REPEn
Revista Paulista de Enfermagem

LITERATURE REVIEW

Submission: 09.02.2025
Approval: 03.09.2026

How to cite this article

Braga CAA, Borges EP, Chaves RC, Guilherme FJA, Fonseca ER, Silva TASM. Conhecimentos, habilidades e atitudes da enfermagem no contexto do voo espacial: revisão de escopo. Rev Paul Enferm. 2026;37:504e6. https://doi.org/10.33159/25959484.repen.2026v37a06e

Nursing knowledge, skills, and attitudes in the context of spaceflight: a scoping review

Conhecimentos, habilidades e atitudes da enfermagem no contexto do voo espacial: revisão de escopo

Conocimientos, habilidades y actitudes de la enfermería en el contexto de los vuelos espaciales: una revisión del alcance

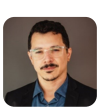
Christian Arantes Almeida Braga [I] ORCID: 0009-0003-8492-0794
Elenildo Pinto Borges [I] ORCID: 0009-0005-2746-6665
Rui Cavalcante Chaves [I] ORCID: 0009-0006-3406-0943
Fábio José de Almeida Guilherme [II] ORCID: 0000-0001-6484-2870
Eliana Rosa da Fonseca [III] ORCID: 0000-0003-0103-2859
Thiago Augusto Soares Monteiro da Silva [I] ORCID: 0000-0001-6870-5101

[I] Universidade de Vassouras. Vassouras, Rio de Janeiro, Brasil.
[II] Instituto de Medicina Aeroespacial General de Brigada Roberto Teixeira. Rio de Janeiro, Rio de Janeiro, Brasil.
[III] Universidade Federal do Rio de Janeiro. Rio de Janeiro, Rio de Janeiro, Brasil.

ABSTRACT

Objective: to identify nursing knowledge, skills, and attitudes in the context of spaceflight.**Method**: a scoping review in accordance with JBI, performed based on database searches without specifying the time frame or language. The selection process consisted of three distinct stages and was conducted by two independent reviewers. Content analysis was performed.**Results**: searches in indexed databases identified 1,947 studies, 31 of which were included after screening according to eligibility criteria. Most studies were descriptive or reflective in nature, with a predominance of North American studies and in English.Content analysis allowed for the categorization of nursing care into three phases: pre-flight, duringflight, and post-flight. The pre-flight phase emphasizes astronauts'physical and emotional preparation, as well as clinical screenings and emergency simulations. During flight, in a microgravity environment, nursing plays a strategic rolein the areas of health monitoring, telenursing, and emergency response. In the post-flight phase, the emphasis is on crew members' physiological and psychosocial readaptation.
Conclusion: nursing practice in space missions requires knowledge, advanced skills, and attitudes to act autonomously, in addition to technological proficiency, to provide qualified/effective care in the complex context of spaceflight.
Descriptors: Nursing; Professional Competence; Space Flight.

Corresponding author



Thiago Augusto Soares Monteiro da Silva
E-mail: augustosilvasa88@gmail.com

RESUMO

Objetivo: identificar os conhecimentos, habilidades e atitudes da Enfermagem no contexto do voo espacial. **Método**: revisão de escopo em conformidade com JBI, realizada a partir da busca em bases de dados sem balizar o recorte temporal e o idioma. O processo de seleção consistiu em três etapas distintas e foi conduzido por dois revisores independentes. Foi realizada a análise de conteúdo. **Resultados**: as buscas em bases indexadas identificaram 1.947 publicações, 31 das quais foram incluídas após triagem de acordo com os critérios de elegibilidade. A maioria dos estudos era de natureza descritiva ou reflexiva, com predominância de publicações norte-americanas e em língua inglesa. A análise de conteúdo permitiu categorização dos cuidados de enfermagem em três fases: antes do voo, durante o voo e após o voo espacial. A fase antes do voo, enfatiza a preparação física e emocional dos astronautas, triagens clínicas e simulações de emergência. Durante o voo, em um ambiente de microgravidade, a enfermagem atua estrategicamente nas áreas de monitoramento de saúde, telenfermagem e resposta as emergências. Na fase pós-voo, a ênfase é na readaptação fisiológica e psicossocial dos membros da tripulação. **Conclusão**: a prática de enfermagem em missões espaciais requer conhecimentos, habilidades avançadas e atitudes para agir de forma autônoma, além do domínio tecnológico, para promover uma assistência qualificada/eficaz no contexto complexo do vôo espacial.
Descritores: Enfermagem; Competência Profissional; Voo espacial.

