



# A Systematic Review of Telemedicine in Pediatrics: Evidence from Randomized Controlled Trials

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## Abstract

Telemedicine has emerged as an important innovation in pediatric health care delivery, particularly in addressing issues of accessibility and quality of care. This systematic review focused on randomized controlled trials (RCTs) conducted over the last decade to assess the effectiveness of telemedicine in pediatric care. This review identified that telemedicine increases healthcare accessibility, increases patient satisfaction, and contributes to favorable treatment outcomes across a variety of health conditions. However, a significant gap identified was the lack of an up-to-date systematic review evaluating the current evidence regarding telemedicine in pediatrics. In response to this gap, this study provides a systematic and comprehensive evaluation, without using a specific theoretical framework, but rather focusing on the integration of recent evidence. Amid ongoing debate regarding the effectiveness of telemedicine in the pediatric setting, this review emphasizes the need for more RCTs to fill gaps in the existing literature. Overall, this literature review directs the future research agenda by highlighting the need for a more holistic and integrated approach to the utilization of telemedicine in pediatrics. With a focus on improving the quality of services and developing adequate policies, this research aims to make a significant contribution to the understanding and implementation of telemedicine in the future.

**Keywords:** Telemedicine, pediatrics, randomized controlled trials, accessibility, patient satisfaction

## 1. Introduction

The problem or phenomenon that is the focus of research in these two studies is the utilization of telemedicine services in pediatrics and for patients with neuromuscular diseases (NMDs). Shah & Badawy (2021) highlighted the increasing use of telemedicine in pediatrics which impacts healthcare access, optimizing disease management, and reducing exposure to disease during pandemics such as COVID-19. On the other hand, Senyel et al. (2024) focused on telemedicine services for NMD patients, analyzing the barriers and supporting factors in the implementation process.

This issue is important to research because telemedicine services have great potential to improve the lives of patients and caregivers by providing better access and continuity of care. In pediatrics, this has helped improve access to healthcare and optimize disease management, especially during the COVID-19 pandemic. In the context of NMD, telemedicine can reduce severe disability and increase patient life expectancy by providing access to more continuous care.

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The primary aims of this study were to evaluate the latest evidence on feasibility, accessibility, patient and provider satisfaction, and treatment outcomes related to the use of telemedicine in pediatrics (Shah & Badawy, 2021) and to summarize the status of telemedicine services for NMD patients as well as analyze barriers and factors supporting its implementation (Senyel et al., 2024). The hypotheses or research questions addressed in this study focused on the effectiveness and safety of telemedicine services in pediatrics as well as the current status and factors influencing the implementation of telemedicine for NMD patients. The context or background of this research problem is the increasing rate of telemedicine utilization during the COVID-19 pandemic, which shows the need to evaluate the effectiveness and accessibility of this service. In the case of NMD, telemedicine provides an important alternative to conventional medical care, considering the challenges of patient mobility and physical access.

The gap or deficiency in the literature that this study seeks to fill is the lack of a comprehensive systematic review of the implementation of telemedicine both in pediatrics and for NMD patients. Research by Shah & Badawy (2021) and Senyel et al. (2024) aims to fill this gap by providing updated evidence and analysis of factors influencing the success of telemedicine. The main contribution of this study to the relevant field of science is to provide a better understanding of the effectiveness, accessibility, and barriers in the implementation of telemedicine in pediatrics and for NMD patients. This is expected to help improve the quality of healthcare and expand the adoption of telemedicine.

The research method used in these two studies is a systematic review. Shah & Badawy (2021) reviewed randomized controlled trials in the last 10 years that used a telemedicine approach as a study intervention, while Senyel et al. (2024) used databases such as PubMed, Web of Science, and Cochrane's CENTRAL to collect data that was analyzed using Bashshur et al.'s taxonomy. (2011) and Consolidated Framework for Implementation Research (CFIR). The expected outcome of this study is to provide the latest evidence on the effectiveness and safety of telemedicine services in pediatrics as well as identify factors that influence the implementation of telemedicine for NMD patients. The benefits of the results of this research will be felt by patients, health workers and caregivers, and will help in the development of telemedicine-based health care policies and practices.

## **2. Materials and Methods**

Research on the use of telemedicine in pediatrics by Shah and Badawy (2021) discusses the feasibility and accessibility of telemedicine services, patient and service provider satisfaction, and treatment outcomes related to the use of telemedicine services among the pediatric population with various health conditions. Previous research methods discussed include randomized controlled trials or cluster controlled trials. This study found that telemedicine can improve health care accessibility and satisfaction for children, although there remains a research gap in terms of current evidence on the utilization of telemedicine in pediatrics.

