacy increased the proportion of variance explained from 7.3% to 10.8% (R^2=.108; ΔR^2=.035), with the final model reaching statistical significance (F(5, 114)=2.77, p=.021).

Notably, self-efficacy remained independently associated with social media addiction after adjustment for sex, age, and educational level. However, the model did not include sever-

Table 5. Hierarchical multiple linear regression predicting social media addiction (N=120)

Variable	Step 1			Step 2		
	B (95% CI)	β	*p*	B (95% CI)	β	*p*
Sex (male vs. female[a])	−1.373 (−2.670 to −0.076)	−.19	.038	−1.296 (−2.576 to −0.016)	−.18	.047
Age (yr)	0.365 (−0.140 to 0.870)	.13	.155	0.345 (−0.153 to 0.842)	.12	.173
Educational level						
Fourth-year student vs. third-year student[a]	0.280 (−0.584 to 1.145)	.06	.522	0.265 (−0.586 to 1.117)	.06	.538
Extended senior vs. third-year student[a]	−0.545 (−1.543 to 0.453)	−.10	.281	−0.515 (−1.499 to 0.469)	−.10	.302
Self-efficacy (GSES)		-	-	−0.094 (−0.182 to −0.006)	−.19	.036
Model summary						
R^2	-	.073		-	.108	
Adjusted R^2	-	.041		-	.069	
ΔR^2	-	-		-	.035	.036

B, unstandardized regression coefficient; β, standardized regression coefficient; CI, confidence interval; GSES, General Self-Efficacy Scale; R^2, coefficient of determination; ΔR^2, change in R^2 from Step 1 to Step 2.

[a]Reference category: Step 1 included sex, age, and educational level (represented by 2 dummy variables, with third-year students as the reference category). Step 2 added self-efficacy (GSES). Sex was coded with female students as the reference group and male students as the comparison group.

al established psychosocial correlates of problematic social media use, such as impulsivity, fear of missing out (FOMO), depression, anxiety, loneliness, peer norms, and sleep disturbances. The self-efficacy estimate should therefore be interpreted as an adjusted association rather than a unique or comprehensive effect. In the final model, self-efficacy was negatively associated with social media addiction (B = –0.094; 95% CI, –0.182 to –0.006; β = –.19, p = .036).

DISCUSSION

After controlling for sociodemographic factors, self-efficacy was negatively associated with social media addiction (β = −.19, p = .036). However, several established correlates of problematic social media use, including impulsivity, emotional dysregulation, FOMO, depressive symptoms, peer norms, loneliness, and sleep disturbances, were not included in the model. Their omission may have introduced omitted-variable bias and contributed to residual confounding. The results therefore provide tentative evidence of a small negative association between general self-efficacy and social media addiction among Indonesian young adults, but they do not establish a causal or unique effect of self-efficacy.

Beyond statistical significance, the practical magnitude of this association warrants consideration. The standardized coefficient for self-efficacy (β = −.19) and its incremental contribution to explained variance (ΔR^2 = .035, 3.5%) indicated a small effect by conventional criteria. Moreover, the final model explained only 10.8% of the variance in social media addiction, suggesting that generalized self-efficacy was a modest correlate rather than a standalone factor for reducing problematic use. In nursing practice, self-efficacy may therefore be more appropriately addressed as part of multicomponent, multilevel interventions incorporating educational, social, and environmental strategies rather than as a primary intervention target. Therefore, the 3.5% incremental variance should be interpreted cautiously, particularly given the established correlates omitted from the model.

The mean BSMAS score in the present study was 19.11, corresponding to an average item score of approximately 3.19 on the 5-point response scale. Although estimating the prevalence of social media addiction was not the primary aim, this score suggests that social media-related addictive tendencies were not negligible among the participating nursing students. The Indonesian version of the BSMAS has demonstrated satisfactory psychometric properties among university students, supporting its use in assessing the risk of problematic social media use in this population [20]. For context, a recent study involving nursing students reported a mean BSMAS score of 17.73±5.61, although differences in the populations and study contexts limit direct comparison [21]. The relatively elevated score observed in the present study may therefore warrant attention, particularly given university students' extensive use of digital platforms for academic, interpersonal, and informational purposes. Nevertheless, the mean BSMAS score should not be interpreted as establishing the prevalence or a clinical diagnosis of social media addiction. Thus, further research using validated diagnostic or risk thresholds in Indonesian nursing student populations is needed.

The relatively small proportion of explained variance observed in this study should also be considered in the context of the study design. The model was designed to examine the independent association of self-efficacy within a limited set of variables rather than to provide a comprehensive explanation of social media addiction. Previous studies have identified multiple determinants of problematic social media use, including impulsivity, emotional regulation, peer influence, social support, and exposure to digital media [17], but these factors were not incorporated into the current model. The association with self-efficacy thus represents 1 component of a broader multifactorial process and should not be interpreted as a comprehensive explanation of problematic social media use.

