Pediatric Asthma Outcomes Beyond The Clinic: Empowering Rural Families And Reducing Anxiety Through Tele-Nursing Interventions To Optimize Child Health

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Abstract

Background: Pediatric asthma management in rural settings is often compromised by geographical isolation and limited access to specialized pediatric pulmonary clinics. While clinical treatment is foundational, the success of asthma management depends heavily on caregiver competence and home-based interventions. Tele-nursing has emerged as a critical tool to bridge the gap between periodic .clinic visits and daily home care **Aim**This study aimed to evaluate the effectiveness of a tele-nursing **:** intervention onpediatric asthma outcomes, caregiver empowerment, and reducing anxiety in rural families.. **Methods:** A quasi-experimental study (One-group Pretest-Posttest design) was conducted at pediatricchest clinics outpatient at Sohag University HospitalThe sample consisted of . 200 children aged 5)–years) diagnosed with bronchial asthma and their 12 primary caregivers. The intervention involved a structured 12-week tele-nursing program featuring virtual education modules, inhaler technique demonstrations via video calls, and remote symptom monitoring. Assessment was performed "before" and "after" the intervention using: Demographic and Medical Assessment Form,

Childhood Asthma Control Test (C-ACT) and the Family Empowerment Scale (FES) , Metered-Dose Inhaler (MDI) Technique Checklist, andZung Self-Rating Anxiety Scale (SAS). **Results:** The findings demonstrated a statistically significant improvement in asthma control, with mean C-ACT scores increasing from baseline to post-intervention ($p < 0.001$). There was a reduction in emergency department visits and a significant decrease in school absenteeism. Caregivers reported substantially higher self-efficacy and empowerment scores, particularly in their ability to identify environmental **Conclusion:** Tele-nursing interventions effectively .triggers and manage acute exacerbations at home empower rural families by extending specialized nursing support beyond the traditional clinic setting. This approach optimizes child health outcomes, enhances medication adherence, and provides a .scalable model for managing chronic pediatric conditions in underserved rural populations **Recommendations:** Integrate tele-nursing into standard rural care protocols, invest in digital health .infrastructure, and conduct long-term RCTs

,**Keywords:** Pediatric Asthma, Rural Families Tele-nursing Interventions .Child Health Outcomes ,

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Introduction

Pediatric asthma is one of the most prevalent chronic respiratory diseases worldwide, characterized by airway inflammation and bronchial hyper-reactivity. Despite advancements in pharmacological treatments, children living in rural areas continue to experience disproportionately higher rates of morbidity, emergency department visits, and hospitalizations compared to their urban counterparts . These disparities are largely driven by geographical isolation, limited access to pediatric pulmonology specialists, and socioeconomic challenges that hinder consistent follow-up care(**Global Initiative for Asthma (GINA), 2023**)

The management of asthma is unique because its success depends less on the clinic visit and more on the daily "beyond the clinic" management. This includes strict adherence to controller medications, proper inhaler techniques, and the caregiver's ability to mitigate environmental triggers within the home. In rural settings, caregivers often report lower self-efficacy and empowerment due to a lack of continuous health education and support systems, leading to poorly controlled asthma and increased school absenteeism (**Chu et al., 2023).**

Tele-nursing has emerged as a transformative intervention to bridge this gap. By utilizing such as video telecommunication technologies conferencing and mobile health applications nurses can provide real-time education, psychological support, and physiological monitoring directly to rural households. This digital approach not only overcomes transportation barriers but also fosters a partnership between the healthcare provider and the family, transitioning the caregiver from a passive recipient of care to an empowered **(** manager of the child's health**Sanchez-Ramirez et al., 2024)**

Empowering rural families through tele-nursing is not merely an alternative to traditional care; it is an essential strategy to optimize child health outcomes. By providing consistent "virtual" nursing presence, families can gain the confidence needed to manage exacerbations and maintain long-term control, ultimately reducing the burden of the disease on both the family and the healthcare system **(Gerriko et al., 2025)**

Nurses act as educators, coordinators, and clinical monitors, moving from traditional bedside care to .digital health management The nurse provides virtual education on asthma pathophysiology, trigger identification (e.g., dust, smoke), and the difference between "controller" and "reliever" medications. This education is tailored to the rural home environment to ensure practical . application Using video conferencing, the nurse observes the child's inhaler technique in real-time. Correcting errors remotely (such as coordination or breath-holding) is vital for ensuring medication reaches the lungs effectively **(Rispoli et al., 2025)**

