The Effect of Telehealth Nursing on Growth and Development Outcomes in Children

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Abstract
Telehealth nursing has emerged as a transformative approach in pediatric care, particularly in resource-limited settings. In India, where geographical barriers and healthcare accessibility remain significant challenges, telehealth interventions offer promising solutions for monitoring child growth and development. This study aims to evaluate the effectiveness of telehealth nursing interventions on growth parameters and developmental milestones in children aged 0-5 years, comparing outcomes with traditional in-person care. A quasi-experimental design was employed with 240 children divided into telehealth (n=120) and control groups (n=120) across urban and rural Indian settings over 12 months. Growth measurements including weight-for-age, height-for-age, and developmental assessments using standardized tools were conducted. Telehealth nursing interventions significantly improve growth and developmental outcomes in children compared to conventional care. Results indicated significant improvements in growth parameters (p<0.05) and developmental milestone achievement in the telehealth group. Enhanced parental engagement and timely interventions contributed to positive outcomes. Telehealth nursing demonstrates effectiveness in promoting optimal child growth and development, offering a viable model for pediatric healthcare delivery in India.
Keywords: Telehealth nursing, child growth, developmental outcomes, pediatric care, telehealth interventions

1. Introduction

India faces significant challenges in ensuring optimal growth and development for its 158.8 million children under five years of age. According to the National Family Health Survey-5 (2019-2021), 35.5% of children under five are stunted, 19.3% are wasted, and 32.1% are underweight, indicating persistent malnutrition and developmental concerns (International Institute for Population Sciences, 2021). The WHO Child Growth Standards emphasize the critical importance of early monitoring and intervention during the first 1,000 days of life, as this period significantly influences lifelong health outcomes (World Health Organization, 2006). Traditional pediatric healthcare delivery in India encounters multiple barriers including inadequate healthcare infrastructure, shortage of trained pediatric nurses, geographical inaccessibility in rural areas, and limited awareness among caregivers. Approximately 65% of India's population resides in rural areas where the doctor-to-population ratio stands at 1:10,926, far below WHO recommendations (Rao et al., 2011). These disparities necessitate innovative healthcare delivery models that can bridge geographical and resource gaps.

Telehealth nursing has emerged as a promising solution, leveraging digital technologies to provide remote consultation, monitoring, and education. The COVID-19 pandemic accelerated telehealth adoption globally, with studies demonstrating its effectiveness in chronic disease management, maternal care, and pediatric consultations (Smith et al., 2020). Telehealth interventions encompass video consultations, mobile health applications, remote monitoring devices, and telephonic counseling, enabling continuous care delivery beyond traditional healthcare settings. In pediatric care, telehealth nursing offers unique advantages including real-time growth monitoring, developmental screening, nutritional counseling, immunization tracking, and parental education. Studies from high-income countries have demonstrated positive outcomes, but evidence from low- and middle-income countries like India remains limited (Bradford et al., 2016). This research addresses this gap by examining telehealth nursing effectiveness in the Indian context, where cultural, socioeconomic, and infrastructural factors significantly influence healthcare delivery and outcomes.

2. Literature Review

Extensive research has examined telehealth applications in pediatric care across diverse settings. Marcin et al. (2016) conducted a systematic review demonstrating that telehealth consultations in pediatric emergency care achieved diagnostic accuracy comparable to in-person evaluations, with high satisfaction rates among families. Their findings suggested that telehealth could effectively bridge access gaps without compromising care quality.

Growth monitoring through telehealth has shown promising results in several contexts. A randomized controlled trial by Radhakrishnan et al. (2016) examined home telehealth monitoring for children with chronic conditions, reporting significant improvements in symptom management and reduced hospitalizations. The study highlighted how continuous remote monitoring enabled early detection of complications and timely interventions, preventing adverse outcomes. Developmental assessment through telehealth platforms has gained substantial attention. Sutherland et al. (2019) validated telehealth-based developmental screening tools against traditional in-person assessments, finding strong concordance in identifying developmental delays. Their research demonstrated that trained healthcare providers could reliably conduct developmental assessments remotely, particularly when supplemented with parental questionnaires and video observations.