Another limitation was the possibility of omitted-variable bias. Meta-analyses have shown that problematic social media use tends to be associated with a battery of psychosocial variables such as impulsivity, depressive and anxiety symptoms, emotional dysregulation, FOMO, peer norms, and sleep disturbances [17]. When relevant variables are omitted from a regression model, the coefficient of an included variable may be confounded and not reflect its unique effect. This occurs because the observed association may partly reflect the influence of omitted variables. Consequently, the association between self-efficacy and social media addiction observed in this study ($\beta = -.19$) might be an overestimate. Confirmatory studies incorporating a broader set of well-recognized psychosocial predictors are therefore needed to determine the unique contribution of self-efficacy beyond that of stronger and more proximal predictors.

Despite these limitations, the negative association between self-efficacy and social media addiction is consistent with previous reports of a positive association between self-efficacy and self-regulation in digital environments [22]. Previous studies of college samples have also identified a relationship between higher self-efficacy, less problematic Internet use, and better control of online behavior [23]. Together, these results suggest that self-efficacy has a limited association with social media addiction and cannot, on its own, explain problematic digital behavior. The relatively low explanatory power of the model, compared with models incorporating multiple psychosocial predictors, further supports a multifactorial interpretation. From this perspective, social media addiction may reflect the interplay of intrapersonal, interpersonal, and environmental factors [24], meaning that self-efficacy is better viewed as a contributing factor than as the sole determinant of problematic social media use [25,26].

Through a social cognitive lens, self-efficacy refers to people's belief in their ability to regulate their behavior and manage situational demands [27]. Greater self-efficacy in using social media platforms could enhance confidence in limiting time online and resisting digital distractions [28]. However, the small effect size observed in this study showed that behavioral regulation in digital environments cannot be explained by efficacy beliefs alone [29]. Social cognitive theory posits that personal, behavioral, and environmental factors interact to influence behavior. This interaction helps explain why self-efficacy accounted for only a small proportion of the variance in social media addiction [18]. Thus, the results provide support for theoretical models, suggesting that maladaptive social media use is an outcome of multilevel processes rather than a single macro-level factor [30].

Social and cultural contexts in Indonesia may also help explain the modest explanatory power of self-efficacy for social media use among young adults. Social norms, peer connectedness, collectivist values, and expectations regarding online presence shape digital behavior beyond individual psychological factors. Beliefs about personal capability may therefore be influenced by prevailing social expectations and norms surrounding digital engagement. The modest explanatory power observed in the present study ($R^2 = .108$) supports a culturally sensitive perspective when examining psychological predictors of digital behavior in the Indonesian context. These results also have implications for nursing interventions targeting digital health among young adults. Although self-efficacy is insufficient as a primary intervention target, it can be incorporated into broader preventive strategies that promote digital self-regulation, coping, and healthy technology use. In other words, interventions combining educational, social, and environmental strategies are more appropriate than approaches focused solely on individual characteristics. Embedding psychological strategies within multilevel public health interventions offers a more comprehensive approach to addressing problematic social media use.

Despite the key findings presented here, the results should be interpreted with caution due to several limitations concerning the study's design, measurement, sampling, and analytic scope. (1) In terms of design, the cross-sectional approach precludes causal inference about the relationship between self-efficacy and social media addiction. (2) With respect to measurement, reliance on self-report data may introduce reporting bias. (3) The GSES captures generalized rather

than domain-specific self-efficacy, which may underestimate the role of efficacy beliefs in regulating social media use. Future studies should explore whether domain-specific efficacy, alongside psychological and contextual antecedents, generates more adequate explanatory models. (4) Regarding sampling, participants were restricted to Indonesian nursing students, limiting generalizability to other age groups and cultural contexts. The sample also had a pronounced sex imbalance (90.8% female, 9.2% male), so caution is needed when generalizing the results to male and female students or making comparisons between them. (5) Sex-stratified or oversampling strategies could improve precision for male students. (6) In terms of analytical scope, the final model explained 10.8% of the variance in social media addiction ($R^2 = .108$) and had approximately 58% power to detect the small incremental effect of self-efficacy ($f^2 = 0.04$), indicating a need for larger samples in future studies. Furthermore, the model adjusted only for sociodemographic factors and excluded established correlates of problematic social media use, including impulsivity, depression, anxiety, emotional dysregulation, FOMO, peer norms, and sleep disturbances. (7) This omission may introduce omitted-variable bias and limit the interpretation of self-efficacy as an independent predictor. Overall, these limitations suggest potentially opposing sources of bias. The use of a generalized measure may have underestimated the association, whereas the omission of stronger and more proximal correlates may have resulted in overestimation. The net direction of bias therefore cannot be determined, and the observed association should be considered provisional. However, this study provides preliminary, theoretically grounded evidence on generalized self-efficacy and social media addiction among Indonesian university students and supports further study using larger samples, domain-specific measures, and more comprehensive models incorporating relevant psychosocial determinants.

CONCLUSION

Self-efficacy had a weak negative association with social media addiction among Indonesian university students. However, given the limited explanatory power of the model and the exclusion of several established predictors, this result should not be interpreted as evidence of a unique or causal protective effect. Instead, self-efficacy should be considered alongside psychological, social, and behavioral determinants of social media addiction.