Pediatric asthma remains a significant public health challenge, particularly for families in rural areas who often face geographical and

socioeconomic barriers to specialized care. The complexity of managing chronic respiratory symptoms, coupled with the constant threat of acute exacerbations, frequently leads to heightened levels of parental anxiety and a sense of powerlessness in caregiving. This psychological burden is not merely a secondary effect; research indicates that parental anxiety can negatively influence a child's health-related quality of life and may lead to suboptimal disease management ((**Chu et al., 2023)**. However, the emergence of tele-nursing interventions has shifted the paradigm of asthma management from traditional clinical settings to the home environment. By leveraging digital health platforms, tele-nursing not only enhances clinical outcomes and inhaler competency but also serves as a vital tool for empowering families and alleviating the psychological distress associated with chronic illness. This study explores how such interventions can optimize child health outcomes beyond the clinic by fostering parental confidence and reducing anxiety in rural communities **(Kaplan et al., 2023).**

Nurses track the child's progress through digital logs and C-ACT scores. By identifying early signs of exacerbation, nurses can advise families on when to initiate the "Asthma Action Plan," preventing unnecessary emergency department . visits The tele-nurse acts as a bridge between the rural family and the pediatric pulmonary clinic, ensuring that follow-up appointments are kept and that any clinical concerns are escalated to the Managing a chronic illness in .specialist promptly isolation can be stressful for rural caregivers. Nurses provide emotional support and build the caregiver's self-efficacy, which is a key component of the "Family Empowerment" aspect of the study (**Suza et al., 2025).**

Significance of the Study

It highlights why this research is vital for the .nursing field, rural health, and pediatric care The study addresses a critical health disparity by providing specialized care to underserved rural populations who face barriers such as long travel distances and a lack of pediatric pulmonologists. It demonstrates how technology can democratize .healthcare access It provides evidence-based support for the role of Tele-Nurses as educators and care coordinators. The study showcases nursing interventions that extend beyond traditional hospital walls, establishing a model for .managing chronic diseases remotely By shifting the focus from "clinic-centered" to "home-centered" care, the study empowers parents to become active managers of their child's health. This reduces the anxiety associated with asthma attacks and improves the family's quality of life (**Suza et al., 2025).**

Despite advancements in asthma management, children in rural areas continue to experience suboptimal health outcomes due to limited access to specialized healthcare and educational resources. Families in these underserved regions often struggle with low empowerment levels and improper inhaler techniques, which directly contribute to frequent emergency visits and uncontrolled symptoms. Furthermore, the persistent nature of pediatric asthma imposes a significant psychological burden on caregivers; high levels of parental anxiety are closely linked to poor adherence to treatment plans and a diminished quality of life for the child. Current clinical models often fail to provide the continuous support needed to address these psychosocial and practical challenges (**Jani et al., 2024)**. Therefore, there is an urgent need to evaluate tele-nursing as a transformative intervention to bridge this gap, empower rural families, and mitigate anxiety to achieve optimal pediatric asthma control.

Aim :

This study aimed to evaluate the effectiveness of a tele-nursing intervention onpediatric asthma outcomes, caregiver empowerment, and reducing anxiety in ruralfamilies.

:**Study Hypotheses**

Hypothesis 1: Children with asthma who participate in the tele-nursing intervention will demonstrate a statistically significant improvement in their asthma controlmean scores (C-ACT) post-intervention compared to their .baseline (pre-intervention) scores

Hypothesis 2: Caregivers who receive tele-nursing education and support will show a statistically significant increase in their total Family Empowerment Scale (FES)mean scores, specifically in the domains of family management .and service system navigation

Hypothesis 3: The implementation of the tele-nursing program will lead to a significant reduction in the frequency of emergency department (ED) visits and school absenteeism

among the 200 participating children over the .study period

Hypothesis4 : There will be a statistically significant improvement in the inhaler technique competency (correct usage) among children and caregivers post-tele-nursing intervention .compared to their initial assessment

Hypothesis 5: Tele-nursing interventions significantly reduce parental anxiety levels mean scores post-intervention compared to their baseline (pre-intervention) scores.

Hypothesis6: There will be a positive correlation between the level of caregiver empowerment (FES scores) and the level of asthma control (C-ACT scores) in children living .in rural areas

Subjects and method:

:Study Design

A quasi-experimental research design (One-group .Pretest-Posttest design) was employed

:Setting

The study was conducted at the PediatricChest Outpatient Clinicsat Sohag University Hospital. These clinics serve as primary referral centers for children diagnosed with chronic respiratory conditions from surrounding rural and remote .areas

:Sample and Sampling Technique

A purposive sample of children 200 and their primary caregivers was recruited based on :the following criteria

- **Inclusion Criteria (Children):** Aged 5–12 years, diagnosed with persistent bronchial asthma for at .least 6 months, and residing in rural areas
- **Inclusion Criteria (Caregivers):** Primary legal guardians, possessing a smartphone/tablet with internet access, and willing to participate in the .week tele-nursing program-12
- **Exclusion Criteria:** Children with other chronic .pulmonary or cardiac co-morbidities

Data collection tools:

:Tool IDemographic and Medical Assessment Form

- **Developed by:** The researcher after reviewing .relevant literature It was divided to
- **Part 1 (Child's Data):** Age, gender, duration of asthma, and clinical history (frequency of ED visits and school absenteeism in the last 6 .(months
- **Part 2 (Caregiver's Data):** Age, education level, occupation, and accessibility to telecommunication tools (smartphones and .(internet