RESUMEN

Objetivo: identificar los conocimientos, habilidades y actitudes de enfermería en el contexto de los vuelos espaciales. **Método**: revisión del alcance según JBI, realizada mediante búsqueda en bases de datos sin limitar el período ni el idioma. El proceso de selección constó de tres etapas distintas y fue llevado a cabo por dos revisores independientes. Se realizó un análisis de contenido. **Resultados**: las búsquedas en bases de datos indexadas identificaron 1.947 publicaciones, de las cuales 31 se incluyeron tras la selección según los criterios de elegibilidad. La mayoría de los estudios fueron de carácter descriptivo o reflexivo, con predominio de publicaciones norteamericanas y en inglés. El análisis de contenido permitió categorizar la atención de enfermería en tres fases: pre-vuelo, durante el vuelo y post-vuelo. La fase pre-vuelo se centra en la preparación física y emocional de los astronautas, las evaluaciones clínicas y las simulaciones de emergencia. Durante el vuelo, en un entorno de microgravedad, la enfermería actúa estratégicamente en las áreas de monitorización de la salud, teleenfermería y respuesta a emergencias. En la fase post-vuelo, el énfasis recae en la readaptación fisiológica y psicosocial de los miembros de la tripulación. **Conclusión**: la práctica de enfermería en misiones espaciales requiere conocimientos, habilidades avanzadas y actitudes para actuar de forma autónoma, además del dominio tecnológico, para promover una atención cualificada y eficaz en el complejo contexto de los vuelos espaciales.
Descriptores: Enfermería; Competencia Profesional; Vuelo Espacial.

INTRODUCTION

The advancement of space exploration, especially with long-duration missions, has expanded the frontiers of human knowledge. However, while these achievements offer new scientific possibilities, they present multiple challenges to astronauts' health and well-being that extend beyond the scope of traditional nursing practice. Thus, aerospace nursing emerges as a specialized area, essential for meeting individuals' health needs in extreme environments and with unique limitations, such as spaceflight[(1)].

Despite the traditional role of nursing on Earth, the context of spaceflight requires specific knowledge, skills, and attitudes, ranging from basic care to the management of complex health situations in microgravity[(2-3)]. The importance of nurses' role in space missions has been recognized since the early decades of space exploration, with professionals performing advanced healthcare in aerospace environments[(2-4)], which highlight the need for adaptation to the microgravity environment, support the inclusion of nurses in space programs, and require specific protocols, assessment of radiation exposure risks, and limitations in the provision of medical resources[2-5].

Nursing in the space context can contribute to astronauts' physical and psychological preparation, with the development of protocols for care in space[2,6] and in the transition from the microgravity environment to the return to Earth[2,6]. It is recognized that there is a need for the systematization of knowledge, skills, and attitudes for nurses to work in space missions, in addition to have an understanding of life support technologies, health monitoring in closed environments, and the ability to manage emergencies in hard-to-reach locations, such as the International Space Station[7]. It is understood that despite the historical recognition of nurses in aerospace missions, there is still no clear systematization of the knowledge, skills, and attitudes necessary for safe and effective care in a microgravity environment, which reinforces the need for this review.

To support the investigation into nursing knowledge, skills, and attitudes in the context of spaceflight, the concept of competence was used, which is understood as the ability to mobilize, articulate, and integrate knowledge, skills, attitudes, and resources in order to guide actions and interactions in complex and constantly changing contexts[8].

The rationale for conducting this scoping review is based on a preliminary search that was carried out from January to April 2025 in the MEDLINE (via PubMed), JBI Evidence Synthesis, Cochrane Database of Systematic Reviews, and PROSPERO databases, during which a literature review[6] was identified that addressed astronauts' basic needs, nursing roles and the challenges they will face in the space context, but did not address nurse knowledge, skills, and attitudes in the space context. It is worth noting that no other scoping or systematic reviews on the phenomenon have been identified, thus this scoping review becomes essential to broaden the understanding of this emerging and highly specialized field of nursing.

In this regard, this review is justified by enabling the systematization and consolidation of evidence regarding nursing knowledge, skills, and attitudes in the context of spaceflight, contributing to the development of protocols, strengthening professional training, and fostering discussions about the need for the inclusion and advancement of nursing knowledge in the context of space programs. The relevance of this study lies in its potential to support innovative care practices in extreme environments, expanding the possibilities for nursing practice with the goal of promoting safety and quality of life for astronauts on space missions.