Future studies should use longitudinal designs to clarify the temporal relationship between self-efficacy and problematic social media use and incorporate a broader range of psychosocial factors. Examining family, peer, and institutional contexts, alongside mixed-method approaches, could provide a more comprehensive understanding of social media addiction. The resulting evidence could inform the development of evidence-based nursing interventions to promote digital health.

ARTICLE INFORMATION

Authors' contribution

Conceptualization: all authors. Methodology: all authors. Formal analysis: SGM, LH. Data curation: all authors. Writing–original draft: all authors. Writing–review & editing: SGM, NSA. Final approval of published version: all authors.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

The data that support the results of this study are not publicly available due to ethical restrictions and participant privacy considerations. De-identified data may be obtained from the corresponding author upon reasonable request, subject to approval by the relevant ethics committee and institutional regulations.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this study, the author(s) did not use any generative artificial intelligence (AI) or AI-assisted technologies.

ORCID and ResearcherID

Sugeng Mashudi https://orcid.org/0000-0003-3049-7014
https://researcherid.com/rid/ADJ-5903-2022

Lukman Handoko
https://orcid.org/0000-0002-0857-2500
https://researcherid.com/rid/AAC-7675-2022
Nurul Syameera Aduka
https://orcid.org/0000-0001-9338-8515
https://researcherid.com/rid/ABI-7687-2022

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Instructions to Authors

CHNR
Child Health Nursing Research

Child Health Nursing Research
Enacted in April 2006 | Most recently revised in May 2026 (applied from Vol. 32, No. 3, July 2026)

I. General Information

Child Health Nursing Research (CHNR) is the official, open-access, double-blind, peer-reviewed journal of the Korean Academy of Child Health Nursing (KACHN). As an international English-language journal, CHNR adheres to high global standards of research integrity.

CHNR is dedicated to advancing scientific knowledge and clinical practice in child health nursing. The journal promotes the health, development, and well-being of infants, children, adolescents, and their families worldwide by disseminating rigorous research on evidence-based practices.

CHNR is indexed in major international databases, including Scopus, PubMed Central (PMC), Korea Citation Index (KCI), CINAHL, KoreaMed, KoMCI, the Directory of Open Access Journals (DOAJ), ScienceCentral, and Google Scholar. All articles are assigned a Digital Object Identifier (DOI) through Crossref and are made available online immediately upon publication.

The scope of CHNR includes recent clinically and academically relevant topics in healthcare and nursing from the beginning of life to young adulthood, with attention to both children and their families. The journal publishes original research, reviews, and methodological papers that address theory, research, and practice in child health nursing, including but not limited to the following areas:

- Evidence-based child health nursing in clinical settings
- Health promotion, disease prevention, and community care
- Acute, critical, and chronic illness management in children
- Neonatal nursing and early childhood development
- Family-centered care and psychosocial support
- Cross-cultural issues, health disparities, and global health policies affecting child health

The primary readership of CHNR includes academic researchers, pediatric nurses, advanced practice registered nurses, healthcare administrators, educators, and policymakers dedicated to pediatric care. CHNR aims to build a robust body of knowledge that translates into improved clinical practice and better global health outcomes for children and their families.

CHNR is published quarterly in January, April, July, and October. The journal is open access, and all articles are freely available online immediately upon publication.

For policies on research and publication ethics not addressed in these Instructions, authors should follow the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals of the International Committee of Medical Journal Editors (ICMJE; https://www.icmje.org/icmje-recommendations.pdf) or the COPE Guidelines (https://publicationethics.org/retraction-guidelines). All processes for handling research and publication misconduct will follow the applicable COPE flowcharts (https://publicationethics.org/resources/flowcharts).

II. Research and Publication Ethics

1. Bioethics and Protection of Human/Animal Rights

Research Involving Human Participants

Clinical research involving human participants is required to be conducted in strict compliance with international standards of ethical practice, particularly the principles outlined in the Declaration of Helsinki (https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/) and relevant local regulations, including the Bioethics and Biosafety Act of Korea (https://elaw.klri.re.kr/). Clinical studies that do not meet these ethical standards will not be considered for publication. To protect participant privacy, identifiable information, such as patients' names, initials, hospital numbers, dates of birth, or other protected health information, must not be disclosed in the manuscript.

Research Involving Animals

When animals are used as research subjects, the study must be conducted in accordance with institutional and national guidelines, including those of the Institutional Animal Care and Use Committees (IACUCs; https://olaw.nih.gov/) or the NIH Guide for the Care and Use of Laboratory Animals (https://grants.nih.gov/grants/olaw/guide-for-the-care-and-use-of-laboratory-animals.pdf). The ethical treatment of all experimental animals must be maintained throughout the study.

2. Informed Consent and Institutional Review Board (IRB) Approval

IRB Approval

For all clinical studies involving human participants, researchers must obtain formal approval, an agreement, or a certificate of exemption from the Institutional Review Board (IRB) of the author's affiliated institution before commencing the study.