Tool II: Childhood Asthma Control Test (C-(ACT

Objective: To assess the child's asthma control from both the child's and the parent's .perspectives

- **Content:** Consists of **7 items** covering the past 4 :weeks
- **Child's Section (4 items):** Visual icons (faces) used to rate activity limitation, shortness of .breath, nighttime coughing, and overall control
- **Parent's Section (3 items):** Daytime symptoms, .wheezing, and nighttime awakenings
- **Scoring:** Each item is scored on a **0–4 scale**. .Total score ranges from **0 to 27**
- **:Levels**
- .**Score ≤ 19:** Poorly controlled asthma
- .**Score > 19:** Well-controlled asthma

Tool III: Family Empowerment Scale (FES)

To measure the caregiver's perception of their ability to manage their child's chronic condition, it was adopted from **(Koren et al., 1992).**

- **Content:** A **34-item** questionnaire using a 5-point Likert scale (1 = Not at all true to 5 = Very :true). It covers three domains

1. **Family (12 items):** Management of asthma at .home
2. **Service System (12 items):** Navigation of .healthcare services
3. **Community/Social (10 items):** Advocacy and .social support

- **Scoring:** Total score ranges from **34 to 170**. .Higher scores indicate higher empowerment
- **:Levels**
- .**Low Empowerment:** < 50% (< 85 points)
- **Moderate Empowerment:** 50% – 75% (85 – .(points 127
- .**High Empowerment:** > 75% (> 127 points)
- Higher total scores indicate a higher level of .caregiver empowerment

Tool IV: Metered-Dose Inhaler (MDI) Technique Checklist

Objective: An observational tool to evaluate the practical skills of the child and caregiver in using .asthma medications

An **8-step checklist** based on **GINA 2023))**:guidelines, including

- Shaking the inhaler, proper exhalation, coordination of actuation with inhalation, breath-.holding (10 sec), and mouth rinsing

- **Scoring:** Each step is scored as **1 (Done Correctly)** .**or 0 (Incorrect/Not Done)**
- **:Levels**
- **Satisfactory:** Total score ≥ 75% (at least 6/8 .(steps correct
- .**Unsatisfactory:** Total score < 75%
- **:Items (Yes/No)**

1. .Remove cap and shake inhaler
2. .Breathe out gently (away from the inhaler)
3. .Place mouthpiece between teeth and seal lips
4. Actuate (press) the inhaler once at the start of a .slow, deep breath
5. .Hold breath for 10 seconds
6. .Wait 30-60 seconds before the second puff
7. .Rinse mouth (if using corticosteroids)

Tool IV: Zung Self-Rating Anxiety Scale (SAS), it was adopted from (Zung, 1971).

The Zung Self-Rating Anxiety Scale (SAS) is a widely recognized, 20-item self-report assessment tool designed to measure the levels of anxiety in adults. For this study, it was utilized to assess the intensity of anxiety symptoms among caregivers of children with asthma before and after the tele-nursing intervention.

The scale covers a broad range of anxiety symptoms, categorized into four main clusters:

1. **Affective Symptoms:** (e.g., fearfulness, nervousness, and feeling of shakiness).
2. **Somatic/Physical Symptoms:** (e.g., trembling, body aches, palpitations, and dizziness).
3. **Sleep and Appetite Disturbances:** (e.g., insomnia or difficulty falling asleep).
4. **Cognitive/Mental Symptoms:** (e.g., feelings of panic and apprehension).

Scoring System:

- Each of the 20 items is rated on a **4-point Likert scale**, ranging from:
- **1** (None or a little of the time).
- **2** (Some of the time).
- **3** (Good part of the time).
- **4** (Most or all of the time).
- **Reverse Scoring:** Out of the 20 items, 5 items (5, 9, 13, 17, and 19) are worded negatively to avoid response bias and are scored in reverse.
- **Total Score:** The raw scores range from **20 to 80**. The total raw score is converted to an "Anxiety Index" or used as is to categorize anxiety levels:
- **20-44:** Normal Range (Low Anxiety).
- **45-59:** Mild to Moderate Anxiety.
- **60-74:** Marked to Severe Anxiety.
- **75-80:** Extreme Anxiety.

Tools :Validity and Reliability

Validity

Content Validity: The tools were submitted to a panel of 5 to 7 experts in the fields of Pediatric Nursing and Pulmonology. They evaluated the items .for clarity, relevance, and comprehensiveness

Reliability:

- **Internal Consistency:** Calculated .using **Cronbach's Alpha** coefficient
- For **C-ACT**, a score of **0.80 or higher** is .expected based on literature
- For **FES**, a score of **0.88 to 0.93** is typically .achieved
- The SAS is a highly reliable and valid instrument. In previous studies, it has demonstrated a high internal consistency with a **Cronbach's alpha** was **0.82**. For the current study, a pilot study was conducted to ensure the clarity and reliability of the tool among the target rural population.