Given the above, this scoping review aimed to identify nursing knowledge, skills, and attitudes in the context of spaceflight.

METHOD

The scoping review was conducted in accordance with the method proposed by JBI[9], and submitted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)[10] and had its protocol registered in the Open Science Framework (OSF) with DOI: https://doi.org/10.17605/OSF.IO/UK4QC.

The study's review question was: what knowledge, skills, and attitudes are present in nursing in the context of spaceflight?

Eligibility criteria

Studies on the integration of nursing professionals with responsibilities in space missions who apply knowledge, skills, and attitudes acquired both in caregiving situations and in training and discipline requirements within the context of microgravity environments, deep space missions, orbital stations, and other extraterrestrial scenarios were included.

Types of sources

Primary studies, with quantitative, qualitative, and mixed approaches were considered, with various types of study designs, in addition to integrative, scoping, and systematic reviews, in accordance with the research question and eligibility criteria. A search of studies in grey literature was also considered through the websites of Aerospace Nursing societies; however, searches in grey literature did not result in inclusions in this review. To broaden the scope of the searches, time frame and language were not limited. Theses and dissertations, protocols, guidelines, guides, books, book chapters, letters, and opinions were not included.

Research strategy

The first stage comprised a preliminary search from January to April 2025 in the MEDLINE (via PubMed), JBI Evidence Synthesis, Cochrane Database of Systematic Reviews, and PROSPERO databases, through which articles' titles, abstracts, and descriptors were analyzed. The article description index terms were used to develop the search strategy (Table 1). It should be noted that the search strategy was adapted for each selected database with the support of an experienced librarian specializing in health studies.

Table 1 – MEDLINE search strategy

Search	Query	Results
#1	Search: **Nurses[mh] OR Nursing[mh] OR Nursing*[tiab] OR Nurse*[tiab]**	735,124
#2	Search: **"Space Flight"[mh] OR Space Exploration*[tiab] OR "Space Flights"[tiab] OR Space Travel*[tiab] OR Spaceflight*[tiab] OR "Spacecraft"[mh] OR Artificial Satellite*[tiab] OR "extravehicular activity"[tiab] OR "orbital station"[tiab] OR "rocket flight"[tiab] OR "space cabin"[tiab] OR "space craft"[tiab] OR "space flight model"[tiab] OR "space lab"[tiab] OR "space simulation"[tiab] OR "space station"[tiab] OR "suborbital flight"[tiab] OR "space flight"[tiab] OR "Aerospace Medicine"[mh] OR "Aviation Medicine"[tiab] OR "Space Medicine"[tiab] OR Microgravity healthcare[tiab] OR Microgravity[tiab]**	38,117
#3	Search: **Space nursing[tiab] OR Aerospace nursing[tiab] OR Astronautical nursing[tiab] OR Spaceflight nursing[tiab]**	55
#4	Search: **(#1 AND #2) OR #3**	328

The second stage involved a complete search of all databases selected for the development of this study, based on the definitive search strategy applied and adapted – using the Boolean operators "AND" and "OR" along with keywords and descriptors – in the Virtual Health Library (VHL) Regional Portal under the responsibility of *Centro Latino-Americano e do Caribe de Informação em Ciências da Saúde* (BIREME) in its main databases: *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILACS); *Bancos de Dados de Enfermagem* (BDENF);*Red Peruana de Bibliotecas en Salud* (LIPECS); BINACIS; PAHOIRIS; MedCarib; SES-SP; VETINDEX; CUMED; SMS-SP; *ColecionaSUS*; MEDLINE/PubMed; Scientific Electronic Library Online (SciELO); Cochrane Library/Wiley; Epistemonikos; and *La Reference*.

The following databases were used through the CAPES Journals Portal: Elsevier: Embase and Scopus; Clarivate Analytics: Web of Science; EBSCO: Cumulative Index to Nursing and

Allied Health Literature (CINAHL); Academic Search Premier (ASP); *Fonte Acadêmica*; SocINDEX; Computers & Applied Sciences Complete; and PsycInfo/APA. The following gray literature integrative portal Science.gov was also accessed: USA.gov; Epistemonikos: Database of the Best Evidence-Based Health Care, Information Technologies, and a network of experts; and Science.gov, specifically for gray literature studies.

The search also included websites of the Space Nursing Society, Society of Rogerian Scholars, Visions Journal, professional legislation, the International Council of Nurses (ICN), digital libraries of theses and dissertations, and internet search engines.

