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Telemedicine training in undergraduate medical education: An exploratory systematic review.

Formación en telemedicina en la educación médica de pregrado: Una revisión sistemática exploratoria.

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Summary

Introduction: Telemedicine has become a key tool in healthcare systems in the post-COVID-19 pandemic, generating a need to incorporate specific competencies into undergraduate medical training. However, its curricular integration is heterogeneous and lacks comprehensive frameworks. **Objective:** To map the literature published between 2021 and 2026 on telemedicine training for undergraduate medical students, identifying types of educational interventions, competencies addressed, evaluation methods, trends, and knowledge gaps. **Methods:** An exploratory systematic review was conducted following the methodological framework of Arksey and O'Malley, the recommendations of Levac et al., and the guidelines of the Joanna Briggs Institute, reported according to PRISMA-ScR. A systematic search was conducted in PubMed, Scopus, Web of Science, and LILACS for the period January 2021–January 2026. Empirical and non-empirical studies related to telemedicine training in undergraduate medical education were included. Selection was performed by independent reviewers. Data were extracted using a data extraction matrix and synthesized descriptively and thematically. **Results:** Thirty-five studies were included. The evidence shows heterogeneous curricular integration globally, with a predominance of studies from high-income countries. Educational interventions are mainly structured in hybrid models that combine asynchronous learning, clinical simulation (including tele-OSCE), and supervised practice. The most frequently addressed competencies are virtual clinical communication and digital technical skills, while domains such as digital professionalism and data security are underrepresented. Assessment methods are predominantly based on perception surveys and self-confidence measures, with limited use of objective assessments. Significant gaps were identified, including a lack of curriculum standardization, a scarcity of longitudinal studies, and the absence of uniform competency frameworks. **Conclusions:** Telemedicine training at the undergraduate medical level is a growing field with high variability in its implementation and evaluation. Progress is needed toward a more structured curriculum integration based on standardized competencies, with robust evaluation methods adapted to different contexts. Future research should focus on longitudinal designs and the objective evaluation of the impact on clinical performance.

Keywords: Telemedicine, Undergraduate Medical Education, Curriculum, Clinical Competencies, Scope Review.

Resumen

Introducción: La telemedicina se ha consolidado como una herramienta clave en los sistemas de salud posterior a la pandemia por COVID-19, generando la necesidad de incorporar competencias específicas en la formación médica de pregrado. Sin embargo, su integración curricular es heterogénea y carece de síntesis integradoras. **Objetivo:** Mapear la literatura publicada entre 2021 y 2026 sobre formación en telemedicina en estudiantes de medicina de pregrado, identificando tipos de intervenciones educativas, competencias abordadas, métodos de evaluación, tendencias y brechas de conocimiento. **Métodos:** Se realizó una revisión sistemática exploratoria siguiendo el marco metodológico de Arksey y O'Malley, las recomendaciones de Levac et al. y las directrices del Joanna Briggs Institute, reportada conforme a PRISMA-ScR. Se efectuó una búsqueda sistemática en PubMed, Scopus, Web of Science y LILACS para el período enero 2021–enero 2026. Se incluyeron estudios empíricos y no empíricos relacionados con formación en telemedicina en educación médica de pregrado. La selección se realizó por revisores independientes. Los datos fueron extraídos mediante una matriz de extracción de datos y sintetizados de forma descriptiva y temática. **Resultados:** Se incluyeron 35 estudios. La evidencia muestra una integración curricular heterogénea a nivel global, con predominio de estudios provenientes de países de altos ingresos. Las intervenciones educativas se estructuran principalmente en modelos híbridos que combinan aprendizaje asincrónico, simulación clínica (incluyendo tele-OSCE) y práctica supervisada. Las competencias más frecuentemente abordadas corresponden a la comunicación clínica virtual y habilidades técnicas digitales, mientras que dominios como profesionalismo digital y seguridad de datos están subrepresentados. Los métodos de evaluación se basan predominantemente en encuestas de percepción y medidas de autoconfianza, con limitada utilización de evaluaciones objetivas. Se identifican brechas relevantes, incluyendo falta de estandarización curricular, escasez de estudios longitudinales y ausencia de marcos de competencias uniformes. **Conclusiones:** La formación en telemedicina en pregrado médico es un campo en expansión, con alta variabilidad en su implementación y evaluación. Se requiere avanzar hacia una integración curricular más estructurada, basada en competencias estandarizadas, con métodos de evaluación robustos y adaptados a distintos contextos. Futuras investigaciones deberían enfocarse en diseños longitudinales y en la evaluación objetiva del impacto en el desempeño clínico.

Palabras clave: Telemedicina, Educación de Pregrado en Medicina, Currículum, Competencias clínicas, Revisión de Alcance.

1. Introduction

The digitization of healthcare systems has profoundly altered how healthcare services are delivered globally. Within this context, telemedicine has become a key tool for improving access, clinical follow-up, and the efficiency of healthcare systems. However, it wasn't until the global health emergency caused by COVID-19 that the development of new ways to bring healthcare closer to the population was spurred (1-2). The World Health Organization has recognized telemedicine as a strategic component for strengthening healthcare systems and advancing towards universal coverage, bringing specialists to areas with shortages and expanding healthcare coverage to geographically inaccessible areas (1). This transformation process has not only impacted the organization of services but has also driven a redefinition of the competencies required for medical practice, making the development of skills in remote clinical care essential for future physicians.

For the purposes of this study, telemedicine will be understood as remote clinical care, whether synchronous or asynchronous, including virtual consultations, teleconsultations,

telemonitoring, and remote diagnostic support (1). Telemedicine training will be defined as any curricular activity aimed at developing competencies for technology-mediated clinical practice. Undergraduate medical education will refer exclusively to training leading to the professional title of physician, including clinical rotations and internship, and excluding specialization programs.

Practicing telemedicine effectively requires communication skills in adapted virtual environments, such as understanding the ethical and legal aspects of remote care, securely managing clinical data, and adapting clinical reasoning to the digital environment, among others. The literature has documented numerous initiatives to incorporate telemedicine into medical school curricula, particularly following the educational curriculum reorganization prompted by the COVID-19 pandemic. Reports on curriculum implementation, student perception assessments, and proposals for integrating digital competencies into clinical subjects have been published (3-4).

Despite this proliferation of publications, the available evidence on telemedicine education is characterized by marked heterogeneity in intervention designs, implementation contexts, and reported outcomes, hindering comparisons between studies and the synthesis of their findings, particularly regarding their long-term impact (5, 6). In this context, the literature describes wide variability in the digital health competencies addressed in medical training, as well as in the approaches used for their teaching and assessment, which differ substantially between programs and, in many cases, are not standardized (7). Furthermore, the curricular integration of telemedicine has been reported as variable and dependent on institutional and contextual factors, without a comprehensive characterization that allows for consistent distinctions between training strategies such as theoretical modules, clinical experiences, or virtual simulation activities (3-4).

Given the breadth of the field, the heterogeneity of educational interventions, and the lack of comprehensive syntheses, an exploratory systematic review approach is appropriate for mapping the available evidence and characterizing the current state of knowledge. In response to this need, a scoping review was conducted to map and characterize the literature published between 2021 and 2026 (considering the significant increase in publications following the COVID-19 pandemic) on telemedicine training for undergraduate medical students, as well as to identify trends, gaps, and opportunities for future curriculum development. To ensure the coherence of the analysis, the competency dimensions assessed (communication, technical, ethical, and clinical) are directly aligned with the operational definitions of synchronous and asynchronous telemedicine described previously, allowing for a systematic mapping that links the intervention modality with the developed pedagogical domain.

The overall objective was to map the literature published between 2021 and 2026 on telemedicine training for undergraduate medical students and to identify trends, gaps, and opportunities for curriculum development. Our specific objectives were to:

1. Identify and describe the general characteristics of the included studies: year of publication, country or region, type of institution, methodological design, sample size.
2. Characterize the types of educational interventions in telemedicine implemented: modality (synchronous, asynchronous, hybrid), type of activity (formal course, module, simulation, virtual clinical practice, tele-OSCE, etc.).
3. Identify the telemedicine competencies addressed in the training programs: virtual clinical communication, ethical-legal aspects, data security, digital technical skills, clinical reasoning in a remote environment, digital professionalism.
4. Describe the assessment methods used to evaluate learning: perception surveys, practical assessments, virtual OSCE, clinical performance assessments, validated or non-validated instruments.