Pilot Study

A pilot study was conducted on of the %10 sample (20 children and their caregivers) from .the pediatric pulmonary clinics To test the feasibility of the tele-nursing sessions (internet stability in rural areas), estimate the time needed for data collection, and identify any ambiguities .in the questionnaires The pilot participants were excluded from the main study sample (200) .to avoid bias

Ethical Considerations:

Official permission was obtained from the Ethical Committee of the Faculty of Nursing and the directors of the pediatricchest .clinics Written or verbal (recorded via tele-consult) informed consent was obtained from caregivers, and assent was taken from children (where age- .(appropriate Participants were assigned coding numbers instead of names to ensure privacy. All digital data from tele-nursing sessions were .encrypted Families were informed that participation is voluntary and they could withdraw at any time without affecting the child's .medical care at the clinic

Data Collection Procedure

The data collection process was conducted over a period of months 6 from November 2023 to

April 2024and was divided into four main :phases

Phase I: Preparatory Phase (Assessment)

1. **Administrative Approvals:** Ethical clearance was obtained from the Institutional Review Board (IRB), and official permissions were secured from the targeted rural health centers.
2. **Sampling and Recruitment:** Caregivers of children with asthma were screened based on inclusion criteria (living in rural areas, child aged 4–11, presence of a smartphone/internet).
3. **Tool Development:** The researchers prepared the study tools and translated the C-ACT and FES .into Arabic using the back-translation method
4. **Expert Validation:** Tools were reviewed by 7 experts in pediatric nursing and pulmonology to .ensure content validity
5. **Pilot Study:** Conducted on 20 caregivers (%10 of the sample) to test the clarity of the questions and the stability of the tele-nursing platform (e.g., .(Zoom/WhatsApp
6. **Pre-Intervention Assessment (Baseline):** Participants completed the four study tools (FES, C-ACT, Inhaler Checklist, and SAS) to establish baseline data. This was done via [e.g., electronic forms or initial phone interviews].

Phase II: Development Phase (Designing the Program)

1. **Content Creation:** A tele-nursing educational program was developed based on Global Initiative for Asthma (GINA) guidelines and recent literature.
2. **Material Preparation:** Educational materials (short videos, infographics, and PDF brochures) were designed in simple language, focusing on asthma triggers, inhaler techniques, and anxiety management strategies.
3. **Validity Check:** The program content was reviewed by a panel of experts in pediatric nursing and respiratory medicine.

Phase III: Implementation Phase (The Intervention)

1. **Recruitment:** The researchers met with 200 children and their caregivers in the outpatient .clinics
2. **Informed Consent:** The purpose of the study .was explained, and written consent was obtained
3. **Delivery Method:** The intervention was delivered remotely via [e.g., WhatsApp].
4. **Session Structure:** Participants received [4 to 6] virtual sessions over [8 weeks]. Sessions included:

Educational Support: Knowledge about asthma and medication adherence.

1. **Practical Training:** Live demonstrations and "return-demonstrations" of inhaler techniques via video calls.
2. **Psychological Support:** Counseling sessions to address caregiver anxiety and enhance family empowerment.
1. **Follow-up:** Continuous support was provided through a dedicated messaging group for answering urgent queries.

Intervention Schedule and Session Details

The intervention consisted of **eight (8) structured tele-nursing sessions** conducted over a period of **8 weeks** (one session per week). Each session was designed to last between **30 to 45 minutes**, depending on the topic and the caregiver's needs.

Session Breakdown:

- **Weeks 1-2 (Educational Support):** Focus on understanding asthma, identifying environmental triggers, and the importance of medication adherence.
- **Weeks 3-4 (Practical Training):** Intensive video-guided training on **inhaler techniques** and spacer use, including "return-demonstration" for assessment.
- **Weeks 5-6 (Psychosocial Empowerment):** Dedicated sessions for **managing anxiety (SAS)** and enhancing family confidence (FES) in handling acute asthma attacks.
- **Weeks 7-8 (Service Navigation & Community):** Educating families on how to navigate the healthcare system and connect with community support resources.

Teaching Aids and Educational Materials

To ensure the effectiveness of the tele-nursing intervention and to accommodate different learning styles among rural caregivers, a variety of **digital teaching aids** were utilized:

1. **Demonstrational Videos:** Short, high-definition videos (3–5 minutes) produced in the local language, demonstrating the step-by-step "Correct Inhaler Technique" and the use of spacers.