The third stage involved a reverse search using reference lists that met the established eligibility criteria. Moreover, this review also included seeking supplementary information by contacting the authors of the mapped primary studies via email.

Evidence source study/selection

After the searches, all references were imported into the EndNote 21 reference manager (Clarivate Analytics, PA, USA) and duplicate studies were identified. Then, the identified references were imported into the Rayyan® application (Qatar Computing Research Institute, Doha, Qatar) for study selection. Initially, the sources were analyzed by two reviewers regarding titles, abstracts, and keywords, according to the eligibility criteria of the review. Disagreements among reviewers were resolved by consensus or by a third reviewer's decision. Sources with potential relevance were retrieved in full for complete text reading, and selection information and reviewer decisions were recorded in Rayyan®.

The excluded studies were recorded and described in terms of the reasons for exclusion. Eligible texts were archived in digital folders, read and assessed in full by two researchers. The selection results were presented in a flowchart[10] (Figure 1).

Data extraction

Data were extracted after reading the texts in full. For this purpose, a standard JBI instrument[9] was used to characterize the selected studies and to extract evidence relating to the eligibility criteria. It should be noted that, for the use of this instrument, a pilot test was carried out on five sources, seeking familiarity with the process of searching, selecting and extracting data and identifying and making any necessary adjustments.

Data analysis and presentation

After data extraction, a content analysis was performed following pre-analysis, material exploration, and treatment of results, inference, and interpretation[11-12]. The results were presented in the form of diagrams, flowcharts, and tables. It should be noted that a descriptive presentation accompanied the mapped results.