5. Analyze the gaps and underexplored areas in the literature: underrepresented regions, lack of curriculum standardization, absence of theoretical frameworks, scarce longitudinal evaluation.
6. Synthesize emerging trends in post-pandemic curriculum integration: permanent structural changes, pedagogical innovations, regulatory adaptations.

2. Methods

2.1 Study design

The review was conducted following the methodological framework proposed by Arksey H and O'Malley L (2005), incorporating the subsequent methodological recommendations of Levac D et al. (9) and the Joanna Briggs Institute guidelines. This review report was prepared according to the PRISMA Extension for Scoping Reviews (PRISMA-ScR) (10). The protocol for this exploratory review was registered in the Open Science Framework (OSF) (https://osf.io/e8ngj). The initial search strategy was high sensitivity, aiming to capture as much relevant literature as possible in an emerging and heterogeneous field such as telemedicine training. Since many studies do not clearly distinguish between levels of training (undergraduate vs. postgraduate) in their indexing or abstract terms, terms related to broader clinical training, such as "Internship and Residency" and "residents," were included. The specificity regarding the selected population (in this case, undergraduate students) was subsequently refined manually during the study selection process, through the application of predefined inclusion and exclusion criteria. With these considerations, the review was structured using the PCC (Population–Concept–Context) framework, where:

- Population: Undergraduate medical students (preclinical, clinical and internship cycles).
- Concept: Training in clinical telemedicine.
- Context: Formal university medical education programs.

The question that guided the review was: How has telemedicine training been integrated into undergraduate medical students between 2021 and 2026, what skills and educational interventions have been reported, how have they been evaluated, and what gaps persist?

2.2 Eligibility criteria

Empirical and non-empirical sources of evidence relevant to telemedicine training in undergraduate medical education were included. Empirical sources included quantitative, qualitative, and mixed-methods studies that reported data derived from the implementation or evaluation of educational interventions. Non-empirical sources included literature reviews, perspective articles, document analyses, Delphi studies, educational guides, and curriculum development reports, when they provided relevant information on the design, implementation, or conceptualization of telemedicine training. The data were synthesized using a categorical approach that considered the type of source, the level of evidence reported, and the competencies addressed. Studies addressing general components of digital health—such as artificial intelligence, data analysis, electronic health records, or digital literacy—were excluded unless explicitly linked to teaching remote clinical practice in telemedicine.

2.3 Inclusion criteria

Studies were included that:

- would involve undergraduate medical students, considering all years of university training,
- involved postgraduate medical students provided they explicitly included undergraduate students or differentiated outcomes for this group,
- Describe interventions, strategies, or training experiences related to clinical telemedicine, understood as remote medical care using digital technologies.

- They will address the design, implementation, or evaluation of programs aimed at developing the skills necessary for remote clinical practice.
- were described in undergraduate medical education programs in any country,
- would have been published between January 2021 and January 2026,
- were available in full text,
- were published in English or Spanish,
- These should correspond to primary quantitative, qualitative or mixed studies, including descriptive, perspective, peer-reviewed curriculum implementation studies, book chapters and literature reviews.

The publication period was specifically selected to capture the curricular reorganization that occurred after the start of the COVID-19 pandemic, given the need to consolidate telemedicine in medical training.

2.4 Exclusion criteria

Studies were excluded that:

- They will focus exclusively on postgraduate training, medical residency, or continuing medical education, excluding undergraduate students.
- included only other health professions without the participation of undergraduate medical students,
- They will address digital health components (e.g., artificial intelligence, electronic health records, or data analytics) without an explicit component of training in remote clinical care,
- They will exclusively evaluate the clinical implementation of telemedicine without an educational component,
- These correspond to editorials, letters to the editor, commentaries, narrative reviews, protocols without results, or conference abstracts without full text available,
- lack verifiable bibliographic identification (e.g., absence of a DOI or other permanent identifier), which prevents their proper traceability and retrieval, and whose full text could not be obtained after making reasonable attempts to access it through institutional databases, academic repositories, or others.

2.5 Information sources and search strategy

A systematic search was conducted in the electronic databases PubMed/MEDLINE, Scopus, Web of Science, and LILACS. The search strategy combined terms related to “telemedicine,” “telehealth,” “medical education,” “undergraduate medical students,” and equivalent terms in Spanish, using Boolean operators (AND/OR) and adapting to the specifics of each database. Both controlled terms (e.g., MeSH) and free-text keywords were used. The search was performed on January 26, 2026, limiting the results to publications between January 2021 and January 2026.

The formula “("Telemedicine"[MeSH] OR telemedicine OR telehealth OR "virtual care") AND ("Education, Medical"[MeSH] OR "Medical Students"[MeSH] OR "Internship and Residency"[MeSH] OR "medical education" OR "medical students" OR residents) AND (education OR training OR teaching OR curriculum OR competence*) was used, obtaining 1873 results. The complete strategy for each database is presented in the material supplementary.

2.6 Study selection process

The identified records were exported to the Rayyan bibliographic manager for duplicate removal. Subsequently, four independent reviewers conducted the selection process in two stages: (1) review of titles and abstracts and (2) evaluation of the full text of potentially eligible studies. Discrepancies were resolved through discussion and consensus. In total, 4,849 records were identified in the databases (disclosed in Figure 1), of which 1,755 were removed due to duplication,

leaving 3,094 records for the screening phase. After evaluating titles and abstracts, 2,997 records were excluded, and 52 studies were selected for full-text review. Of these, 4 could not be retrieved because the full text was not available. Of the remaining 48, 14 were excluded for not meeting the inclusion criteria, mainly because they included ineligible populations (e.g., students from other health science disciplines) or because they did not address interventions related to clinical telemedicine. Finally, 34 studies were included in the review. The selection process is presented in Figure 1 using a flowchart according to PRISMA-ScR.

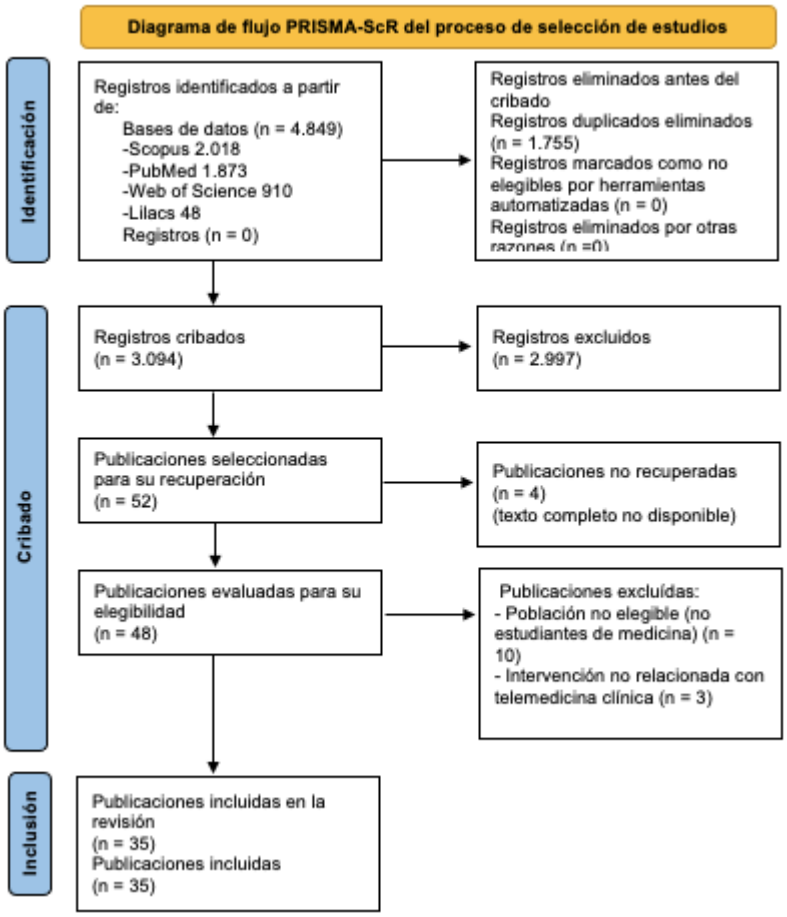

Figura 1. PRIMSA-ScR flowchart.

