

A Digital Nursing Support Program to Enhance Climate Change Resilience and Reduce Eco-Anxiety among Parents of Children with Respiratory Allergies

Shimaa Mohammed Hassan Ali¹, Shaymaa Mahmoud Ahmed Mostafa², Abeer Farag AbdelAzim Ahmed³, Sayeda Mohamed Ahmed Soliman⁴, Lamiaa Abd El Hakeem Ali Ahmed⁵, Entisar Mohammed Mahmoud Abu Salem⁶, Amal Mohamed Elhusein Salih⁷, Murtada Mustafa Gabir Tia⁸, Amna Mohammed Ali Mustafa⁹, Suaad Ahmed Suliman Omer¹⁰, Aida Ahmed Fadlala Ahmed¹¹, Elshimaa Atta Hassan Abdelghafar¹²

¹Assistant Professor of Psychiatric/Mental Health Nursing, Faculty of Nursing, Beni-Suef University. Email: drshimaaahassan145@gmail.com

²Lecturer of Psychiatric and Mental Health Nursing, Faculty of Nursing, Beni-Suef University.

³Lecturer of Community Health Nursing, Badr University in Cairo.

⁴Assistant Professor of Community Health Nursing; North Private College of Nursing; Arar, Saudi Arabia. PhD. Cairo University. Faculty of Nursing. ORCID: <https://orcid.org/0009-0001-7158-9903>. Email: d.sayedamohammed@gmail.com

⁵Lecturer of Psychiatric Mental Health Nursing, Faculty of Nursing, Cairo University, Cairo, Egypt. Assistant Professor of Psychiatric Mental Health Nursing at North Private College of Nursing, Arar, Saudi Arabia. Email: lamiaabdelhakim@cu.edu.eg

ORCID ID: 0009-0004-1688-0230

⁶Assistant Professor of Psychiatric Mental Health Nursing, Faculty of Nursing, Beni-Suef University, Egypt, Badr University in Cairo.

⁷Assistant Professor of Pediatric Nursing, Nursing Department/Faculty of Applied Medical Science/University of Bisha/King Saudi Arabia. Pediatric Department/Faculty of Nursing Science/University of Khartoum/Sudan.

⁸Assistant Professor of Pediatrics Nursing, College of Applied Medical Sciences, University of Bisha, Bisha, Kingdom of Saudi Arabia.

⁹College of Nursing and Health Sciences, Jazan University, Jazan, Saudi Arabia. Email: Amna.m.ali@hotmail.com

¹⁰Assistant Professor in Pediatrics Nursing, Faculty of Nursing AL-BAHA University. Email: sasuliman@bu.edu.sa

¹¹Nursing Department, AlNahda College of Pharmacy and Medical Sciences, Riyadh, Kingdom of Saudi Arabia. Email: a.ahmed@alnahda.edu.sa

¹²Lecturer at Psychiatric and Mental Health Department, Faculty of Nursing, Beni-Suef University.

Received: 25th May, 2026; **Revised:** 6th June, 2026; **Accepted:** 8th June, 2026; **Available Online:** 17th June, 2026

Abstract:

Background: Climate change significantly exacerbates respiratory allergies in children due to prolonged pollen seasons and increased air pollution. These environmental shifts not only threaten children's physical health but also trigger "eco-anxiety" among parents, who feel overwhelmed by the uncontrollable nature of environmental hazards. Nurses, as frontline educators, play a pivotal role in bridging the gap between climate awareness and health management. **Aim:** This study aimed to evaluate the effectiveness of a digital nursing support program to enhance climate change resilience and reduce eco-anxiety among parents of children with respiratory allergies. **Methods:** A quasi-experimental design (pre-test/post-test) was conducted involving a convenient sample of all 300 parents with six months from the Pediatric Outpatient Clinics at Sohag University Hospitals. The digital program was delivered via a mobile-based platform. Data were collected using the Parents' demographic data, Eco-Anxiety Scale and a Climate Resilience Competency Questionnaire. **Results:** Post-intervention findings revealed a statistically significant increase in parents' climate resilience scores ($p < 0.001$). There was a notable improvement in their ability to implement proactive health measures during extreme weather events. Concurrently, levels of eco-anxiety significantly decreased, as parents reported feeling more empowered and less paralyzed by environmental concerns. A strong correlation was found between high resilience levels and improved management of their

children's allergy symptoms. **Conclusion:** The digital nursing support program proved to be an effective tool for equipping parents with the necessary skills to navigate climate-related health challenges. By integrating mental health support with environmental health education, telenursing can foster family resilience in an era of rapid climate change. **Recommendations:** It is recommended to integrate climate-health counseling into routine pediatric nursing care and to expand digital support platforms to reach vulnerable populations at risk of environmental health disparities.