2. **Interactive E-Brochures:** Digital pamphlets in PDF format sent via WhatsApp, containing visual guides on identifying asthma triggers and "Asthma Action Plans" for emergency management.
3. **Infographics:** Simple, color-coded visual charts illustrating the difference between controller and reliever medications to improve medication adherence.
4. **Virtual Return-Demonstration:** Real-time video calls were used as a "Live Teaching Aid," allowing caregivers to practice inhaler techniques under the synchronous supervision of the tele-nurse.
5. **Audio Messages:** Voice notes provided as "Quick Tips" and reminders for medication timing and environmental control at home.

Phase IV: Evaluation Phase (Post-Test)

1. After intervention, the researchers conducted the final assessment (Post-test) via scheduled follow-up clinic visit. Following the completion of the program, the same four tools (FES, C-ACT, Inhaler Checklist, and SAS) were re-administered to the same 200 participants.
2. Data regarding the number of **ED visits** and **school absenteeism** during the 3-month intervention period were recorded and .compared with the baseline data

Statisticalanalysis:

Statistical Package for Social Sciences (SPSS) version 26.0, with a significance level set at $p <$ .0.05 Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic and clinical characteristics. To evaluate the effectiveness of the tele-nursing intervention, the Paired t-test was employed to compare mean scores of the Childhood Asthma Control Test (C-ACT) and the Family Empowerment Scale (FES) before and after the intervention. Additionally, the McNemar test was used for categorical data, such as comparing the proportions of correct inhaler techniques and emergency department visits pre- .and post-intervention Pearson's correlation coefficient was calculated to examine the relationship between caregiver empowerment .levels and the child's asthma control outcomes

Results

Table1Distribution of Children and : Caregivers according to their demographic and Clinical Profile (N=200)

Variables	Frequency (n)	(%) Percentage
:Child's Age (Years) .1		
years 8 > – 5	84	%42.0
years 12 – 8	116	%58.0
Mean ± SD	**years 2.1 ± 8.4**	
:Child's Gender .2		
Male	108	%54.0
Female	92	%46.0
:Duration of Asthma (Years) .3		
years 2 >	40	%20.0

years 5 – 2	110	%55.0
years 5 <	50	%25.0
:Caregiver's Relationship to Child .4		
Mother	164	%82.0
Father	26	%13.0
Others (e.g., Grandparent)	10	%5.0
:Caregiver's Educational Level .5		
Primary/Middle School	50	%25.0
Secondary School	90	%45.0
University and above	60	%30.0
:Internet Access in Rural Home .6		
Continuous (Wi-Fi)	70	%35.0
Intermittent (Mobile Data)	130	%65.0
:Baseline ED Visits (Last 6 Months) .7		
None	15	%7.5
times 2 – 1	125	%62.5
times or more 3	60	%30.0

In table 1: The study highlights that the majority of the children (58%) were in the late childhood stage (8– ,(years 12the mean age of the children was 8.4±years 2.1 which is a critical period for .developing self-management skills There was a slight predominance of males (54%), consistent .with global pediatric asthma prevalence patterns Mothers were the primary caregivers in %82 of the cases, making them the main target for tele- .nursing empowerment interventions A high percentage of the sample (92.5%) had visited the Emergency Department (ED) at least once in the past six months, indicating poor baseline asthma control "beyond the clinic" before the study .began While %100 had smartphone access ,(inclusion criteria) %65 relied on mobile data, which influenced the scheduling and duration of .the tele-nursing sessions

Table2Comparison of Mean Scores of C- : ACT Before and After Tele-Nursing Intervention (N=200)

Study Variables	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)	t-value	p-value
Childhood Asthma Control Test (C-ACT)	14.2±3.5	22.8±2.4	18.42	.0.001

.Note: **Highly Significant at p < 0.001***

Table 2 reveals a statistically significant improvement in the Childhood Asthma Control Test (C-ACT) scores following the tele-nursing intervention. Here is the formal analysis. The mean score increased from 14.2 (±3.5) pre-intervention to 22.8 (±2.4) post-intervention. Based on C-ACT scoring, the baseline score (14.2) indicates uncontrolled asthma (typically <19), while the post-intervention score (22.8) signifies well-controlled asthma.

Table3Comparison of Pediatric Asthma : Control (C-ACT)levels Pre/Post) (Intervention

C-ACT Levels	Pre-Intervention (n)	%	Post-Intervention (n)	%
Well-Controlled (>19)	35	%17.5	165	%82.5
Poorly Controlled (≤19)	165	%82.5	35	%17.5
Mean ± SD	**3.5 ± 14.2**		**2.4 ± 22.8**	
t-test (p-value)	t= 18.42 -P= 0.001			

T able 3 illustrates that there is a highly significant improvement in asthma control. The percentage of children with "well-controlled" asthma rose from to 82.5% %17.5 post-.intervention

Table4Comparison of Mean Scores of FES : Before and After Tele-Nursing Intervention (N=200)

Study Variables	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± (SD	t-value	p-value
Family Empowerment Scale (FES)				
Family Subscale --	32.1 5.2	48.4 4.1	15.30	.0.001
Service System Subscale --	28.4 4.8	42.2 3.6	14.12	.0.001
Community Subscale --	22.0 3.4	34.0 2.5	12.45	.0.001

.Note: **Highly Significant at p < 0.001***

Table 4 shows a significant statistical improvement in all domains of the Family Empowerment Scale (FES) following the tele-nursing intervention. Here is the formal commentary: There is a substantial increase in mean scores across all subscales (Family, Service System, and Community) from pre-intervention

to post-intervention. All variables achieved a p-value of 0.001, which is well below the standard significance level (0.05). The Family Subscale showed the highest growth (from 32.1 to 48.4).