2.7 Data Extraction

A data extraction matrix, previously piloted in a subset of studies, was developed to ensure consistency and clarity in data collection. Extraction was performed by one reviewer and verified by a second. Digital tools (Notebook LM, Google) were used only for preliminary data organization, with the researchers maintaining methodological control and final categorization. The collected data is included in Table 2 at the end of this document due to its length. The data were descriptively summarized using summary tables and a structured narrative synthesis. A thematic categorization was performed on the types of training interventions, competencies developed, and reported assessment methods.

In accordance with the PRISMA-ScR guidelines for exploratory reviews, no formal assessment of the methodological quality or risk of bias of the included studies was conducted. This approach allows for a comprehensive mapping of the field's heterogeneity; however, it is recognized as a fundamental limitation for establishing causal relationships regarding the effectiveness of the

reported interventions. Therefore, the results presented should be interpreted as a descriptive synthesis of the current state of teaching practice and not as evidence of pedagogical effectiveness.

2.8 Ethical considerations

Since it was a review of published literature, approval by an ethics committee was not required.

3. Results

In order to maintain conceptual consistency with the operational definition of telemedicine used in this review —understood as remote clinical practice mediated by technology—, the included studies were also organized into three different analytical categories according to their level of proximity to the phenomenon of interest:

a) Direct educational interventions in clinical telemedicine, corresponding to studies that describe or evaluate training activities explicitly focused on remote clinical care;
b) Studies of curricular context and training needs, which address the integration of telemedicine within broader frameworks of medical education or digital health;
c) Competency frameworks and conceptual proposals, including theoretical models, international consensus, or reviews aimed at defining relevant competencies for digital clinical practice.

This distinction allowed the preservation of the characteristic breadth of an exploratory systematic review, while avoiding the overinterpretation of heterogeneous evidence as if it were directly comparable.

3.1 Curriculum mapping: General characteristics of the studies

The evidence presented in this section mainly corresponds to curricular context studies, which allow us to understand the structural conditions in which telemedicine training is embedded.

The integration of telemedicine into medical curricula shows significant heterogeneity worldwide. Retrospective analyses in the United States reveal that the availability of telemedicine courses increased from 41% to 60% between 2013 and 2018, although this growth was concentrated in the early years of the period due to the difficulty of incorporating new content into already saturated curricula (11). National surveys indicate that, by the end of 2019, only 56.3% of US medical schools had a formal telehealth curriculum, identifying the main barriers as a lack of curricular time, a shortage of expert faculty, and the rapid evolution of technologies (12).

This heterogeneity is accentuated when considering different geographical contexts; for example, a documentary analysis in Saudi Arabia revealed that only 16.7% of medical schools offer courses dedicated to medical informatics or digital health, highlighting the urgent need for reforms that align medical education with national digital transformation goals (13). In response to this deficiency, models have been reported that seek to mitigate these gaps through interdisciplinary teaching projects between medical informatics and clinical medicine departments, allowing for a more formal and robust integration of digital competencies into the undergraduate curriculum (14). To address these challenges, the proposal to integrate digital competencies through Community-Engaged Medical Education (CEME) models has also emerged. These models aim to close this gap by linking academic training with the real-world challenges of vulnerable populations, grounding the situation in reality and promoting social responsibility and technological equity from the undergraduate level (15).

This heterogeneity is accentuated when considering that some of the evidence comes from studies of digital health in a broader sense, which do not focus exclusively on clinical telemedicine but provide relevant information about the educational context. For example, documentary

analyses such as that of Alhur (2024) reveal gaps in the integration of digital content into medical curricula, while proposals such as the CEME model described by Punzalan (2025) place telemedicine within a broader ecosystem of digital competencies oriented towards equity and social responsibility.

3.2 Student Perception

The findings in this section are primarily derived from empirical studies of educational interventions and evaluations of training programs. Carney et al. note that up to 81% of students do not receive formal instruction in telemedicine during their preclinical years, resulting in a large proportion of students feeling unprepared to conduct virtual consultations independently (16). Consequently, students express a positive attitude toward integrating telemedicine into the curriculum, with 74% identifying the need for early training to improve access to healthcare and reduce burnout (17-18). Regarding pedagogical preferences, students prefer e-learning due to its flexibility, although this flexibility diminishes in the final clinical years if it is not directly integrated with hospital practice (19). After completing these educational interventions, students report moderate to high levels of self-confidence, reinforcing the perception that these tools are essential for their future professional practice (20-21). Additionally, it has been shown that the active participation of medical students in the provision of telemedicine services not only fosters the acquisition of theoretical knowledge but also the development of specific skills such as virtual empathy and the technical operation of remote diagnostic equipment (22). Recent systematic reviews confirm a positive association between formal training and improvements in remote consultation skills—referred to as "webside manner"—which translates into a significant increase in student self-confidence in managing virtual encounters (23). Furthermore, the use of innovative technological applications that integrate automatic detection and feedback of nonverbal communication has been validated as a feasible strategy for increasing self-awareness and the quality of doctor-patient interaction in digital environments (24).

3.3 Types of educational interventions and skills taught

To structure the heterogeneity of the reported competencies, an analytical categorization was performed based on the domains previously defined in the review objectives. The competencies identified in the included studies were grouped into six main categories: (1) virtual clinical communication, (2) ethical and legal aspects, (3) data security and management, (4) digital technical skills, (5) clinical reasoning in remote environments, and (6) digital professionalism. This taxonomy allowed for the systematic mapping of the frequency, teaching methods, and assessment methods associated with each domain.

As shown in Table 1, the most frequently addressed competencies are virtual clinical communication and digital technical skills, particularly in interventions based on clinical simulation, tele-OSCE, and asynchronous modules. Conversely, domains such as digital professionalism and data security appear less systematically integrated and, in many cases, are not explicitly assessed. This pattern suggests a prioritization of operational and observable competencies in the design of educational interventions, in contrast to more complex or contextual domains that remain underrepresented.

Telemedicine training is predominantly structured around hybrid and progressive models. In the theoretical phase, asynchronous strategies are used to enable autonomous learning; for example, Frankl et al. reported an increase in knowledge from 15.1% to 84.3% using a curriculum based on Bloom's Taxonomy (30). Similarly, Cheok Liew et al. taught using microlearning (short video lessons), which increased self-efficacy for conducting virtual consultations by 95.9% (29). Vogt et al., for their part, used the Moodle digital platform, obtaining significant improvements in students' confidence in conducting medical histories and handovers (28). Subsequently, in applied phases, high-fidelity simulated environments are used. Abrams et al. reported that a progressive

curriculum with standardized patients adequately prepared more than 95% of students (25). Costich et al. They apply the flipped classroom model, where face-to-face time is dedicated to synchronous workshops to guide assisted physical examinations (37). In challenging subjects, Rivet et al. demonstrated that deliberate practice (repeating simulations after receiving feedback) significantly improves virtual communication skills (26). New methodologies seek to refine individual skills and democratize access to practice. Greengold et al. highlight the value of individualized coaching (one-on-one sessions), which improves self-efficacy and video presence more effectively than standard methods (27). Cheema & Awan introduce "virtual teleshadowing," allowing thousands of students to observe real or simulated interactions, eliminating geographical barriers and optimizing learning time (38).

Table 1. Classification of competencies in telemedicine training at the undergraduate level (2021–2026).