Informed Consent and Vulnerable Populations

Researchers must obtain and securely retain written, voluntary informed consent from all study participants or their legally authorized representatives, such as parents or guardians. If the research involves children or other vulnerable populations, strict safeguards must be implemented to ensure safety and protect human rights. In addition to parental consent, researchers are strongly encouraged to obtain the child's assent in a manner appropriate to the child's developmental age and understanding.

Document Verification

The CHNR Editorial Board or peer reviewers may request copies of informed consent forms and official proof of IRB approval at any point during the review process. Authors conducting secondary data analyses may be asked to provide IRB documentation, including approval or exemption, appropriate to the data type, such as public, institutional, or special-purpose datasets.

3. Authorship and Acknowledgements

Criteria for Authorship

Authorship is limited to individuals who have made substantial contributions to the manuscript, and every designated author must meet all four ICMJE criteria (https://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html) There criteria require the following:

- Substantial contributions to the conception or design of the work, or to the acquisition, analysis, or interpretation of data;
- Drafting the work or reviewing it critically for important intellectual content;
- Final approval of the version to be published; and
- Agreement to be accountable for all aspects of the work by ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

At the time of submission, all authors, including the order of their names, must be confirmed. All authors must provide their ORCID ID (https://orcid.org). Artificial intelligence (AI) tools or other AI-assisted technologies cannot be listed as authors.

Corresponding Author and First Author

CHNR does not allow multiple first authors or co-corresponding authors for a single article. Only one author per article should communicate with the editorial office and reviewers. The corresponding author is primarily responsible for addressing all issues raised by the editor and readers and must confirm that all appropriate persons are listed as authors and that all authors have approved the final manuscript.

- When a master's thesis or doctoral dissertation is submitted for publication, the first author should be the degree recipient and must declare that the content is derived from the thesis or dissertation.

Authorship Taxonomy (CRediT)

Each author's contribution must be described using the CRediT taxonomy (https://credit.niso.org/) during the submission process. This information will appear above the references section of the published paper.

Term	Definition
Conceptualization	Ideas; formulation or development of overarching research goals and aims
Methodology	Development or design of methodology; creation of models
Software	Programming, software development; designing computer programs; testing of existing code components
Validation	Verification of the overall replication/reproducibility of results/experiments and other research outputs
Formal analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
Investigation	Conducting a research and investigation process, specifically performing experiments or data/evidence collection
Resources	Provision of study materials, reagents, patients, laboratory samples, animals, instrumentation, or other analysis tools
Data curation	Management activities to annotate, clean data, and maintain research data for initial use and later reuse
Writing – original draft	Preparation, creation, and/or presentation of the published work, specifically writing the initial draft
Writing – review & editing	Critical review, commentary, or revision of the published work by the original research group
Visualization	Preparation, creation, and/or presentation of the published work, specifically visualization/data presentation
Supervision	Oversight and leadership responsibility for the research activity planning and execution
Project administration	Management and coordination responsibility for the research activity planning and execution
Funding acquisition	Acquisition of financial support for the project leading to the publication

Changes to Authorship

Before Publication

Requests for authorship changes, including the addition, removal, or reordering of authors, must be submitted before manuscript acceptance. Such requests must be accompanied by a formal letter to the Editor, signed by all authors, including those being added or removed, that provides a clear justification for the change. The Editorial Board reserves the right to conduct a formal review and may request further clarification before reaching a decision. All processes will strictly follow COPE guidelines (https://publicationethics.org/guidance/Flowcharts).

After Publication

Authorship changes after publication are generally not permitted in order to maintain the integrity of the scholarly record. However, if a genuine error is identified, such as an editorial mistake or the justifiable omission of a contributor, the Editorial Board may consider a request for a correction. Such requests must be accompanied by a detailed explanation and written consent from all original and prospective authors. All cases will be handled in accordance with COPE guidelines.

Acknowledgements for Non-author Contributors

Contributors who do not meet all four ICMJE criteria for authorship should be listed in the Acknowledgements section. Roles such as funding acquisition, data collection, general supervision, writing assistance, and technical or language editing do not, by themselves, justify authorship.

4. Conflict of Interest Statement

A conflict of interest exists when professional judgment concerning a primary interest, such as research validity or patient welfare, may be influenced by a secondary interest, such as financial gain. All authors must transparently disclose any financial or personal relationships, including employment, consultancies, stock ownership, honoraria, or academic competition, that could potentially bias their work, even if the authors believe their judgment was not influenced.

Authors must complete and submit the ICMJE Disclosure Form (https://www.icmje.org/disclosure-of-interest/) and declare any potential conflicts on the manuscript title page and in a dedicated Conflict of Interest section at the end of the main text. If no conflicts exist, the following statement must be included: "*The authors declare no conflict of interest*."

Authors must explicitly identify all sources of financial support and describe the exact role of each funding sponsor in study design, data collection, analysis, interpretation, and the decision to submit the manuscript for publication.