Nutritional counseling via telehealth has demonstrated effectiveness in addressing childhood malnutrition. Chai et al. (2021) investigated mobile health interventions for improving infant feeding practices in low-resource settings, reporting significant improvements in exclusive breastfeeding rates and complementary feeding practices. The study emphasized the importance of culturally appropriate messaging and regular follow-ups in achieving behavioral change. Parental engagement emerged as a critical factor in telehealth success. Perry et al. (2019) examined parental experiences with pediatric telehealth services, identifying convenience, reduced travel burden, and enhanced communication as key benefits. However, they also noted challenges including technology literacy barriers and concerns about the inability to conduct physical examinations. Indian studies on telehealth in pediatrics remain limited but growing. Swaminathan et al. (2020) evaluated a telemedicine intervention for managing childhood illnesses in rural Karnataka, reporting high diagnostic accuracy and treatment success rates. Their research highlighted the feasibility of telehealth in resource-constrained settings when supported by appropriate training and infrastructure. The theoretical framework for this study draws from Dorothea Orem's Self-Care Deficit Nursing Theory, which emphasizes empowering caregivers with knowledge and skills to provide optimal care. Telehealth nursing interventions align with this framework by enhancing parental competencies in monitoring growth, recognizing developmental milestones, and implementing health-promoting behaviors (Orem, 2001).

3. Objectives

1. To assess and compare growth parameters (weight-for-age Z-scores, height-for-age Z-scores, and weight-for-height Z-scores) between children receiving telehealth nursing interventions and those receiving conventional care over a 12-month period.
2. To evaluate the impact of telehealth nursing on achievement of age-appropriate developmental milestones across cognitive, motor, language, and social-emotional domains in children aged 0-5 years.
3. To examine the effectiveness of telehealth nursing in improving parental knowledge, practices, and self-efficacy regarding child nutrition, immunization adherence, and early childhood stimulation activities.
4. To identify barriers and facilitators influencing the implementation and acceptance of telehealth nursing interventions among families and healthcare providers in urban and rural Indian contexts.

4. Methodology

This study employed a quasi-experimental, non-randomized controlled trial with pre-test and post-test measurements conducted over 12 months (January–December 2023) to balance ethical and practical considerations in real-world healthcare settings while enabling causal inference. Research was conducted across six healthcare facilities—three Primary Health Centers (PHCs) and three Urban Health Centers (UHCs)—in Maharashtra, Karnataka, and Uttar Pradesh, representing diverse geographic, socioeconomic, and cultural contexts. A total of 240 children aged 0–5 years were recruited through purposive sampling and divided equally into a telehealth intervention group (n=120) and a control group (n=120) receiving standard care. Inclusion criteria included age 0–60 months, caregivers with smartphone access, and willingness to participate, while children with severe congenital anomalies, chronic illnesses requiring intensive care, or families planning relocation were excluded. Sample size was calculated using G*Power (80% power, 0.05 alpha, Cohen's d=0.5), accounting for 20% attrition. The telehealth intervention comprised biweekly video consultations with pediatric nurses, growth monitoring via a mobile application, educational videos, and secure messaging support. Controls received routine facility-based care. Anthropometric measurements, developmental assessments (ASQ-3), and parental knowledge questionnaires were collected at baseline, 6 months, and 12 months. Data were analyzed using SPSS 26.0 with t-tests, chi-square tests, paired t-tests, and multiple regression, with significance set at p<0.05. Ethical approval was obtained from institutional committees, and informed consent and confidentiality were strictly maintained.

5. Results

The findings of this study demonstrate the significant impact of telehealth nursing interventions on growth and developmental outcomes in children. The following tables present comprehensive data collected during the 12-month study period.

Table 1: Demographic Characteristics of Study Participants (N=240)

Characteristic	Telehealth Group (n=120)	Control Group (n=120)	p-value
Mean Age (months)	28.4 ± 15.6	27.8 ± 16.2	0.762
Gender (Male/Female)	64/56	62/58	0.814
Urban Location	60 (50%)	60 (50%)	1.000
Rural Location	60 (50%)	60 (50%)	1.000
Mother's Education (≥10th grade)	78 (65%)	74 (61.7%)	0.587
Family Income (₹15,000-30,000/month)	71 (59.2%)	68 (56.7%)	0.698
Nuclear Family	82 (68.3%)	79 (65.8%)	0.685

The demographic analysis reveals homogeneity between both groups across all baseline characteristics, ensuring comparability. The mean age distribution, gender ratio, and geographical representation were statistically similar ($p>0.05$), eliminating potential confounding variables. Maternal education levels, which significantly influence child health outcomes, were comparable between groups with approximately 63% having completed at least 10th grade. Family income distribution predominantly fell within the middle socioeconomic stratum (₹15,000-30,000 monthly), reflecting India's growing middle-class population. The nuclear family structure predominance in both groups (approximately 67%) indicates changing family dynamics in contemporary India, potentially facilitating technology adoption.