Domain of competence	Frequency in literature	Type of intervention where it appears	Reported evaluation methods	Examples of studies
Virtual clinical communication	High	Simulation with standardized patients, tele-OSCE, coaching, supervised clinical practice	Performance rubrics, OSCE, self-confidence surveys, observer assessment	Abrams et al. (2021); Rivet et al. (2023); Newnham et al. (2025); Greengold et al. (2024)
Digital technical skills	High	E-learning, asynchronous modules, microlearning, virtual simulation	Checklists, pre/post surveys, knowledge assessments	Vogt et al. (2022); Cheok Liew et al. (2023); Frankl et al. (2021)
Clinical reasoning in a remote environment	Moderate	Clinical simulation, tele-OSCE, supervised practice	Clinical performance assessment, structured rubrics	Bajra et al. (2023b); Abrams et al. (2021)
Ethical and legal aspects	Moderate	Theoretical modules, integration into formal curricula	Perception surveys, theoretical evaluation (poorly standardized)	Adams & Ecker (2021); Noronha et al. (2022); Anawati (2022)
Data security and handling	Low	Theoretical content within telehealth curricula	Scarcely evaluated in a specific way	Noronha et al. (2022); Car et al. (2025)
Digital professionalism	Low	Implicit integration in clinical activities or conceptual frameworks	Generally not explicitly evaluated	Muntz et al. (2021); Punzalan (2025); Car et al. (2025)

3.4 Barriers and challenges

Despite progress, the literature reports a persistent deficit in the standardization of telemedicine training, with high variability in the depth, duration, and formalization of educational interventions (5). Key challenges include technical limitations, the need for greater clinical supervision in virtual environments, and the absence of uniform competency frameworks to guide curriculum development and ensure the sustainability of teaching (5, 22).

3.5 Emerging trends: Creation of national and international standards that guide curricula.

In the area of conceptual frameworks and competency proposals, the consolidation of global standards has become a central element for the development of telemedicine training (39). The international DECODE framework represents one of the most relevant efforts in this area, where, through a Delphi consensus among experts, competencies and learning outcomes were defined, ranging from digital clinical care to ethical, technological, and data management aspects (35). This need to establish robust regulatory frameworks is important given the responsibility of medical schools to ensure that their graduates meet safe and effective virtual care standards (34).

Institutions such as the Association of American Medical Colleges (AAMC) and the Accreditation Council for Graduate Medical Education (ACGME) have promoted the longitudinal integration of telehealth competencies, prioritizing virtual communication, ethical data collection, and patient safety (40, 33). In this regard, the implementation of national standards and structured programs has proven to be an effective strategy for improving competency acquisition (41). However, the literature suggests that these frameworks should be adapted to local contexts to ensure their applicability, considering the particularities of each health system (42).

Finally, a transition is observed from reactive, pandemic-driven approaches to more structured models that integrate telemedicine as a permanent component of the medical curriculum, including real clinical experiences, the adaptation of structured clinical examinations to virtual formats (tele-OSCE), and the use of competency-based rubrics, ensuring that training meets institutional accreditation requirements and AAMC competency standards (32, 36, 43, 44).

4. Discussion

This exploratory systematic review systematically mapped the literature published between 2021 and 2026 on telemedicine training for undergraduate medical students, revealing a rapid evolution in the field from emerging strategies driven by the COVID-19 pandemic to more structured curricular consolidation efforts. In line with international reports, the analyzed results suggest that telemedicine has positioned itself as a key competency within current medical training, aligned with the objectives of strengthening health systems and achieving universal coverage (1-2). According to the mapping, while there is a growing recognition of its relevance, the curricular integration of telemedicine is reported as highly heterogeneous globally. This variability has been described in the literature, which shows substantial differences in the depth, duration, and formalization of educational programs (5, 7). The reviewed publications report curricular overload, the limited availability of trained instructors, and rapid technological evolution as structural barriers that hinder its systematic implementation (12, 34).

The predominance of studies from high-income countries is noteworthy, which could reflect global inequalities in telemedicine training, as noted in recent reviews (13, 15). However, this requires further analysis, which is beyond the scope of this review. This disparity is treated in this study as a key methodological limitation, not merely a descriptive one, since it restricts the ability to extrapolate the observed patterns to contexts with structural barriers not directly analyzed in the mapped literature. Furthermore, the mapping reveals that current training focuses almost exclusively on synchronous teleconsultation, leaving emerging competencies (such as advanced data management) less explored in the literature.

Regarding pedagogical strategies, the mapped evidence suggests a trend toward hybrid educational models that combine asynchronous learning, clinical simulation, and supervised practice. This approach is consistent with new medical education strategies that promote active and progressive competency-based learning (3). In particular, the use of virtual simulations, tele-OSCE, and methodologies such as microlearning is frequently reported as a valuable strategy for acquiring

specific skills in controlled environments, which aligns with previous findings highlighting the value of simulation in learning complex clinical competencies (4). However, given the descriptive nature of this review, it is not possible to determine the comparative clinical or pedagogical effectiveness of these interventions over other traditional methods.

A key finding of this review is the persistent gap between self-perceived abilities and clinical performance in telemedicine. While multiple studies report high levels of student satisfaction and confidence, consistent difficulties are identified in areas such as remote physical examinations and empathetic communication in virtual environments. This phenomenon has also been associated with limitations inherent in training based primarily on self-assessments. In this regard, the heavy reliance on self-reported data in the included studies may introduce measurement biases, limiting the correspondence between students' perceptions and their actual clinical performance. Consequently, the literature suggests the need to incorporate more objective and standardized assessment tools (23). In this context, the development of *webside manner* emerges as a relevant component of telemedicine training, highlighting the importance of specific interventions aimed at strengthening communication skills in digital environments.

From a conceptual perspective, the review reveals a lack of uniformity in the definition and operationalization of telemedicine competencies, which hinders comparisons between studies and the development of coherent curricular frameworks. In response to this problem, international initiatives such as the DECODE framework have proposed structured, consensus-based sets of competencies, encompassing domains that include digital clinical care, ethics, data management, and emerging technologies (35). However, several authors agree that these frameworks must be adapted to local contexts to ensure their relevance and applicability, taking into account the specific characteristics of each healthcare system (34, 42).

Regarding knowledge gaps, this review identifies a scarcity of longitudinal studies evaluating the sustained impact of telemedicine training on professional performance and health outcomes. It also notes a limited representation of low- and middle-income contexts, as well as a lack of integration of explicit theoretical frameworks in the design of educational interventions. These limitations have been previously highlighted in the literature and represent priority areas for future research (13, 15).

From an implications standpoint, the findings suggest the need to move toward a more systematic curricular integration, based on clearly defined competencies, validated assessment methods, and a progressive articulation between theory and clinical practice. Likewise, it is necessary to strengthen teacher training in telemedicine and promote the development of educational policies that support its formal incorporation into undergraduate programs.

Finally, the results of this exploratory systematic review should be interpreted considering the inherent limitations of both the included studies and the methodological approach itself. As expected for this type of review, no quality-of-evidence assessment was performed, which limits the possibility of drawing conclusions about the effectiveness of the interventions. Nevertheless, this study provides a comprehensive overview of the current state of the field, identifying key trends, knowledge gaps, and opportunities for the future development of telemedicine medical education.

Limitations of the study

Despite the advances reported in the literature between 2021 and 2026, the evidence on the integration of telemedicine into the medical curriculum has limitations, highlighting a significant geographical bias towards institutions in high-income countries, which restricts the applicability of the findings in contexts with limited infrastructures or different regulatory frameworks.

Methodologically, the search strategy initially prioritized sensitivity over specificity, which may have increased the retrieval of irrelevant studies in the early stages, particularly those focused on postgraduate training. However, this approach is consistent with methodological recommendations for exploratory reviews and was offset by a rigorous selection process based on explicit criteria. Furthermore, there is a predominant reliance on self-reported data and students' subjective perceptions of confidence and knowledge, rather than on objective measures of clinical competence or direct patient care outcomes, which introduces a significant measurement bias when assessing complex clinical competencies.

Furthermore, the studies often lack control groups and long-term follow-up, frequently being limited to single-institution experiences with small samples and low response rates, which compromises representativeness and the ability to establish causal relationships. It is worth noting as an additional limitation that some studies lack specific sample size reporting and a detailed breakdown of the sample. Finally, the scope of the research is thematically narrow, focusing almost exclusively on synchronous teleconsultation and omitting other emerging digital skills, compounded by a linguistic bias that excludes literature not published in English or Spanish.

Regarding pedagogical strategies, the mapped evidence suggests a trend toward hybrid educational models that combine asynchronous learning, clinical simulation, and supervised practice. This approach is consistent with new medical education strategies that promote active and progressive competency-based learning (Darnton et al., 2020). In particular, the use of virtual simulations, tele-OSCE, and methodologies such as microlearning is frequently reported as a valuable strategy for acquiring specific skills in controlled environments, which aligns with previous findings highlighting the value of simulation in learning complex clinical competencies (Iancu et al., 2020). However, given the descriptive nature of this review, it is not possible to determine the comparative clinical or pedagogical effectiveness of these interventions over other traditional methods.