Both reviewers and editors must disclose any potential conflicts of interest. If a conflict exists, the individual must immediately notify the editorial office and recuse themselves from the review or decision-making process. Manuscripts submitted by editors or Editorial Board members are handled as standard unsolicited submissions, and those individuals are strictly excluded from reviewer selection, evaluation, and final decision-making for their own manuscripts. Any such conflict of interest must be explicitly declared in the dedicated Conflict of Interest section of the manuscript.

5. Originality and Misconduct

Reporting Standards and Originality

Authors must report their research accurately and objectively. Methods and procedures should be described in sufficient detail to allow replication. Authors must never produce, record, or report nonexistent data (fabrication) or change or omit data (falsification). Manuscripts must be original works and must properly cite all sources. Plagiarism, including self-plagiarism, is strictly prohibited. All submissions are screened using the Crossref Similarity Check tool powered by iThenticate (https://www.crossref.org/services/similarity-check/); manuscripts with a high similarity index will be rejected. Manuscripts with substantial unattributed overlap may be rejected following editorial assessment.

Duplicate Publication and Salami Slicing

Multiple, simultaneous, or duplicate submissions are strictly prohibited in accordance with ICMJE recommendations. Authors must not divide one substantial manuscript into multiple smaller publications ("salami slicing"). Secondary publication in a different language requires explicit approval from the Editors-in-Chief of both the primary and secondary journals. If duplicate submission is detected, sanctions may be imposed in accordance with COPE guidelines, including temporary suspension of submission privileges and notification of the authors' institutions.

6. Image Integrity Policy

The integrity of all images submitted to CHNR must be maintained. Manipulating images in a manner that misrepresents the original data or findings constitutes research misconduct and may result in rejection or retraction of the manuscript. The following standards apply:

- Global adjustments, such as brightness, contrast, and color balance, are permitted only when applied equally and uniformly to the entire image and when they do not obscure or eliminate any information present in the original.
- Enhancements, erasures, splicing, cloning, or other manipulations of specific image regions are strictly prohibited.
- Any image processing performed, including the software used and adjustments made, must be described in the Methods section.
- Original, unprocessed image files must be retained by the authors and provided to the editorial office upon request.

7. Research Data Sharing Policy

CHNR encourages authors to share the research data supporting their publications, where appropriate, and to link these data to their published articles. To facilitate reproducibility and data reuse, the journal also encourages the sharing of software, code, models, algorithms, protocols, methods, and other useful materials.

Authors must include a Data Availability Statement in the manuscript describing how readers can access the data, code, and other resources supporting the research findings.

Example 1 (Data available upon request):
The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.
Example 2 (Data included in the article):
All data generated or analyzed during this study are included in this published article and its supplementary information files.
Example 3 (Data in a public repository):
The data that support the findings of this study are available in [Name of Repository] at https://dx.doi.org/[DOI].

8. Management of Research Misconduct and Corrections

CHNR is committed to maintaining the integrity of the scientific record. When research misconduct is suspected or errors are identified, the journal follows a systematic process for investigation and resolution.

Process for Handling Misconduct

If reviewers, editors, or readers suspect any form of publication malpractice, including data fabrication or falsification, salami slicing, plagiarism, simultaneous or duplicate submission, inappropriate authorship changes, undisclosed conflicts of interest, ethical violations involving research participants or animals, or a reviewer's appropriation of an author's data, a formal resolution process will be initiated in accordance with the COPE (Committee on Publication Ethics) flowcharts (https://publicationethics.org/guidance/Flowcharts).

The journal's ethics committee and Editorial Board are responsible for adjudicating all suspected cases. If authors discover a fundamental error in their published manuscript, they must immediately inform the editor and cooperate fully to correct or retract the manuscript.

Post-Publication Mechanisms

To address identified errors or confirmed misconduct, CHNR uses the following mechanisms in accordance with the COPE Retraction Guidelines (https://publicationethics.org/retraction-guidelines). All correction requests must be submitted to the Editorial Office with a detailed explanation.

- **Expression of Concern:** Issued when the Editorial Board becomes aware of evidence regarding the unreliability of a study or potential misconduct, but a final determination has not yet been reached.
- **Retraction:** Issued when serious errors or misconduct, such as data fabrication, falsification, or plagiarism, invalidate the findings of a study. Retracted articles remain accessible online to preserve the scholarly record but are clearly and permanently marked as "RETRACTED."
- **Corrigendum:** A correction issued for significant errors identified by the author(s) that do not undermine the scientific integrity or conclusions of the article.
- **Erratum:** A correction for production errors made by the publisher, such as typesetting or figure-placement errors, that materially affect the content or metadata.

III. Manuscript Preparation

1. Types of Manuscripts

CHNR publishes the following article types:

Article Type	Abstract (words)	Main Text (words)	References	Tables & Figures
Original article	250	6,000	30	5
Review article	250	8,000	No limit	5
Editorial	N/A	2,500	10	5

Note: No strict reference limit applies to systematic reviews and meta-analyses. For original articles, the recommended number of references is 30 or fewer, although exceptions may be considered for certain study types, such as structural equation modeling studies. The total word count for the main text excludes the abstract, references, tables, and figure legends.