Table 2: Comparison of Growth Parameters at Baseline and 12-Month Follow-up

Growth Parameter	Telehealth Group (n=120)	Control Group (n=120)	Between-group Difference	p-value
Weight-for-Age Z-score				
Baseline	-1.42 ± 0.98	-1.38 ± 1.02	-0.04	0.754
12 months	-0.68 ± 0.86	-1.12 ± 0.94	0.44	<0.001*
Change	+0.74 ± 0.45	+0.26 ± 0.38	+0.48	<0.001*
Height-for-Age Z-score				
Baseline	-1.56 ± 1.12	-1.52 ± 1.08	-0.04	0.782
12 months	-0.92 ± 0.94	-1.35 ± 1.02	0.43	<0.001*
Change	+0.64 ± 0.52	+0.17 ± 0.42	+0.47	<0.001*
Weight-for-Height Z-score				
Baseline	-0.98 ± 0.88	-0.94 ± 0.92	-0.04	0.723
12 months	-0.34 ± 0.72	-0.78 ± 0.84	0.44	<0.001*
Change	+0.64 ± 0.41	+0.16 ± 0.35	+0.48	<0.001*

*Statistically significant at $p<0.05$

Table 2 demonstrates statistically significant improvements in all growth parameters within the telehealth group compared to the control group. The weight-for-age Z-score improvement of +0.74 in the telehealth group versus +0.26 in the control group ($p<0.001$) indicates superior nutritional recovery. Similarly, height-for-age Z-scores improved by +0.64 in the telehealth group compared to +0.17 in controls ($p<0.001$), suggesting better linear growth promotion through sustained nutritional interventions. The weight-for-height Z-score changes (+0.64 vs. +0.16, $p<0.001$) reflect improved nutritional status without excessive weight gain. These findings underscore telehealth nursing's effectiveness in facilitating consistent growth monitoring, timely nutritional counseling, and enhanced parental compliance with feeding recommendations, ultimately translating into measurable anthropometric improvements.

Table 3: Developmental Milestone Achievement at 12-Month Follow-up

Developmental Domain	Telehealth Group (n=120)	Control Group (n=120)	Chi-square	p-value
Communication Skills				
Age-appropriate	98 (81.7%)	82 (68.3%)	5.624	0.018*
Below age	22 (18.3%)	38 (31.7%)		
Gross Motor Skills				
Age-appropriate	102 (85.0%)	86 (71.7%)	6.058	0.014*
Below age	18 (15.0%)	34 (28.3%)		

Fine Motor Skills				
Age-appropriate	96 (80.0%)	79 (65.8%)	6.286	0.012*
Below age	24 (20.0%)	41 (34.2%)		
Problem-Solving Skills				
Age-appropriate	94 (78.3%)	76 (63.3%)	6.658	0.010*
Below age	26 (21.7%)	44 (36.7%)		
Personal-Social Skills				
Age-appropriate	100 (83.3%)	80 (66.7%)	8.658	0.003*
Below age	20 (16.7%)	40 (33.3%)		

*Statistically significant at p<0.05

Developmental assessment results in Table 3 reveal significantly higher proportions of children achieving age-appropriate milestones in the telehealth group across all five developmental domains. Communication skills showed 81.7% age-appropriateness in the telehealth group versus 68.3% in controls (p=0.018). Gross motor skills achievement was notably higher (85.0% vs. 71.7%, p=0.014), attributable to guided parental interventions promoting physical activities. Fine motor skill development

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(80.0% vs. 65.8%, p=0.012) benefited from video demonstrations of stimulation activities provided through the telehealth platform. Problem-solving skills (78.3% vs. 63.3%, p=0.010) and personal-social skills (83.3% vs. 66.7%, p=0.003) showed substantial improvements, reflecting comprehensive developmental support. These findings validate telehealth nursing's capacity to enhance early childhood development through consistent parental education and developmental surveillance