5. Conclusions

- This exploratory review maps the current state of telemedicine training for undergraduate medical students, revealing an expanding field, albeit one still heterogeneous in its approaches, content, and assessment strategies. The available literature shows a growing interest in integrating telemedicine into curricula, primarily through targeted educational interventions, with an emphasis on communication skills, technical competencies, and ethical and legal considerations.
- The evidence gathered is based primarily on self-reported measures and has limitations regarding the assessment of objective, long-term outcomes. The review highlights a higher concentration of studies in high-income countries, which presents an opportunity for future research. However, given the exploratory nature of this review and the lack of a focused analysis of geographical comparisons, these results should be interpreted descriptively, without allowing for conclusive inferences about the global distribution of evidence.
- Furthermore, significant gaps were identified in the standardization of competencies, the consistency of assessment methods, and the longitudinal integration of telemedicine within medical training. Linking these findings, identified in Table 1, to future needs, it is recommended that the implementation of frameworks such as DECODE or AAMC not be universal, but rather include an explicit warning about the need for significant adaptation to local regulations and curricular structures, especially in low-resource settings where technological infrastructure varies considerably.
- Taken together, these findings reinforce the need to move toward the development of more structured, contextualized training programs grounded in explicit conceptual frameworks, along with more robust assessment strategies that allow for the evaluation of both learning

and its transfer to clinical practice. Telemedicine education remains a developing field that requires strengthening its empirical foundation through more rigorous designs and longitudinal approaches, with a view to more consistent curricular integration in undergraduate medical education.

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6. References

1. World Health Organization. Geneva: WHO. *Global strategy on digital health 2020–2025.* **2021.**
2. Keesara S, Jonas A, Schulman K. Covid-19 and health care's digital revolution. *N Engl J Med.* **2020,** 382, e82. https://doi.org/10.1056/NEJMp2005835.
3. Darnton R, Lopez T, Anil M, et al. Medical students consulting from home: A qualitative evaluation of a tool to maintain student exposure to patients during lockdown. *MedTeach.* **2021,** 43, 160-167. https://doi.org/10.1080/0142159X.2020.1829576.
4. Iancu AM, Kemp MT, Alam HB. Unmuting medical students' education: Utilizing telemedicine during the COVID-19 pandemic and beyond. *J Med Internet Res.* **2020,** 22, e19667. https://doi.org/10.2196/19667.
5. Chike-Harris KE, Durham C, Logan A, Smith G, DuBose-Morris R. Integration of Telehealth Education into the Health Care Provider Curriculum: A Review. *Telemed JE Health.* **2021,** 27, 137-149. https://doi.org/10.1089/tmj.2019.0261.
6. Edirippulige S, Armfield NR. Education and training to support the use of clinical telehealth: A review of the literature. *J Telemed Telecare.* **2017,** 23, 273-282. https://doi.org/10.1177/1357633X16632968.
7. Waseh S, Dicker AP. Telemedicine training in undergraduate medical education: Mixed-methods review. *JMIR Med Educ.* **2019,** 5, e12515. https://doi.org/10.2196/12515.
8. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. *Int J Soc Res Methodol.* **2005,** 8, 19-32. https://doi.org/10.1080/1364557032000119616.
9. Levac D, Colquhoun H, O'Brien KK. Scoping studies: Advancing the methodology. *Implement Sci.* **2010,** 5, 69. https://doi.org/10.1186/1748-5908-5-69.
10. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Ann Intern Med.* **2018,** 169, 467-473. https://doi.org/10.7326/M18-0850.
11. Pourmand A, Ghassemi M, Sumon K, Amini SB, Hood C, Sikka N. Lack of Telemedicine Training in Academic Medicine: Are We Preparing the Next Generation? *Telemed JE Health.* **2021,** 27, 62-67. https://doi.org/10.1089/tmj.2019.0287.
12. Khullar D, Mullangi S, Yu J, Weems K, Shipman SA, Caulfield M, et al. The state of telehealth education at US medical schools. *Healthcare.* **2021,** 9, 100522. https://doi.org/10.1016/j.hjdsi.2021.100522.
13. Alhur A. Curricular Analysis of Digital Health and Health Informatics in Medical Colleges Across Saudi Arabia. *Cureus.* **2024,** 1 6, e66892. https://doi.org/10.7759/cureus.66892.
14. Behrends, M., Paulmann, V., Koop, C., Foadi, N., Mikuteit, M., & Steffens, S. Interdisciplinary Teaching of Digital Competencies for Undergraduate Medical Students - Experiences of a Teaching Project by Medical Informatics and Medicine. *Studies in Health Technology and Informatics.* **2021,** 281, 891-895. https://doi.org/10.3233/SHTI210307.
15. Punzalan JK, Punzalan MG. Integrating digital health competencies in community-engaged medical education: A scoping review for developing teaching and learning strategies for digital health. *J Educ Health Promot.* **2025,** 14, 190. https://doi.org/10.4103/jehp.jehp_1240_24.
16. Carney M, Thornton ME, Avancha K, Nolin JR, Alexander J. The Need for Telehealth Education in the Medical School Curriculum. *Cureus.* **2025,** 1 7, e90598. https://doi.org/10.7759/cureus.90598.

17. Abbas D. From classroom to clinic: A student's perspective. *DigitalHealth.* **2025,** 32, 443-451. https://doi.org/10.1016/B978-0-443-23901-4.00032-5.
18. Ahmad MS, Shaik RA, Alzahrani R, Bhat M, Matbouly G, Ahsan M, et al. The effect of medical informatics training on students' knowledge and attitude to use it in future medical work: a comparative study among Saudi medical students. *Bangladesh J Med Sci.* **2025,** 23, S170-S177. https://doi.org/10.3329/bjms.v24i10.79198.
19. Bigay R, Dmujeres F, Tannier X, Seroussi B. Teaching Digital Health at Sorbonne University: The Year One Review of the SN@SU Project. *Stud Health Technol Inform.* **2025,** 311, 1412-1416. https://doi.org/10.3233/SHTI251071.
20. Ostrovsky DA, Heflin MT, Bowers MT, Hudak NM, Leiman ER, Truong T, et al. Development, Implementation, and Assessment of an Online Modular Telehealth Curriculum for Health Professions Students. *Adv Med Educ Pract.* **2024,** 15, 743-753. https://doi.org/10.2147/AMEP.S468833.
21. DuBose-Morris R, McSwain SD, McElligott JT, King KL, Ziniel S, Harvey J. Building telehealth teams of the future through interprofessional curriculum development: A five-year mixed methodology study. *J Interprof Care.* **2023,** 37, 100-108. https://doi.org/10.1080/13561820.2021.2005556.
22. Cheng C, Humphreys H, Kane B. Transition to telehealth: Engaging medical students in telemedicine healthcare delivery. *Go J Med Sci.* **2021,** 191, 2405-2422. https://doi.org/10.1007/s11845-021-02720-1.
23. Newnham A, Tattersall T, Odendaal J. Do Medical Schools Need to Adapt Their Curriculum in Order to Teach Medical Students Webside Manner? A Systematic Review. *Med Sci Educ.* **2025,** 1, 1-9. https://doi.org/10.1007/s40670-025-02498-2.
24. Kyyhkynen R, Peltonen LM, Smed J. Videoconferencing Applications for Training Professionals on Nonverbal Communication in Online Clinical Consultations. *Healthc Inform Res.* **2023,** 29, 394-399. https://doi.org/10.4258/hir.2023.29.4.394.
25. Abrams MP, Hartman E, Kay D, Kauffman C, Castiglioni A. Lessons Learned in the Design and Implementation of Virtual Telemedicine Curriculum for Third Year Medical Students Incorporating New AAMC Telehealth Competencies. *MedEdPublish.* **2021,** 10, 154. https://doi.org/10.15694/mep.2021.000154.1.
26. Rivet EB, Feldman M, Khandelwal S, Anderson A, Bedros N, et al. Adapting Compassionate Conversations for Virtual Mediated Communication. *J Surg Educ.* **2023,** 80, 1296-1301. https://doi.org/10.1016/j.jsurg.2023.06.012.
27. Greengold J, Spahic H, Serwint J, Dlhosh S, Barouch L, Gattamorta K, et al. Novel educational strategies to improve the telemedicine clinical skills of medical students. *Prim Health Care Res Dev.* **2025,** 26, e10. https://doi.org/10.1017/S1463423625000040.
28. Vogt L, Schmidt M, Follmann A, Lenes A, Klasen M, Sopka S. Telemedicine in medical education: An example of a digital preparatory course for the clinical traineeship - a pre-post comparison. *GMS J Med Educ.* **2022,** 39, Doc46. https://doi.org/10.3205/zma001567.
29. Cheok Liew S, Tan MP, Breen E, Krishnan K, Sivarajah I, Raviendran N, et al. Microlearning and online simulation-based virtual consultation training module for the undergraduate medical curriculum: a preliminary evaluation. *BMC Med Educ.* **2023,** 23, 796. https://doi.org/10.1186/s12909-023-04777-1.
30. Frankl SE, Joshi A, Onorato S, Jawahir GL, Pelletier SR, Dalrymple JL, et al. Preparing Future Doctors for Telemedicine: An Asynchronous Curriculum for Medical Students Implemented During the COVID-19 Pandemic. *Acad Med.* **2021,** 96, 1696-1701. https://doi.org/10.1097/ACM.0000000000004260.
31. Bajra, R., Srinivasan, M., Torres, EC, Rydel, T., & Schillinger, E. Training future clinicians in telehealth competencies: outcomes of a telehealth curriculum and teleOSCEs at an academic medical center. *Frontiers in Medicine.* **2023,** 10, 1222181. https://doi.org/10.3389/fmed.2023.1222181.
32. Adams JE, Ecker DJ. Telehealth: from the abstract to necessity to competence. *FASEB BioAdvances.* **2021,** 3, 475-481. https://doi.org/10.1096/fba.2020-00098.
33. Noronha C, Lo MC, Nikiforova T, Jones D, Nandiwada DR, Leung TI, et al. Telehealth Competencies in Medical Education: New Frontiers in Faculty Development and Learner Assessments. *J Gen Intern Med.* **2022,** 37, 3168-3173. https://doi.org/10.1007/s11606-022-07564-8.
34. Anawati MK. Virtual Care in Undergraduate Medical Education: perspectives beyond the pandemic. *Can Med Educ* J. **2022,** 13, 92-98. https://doi.org/10.36834/cmej.73879.