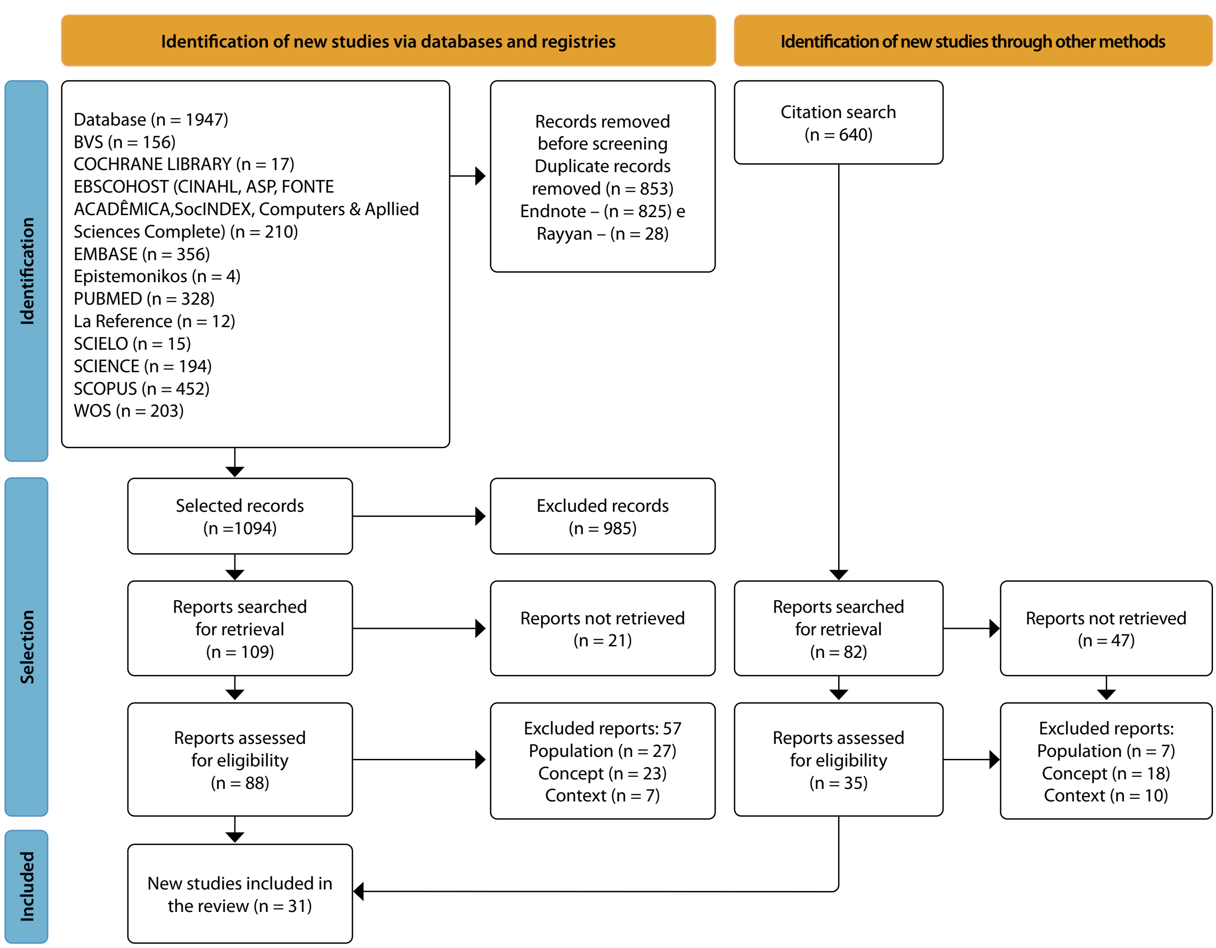
RESULTS

The search using the descriptors resulted in the identification of 1,947 studies in the indexed databases. Of these, 853 were excluded due to duplication. The remaining 1,094 studies were screened using Rayyan®, considering titles and abstracts, with 985 being excluded for not meeting the eligibility criteria. Moreover, 109 studies remained for full-text assessment, and of these, 21 full texts could not be retrieved. After reading 88 studies in full, 27 were excluded for not addressing nursing, 23 for not covering the context of spaceflight – restricting themselves to commercial flights, civil aviation, or medical practice without mentioning nurses – and seven for not addressing knowledge, skills, and attitudes.

Additionally, a search for other strategies was conducted, resulting in the identification of 640 studies. Of these, 82 were selected for analysis, of which 47 were not retrieved. Thus, 35 studies were assessed in full: seven were excluded for not addressing the population; 18 were excluded for not addressing the concept; and ten were excluded for referring to the context of air ambulance transport and rescue flights in helicopters and airplanes. In the end, 31 studies were included for analysis (Flowchart 1).

Through chronological analysis it was identified that the first records date from 1967[13-14], with studies spaced out until 1990[15-18]. The years 1991 and 2024[6,19-42] stood out for concentrating two to three articles each, while subsequent years reveal a gradual growth in academic interest.Most studies are descriptive, theoretical or reflective in nature[6,13-42], with studies involving direct empirical application being scarce, due to the fact that these are still more complex flights with higher costs (Table 2).

Concerning geographical origin, 25 studies were conducted in the United States[13-23,25-36,40], highlighting the country's tradition and leading role in manned space missions. Only from 1992[34-35] onwards was there an emergence of research from Canada[24], Australia[37], India[38-39], China[41], the United Kingdom[42], and Peru[6], pointing to an initial process of internationalization of scientific production.English[6,13-42] was predominant in all studies.



Flowchart 1 –Study selection

Table 2 –Selected studies

Study (P)	Year	Country of origin	Journal	Language
S1[13]	1967	United States of America	AORN Journal	English
S2[14]	1967	United States of America	American Association of Industrial Nurses Journal	English
S3[15]	1968	United States of America	American Association of Industrial Nurses Journal	English
S4[16]	1980	United States of America	Occupational Health Nursing	English
S5[17]	1989	United States of America	Journalof Professional Nursing	English
S6[18]	1989	United States of America	Orthopaedic Nursing	English
S7[19]	1990	United States of America	Journal of Obstetric, Gynecologic, & Neonatal Nursing	English
S8[20]	1991	United States of America	Journal AAON	English
S9[21]	1991	United States of America	Nursing Management	English
S10[22]	1992	United States of America	Holistic Nursing Practice	English
S11[23]	1992	United States of America	Nursing Science Quarterly	English
S12[24]	1992	Canada	Nursing Science Quarterly	English
S13[25]	1993	United States of America	Visions	English
S14[26]	1993	United States of America	Visions	English
S15[27]	1998	United States of America	Journal of Emergency Nursing	English
S16[28]	1999	United States of America	The Journal of Rogerian Nursing Science	English
S17[29]	2000	United States of America	AORN Journal	English
S18[30]	2000	United States of America	The American Journal of Nursing	English
S19[31]	2003	United States of America	Reflections on Nursing Leadership	English
S20[32]	2003	United States of America	Journal of Pharmacy Practice	English
S21[33]	2004	United States of America	Journal for Specialists in Pediatric Nursing	English
S22[34]	2004	United States of America	The American Nurse	English
S23[35]	2009	United States of America	Journal of Trauma Management & Outcomes	English
S24[36]	2015	United States of America	American Journal of Critical Care	English
S25[37]	2017	Australia	Frontiers in Physiology	English
S26[38]	2018	India	International Journal of Current Advanced Research	English
S27[39]	2020	India	Narayana Nursing Journal	English
S28[40]	2022	United States of America	Journal of Clinical Nursing	English
S29[41]	2022	China	Open Astronomy	English
S30[42]	2024	United Kingdom	International Journal of Mental Health Nursing	English
S31[6]	2024	Peru	The Open Nursing Journal	English