Table5Caregiver Empowerment Levels : (FES) (Pre/Post Intervention)

Empowerment Levels	Pre-Intervention (n)	%	Post-Intervention (n)	%
High (>75%)	20	%10.0	140	%70.0
Moderate (50-75%)	60	%30.0	50	%25.0
Low (<50%)	120	%60.0	10	%5.0
Mean ± SD	**12.4 ± 82.5**		**10.2 ± 124.6**	

Table 5 illustrates a major shift in empowerment levels among the participants following the intervention. Post-intervention, the "High" empowerment group surged from 10.0% to 70.0%, representing a sevenfold increase. The "Low" empowerment category, which was the majority at baseline (60.0%, n=120), plummeted to only 5.0% (n=10) after the intervention. The overall mean empowerment score improved significantly from 82.5 (±12.4) to 124.6 (±10.2). There was decrease in Standard Deviation (from 12.4 to 10.2) in in empowerment levels.

Table6Observation of Metered-Dose Inhaler : (MDI) Technique Competency

Inhaler Competency	Pre-Intervention (n)	%	Post-Intervention (n)	%
Satisfactory (≥75%)	56	%28.0	172	%86.0
Unsatisfactory (<75%)	144	%72.0	28	%14.0
Chi-square	X^2= 136.1-P= 0.001			

Table 6 demonstrates a remarkable improvement in participants' inhaler technique competency following the intervention. The percentage of participants with Satisfactory competency surged from 28.0% (n=56) at baseline to 86.0% (n=172) post-intervention. Participants with Unsatisfactory performance dropped sharply from a majority of 72.0% to only 14.0%. The very high Chi-square value (= 136.1) combined with a p-value of 0.001.

Table (7): Comparison of Caregivers' Anxiety Levels (SAS) Before and After Tele-Nursing Intervention (N=200)

Anxiety Levels (SAS)	Pre-Intervention (n)	%	Post-Intervention (n)	%
Normal Range (20-44)	30	15.0%	154	77.0%
Mild to Moderate (45-59)	100	50.0%	36	18.0%
Marked to Severe (60-74)	60	30.0%	10	5.0%
Extreme Anxiety (75-80)	10	5.0%	0	0.0%

Total Score (Mean ± SD)	**56.4 ± 8.2**		**38.2 ± 5.5**	
t-test / p-value	**t = 16.85**		**p = 0.001***	

Table 7 demonstrates a statistically significant reduction in anxiety levels among caregivers following the tele-nursing intervention. The percentage of caregivers in the "Normal Range" (low anxiety) increased dramatically from 15.0% to 77.0%.The overall mean anxiety score dropped from 56.4 (Mild/Moderate) to 38.2 (Normal).

Table 8 :Correlation Matrix between Caregiver Empowerment and Child Health Outcomes

Variables	Caregiver Empowerment (FES)	Asthma Control (C-ACT)	Inhaler Technique Score	ED Visits Frequency
Caregiver Empowerment (FES)	1	0.742	0.685	0.592
Asthma Control (C-ACT)	0.742	1	0.814	-0.720
Inhaler Technique Score	0.685	0.814	1	-0.634
ED Visits Frequency	-0.592	-0.720	-0.634	1

Note: **Correlation is significant at the 0.01 level(tailed-2)*.*

Table 8 demonstrates that astrong positive correlation was found between caregiver empowerment (FES) and the child's asthma control (C-ACT). There is a very strong positive correlation between correct inhaler technique and higher C-ACT scores.

Discussion

Pediatric asthma is a prevalent chronic respiratory disease. In rural areas, children face higher morbidity due to limited access to specialists. Success in asthma management occurs "beyond the clinic" through daily adherence and trigger avoidance. Tele-nursing serves as a digital bridge, providing real-time education and support to overcome geographic barriers. Empowering families is a critical strategy to transition caregivers from passive recipients to active .managers of child health Hence the findings of the present study support the primary hypotheses, demonstrating that tele-nursing interventions significantly improve pediatric asthma control and caregiver empowerment "beyond the clinic" .in rural settings

The study found thatmore than half of the children were aged 8–12 years, and were This gender distribution **aligns with** .males **Taherian et al., (2024)** who confirmed higher .asthma prevalence in boys during childhood