35. Car J, Ong QC, Fox TE, Leightley D, Kemp SJ, Švab I, et al. The Digital Health Competencies in Medical Education Framework: An International Consensus Statement Based on a Delphi Study. *JAMA Network Open*. **2025,** 8, e2453131. https://doi.org/10.1001/jamanetworkopen.2024.53131.
36. Muntz MD, Franco J, Ferguson CC, Ark TK, Kalet A. Telehealth and Medical Student Education in the Time of COVID-19—and Beyond. *Acad Med*. **2021,** 96, 1655-1659. https://doi.org/10.1097/ACM.0000000000004014.
37. Costich M, Picoraro J, Scott T, Barron B, Feldman E, Friedman S. Creation of a Multimodal Telemedicine Curriculum for Preclinical Medical Students. *MedEdPORTAL*. **2025,** 21, 11483. https://doi.org/10.15766/mep_2374-8265.11483.
38. Cheema M, Awan OA. Virtual Clinical Shadowing: The Future of Medical Student Education Through Telemedicine. *Acad Radiol*. **2026,** 33, 1-3. https://doi.org/10.1016/j.acra.2025.05.030.
39. Cruz-Panesso I, Tanoubi I, Drolet P. Telehealth Competencies: Training Physicians for a New Reality? *Healthcare*. **2023,** 12, 93. https://doi.org/10.3390/healthcare12010093.
40. Murren-Boezem J, Zettler-Greeley CM, Ali-Panzarella A, Solo-Josephson P. Development of a Virtual Pediatric Telemedicine Training Program. *Telemed Rep*. **2024,** 5, 123-133. https://doi.org/10.1089/tmr.2024.0004.
41. Bajra R, Frazier W, Graves L, Jacobson K, Rodriguez A, Theobald M, et al. Feasibility and Acceptability of a US National Telemedicine Curriculum for Medical Students and Residents: Multi-institutional Cross-sectional Study. *JMIR Med Educ*. **2023,** 9, e43190. https://doi.org/10.2196/43190.
42. Moeini S, Honarvar MR, Aarabi M, Kabir MJ, Aarabi M. Developing a structured telemedicine curriculum for medical students: a qualitative study based on expert interviews. *BMC Med Educ*. **2026,** 26, 50. https://doi.org/10.1186/s12909-025-08409-8.
43. Wamsley M, Cornejo L, Kryzhanovskaya I, Lin BW, Sullivan J, Yoder J, et al. Best Practices for Integrating Medical Students Into Telehealth Visits. *JMIR Med Educ*. **2021,** 7, e27877. https://doi.org/10.2196/27877.
44. Sartori DJ, Lawrence K. Simulating Virtual Care: Integrating Telemedicine into Objective Structured Clinical Training. *Objective Structured Clinical Examinations*. **2025,** 9, 151-158. https://doi.org/10.1007/978-3-031-88752-9.

Table 2. Extraction of data on telemedicine training in medical education (2021–2026).

Authors, year, reference	Country	Methodological design	Participants (n) / Characteristics	Study objective	Measuring instruments	Detailed main results
Abbas (2025) (17)	USA	exploratory systematic review	n=1220 records; Medical students and educators	Exploring the transition from school to the world of digital health from a student's perspective	PRISMA diagram, approval surveys. It was based on 3 educational interventions (3 different studies)	Social benefits of telemedicine, prevention of burnout, need for early training. All studies state that telemedicine should be integrated into education.
Abrams et al. (2021) (25)	USA	Report on a new educational method	n=114; 3rd year medical students (Class of 2022).	Design and implement a virtual curriculum incorporating the new telehealth competencies of the AAMC (access-equity, communication, virtual EF, privacy-security)	Satisfaction surveys, formative quiz items	Students felt more prepared and comfortable, with an increased perception of its usefulness. Telemedicine should be integrated into the curriculum (necessary in the long term). Students valued the real-time feedback.
Adams & Ecker (2021) (32)	USA	Curriculum innovation	Not reported; Preclinical and clinical students	Prepare students for virtual care and assure clinical partners through a "skeleton" curriculum. Evaluate the feasibility of using virtual simulations and standardized patients to meet accreditation requirements (LCME)	Asynchronous self-learning, zoom simulations, OSCE. Utility surveys (Likert scale)	Effectiveness of the simulation (without risk of COVID exposure), achievement of objectives, institutional validation (curriculum validated as a substitute for in-person practice), emphasis on competencies (technological skills, communication, adapted physical education, legal and ethical framework). It should remain in academic curricula; feedback is important.