Thematic analysis allowed for the categorization of nursing knowledge, skills, and attitudes into three main phases:

- Pre-flight (preparation in a gravity environment – Earth):clinical screening[6,13-22,24-26,28-30,32-34,37-42]; physical [6,13-21,24-26,28-30,32-35,37-41], psycho-emotional, behavioral[16-22,24-25,27,29-30,32,34,38-42],and spiritualpreparation[34]; training for self-care and emergency management[13-15,17-21,24,28-31,33,35,38-42]; realistic simulations[14,24,26,31,33,36]; assessment of functional health standards and physiological tests[6,13-22,24-26,28-41]; assessment of aircraft environment safety[6,15,26]; equipment check[6,15,26,35]; development of health protocols and algorithms[16-17,19,28-29,32,35,38]; development of care technologies[13,19,23,25-26,29,31-32,35,40,42].

- During flight (transition to a microgravity environment):adaptation of techniques and care(6,13-14,16-17,19-30,32-35,37-41); continuous monitoring of functional health patterns(6,13-35,37-40,42); promotion of physical and psycho-emotional adaptation(6,13-29-30,32,34,37,39-41); implementation of safety and ergonomics protocols(13-14,18-20,26,28-33,38-40,42); telenursing and remote counseling(13,24,42); maintenance of the integrity of human and environmental fiel ds(6,15,18-19,22-23,25,29,34); promotion of relaxation techniques and energy interaction(6,22-24,25,34); support for family members(18,21,31-32).
- Post-flight (transition to a gravity environment): assessment of the effects of gravity(6,13-22,24-25,27-35,37-42); promotion of readaptation of bodily cycles(6,13-22,24-26,28-29,30-32,34-35,37-42); promotion of readaptation to physical and social environments(6,14-22,24-26,28-29,30-32,34-35,37-42); neuropsychological support(6,13-14,16-19,21-22,24-25,29-30,32,34,38-42); discussion of lessons learned from space missions(13-15,17,19,22-23,26-28,30-31,36,38); research and development of health policies and technologies(13-15,17,19,22-23,26-29,30-31,34,36,40); promotion of individuals' reintegration into the terrestrial environment(6,13,15-26,28-29,31-32,34,36-42); ethical and compassionate care(13-22,24-35,37-42).

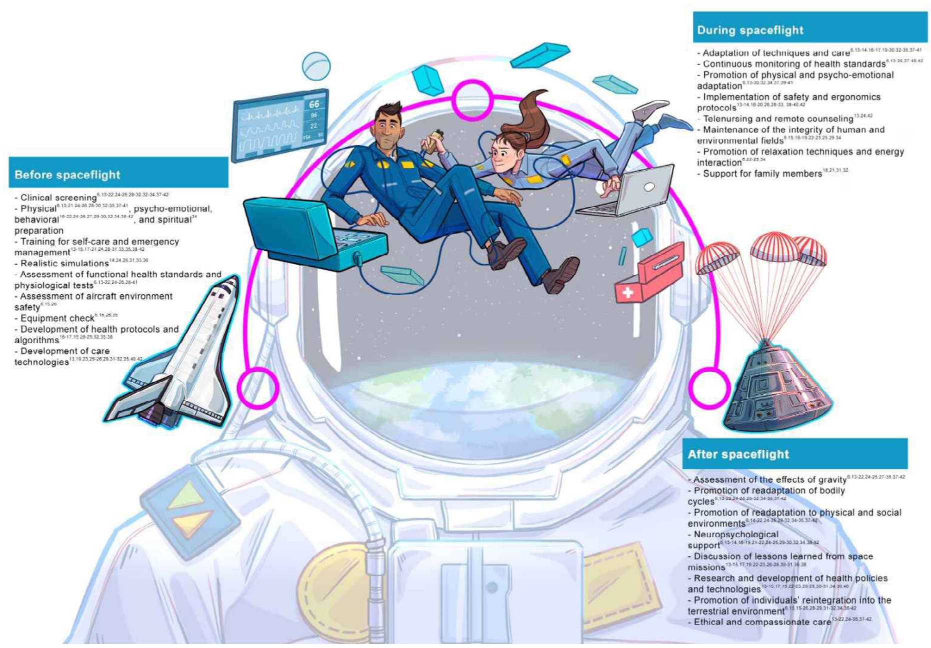


Figure 1 –Summary of the mapped results by stage: pre-flight, during flight, and post-flight

The knowledge, skills, and attitudes mapped are inherent to different types of aircraft, capsules, and in the context of orbital stations, deep space missions, and other extraterrestrial scenarios.