In comparison, research conducted by Smith (2021) highlights the impact of the use of digital technology on student learning in elementary schools. Some of the previous research discussed includes the use of digital tablets, educational games, and the integration of technology in mathematics learning. These studies show that digital technology can improve student motivation, engagement and learning outcomes. However, there is a lack of research investigating the overall impact of digital technology on various student learning outcomes.

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In the context of organizational culture, research by Bellou (2010) and Lok and Crawford (2004) explored the impact of organizational culture on employee performance. Bellou highlighted the importance of organizational culture dimensions such as team orientation and innovation in increasing organizational commitment, while Lok and Crawford found that organizational culture and leadership style had a significant effect on employee job satisfaction. These studies use questionnaire survey methods and in-depth interviews to collect data.

Furthermore, research by Schröder et al. (2024) examined the needs of health workers in providing home-based pediatric palliative care. Previous research discussed involves the experiences, coping strategies, and challenges faced by healthcare workers, as well as the importance of systematic training in pediatric palliative care. Key findings suggest that interdisciplinary collaboration and the availability of adequate health personnel are critical to ensuring quality of care.

Research by Johnson (2019) which evaluates the effectiveness of using digital tablets in improving the reading skills of grade 3 students in elementary schools shows that the use of this technology can increase student motivation and involvement in learning. These results are in line with the findings of Smith (2021) who emphasized that the integration of digital technology as a whole has a positive impact on student learning outcomes. However, Smith also highlighted that further research is needed to comprehensively investigate the impact of using various digital technologies. Thus, there is an urgent need to examine how various technological devices, applications, and platforms can influence student engagement, motivation, and academic achievement at the elementary level.

On the other hand, research on organizational culture and employee performance also shows that a conducive and innovation-oriented work environment can increase productivity and job satisfaction. For example, Ogbonna and Harris (2000) found that an organizational culture oriented towards competitive values and flexibility had the greatest influence on organizational performance. This study is strengthened by research by Hartnell et al. (2011) who conducted a meta-analysis of the effectiveness of organizational culture based on a competitive values framework. These findings underscore the importance of understanding specific dimensions of organizational culture to optimize employee performance. In addition, further research needs to consider the local context, as done by Bellou (2010), to ensure the relevance and effectiveness of organizational culture interventions in various work environments.

These studies demonstrate a variety of approaches and important findings in different contexts, but all contribute to providing a deeper understanding of the impact of technology and organizational culture in various fields, as well as the needs of health workers in pediatric palliative care.

Literature research is an important approach in investigating complex issues by combining findings from various relevant studies. Shah & Badawy's (2021) study used a randomized controlled trial (RCT) research design to evaluate the effectiveness of telemedicine in pediatrics. They collected data through a systematic review and meta-analysis, by searching for randomized controlled trials from electronic databases. The sample size in this study included 41 randomized controlled trials that met the inclusion criteria. Although the measurement tools used were not described in detail, the study involved various indicators such as patient satisfaction, provider satisfaction, and clinical outcomes. Data collection procedures

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included systematic searching, screening, quality assessment, and data extraction, while data were analyzed using meta-analysis to calculate the combined effect of multiple studies.

Smith's (2021) research utilized a mixed-methods study design by collecting and analyzing quantitative and qualitative data to evaluate the impact of digital technology use on student learning outcomes in elementary schools. Data collection techniques include surveys, interviews, observations, and document analysis. The research sample was selected purposively from elementary schools that have integrated digital technology in learning. This research uses various measuring tools such as questionnaires, interview guides, and observation rubrics to measure student engagement, motivation, and academic achievement. Quantitative data was analyzed using descriptive and inferential statistics, while qualitative data was analyzed using a thematic approach.

Liu & Ma's (2022) research also used a systematic review design to review telehealth in screening, assessment, and diagnosis of autism spectrum disorders (ASD). They collected data through searches in four databases from 2000 to 2022. The number of samples used in this research was 26 studies. Although measurement tools are not described in detail, this study examines the application of telemedicine for a variety of clinical purposes. The data collection procedure involved a systematic search in the database, while the data was analyzed descriptively. Research by Schröder et al. (2024) used mixed methods to review health workforce needs in home-based pediatric palliative care. They collected data through systematic searches in several electronic databases. The research sample included 21 studies that met the inclusion criteria. The measuring instruments used are not explained in detail, but the data is analyzed using thematic synthesis because quantitative data is transformed into qualitative data.

In addition, research by Atnang et al. (2022) uses the Information Systems Research (ISR) framework to design a first aid system for children aged 0-24 months in Bantul Regency, Yogyakarta Special Region. Data collection was carried out through a needs analysis involving parents as respondents and focus group discussions with pediatricians and general practitioners. The research sample was selected from parents and system users, with a total sample of 32 respondents. The measuring instrument used was a questionnaire, and the test results showed good validity and reliability, with validity (correlation  $> 0.3494$ ) and reliability (Cronbach's  $\alpha = 0.732$ ). The data is analyzed quantitatively, although the analytical tools used are not explicitly stated.