Ahmad et al. (2025) (18)	Saudi Arabia	Cross-sectional descriptive study	n=1508; Senior medical students	To investigate the impact of medical informatics training on students' knowledge and attitudes.	Intervention with a curriculum that includes digital health concepts + electronic records + telemedicine. Validated 24-item questionnaire	Increased knowledge about medical informatics, positive attitude towards the incorporation of telemedicine, good perception of the usefulness of virtual simulations, approval of integration into medical education. Need for standardization, reduction of burnout, recommends early simulations.
Alhur (2024) (13)	Saudi Arabia	Documentary analysis. Descriptive and comparative analysis of medical curricula	n=18 institutions; Public and private medical schools	To assess the current state of digital health integration into medical school curricula globally, identify disparities in technological training between different countries and regions, and determine which specific digital health topics are receiving the highest educational priority.	Structured database for extraction	Global heterogeneity with a significant gap, predominance of telemedicine in academic curricula, AI training is limited at the undergraduate level, identification of obstacles to implementation. Conclusions: urgent curriculum reform, international standardization, interdisciplinary collaboration.
Anawati (2022) (34)	Canada	Scientific committee report. Perspective and review article.	n~330; Medical students (MD2021/22)	Explore how to permanently integrate virtual care into the undergraduate medical curriculum (cultural change). Identify institutional barriers and opportunities for standardized training in the Canadian context.	Feedback forms	Need for national standards (to ensure that all graduates have the same competencies), importance of seeing professionals use telemedicine, importance of identifying inequities that occur in telemedicine, focus training (virtual EF, confidentiality, modality selection, soft skills).
Bajra et al. (2023) (31)	USA	Curriculum and pedagogical instruction	n=133; 3rd and 4th year medical students	To evaluate the effectiveness of a telehealth curriculum designed for undergraduate medical students based on AAMC competencies, comparing students' self-	Rubric that evaluates competencies addressed (environment, empathetic communication,	High technical performance, challenge in the virtual EF, virtual dg capability requires more specific practice, satisfaction with teleOSCE

				perceived confidence vs. actual performance observed by evaluators.	assisted EF, plan management) Self-confidence surveys, teleOSCEs	
Car et al. (2025) (35)	International	Delphi Study	n=211 (R1); n=149 (R2); Experts from 79 countries	Develop a digital health competency framework (**DECODE**) for the design of digital health curricula globally, that is evidence-based, consensus-driven, and globally adaptable. Closing the gap between the rapid digitization of health and the lack of formal training in medical schools.	Two-round Delphi surveys	Consensus on **5 main domains** (digital health foundations, information technology, digital clinical care, ethics and legal aspects, emerging technologies) and **26 key competencies,** with 178 learning outcomes (33 compulsory and 145 discretionary). Adaptability of DECODE according to country (institutional urgency), continuous evaluation is suggested.
Carney et al. (2025) (16)	USA	Survey research	n=43; Students of osteopathic medicine (WHO III/IV)	Evaluate the need to incorporate more telemedicine education into the medical curriculum.	Google Forms (15 questions)	81% of students reported not having received training on how to conduct a telehealth visit during their preclinical years. The majority of respondents stated they did not feel prepared to conduct a telehealth consultation independently. 93% of students believe that a proper physical examination cannot be performed virtually. Furthermore, over 70% rated this part as the most difficult aspect of the encounter. 41% of respondents found it difficult to establish a connection. 74% indicated a need for telemedicine training at the undergraduate level. A training model was suggested that includes online modules, simulation workshops, OSCE (Organization for Standardization and Certification), and faculty development.

Cheema & Awan (2026) (38)	USA	Educational perspective	n>5000 (global); Medical and pre-medical students	Exploring the potential of virtual "teleshadowing" as an educational innovation.	Program description and quizzes	The program allows users to observe how an experienced professional treats simulated patients remotely as a form of "shadowing" learning, thus reducing the negative effects of the COVID-19 pandemic.
Cheng et al. (2021) (22)	Ireland	Literature review	n=33 articles; Medical students (all levels)	Review student participation in telemedicine and determine benefits and challenges.	Narrative review with structured search	Participation in telemedicine activities fosters the development of specific competencies for remote care—including communication skills in virtual environments—; however, students report significant challenges, such as difficulties conveying empathy and establishing a doctor-patient relationship, limitations in performing physical examinations, and technical problems associated with the virtual modality.
Cheok Liew et al. (2023) (29)	Malaysia	Quasi-experimental pilot study with pre-test/post-test design without a control group, aimed at the preliminary evaluation of a competency-based educational module.	n=52; Clinical students and recent graduates	To describe the implementation and conduct a preliminary evaluation of a virtual consultation (VC) training module based on microlearning and online simulation, to develop skills in undergraduate medical students.	DOVCS checklist (objective pre/post evaluation) + electronic satisfaction survey (Likert).	A significant improvement in performance during virtual consultations was observed, as measured by the DOVCS checklist ($t = 16.33$; $p < 0.05$). Furthermore, 95.9% of students reported an increase in their self-efficacy for conducting virtual consultations.
Costich et al.	USA	Curriculum	Approximately 140	To design and evaluate a	Satisfaction surveys -	A significant increase ($p <.001$) in students'

(2025) (37)	(Columbia University Vagelos College of Physicians and Surgeons).	evaluation study of a hybrid (multimodal) method using qualitative and quantitative methodology. A "flipped classroom" model was employed *with* an asynchronous online module and synchronous skills workshops.	preclinical medical students participated each year (2021 and 2022). For the specific knowledge assessment in 2022, n=50 students participated. Seven of the ten facilitating professors were also interviewed.	hybrid curriculum to provide preclinical medical students with the knowledge and skills necessary to conduct telemedicine encounters. The study sought to assess the perspectives of faculty and students on the design and the increase in self-reported knowledge.	survey, retrospective pre/post knowledge assessment, semi-structured interviews, telemedicine skills checklist completed by teachers and simulated participants	self-reported knowledge was demonstrated in all areas assessed, with the greatest gain in differentiating between telemedicine and telehealth. • High student satisfaction: 93% reported being satisfied or very satisfied with the workshop.
Cruz-Panesso et al. (2023 - indexed in 2024) (39)	Canada (University of Montreal).	Theoretical perspective	Not reported; Aimed at medical students and practicing physicians. The proposed framework is based on the authors' combined experience of over 10,000 hours in curriculum development and telesimulation.	Reflecting on the challenges of integrating telehealth curricula into medical training, proposing a change from the "classic expert" model to one of simultaneous learning, and presenting telesimulation as the ideal instructional method.	Not applicable (theoretical study). However, it analyzes and adapts competency frameworks from the ACGME, the AAMC, and the future CanMEDS 2025.	Telesimulation is proposed as a "direct descendant of telehealth", allowing the recreation of standardized and safe scenarios for training in technical and communication skills.
DuBose-Morris et al. (2023) (21)	United States (Medical University of South Carolina - MUSC	This five-year (12-semester) mixed-methods study used a concurrent transformative design. It was based on Kern's	n=170 students from six different faculties self-selected for the course. Disciplines included medicine, nursing, pharmacy,	To evaluate the impact of a formal telehealth curriculum on students' self-perception of their experience, comfort, and potential for integrating telehealth into interprofessional practice	REDCap Survey (pre/post course with scales). Self-assessment of the effectiveness of teamwork Open questions for	Significant improvements in knowledge and trust metrics were observed after just one semester ($p < 0.001$). • The percentage of students who felt comfortable explaining three telehealth tools increased from **6.1% to 78%.**

		six-step model for curriculum development and Kirkpatrick's model for evaluation.	dentistry, health administration, and clinical research.		qualitative thematic analysis, mendicant inductive coding	• Qualitative themes revealed that the course fostered teamwork, collaboration, and a greater appreciation for other professions. • The students identified telehealth as a way to improve the quality of care, efficiency, and health outcomes for patients.
Bigay et al. (2025) (19)	France (Sorbonne Université)	Five-year educational project review (SN@SU) Includes the development of multimodal educational resources (e-learning, virtual simulations, face-to-face classes) and a satisfaction evaluation using a mixed design (quantitative and qualitative).	n=2242; Medical students (Y1, Y2, Y4) within a total of 3588 students. Subsample of second-year (n=471) and fourth-year (n=457) students of the program	To present an overview of the first year of the SN@SU project, describing the digital health teaching initiatives, the materials developed, and evaluating student reception and satisfaction.	Satisfaction survey adapted from the standard QSB 18-B questionnaire, 5-point Likert scale, open-ended questions, e-learning platform activity data	A total of 8,750 hours of instruction were generated, averaging 7.4 hours per active student. 62% of Year 2 students versus 27% of Year 4 students considered this training important. E-learning was the preferred format (75% in Year 2, 73% in Year 4) due to its flexibility. Year 4 students reported low satisfaction (17%) due to the lack of hands *-on components* and the perception that it competed with their clinical coursework.
Frankl et al. (2021) (30)	USA (Harvard Medical School - HMS).	Educational innovation report with curriculum evaluation using a mixed methodology (quantitative surveys and qualitative text analysis). The curriculum was asynchronous,	n=252; Harvard medical students in clinical rotations. Cohort composed of students in their clerkship year (n=167) and students at higher levels in elective rotations (n=85)	Develop and implement an asynchronous telemedicine curriculum so that clinical students could maintain their ability to participate in virtual meetings and continue their learning during the transition forced by COVID-19 s	Pre/post course surveys, 3-page final group reflection essay, qualitative analysis of open-ended responses on the asynchronous format	Self-reported knowledge increased from 15.1% to 84.3% ($p<0.001$); 85.9% said it met their learning needs. 90.1% rated the asynchronous learning experience as positive due to its flexibility and self-paced learning.