Keywords: Children with Respiratory Allergies, Climate Change Resilience, Digital Nursing Support Program, Eco-Anxiety, Parents.

How to cite this article: Ali SMH, Mostafa SMA, Ahmed AFA, Soliman SMA, Ahmed LAEAH, Salem EMMA, Salih AME, Tia MMG, Mustafa AMA, Omer SAS, Ahmed AAF, Abdelghafar EAH. A Digital Nursing Support Program to Enhance Climate Change Resilience and Reduce Eco-Anxiety among Parents of Children with Respiratory Allergies. *Int J Drug Deliv Technol.* 2026;16(61s): 289-303. DOI: 10.25258/ijddt.16.61s.35

Source of support: Nil.

Conflict of interest: None.

Introduction

Climate change is increasingly recognized as the defining public health challenge of the 21st century, fundamentally altering global weather patterns and air quality. Scientific evidence indicates that rising temperatures extend plant growing seasons, leading to intensified and prolonged pollen cycles. These shifts significantly exacerbate the prevalence and severity of respiratory allergies in pediatric populations (Watts et al., 2021).

Children with respiratory allergies are uniquely vulnerable to environmental stressors driven by climate change, such as increased ground-level ozone and particulate matter. These pollutants act synergistically with aeroallergens to trigger acute asthma exacerbations and allergic rhinitis, complicating the clinical management of these conditions (D'Amato et al., 2020).

Beyond the physiological impacts, the climate crisis has introduced a profound psychological burden known as "eco-anxiety." For parents of children with chronic respiratory issues, this manifests as a chronic fear of environmental doom and a sense of helplessness regarding their child's future health in an unstable climate (Clayton, 2020).

Building climate resilience is essential for families to navigate these emerging risks. Climate resilience in a healthcare context refers to a caregiver's ability to anticipate, prepare for, and adapt to climate-related health threats. Strengthening this resilience allows parents to transition from reactive crisis management to proactive health protection (IPCC, 2022).

Nurses occupy a strategic position at the intersection of environmental health and

clinical practice. As frontline healthcare providers, nurses are uniquely qualified to assess environmental triggers and educate families on the link between climate variables and allergic flares, serving as a vital bridge between scientific data and household application (Kurth, 2017).

In the era of digital transformation, "telenursing" and mobile-based support programs offer innovative pathways for health delivery. Digital nursing platforms provide an accessible, cost-effective medium to deliver real-time guidance, enabling nurses to support a larger volume of parents regardless of geographical barriers (Lehne et al., 2019).

The role of the nurse in managing eco-anxiety involves integrating psychosocial support with environmental education. By validating parental concerns and providing actionable adaptation strategies, nurses help convert "climate paralysis" into empowered advocacy, which is shown to improve overall pediatric health outcomes (Hickman et al., 2021).

Effective nursing interventions must focus on practical skill-building, such as teaching parents how to utilize air quality index (AQI) tools and modify home environments during extreme weather events. These digital interventions empower parents to make informed decisions that mitigate the impact of climate-driven allergens (Nicholas & Breakey, 2024).

Despite the growing threat, there remains a gap in structured support for parents dealing with both the physical and emotional tolls of climate-sensitive allergies. A digital nursing support program addresses this gap by providing a reliable, evidence-based resource that fosters a sense of community and

collective efficacy among caregivers (WHO, 2021).

This study evaluates the impact of a digital nursing intervention focusing on enhancing resilience and alleviating eco-distress. By demonstrating the efficacy of such programs, the research advocates for the integration of climate-health counseling into routine pediatric nursing care to protect the next generation (Gauthier, 2023).

Significance of the Study

This study holds significant importance as it addresses the emerging intersection between climate change, mental health, and pediatric nursing care. By pioneering the use of telenursing to combat "eco-anxiety," the research fills a critical gap in traditional nursing interventions that often overlook the psychological distress caused by environmental instability. Furthermore, the program's focus on enhancing climate resilience empowers parents to move from reactive to proactive management of respiratory triggers, potentially reducing healthcare utilization and acute allergy exacerbations. Ultimately, this study provides an evidence-based model for integrating environmental health literacy into routine nursing practice, aligning with global health mandates to protect vulnerable populations in an era of rapid climate transformation.