DISCUSSION

This scoping review mapped nursing knowledge, skills, and attitudes in the context of spaceflight from 31 studies distributed over almost six decades. Chronological analysis of included studies, with initial records in 1967, scattered studies until 1990, and gradual growth from the 2000s onwards, indicates that the scientific systematization of space nursing competencies remains incipient[6,13-43]. It became evident that in space nursing, conceptual reflection has preceded practical validity, which is consistent with the still restricted nature of human access to the microgravity environment, thus limiting the consolidation of the mapped competencies and supporting the need for further studies on the phenomenon.

The predominance of theoretical, descriptive, or reflective studies among the included studies reinforces that the findings of this review should be analyzed as guiding hypotheses for new studies, and not as validated operational evidence.

The concentration of 24 out of 31 studies in the United States highlights the country's historical prominence in manned space missions and institutional investment in healthcare professionals, including nursing, in agencies such as the National Aeronautics and Space Administration (NASA)[13-23,25-36,40]. However, this geographic concentration constitutes a significant limitation, as the competency models and descriptive protocols disseminated in studies may reflect organizational, training, and regulatory contexts specific to the North American system, limiting their direct transferability to other settings. The recent emergence of studies from countries such as Canada[24], Australia[37], China[41], India[38-39], the United Kingdom[42] and Peru[6] suggests an initial process of internationalization of the subject matter, although insufficient to ensure epistemological and cultural diversity in the evidence mapped.

In the pre-flight phase, the mapped studies point to a set of nurse knowledge, skills, and attitudes focused on astronauts' physical and emotional preparation for adaptation to the microgravity environment. In the field of knowledge, key areas include aerospace physiology, the fundamentals of life support, and protocols for assessing functional health patterns[6,13-22,24-26,28-41], necessary to support comprehensive clinical screening and identification of conditions that may compromise adaptation to the space mission[6,13-22,24-26,28-30,32-34,37-42]. Converging with the fundamentals of nursing in occupational health and critical care, the studies emphasize that advanced clinical reasoning is the structuring knowledge of this phase[6,13-43].

In terms of skills, it was identified that performing realistic simulations[14,24,26,31,33,36], emergency management training[13-15,17-21,24,28-31,33,35,38-42], equipment verification and aircraft safety assessment[6,15,26,35], and the development of care protocols and technologies[13,16-17,19,23,25-26,28-29,31-32,35,38,40,42]. These skills are not matched by traditional undergraduate nursing curricula, highlighting the need for specialized training. In terms of attitudes, a significant portion of the studies highlights astronauts' psycho-emotional and behavioral preparation as nurses' responsibility[16-22,24-25,27,29-30,32,34,38-42], including in a study the spiritual dimension of care[34]. This finding is relevant because it reaffirms that, even in contexts of high technological density, person-centered care in its physical, emotional, and existential dimensions remains the structuring core of nursing practice, diverging from approaches strictly supported by the biomedical model that tend to predominate in the aerospace health literature.

Human adaptation to microgravity is fundamental to ensuring that crew members maintain their physiological, emotional, and functional balance throughout the mission. In this highly hostile environment, nurses not only act in emergency situations but also play a continuous role in the ongoing and comprehensive care of astronauts[13,20,48].

During the astronauts' stay in space, the knowledge, skills, and attitudes mapped focus on adapting techniques and care to microgravity conditions and on the continuous improvement of the crew's functional health patterns[6,13-35,37-40,42]. Once again, knowledge of aerospace physiology emerges as a fundamental basis, now linked to the early identification of microgravity-induced changes and the implementation of preventive measures, which positions nurses as a leading figure of proactive clinical surveillance on board. This profile of action aligns with contemporary models of Advanced Nursing and diverges from the traditional hospital model, in which the response to acute events tends to predominate over the anticipation of risks[6,20].