		consisting of 5 modules based on Bloom's Taxonomy.				
Greengold et al. (2024) (27)	USA (Johns Hopkins University School of Medicine)	Randomized pilot study comparing two cohorts: one that used only an online learning platform (OLP) and another that combined the platform with an individualized virtual training program (OLP + VCI)	n=12; 4th year medical students	To evaluate the impact of an online learning platform and a standardized training program on the quality of clinical skills in telemedicine among medical students	Pre- and post-study surveys (Kirkpatrick Model), standardized rubric for clinical skills assessment by blind evaluators, and self-reflection forms after standardized patient encounters.	A statistically significant increase in self-reported confidence was observed in all participants ($p < .001$). Significant improvement in communication and examination ($p=0.049$); the coaching group showed greater improvements in self-efficacy.
Chike-Harris et al. (2021) (5)	USA (Medical University of South Carolina).	Systematic review	n=8 articles; The students analyzed in these studies included medical students (e.g., n=112 in one program), nursing students (ABSN, NP, DNP), and interprofessional teams	Identify the presence and integration methods of telemedicine in provider curricula.	Systematic literature review (2008-2018) under **PRISMA guidelines** using Scopus, PubMed and 17 EBSCOHost databases	There is no consistency in the integration; the content varies significantly between a basic talk and a full semester. All programs that reported results indicated high student satisfaction and an increased desire to use telehealth in future practice. • It was concluded that it is imperative to create standardized **national and international competencies** to guide the development of consistent curricula.

Khullar et al. (2021) (12)	USA	National cross-sectional survey	n=71 senior leaders in medical education, faculties; Curriculum deans of medicine	Examine the state of telehealth education in US medical schools.	A structured online survey was conducted with deans to assess curricular inclusion, exposure to modalities, teaching methods, competency assessment, and perceived barriers.	56.3% reported having a telehealth curriculum in 2019; the main barriers are limited time and a lack of expert teachers.
Kyyhkynen et al. (2023) (24)	Finland	Case report (Review)	n=7 studies; Students and professionals	Evaluate videoconferencing applications for training nonverbal communication (NVC).	Analysis of ReflectLive (USA) and EQClinic (Australia)	The applications are feasible and usable for increasing awareness of nonverbal communication; automatic feedback still needs improvement to be useful as it can be distracting.
Moeini et al. (2026) (42)	Iran	Qualitative (Interviews)	n=14; Experts in clinical practice, education and IT	Develop a contextually adapted telemedicine curriculum for Iranian students.	Interviews, MAXQDA analysis	Undergraduate telemedicine training is a strategic and feasible tool that allows students to acquire critical clinical competencies and virtual communication skills. The use of technologies with real-time feedback and active participation in remote consultations increases professional self-awareness and decision-making capacity. However, its global success requires addressing the digital divide, standardizing curricula, and ensuring equity.

Muntz et al. (2021) (36)	USA	Academic perspective	Not reported; Medical students	To propose a strategy to integrate students into post-pandemic telemedicine activities.	Mapping EPAs to telehealth	It is suggested that medical students be integrated into telemedicine, triage, and chronic disease management to expand the capacity of medical teams during and after the pandemic, maintain public health, and develop their professional identity through experiential learning. Overcoming the digital divide is essential to achieving this.
Murren-Boezem et al. (2024) (40)	USA	Mixed study	n=7; 4 medical students, 3 residents	Evaluate knowledge and comfort before and after a virtual training program in pediatric telemedicine.	REDCap pre/post survey	Comfort levels for conducting virtual exams increased from 28.6% to 100%; the program allows for immediate feedback with affiliated physicians; the program's success is attributed to the use of specific clinical guidelines for telemedicine and the personalized one-on-one teaching time with specialists; diagnostic limitations were better understood; the program facilitated the formation of professional identity in technological environments.
Newnham et al. (2025) (23)	UK	Systematic review	n=11 studies; 809 medical students	To evaluate the effect of training in telemedicine consultation skills ("webside manner").	MERSQI instrument	Six out of seven studies reported a positive association between improved communication skills and the ability to generate empathy during consultations; 100% of the studies demonstrated that students increased their confidence when performing telemedicine. Most consider telemedicine courses useful or of high quality. There is significant heterogeneity in teaching methods, with low-quality evidence.

Noronha et al. (2022) (33)	USA	Academic perspective	Not reported; Students and residents	Describe strategies for integrating AAMC competencies and provide direct observation tools.	Observation tools	It is proposed to align medical training with the guidelines of the AAMC and ACGME; three fundamental areas for practice are identified: communication, data collection and safety and appropriate use of telemedicine; teacher development should occur simultaneously with student education using new real-time assessment and feedback tools.
Ostrovsky et al. (2024) (20)	USA	Original Research (Pilot)	n=70 (analyzed); Medical students, medical assistants and nursing students.	Evaluate an online modular curriculum designed for multiple health professions.	Qualtrics Surveys	The primary focus for medical students is acquiring basic digital communication skills. The OSCE is a structured and objective tool with a strong correlation to undergraduate clinical rotation scores. Emphasis on the use of technology and communication in virtual environments is recommended. Direct observation tools adapted for medical students, based on the AAMC domains, are proposed. It is emphasized that students should receive training in nonverbal communication.
Punzalan (2025) (15)	Philippines	exploratory systematic review	n=44 articles; Medical students	Develop strategies to integrate digital health competencies into community education (CEME).	Content Analysis (CEME)	It highlights the importance of digital literacy in mitigating disparities and the need for continuous and dynamic curriculum updates. It proposes a model for building a digital health curriculum, including student needs, the role of teachers, structural modifications to the educational model that enable the development of telemedicine skills, and the value of a commitment to community health to support lower socioeconomic levels.

Pourmand et al. (2021) (11)	USA	Retrospective analysis	n=147 schools; Medical schools (AAMC data)	Examine the evolution of exposure to telemedicine in medical training.	Curriculum inventory reports	The supply of courses increased from 41% to 60% between 2013 and 2018 (p=0.0006), although growth stagnated after 2015.
Bajra et al. (2023) (41)	USA	Multi-institutional study	n=1203 (844 students); FM Students and Residents	Evaluate the acceptability of a national curriculum based on AAMC competencies.	5-point Likert survey	78% reported gaining new knowledge; 87% considered the information to be at the appropriate level for their training.
Rivet et al. (2023) (26)	USA	Original report	n=34; Students and residents	Training and evaluating performance in virtually mediated communication (VMC) for difficult topics.	Performance evaluation (0-12)	Significant improvement in performance between the first and second simulation (p=0.004 for coaches; p=0.001 for SPs).
Sartori & Lawrence (2025) (44)	USA	Technical guide / Book	Not reported; Students and residents	Integrating telemedicine into structured clinical training (OSCE).	Behaviorally anchored checklist	A rubric was developed that maps telemedicine skills (identification, NVC, virtual physical exam) with AAMC domains.
Vogt et al. (2022) (28)	Germany	Pre-post comparison	n=92 (pre); n=41 (post); Students (4th semester)	To investigate whether telemedicine modules increase subjective confidence in practical skills.	Online questionnaire (Likert 6)	Highly significant increases in confidence for history taking, communication, and handover (p<0.001 on all items) in telemedicine care
Wamsley et al. (2021) (43)	USA	Viewpoint / Guide	Not reported; Medical students	Describe strategies for integrating students into telehealth visits in the outpatient setting.	Billett's framework (learning)	Practices to integrate medical students into telehealth visits, providing a series of recommendations before, during and after the visit.
Behrends et al. (2021) (14)	Germany	Project report	n~30 per event; Medical students	Demonstrate the practicality of interdisciplinary teaching of digital skills.	Lesson grades	The DigiWissMed project integrated neurology teleconsultation seminars and medical apps in 1 year with positive reviews.