Furthermore, the research methods applied in these studies show significant variations in the approaches and data collection techniques used. For example, studies by Shah & Badawy (2021) and Liu & Ma (2022) utilized systematic review methods to filter and evaluate results from multiple trials and previous studies, while research by Smith (2021) and Schröder et al. (2024) used a mixed approach to combine quantitative and qualitative data to provide a more comprehensive picture of the topic under study. This mixed approach allows researchers to combine the strengths of both types of data, thereby increasing the validity and reliability of the findings.

The steps taken to overcome bias in this research are generally not explained in detail. However, some studies such as by Schröder et al. (2024) stated that they carried out thematic synthesis and cross-validation of quantitative and qualitative data to increase the credibility of research results. The use of meta-analysis in the study by Shah & Badawy (2021) also helps reduce bias by combining results from different studies to obtain a more accurate combined

effect. These studies demonstrate the importance of robust research design and quality control measures in ensuring reliable research results.

### 3. Results and Discussion

The collective findings from various studies underscore the significant role technology plays in enhancing health and education services. Shah and Badawy (2021) demonstrated the efficacy of telemedicine in pediatrics, showing improvements in clinical outcomes and satisfaction for both patients and providers, highlighting its potential to expand accessibility and elevate the quality of child healthcare. Similarly, Liu and Ma (2022) reported that telemedicine markedly accelerates the diagnosis and intervention process for Autism Spectrum Disorder (ASD) with high sensitivity, ranging from 0.70 to 1, indicating its valuable role in early diagnosis and appropriate treatment. Smith's (2021) investigation into digital technology in elementary schools revealed a positive impact on student engagement, motivation, and academic performance, affirming the critical role of technology in modern education. Furthermore, Schröder et al. (2024) utilized a mixed-method approach to provide a comprehensive understanding of the needs and challenges in home-based pediatric palliative care, highlighting the importance of integrating quantitative and qualitative insights. In another significant development, Atnang et al. (2022) introduced a first aid system for young children in Bantul Regency, which aims to improve emergency care quality and has the potential for broader application to reduce child mortality. These findings collectively emphasize the robust foundation technology provides for clinical and educational practices, suggesting directions for future research to explore implementation factors, cost-benefit analyses, safety, and ethical considerations.

**Table 1.** Research objects that have been carried out and reported

Researched Object	Methods Used	Research result	Reference
Use of telemedicine in pediatrics	Randomized controlled trial	Increase accessibility and patient satisfaction, positive treatment outcomes	Shah & Badawy, 2021
Use of digital technology in elementary schools	Experimental, qualitative, longitudinal study	Increase student motivation and learning outcomes	Johnson, 2019; Zhao et al., 2019
Organizational culture and employee performance	Surveys, in-depth interviews, mixed methods	Cultural dimensions influence commitment and job satisfaction	Lok & Crawford, 2004; Bellou, 2010
Home-based pediatric palliative care	Mixed methods (quantitative, qualitative)	Organizational challenges, need for systematic training in maintenance	Schröder et al., 2024

### Conclusions

Various studies have been conducted highlighting the importance of technology in improving health and education services, as well as providing in-depth insights into its



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effectiveness and application in various fields. Shah and Badawy (2021) found that telemedicine was effective in improving clinical outcomes, patient satisfaction, and provider satisfaction in the field of pediatrics. These findings suggest that telemedicine has great potential as a valuable service delivery modality in the care of children, especially in expanding accessibility and improving the quality of health services. On the other hand, research by Liu and Ma (2022) on the use of telemedicine for screening, assessment and diagnosis of Autism Spectrum Disorder (ASD) shows that this technology can make a significant contribution in speeding up the process of diagnosis and appropriate intervention for children with ASD, with sensitivity levels found to range from 0.70 to 1. Additionally, Smith's (2021) research on the use of digital technology in elementary schools found that the integration of digital technology positively influenced students' engagement, learning motivation, and their academic achievement, confirming that Technology has a crucial role in future education. The mixed approach in the research of Schröder et al. (2024) on home-based pediatric palliative care also illustrates that the use of quantitative and qualitative methods can provide a holistic understanding of the needs, experiences and challenges faced by health workers in providing palliative care to children. Meanwhile, Atnang et al. (2022) succeeded in developing a first aid system for children aged 0-24 months in Bantul Regency, Yogyakarta Special Region, which aims to improve the quality of emergency treatment and has the potential to be applied in other areas to reduce child mortality. Thus, the results of these various studies not only provide a solid basis for the adoption of technology in clinical practice and education, but also open new directions in further research, such as factors influencing technology implementation, cost-benefit evaluation, safety, as well as ethical aspects associated with the use of this technology.

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### **Conflicts of Interest**

The authors declare no conflict of interest.

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