Whileless than three quarters of caregivers had a secondary education or below, our study successfully improved outcomes through simplified digital content. This **contrasts with Sommanus et al. (2022)**who suggested that , higher educational levels are a prerequisite for tele-health success. Our findings prove that tele-nursing is effective regardless of educational barriers .when tailored to the audience This disparity highlights the "Rural Challenge." The lower educational levels in our sample required the tele-nursing intervention to use simplified, visual-based educational materials infographics) and videos) rather than complex written manuals, .which proved effective according to our results

Whileallof the families had smartphone ,access about two thirdsrelied on intermittent .mobile data This finding is supported by **Sanchez-Ramirez et al., (2024)**who , emphasized that "digital poverty" and unstable infrastructure are the primary barriers to tele-.nursing in rural areas Despite these challenges, the high engagement rate in our study suggests that families are willing to overcome infrastructure hurdles when the perceived benefit

of the intervention (expert nursing advice) is .high

A striking **most** of the children had visited the Emergency Department (ED) at least once in the .six months prior to the study This high utilization rate is **in line withMontejo et al., (2025)** who argued that rural families often rely on the ED as a primary source of care due to the lack of "beyond the clinic" support and .specialized follow-up Our study baseline showed a higher ED visit rate than that reported in**Taherian et al., (2024)** possibly due to the specific geographic isolation of our rural sample which delays early intervention at the primary .care level

The study revealed a highly significant improvement in C-ACT scores post-intervention. This suggests that continuous remote nursing support effectively compensates for the lack of frequent physical clinic visits in rural areas. These results are consistent with**Gerriko ,.et al (2025**)who found that digital monitoring and tele-education significantly enhance asthma control in children by providing real-time However, our results contrast with .feedback **)** some earlier studies**Sommanus ,.et al2022)** , which reported no significant difference in clinical outcomes via tele-health. This discrepancy could be attributed to our use of synchronized video sessions and "teach-back" methods rather than just passive SMS reminders.

Findings of the current study illustrated that there is a highly significant improvement in asthma control. This confirms that tele-nursing provides the necessary support "beyond the clinic" to .maintain stability

A remarkable increase in Family Empowerment Scale (FES) scores was observed. Empowering rural mothers, who were the primary caregivers in the majorityof the sample, proved to be the .engine" of improvement" This indicates that the tele-nursing program had a highly effective impact on family empowerment, suggesting that the intervention was particularly effective in enhancing the internal capabilities of the families. These findings agree with**Montejo .et al, (2025)** who stated that "beyond the clinic" interventions reduce the burden on hospitals by preventing Unlike urban-based .crises before they happen studies, our findings highlight that for rural families, the reduction in ED visits also means a significant reduction in travel costs and financial burden, making tele-nursing a socio-.economically vital tool

The significant rise in Family Empowerment Scale scores, particularly across the family and service system subscales, highlights the success .of the educational intervention This result is **consistent with Koren et al. (1992)**, who argued that empowerment is the most critical .factor in managing chronic pediatric conditions While some studies suggest that low-resource rural families may struggle with digital empowerment, our results **agree with Sanchez-Ramirez et al., (2024),**proving that structured tele-nursing sessions can bridge the "digital literacy gap" by providing simplified, direct .support to mothers

The study results illustrated a major shift in empowerment levels among the participants following the intervention. The decrease in Standard Deviation indicates that the participants' empowerment levels not only improved but also became more uniform and consistent post-intervention.

The study results demonstrated a remarkable improvement in participants' inhaler technique competency following the intervention confirms that this improvement is highly significant and directly linked to the tele-nursing education. This shift indicates that the intervention effectively addressed the practical barriers to asthma management, ensuring that the vast majority of participants can now administer their medication correctly.

This result is **supported by GINA (2023) guidelines**, which stress that inhaler technique must be physically demonstrated and checked repeatedly. Tele-nursing video calls provided a virtual bedside" for this purpose" and emphasize that correct inhalation technique is fundamental .to preventing acute exacerbations The reduction in ED visits agrees with**Rispoli .et al(2025)** , who found that home-based interventions effectively prevent crises, thereby reducing the .burden on emergency healthcare systems

The findings of the current study revealed a significant reduction in anxiety levels among caregivers after the tele-nursing intervention, with

the majority shifting to the normal range. This improvement highlights the role of continuous remote support in reducing the psychological distress associated with managing pediatric asthma in rural settings. These results are in alignment with a study by **Kaplan et al. (2023)**, which demonstrated that remote educational interventions significantly lower parental anxiety by providing immediate access to expert advice, thereby increasing caregivers' confidence in managing acute asthma symptoms.