In terms of skills, the implementation of safety and ergonomics protocols[13-14,18-20,26,28-33,38-40,42],the telenursing and remote counseling[13,24,42], and the promotion of relaxation techniques and energy interaction stand out[6,22-25,34]. This last aspect, present in studies guided by the Science of Unitary Human Beings developed by Martha Rogers[23,28], points to a holistic perspective of care that broadens the scope of spatial nursing beyond conventional clinical interventions[22-23,25,34]. In terms of attitudes, the promotion of crew members' physical and psycho-emotional adaptation[6,13-19,30,32,34,37,39-41]and support for family members[18,21,31-32] emerge as nurses' responsibilities, highlighting that care is understood in a broader sense, encompassing not only the individual on board, but also their relational context. The absence of documented records of cardiorespiratory arrest in real missions, mentioned in two studies[49-50], this limits the validity of emergency strategies described in the literature, reinforcing the need for studies using high-fidelity simulators.

In the post-flight period, the mapped knowledge, skills, and attitudes are geared towards assessing the effects of gravity, promoting the readaptation of bodily cycles, and reintegrating the individual into the terrestrial environment[6,13-22,24-26,28-35,37-42]. Collaborative work with multidisciplinary teams is highlighted as a condition for the effectiveness of the physical rehabilitation process, converging with the principles of person-centered care and interprofessional collaborative practice[19,29]. The presence of neuropsychological support as one of the most widely referenced competencies in this phase[6,13-14,16-19,21-22,24-25,29-30,32,34,38-42] points to a dimension frequently underestimated in the aerospace health literature: post-mission readjustment is not only physiological, and the psychosocial challenges of returning to the terrestrial environment demand from nurses qualified listening skills and attitudes of ethical and compassionate care[13-22,24-35,37-42]. Additionally, the discussion of lessons learned from missions and participation in research and the development of health policies and technologies[13-15,17,19,22-23,26-31,34,36,40] emerge as attributes that position nurses not only as an executor of care, but as an active agent in the construction of knowledge in space nursing.

The findings of this review have direct implications for professional training and curriculum development in nursing. The set of knowledge, skills, and attitudes identified in the three phases of the mission reveals a competency profile that does not correspond to traditional undergraduate curricula, ranging from aerospace physiology and microgravity emergency management to telenursing, mental health in isolated and confined environments, and ethics in autonomous decision-making in the space context. The scarcity of specific training programs and standardized instruments for assessing these competencies, identified in only a small number of studies[17,29,34,40], represents a significant gap. The development of specialized curricula should be guided by the mapped competencies and refined after empirical validity studies of these competencies. To this end, international collaboration between space agencies, training institutions, and professional nursing organizations is necessary to overcome current gaps and limitations in knowledge of space nursing.

This study has limitations, including the predominance of studies from a single country, which restricts the generalization of the mapped competencies to other countries and cultural contexts. The predominantly theoretical and reflective nature of the studies implies that the described competencies lack empirical validity in real operational contexts or clinically representative simulations. The lack of standardization in assessment tools for spatial nursing competencies hinders comparisons between studies and the development of evidence-based curricula. These limitations do not invalidate the findings, but reinforce the exploratory nature of this review and the need for future investigations with experimental and observational designs and greater geographical and cultural diversity.

CONCLUSIONS

This scoping review allowed for an exploratory mapping of nursing knowledge, skills, and attitudes in the context of spaceflight, based on 31 studies produced between 1967 and 2024, organized into three time periods: pre-flight preparation; care during the mission; and readaptation after return. The results suggest that: the competencies required of nurses articulate advanced knowledge of aerospace physiology, life support, and emergency management in microgravity; technical skills are adapted to this environment, such as realistic simulations, telenursing, and protocol development; attitudes of proactive vigilance, decisional autonomy, psychosocial sensitivity, and ethical and compassionate care constitute a professional profile that transcends conventional clinical practices and approaches advanced practice nursing models. Structuring these competencies by mission phase can guide the development of specialized training programs and specific assessment instruments for aerospace nursing, addressing an identified gap.

The mapped competencies should be understood as guiding hypotheses for future research, and not as consolidated evidence, given the predominantly theoretical nature of the included studies and the geographical concentration of available evidence. Future studies should prioritize experimental and observational designs and high-fidelity simulators, case studies in real missions, and investigations with greater geographical and cultural diversity. The construction of a validated competency framework, developed in collaboration between space agencies, training institutions, and professional nursing organizations, constitutes a priority agenda for the consolidation of space nursing as a recognized scientific and clinical specialty.

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