- **Original Articles:** Comprehensive papers presenting novel research findings from empirical studies relevant to child health nursing and healthcare for people from the beginning of life to young adulthood, as well as their families. Methodologies include mixed-methods designs, observational, quasi-experimental, and experimental investigations, qualitative methods, and instrument development or evaluation studies.
- **Review Articles:** Critical presentations on themes of interest and importance to child health nursing theory, practice, and education. This category includes comprehensive literature reviews, systematic reviews, scoping reviews, and discussion papers. All review articles must include a critical evaluation of a significant body of research or scholarship.
- **Editorials:** Editorials are published by invitation only and feature remarks by institutional representatives or individuals on topics of current interest. Authors with suggestions for editorials may contact the editorial office.

2. General Information

- **Language and format:** All manuscripts must be written in English and submitted in Microsoft Word format (.doc or .docx) to facilitate international peer review. The document should be prepared on A4 paper with standard margins of at least 25 mm on all sides. Use a 12-point standard font, such as Times New Roman, and double-space the entire text, including the abstract and references.
- **Abbreviations:** Use the complete term at first mention, followed by the abbreviation in parentheses. Abbreviations must not be used in the title.
- **Numbers:** All numbers should be written as Arabic numerals, except at the beginning of a sentence.
- **Survey tools:** Authors must obtain permission from the copyright holder to use any psychosocial questionnaire.
- **Equipment**: When identifying machinery or equipment, include the model and manufacturer in parentheses. Brand names (™, ®) should be used only when necessary.
- **Inclusive language:** Authors are encouraged to use language that acknowledges diversity and respects all individuals. Writing should be free of bias, stereotypes, and cultural assumptions. Gender neutrality is encouraged, such as by using plural nouns (e.g., "patients") rather than gendered pronouns.
- **Reference style:** References and citations must follow National Library of Medicine (NLM) style. Authors are responsible for ensuring adherence to NLM guidelines.
- **Statistical reporting:** Authors must report appropriate effect-size measures, such as Cohen's d, odds ratios, relative risks, and η^2, and 95% confidence intervals (CIs)

alongside p-values wherever applicable. Reporting p-values alone is insufficient. The statistical software and version used must be specified in the Methods section (e.g., IBM SPSS Statistics 29.0, R 4.3.0, SAS 9.4). All statistical tests must be two-tailed unless otherwise justified.

- **English-language quality:** To maintain high standards of linguistic quality and international readability, the Editorial Board may require authors of accepted manuscripts to submit a certificate of professional English editing. Alternatively, if generative AI tools were used for linguistic refinement, authors must provide a detailed disclosure of the tools and processes used, as specified in the "Policies on the Use of Generative AI" section. The Editorial Board reserves the right to request these documents before final publication.
- **Sex and gender equity:** CHNR adheres to the SAGER (Sex and Gender Equity in Research) guidelines to promote gender-sensitive research and systematic reporting of sex and gender. Authors should use the terms "sex" (a biological attribute) and "gender" (an attribute shaped by social and cultural contexts) carefully and distinguish between them. The sex and gender of study participants should be clearly specified in the title or abstract so that the applicability of the findings is transparent from the outset. In the Methods section, authors should describe how sex or gender was determined and justify its relevance to the study design. In the Results section, authors are encouraged to provide data disaggregated by sex or gender, where appropriate. If no such analysis was conducted, the Discussion section must include a rationale for the omission and address how it may affect interpretation and generalizability. For more information, please refer to the SAGER guidelines (https://doi.org/10.1186/s41073-016-0007-6).

3. Reporting Guidelines for Specific Study Designs

Authors are encouraged to adhere to the relevant reporting guidelines for their study design. The EQUATOR Network (https://www.equator-network.org/) provides a comprehensive list.

Study Design	Reporting Guideline
Observational studies (cohort, case-control, cross-sectional)	STROBE
Qualitative studies	COREQ, SRQR
Quasi-experimental / non-randomized trials	TREND
Randomized controlled trials	CONSORT
Diagnostic accuracy / assessment scale	STARD
Systematic review and meta-analysis	PRISMA, MOOSE
Scoping review	PRISMA-ScR
Quality improvement studies	SQUIRE
Animal studies	ARRIVE 2.0
Clinical trial protocol	SPIRIT
Mixed-methods research	GRAMMS

4. Sequence of Headings in an Original Article

The manuscript should be organized as follows, with each section clearly delineated.

Section	Components
Beginning section	Cover letter / Title page / Abstract and keywords
Middle section (main text)	Introduction / Methods / Results / Discussion / Conclusion
Ending section	ORCID and ResearcherID / Authors' contributions / Conflict of interest / Funding resource / Data availability / Acknowledgements / Declaration of generative AI and AI-assisted technologies in the writing / Supplementary materials / References
Other elements	Tables and Figures

1) Beginning Section

(1) **Cover Letter**

Authors must include a cover letter to the editor that summarizes the main components of the manuscript and explains what makes its contribution original and relevant to the aims and scope of CHNR. The author(s) should also address any authorship or publication matters they wish the editors to consider. Disclosure of AI tool use must also be included in the cover letter.