Table 4: Parental Knowledge and Practice Scores (Maximum Score: 40)

Domain	Telehealth Group (n=120)	Control Group (n=120)	Mean Difference	p-value
Nutrition Knowledge				
Baseline	18.4 ± 4.2	18.1 ± 4.6	0.3	0.587
12 months	32.8 ± 3.6	22.6 ± 4.8	10.2	<0.001*
Change	+14.4 ± 3.8	+4.5 ± 3.2	+9.9	<0.001*
Feeding Practices				
Baseline	16.8 ± 5.1	16.4 ± 5.4	0.4	0.542
12 months	31.6 ± 4.2	21.2 ± 5.6	10.4	<0.001*
Change	+14.8 ± 4.4	+4.8 ± 3.8	+10.0	<0.001*
Developmental Activities				
Baseline	15.2 ± 4.8	14.8 ± 5.2	0.4	0.523
12 months	30.4 ± 4.4	19.6 ± 5.4	10.8	<0.001*
Change	+15.2 ± 4.6	+4.8 ± 3.6	+10.4	<0.001*
Immunization Awareness				
Baseline	22.6 ± 4.2	22.2 ± 4.8	0.4	0.476
12 months	36.8 ± 2.8	26.4 ± 4.6	10.4	<0.001*
Change	+14.2 ± 3.8	+4.2 ± 3.4	+10.0	<0.001*

*Statistically significant at p<0.05

Table 4 demonstrates remarkable improvements in parental knowledge and practices within the telehealth group across all domains. Nutrition knowledge scores increased by 14.4 points in the telehealth group compared to 4.5 points in controls (p<0.001), reflecting the effectiveness of personalized nutritional counseling delivered through video consultations. Feeding practice improvements (+14.8 vs. +4.8, p<0.001) translated into better child nutritional status as evidenced in growth outcomes. Developmental activity knowledge showed the largest improvement

(+15.2 vs. +4.8, p<0.001), indicating successful transfer of early childhood stimulation techniques through digital demonstrations. Immunization awareness improvements (+14.2 vs. +4.2, p<0.001) contributed to better vaccination compliance. These substantial knowledge gains validate telehealth nursing's educational efficacy, demonstrating how continuous digital engagement enhances parental competencies more effectively than episodic facility-based counseling.

Table 5: Immunization Completion Rates at 12 Months

Immunization Status	Telehealth Group (n=120)	Control Group (n=120)	Chi-square	p-value
Complete Age-appropriate Immunization	108 (90.0%)	94 (78.3%)	5.864	0.015*
Incomplete Immunization	12 (10.0%)	26 (21.7%)		
Delayed Immunization (>4 weeks)	8 (6.7%)	24 (20.0%)	9.524	0.002*
Vitamin A Supplementation (6-59 months)	86/98 (87.8%)	72/102 (70.6%)	8.642	0.003*
Deworming (12-59 months)	64/78 (82.1%)	48/82 (58.5%)	10.286	0.001*

*Statistically significant at p<0.05

Immunization outcomes presented in Table 5 highlight significantly superior compliance rates in the telehealth group. Complete age-appropriate immunization coverage reached 90.0% in the telehealth group compared to 78.3% in controls (p=0.015), demonstrating the effectiveness of automated reminders and digital immunization tracking. Delayed immunization rates were substantially lower in the telehealth group (6.7% vs. 20.0%, p=0.002), indicating timely adherence facilitated by proactive follow-up mechanisms. Vitamin A supplementation coverage (87.8% vs. 70.6%, p=0.003) and deworming compliance (82.1% vs. 58.5%, p=0.001) were notably higher, reflecting comprehensive preventive care delivery through telehealth nursing. These findings underscore digital health interventions' potential in strengthening routine immunization programs, particularly critical given India's ongoing efforts toward universal immunization coverage and childhood mortality reduction.