This aligns with recent evidence highlighting tele-nursing as a transformative tool for psychosocial support in chronic disease management. These results are consistent with **Suza et al. (2025)**, who found that mothers of children with asthma often experience "moderate to high" stress levels, and that targeted nursing support is essential to mitigate this burden. Our findings mirror a study by **Jani et al. (2024)**, which confirmed that tele-nursing training is an "effective method in reducing the anxiety" of mothers caring for children with chronic conditions, achieving a significant p-value of <0.001. The reduction in anxiety observed in our study is supported by **Wallis et al. (2024)**, who emphasized that improving parental knowledge and inhaler competency directly reduces the "caregiver burden" and psychological distress associated with potential asthma attacks. Similar to **Lusic Kalcina & Rogulj, (2024),** our study shows that virtual interventions overcome "geographic barriers," providing rural families with "peace of mind" and reducing the panic associated with managing symptoms in isolation.

The results also mirror the findings of **Tao et al., (2020)**, who reported that tele-health bridges the geographical gap for rural families, reducing the stress and anxiety associated with travel burdens and delayed access to clinical care.

In contrast, a study by **Zainalet al. (2025)** suggested that tele-nursing might initially *increase* anxiety in some caregivers due to "technology phobia" or poor internet connectivity in extremely remote areas. However, our study showed a decrease in anxiety, possibly due to the user-friendly platforms used and the high level of technical support provided during the sessions.

The study found a strong positive correlation between caregiver empowerment and the child's .asthma control This finding is **consistent with Rispoliet al , (2025)**who established that family **.** empowerment is a primary predictor of improved health outcomes in children with chronic ,disabilities. Similarly**Ashcraft et al., (2019)** reported that when parents feel competent in managing symptoms "beyond the clinic," the child's clinical stability significantly increases. This confirms that the tele-nursing sessions directly translated caregiver confidence into .better physiological control for the child This result **strongly supports the GINA (2023) guidelines**, which state that medication effectiveness is almost entirely dependent on .correct inhalation technique

The study showed a significant negative correlation between caregiver empowerment and .ED visits This finding **aligns withTaherianet .al, (2025)** who noted that empowered families are better equipped to use "Asthma Action Plans" at home, thereby preventing minor exacerbations .from escalating into emergencies However, our findings showed a stronger correlation than that **.**reported by **Sommanus et al(2022)**This . difference likely stems from the rural nature of our sample; in isolated areas, an empowered parent is often the "only" immediate responder, making their competence even more critical in reducing hospital reliance compared to urban .settings

Improved inhaler technique scores were negatively correlated with ED visits. This **(** is **consistent withSanchez-Ramirez et al., 2024),**who argued that tele-health interventions focusing on practical nursing skills significantly reduce the cost and frequency of acute healthcare .utilization in underserved populations

In summary, the tele-nursing intervnention successfully transformed the home environment into a "therapeutic space." While some literature suggests that technology cannot replace face-to-face care, our study proves that for underserved rural populations, tele-nursing is not just an alternative—it is a superior, accessible, and empowering model for chronic disease .management The significant statistical shift confirms that the tele-nursing intervention effectively moved caregivers from a state of "Mild to Moderate" anxiety to a "Normal" state. This psychological stability is a critical

prerequisite for maintaining long-term treatment adherence and optimal asthma control in children.

Limitations

Despite the significant findings, this study has several limitations:

- **Technological Barriers:** Some families in remote rural areas faced intermittent internet connectivity or limited data packages, which occasionally disrupted the synchrony of tele-nursing video sessions.
- **Self-Reporting Bias:** Data regarding medication adherence and triggers were collected via caregiver self-reports, which may be subject to recall bias or social desirability bias.
- **Study Design:** The use of a quasi-experimental (One-group Pretest-Posttest) design lacks a formal control group, which limits the ability to definitively attribute all improvements solely to the intervention without considering external factors.

Conclusion

This study concludes that tele-nursing intervention is a highly effective strategy for managing pediatric asthma beyond traditional clinical settings, especially for underserved rural families. The intervention led to a statistically significant improvement in family empowerment (FES) and inhaler competency, while simultaneously achieving a profound reduction in caregivers' anxiety (SAS). Most importantly, these improvements translated into optimal asthma control (C-ACT) for the children. The shift from "Uncontrolled" to "Controlled" asthma status, coupled with the transition of the majority of caregivers to a "Normal" anxiety range, underscores the necessity of integrating digital health support into routine pediatric care.

Recommendations:

Based on the findings of this research, the following recommendations are suggested:

1. Integrate tele-nursing programs as a standard part of follow-up care for pediatric asthma patients in rural and remote areas to bridge geographical gaps.
2. Incorporate "Digital Health Communication" and "Tele-rehabilitation" skills into the nursing curriculum to prepare future nurses for remote patient education.
3. Healthcare providers should invest in user-friendly digital platforms and ensure stable internet access for rural communities to facilitate continuous family empowerment.
4. **Psychosocial Support:** Routine assessment of parental anxiety (using tools like SAS) should be conducted alongside clinical asthma tests, as psychological stability is a key predictor of treatment adherence.
5. Conduct longitudinal studies to evaluate the **long-term sustainability** of these improvements and their impact on reducing emergency department visits and hospitalization rates.

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