(2) **Title Page**

- The title page should include the following items in this order: title, running title, manuscript type, author(s), corresponding author, conflict of interest, IRB approval, Medical Subject Headings (MeSH; https://www.ncbi.nlm.nih.gov/mesh/) keywords, number of references, and word count of the English abstract.

- Manuscript type: One of the following should be noted: original article, review article, editorial, or invited paper.
- Author(s): This section should list the names of all authors, with each author's position and affiliation, including title, department, and the location of the institution to which the work should be attributed. It should also include each author's ORCID number and ResearcherID and describe each author's role in the study.
- Corresponding author: The corresponding author should be identified by full address, including zip code, email address, telephone number, fax number, and ORCID number or ResearcherID.
- Conflict of interest: Any matter relevant to the research should be noted here, such as sources of research funding, conflicts of interest, or an indication that the manuscript is derived from a dissertation or thesis for an academic degree program.
- IRB approval: The author should provide information about the institution that granted IRB approval, including the approval number and informed consent process. If the study did not involve humans or animals, a statement regarding IRB exemption should be included.
- MeSH keywords: Keywords must be drawn from the MeSH list, include no more than five terms, and be listed in alphabetical order.
- Number of references: Original articles should include no more than 30 references. However, for articles with no reference restriction, such as meta-analyses, systematic reviews, or structural equation modeling studies, authors may provide more references.
- Number of words in the abstract: The abstract word count should be noted and should not exceed 250 words.

(3) **Abstract and Keywords**

An abstract of up to 250 words, including for review articles, should appear on a separate page. It should state the main factual points, including the purpose, methods, results, and conclusions. The abstract should be accompanied by three to five MeSH keywords for indexing, listed in alphabetical order. The abstract must not include abbreviations, references, or diagrams.

2) Middle Section (Main Text)

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

(1) **Introduction:** Clearly state the study rationale and the main research question or hypothesis, and provide a relevant literature review or background summary.

(2) **Methods:** Describe the study design, setting and sample, ethical considerations, measurements or instruments, data collection procedures, and data analysis. For qualitative studies, the research instrument may be omitted. An Ethics Statement must be provided immediately after the Methods heading in a text-box format.

> **Example 1:**
> *Ethics statement: This study was approved by the Human Ethics Committee of the University of XXX (IRB No. 202104-0002-03). Informed consent was obtained from all participants (or their parents/legal guardians).*
> **Example 2:**
> *Ethics statement: This study is a literature review of previously published studies and was therefore exempt from Institutional Review Board approval.*

- Example 1:Ethics statement: This study was approved by the Human Ethics Committee of the University of XXX (IRB No. 202104-0002-03). Informed consent was obtained from all participants or their parents/legal guardians.
- Example 2:Ethics statement: This study is a literature review of previously published studies and was therefore exempt from Institutional Review Board approval.
- Statistical analysis: Authors must specify the statistical software and version used (e.g., IBM SPSS Statistics 29.0, R 4.3.0, SAS 9.4). Effect sizes and 95% confidence intervals (CIs) must be reported alongside p-values. The alpha level for statistical significance must be stated explicitly, typically as $\alpha = .05$. For complex models, such as multilevel modeling or structural equation modeling, model fit indices must be provided.
- For systematic reviews and meta-analyses, authors must provide a PROSPERO registration number (https://www.crd.york.ac.uk/prospero/) in both the abstract and the Methods section to ensure transparency and reproducibility. For randomized controlled trials (RCTs), registration in an ICMJE-recognized clinical trial registry is mandatory, and the registration number must be clearly cited in the manuscript. In exceptional cases in which registration was not possible, a compelling justification must be submitted in the cover letter for evaluation by the Editorial Board.

(3) **Results:** Describe the main results logically and concise-

ly. Report levels of statistical significance and confidence intervals where appropriate. Do not duplicate data presented in tables or figures.

(4) **Discussion:** Base the Discussion only on the reported results. Compare and contrast the findings with relevant prior studies. Describe advances in nursing practice and knowledge development. Discuss limitations and future research directions.

(5) **Conclusion:** State the conclusions and recommendations for further study. Do not summarize the study results again.

3) Final Section

(1) **ORCID and ResearcherID:** Authors should provide their ORCID number and ResearcherID.

(2) **Authors' contributions:** Authors' contributions should be described according to the CRediT authorship taxonomy.

(3) **Conflict of interest:** Authors must disclose commercial or similar relationships with products or companies mentioned in, or related to the subject matter of, the submitted article. If there are no conflicts of interest, the following statement must be included: "*The authors declare no conflict of interest*."

(4) **Funding:** Acknowledge all sources of funding for the manuscript. If there was no funding, state: "None."

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References must follow NLM citation style (Citing Medicine: The NLM Style Guide for Authors, Editors, and Publishers, 2nd ed.; https://www.ncbi.nlm.nih.gov/books/NBK7256/). References should be numbered consecutively in the order in which they appear in the text, with numbers in brackets [ ]. Use the original reference number if a reference is cited more than once. If a work has seven or more authors, list the first six followed by "et al." The use of DOIs is strongly encouraged. The recommended number of references is 30 or fewer for an original article, with no limit for meta-analyses, systematic reviews, or structural equation modeling studies.