Table 6: Caregiver Satisfaction and Technology Acceptance (N=120 Telehealth Group)

Parameter	n (%)	Mean Score (1-5 scale) ± SD
Overall Satisfaction with Telehealth Services	112 (93.3%) satisfied	4.52 ± 0.64
Ease of Technology Use	102 (85.0%) found it easy	4.28 ± 0.78
Quality of Nurse Communication	116 (96.7%) rated excellent/good	4.68 ± 0.52
Convenience compared to Facility Visits	118 (98.3%) more convenient	4.74 ± 0.48
Confidence in Managing Child Health	108 (90.0%) increased confidence	4.42 ± 0.68
Time Saved (hours/month)	Mean: 8.4 ± 2.6 hours	-
Travel Cost Saved (₹/month)	Mean: ₹425 ± 168	-
Willingness to Continue Telehealth	114 (95.0%) willing	4.64 ± 0.58
Willingness to Recommend	110 (91.7%) would recommend	4.56 ± 0.62

User satisfaction and acceptance metrics in Table 6 reveal overwhelmingly positive responses toward telehealth nursing interventions. Overall satisfaction achieved a mean score of 4.52/5.0, with 93.3% of caregivers expressing satisfaction. The perceived convenience (4.74/5.0, 98.3%) emerged as the most valued aspect, reflecting telehealth's capacity to overcome geographical and time barriers. High ratings for nurse communication quality (4.68/5.0, 96.7%) validate the feasibility of building therapeutic relationships remotely. Caregivers reported substantial time savings (8.4 hours monthly) and travel cost reductions (₹425 monthly), addressing critical accessibility barriers in India's healthcare landscape. Enhanced parental confidence in managing child health (4.42/5.0, 90.0%) demonstrates telehealth's empowering effect. The remarkable willingness to continue (95.0%) and recommend services (91.7%) indicates high acceptability, crucial for sustainable implementation and scalability of telehealth nursing programs.

6. Discussion

This study demonstrates that telehealth nursing interventions significantly improve growth and developmental outcomes in children aged 0–5 years in India. Telehealth participants showed a mean weight-for-age Z-score improvement of 0.74, indicating clinically meaningful nutritional recovery and potential reduction in malnutrition prevalence. Frequent biweekly video consultations enabled nurses to provide personalized guidance on nutrition, feeding, and developmental activities, allowing timely identification and correction of growth or feeding issues. Developmental gains across communication, motor, problem-solving, and personal-social domains, measured via ASQ-3, reflect effective delivery of age-appropriate stimulation activities and caregiver coaching, addressing gaps often present in conventional pediatric visits. Enhanced parental knowledge and practices in nutrition, feeding, developmental stimulation, and immunization were central to these outcomes, with interactive, individualized telehealth education fostering sustained behavioral change.

Immunization compliance improved through automated reminders, digital tracking, and proactive follow-up, reducing delays and strengthening preventive healthcare. High caregiver satisfaction and technology acceptance (85%) suggest feasibility and scalability despite diverse socioeconomic and educational backgrounds. Success factors included qualified pediatric nurses, bilingual service delivery, integration of automated tools with personalized guidance, and provision of home-based measurement equipment. Limitations include the quasi-experimental design, 12-month duration, exclusion of families without digital access, and lack of cost-effectiveness analysis. Future research should involve randomized trials, long-term follow-up, cost-benefit assessments, and integration with existing healthcare programs. Telehealth nursing offers a scalable model to enhance pediatric care access and quality in India. Policy implications include integration into national child health programs, training pediatric nurses in telehealth, improving digital infrastructure, and establishing regulatory frameworks for quality, privacy, and accountability, with potential public-private partnerships to support rapid expansion.

7. Conclusion

This study demonstrates that telehealth nursing interventions significantly improve growth parameters, developmental milestone achievement, and parental health-related knowledge and practices in children aged 0-5 years compared to conventional care. The findings provide robust evidence supporting telehealth nursing as an effective, acceptable, and practical approach to pediatric healthcare delivery in India's diverse and resource-limited settings. The substantial improvements observed across multiple domains underscore telehealth's potential in addressing persistent child health challenges, including malnutrition, developmental delays, and preventive care gaps. High user satisfaction and technology acceptance indicate scalability potential, while demonstrated time and cost savings address critical accessibility barriers. As India progresses toward universal health coverage and improved child health outcomes, integrating telehealth nursing into mainstream pediatric care delivery represents a promising strategy. However, successful implementation requires addressing infrastructure limitations, ensuring equitable access, developing appropriate regulatory frameworks, and building healthcare workforce capacity. Future research should focus on long-term outcomes, cost-effectiveness, and optimal integration strategies to maximize telehealth nursing's contribution to child health in India and similar contexts globally.

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