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Journal names should be abbreviated according to the NLM Catalog. For six or fewer authors, list all authors. For more than six authors, list the first six followed by "et al."

· *Park IT, Oh WO. Evaluation of a child abuse prevention program for unmarried mothers in South Korea: a single-case ex-*

perimental design. Child Health Nurs Res. 2024;30(3):187-198. https://doi.org/10.4094/chnr.2024.018

- *Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, et al. Epidemiology of COVID-19 among children in China. Pediatrics. 2020;145(5):e20200702. https://doi.org/10.1542/peds.2020-0702*
- *Kang HK, Kim TB, Kim KH, Kim MJ, Kim JH, Kim HY, et al. Development and effect of a metabolic syndrome prevention program for university students using mobile application. Child Health Nurs Res. 2014;20(3):205-214. https://doi.org/10.4094/chnr.2014.20.3.205*
- *Cesare M, Cocchieri A. Can an increase in nursing care complexity raise the risk of intra-hospital and intensive care unit transfers in children? A retrospective observational study. J Pediatr Nurs. 2024 Nov 28 [Epub]. https://doi.org/10.1016/j.pedn.2024.11.005*

2) **Books and Book Chapters**

- *Book: Harding MM, Kwong J, Roberts D, Hagler D, Reinisch C. Lewis's medical-surgical nursing: assessment and management of clinical problems. 12th ed. St. Louis (MO): Elsevier; 2023.*
- *Book chapter: Meltzer PS, Kallioniemi A, Trent JM. Chromosome alterations in human solid tumors. In: Vogelstein B, Kinzler KW, editors. The genetic basis of human cancer. New York (NY): McGraw-Hill; 2002. p. 93-113.*

3) **Scientific and Technical Reports**

- *World Health Organization. World health statistics 2023: monitoring health for the SDGs, sustainable development goals. Geneva (Switzerland): World Health Organization; 2023.*
- *Korean Women's Development Institute. 2015 National multicultural family survey report. Seoul (Korea): Ministry of Gender Equality & Family; 2016. Report No.: MOGEF2016-3.*

4) **Unpublished Theses or Dissertations**

- *Choi JW. Clinical characteristics and treatment outcomes of pediatric neurofibromatosis type 2: neurosurgical series [master's thesis]. Seoul National University; 2013.*
- *Lee YH. Development and effects of nocturnal emission and menstruation education program using CAI for Korean elementary school children [dissertation]. Ewha Womans University; 2010.*

5) **Conference Proceedings**

- *Chu H, Rosenthal M. Search engines for the World Wide Web: a comparative study and evaluation methodology. Proceedings of the 59th Annual Meeting of the American Society for Information Science; 1996 Oct 21-24; Baltimore (MD). Medford (NJ): Information Today; 1996. p. 127-135.*

6) **Web**

- *World Health Organization. Coronavirus disease (COVID-19) pandemic [Internet]. Geneva (Switzerland): World Health Organization; 2020 [cited 2024 Jan 15]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019*
- *Statistics Korea. Cause of death statistics in 2023 [Internet]. Daejeon (Korea): Statistics Korea; 2024 [cited 2024 Dec 10]. Available from: https://kostat.go.kr/*

7) **Datasets**

- *Kraemer MU, Sinka ME, Duda KA, Mylne A, Shearer FM, Brady OJ, et al. The global compendium of Aedes aegypti and Ae. albopictus occurrence [dataset]. Dryad Digital Repository; 2015 [cited 2024 Dec 10]. Available from: https://doi.org/10.5061/dryad.47v3c*

8) **Software**

- *R Core Team. R: a language and environment for statistical computing, version 4.4.0 [software]. Vienna (Austria): R Foundation for Statistical Computing; 2024. Available from: https://www.r-project.org/*

6. Table and Figure Format

The total number of tables and figures in a manuscript must not exceed five. All tables and figures should be understandable when presented separately from the rest of the manuscript and should present information relevant to the study.

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- Use single horizontal lines only. Do not use vertical lines.
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- Tables should be numbered consecutively, such as Table 1, Table 2, and so on.
- Abbreviations, symbols, and explanatory notes should be provided in table footnotes. All abbreviations used in a table should be defined in the footnotes of every table in which they appear. Example: HR, heart rate; T, temperature.
- In a table, use superscript lowercase letters to indicate

footnotes. Example: a) Surviving case; b) Deceased case.

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All manuscripts must be submitted online through the CHNR submission system (http://www.chnr-submission.org/) or the CHNR website (https://www.e-chnr.org/). Authors should review the submission guidelines and complete the author checklist before submission.

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Reviewers are asked to complete their evaluations within two to three weeks. Authors can generally expect an initial decision within 6 to 8 weeks of submission. The Editorial Board will issue one of the following decisions: Accept, Minor Revision, Major Revision, or Reject.

If revisions are requested, authors must submit the revised

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