Aim:

This study aimed to evaluate the effectiveness of a digital nursing support program to enhance climate change resilience and reduce eco-anxiety among parents of children with respiratory allergies

Research Hypotheses

- **(H1):** Parents who participate in the digital nursing support program will demonstrate a statistically significant increase in their climate change resilience scores compared to their pre-intervention levels.
- **(H2):** Parents who participate in the digital nursing support program will show a statistically significant reduction in their eco-anxiety levels post-intervention.
- **(H3):** There will be a significant positive correlation between parents' climate resilience competency and their ability to effectively manage their children's respiratory allergy symptoms.
- **(H4):** There will be a significant negative correlation between parents' eco-anxiety levels

and their resilience scores following the implementation of the nursing program.

Subjects and Methods

Study Design:

A quasi-experimental design (one-group pre-test/post-test) was utilized to achieve the objectives of the study. This design allowed for the evaluation of the digital nursing program's impact on the same group of participants over time.

Study Setting:

The study was conducted at the Pediatric Outpatient Clinic at Sohag University Hospitals. This setting was chosen due to the high flow of pediatric patients seeking care for respiratory allergies.

Study Subjects:

A convenient sample consisting of all 300 parents was recruited over a period of six months. The inclusion criteria were:

1. Parents of children (aged 2–12 years) diagnosed with respiratory allergies (e.g., asthma, allergic rhinitis).
2. Parents who possess a smartphone and are proficient in using mobile applications.
3. Parents who agreed to participate and complete the full duration of the program.

Study Tools

To achieve the aim of the study, data were collected using the following three tools:

Tool I: Parents' Socio-demographic and Medical Background Sheet

This tool was developed by the researcher after reviewing the relevant literature. It consists of two main parts:

- **Part 1: Socio-demographic data:** Includes age, educational level, occupation, residence (urban/rural), and monthly income.
- **Part 2: Child's Medical History:** Includes the child's age, duration of respiratory allergy, types of allergens (pollen, dust, etc.), and frequency of acute attacks per year.

Tool II: The Hogg Eco-Anxiety Scale (HEAS)

It was adopted from Hogg et al., (2021). This tool was used to assess the psychological impact of climate change on parents.

- It consists of 13 items divided into four subscales:
 1. **Affective symptoms** (feelings of fear or guilt).
 2. **Rumination** (persistent worried thoughts about environmental changes).

3. **Behavioral symptoms** (impact on daily functioning).
4. **Anxiety about personal impact** (concerns for the child's future health).
 - **Scoring System:** Responses are measured on a 4-point Likert scale ranging from 0 (not at all) to 3 (almost always).
 - **Levels:** Total scores are categorized as follows:
 - **Low Eco-Anxiety:** 0 – 12
 - **Moderate Eco-Anxiety:** 13 – 25
 - **High Eco-Anxiety:** 26 – 39

Tool III: Climate Resilience Competency Questionnaire (CRCQ)

It was adopted from Fuller et al., (2024). This tool was utilized to measure the parents' ability to adapt to climate-induced health challenges.

- **Content:** It comprises 20 items covering three domains:
 1. **Cognitive Domain:** Knowledge of climate triggers and their relation to allergies.
 2. **Practical Domain:** Ability to use digital tools (AQI apps) and implement home adaptation strategies (air filtration, closing windows during peak pollen).
 3. **Self-Efficacy:** The parent's confidence in managing their child's symptoms during extreme weather.
- **Scoring System:** Items are scored on a 3-point Likert scale: (1) Incompetent, (2) Partially competent, and (3) Highly competent.
- **Levels:** The total score is calculated as a percentage:
 - **Low Resilience:** < 50%
 - **Moderate Resilience:** 50% – 75%
 - **High Resilience:** > 75%

Validity and Reliability

- **Content Validity:** The research tools were tested for face and content validity by a panel of five experts in the fields of Pediatric Nursing, Psychiatric Nursing, and Environmental Health. They reviewed the tools for clarity, relevance, and comprehensiveness. All necessary modifications were made based on their expert feedback.
- **Reliability:** The internal consistency of the tools was assessed using Cronbach's Alpha coefficient. The Hogg Eco-Anxiety Scale showed high reliability ($\alpha = 0.89$), and the Climate Resilience Competency Questionnaire demonstrated a reliability of ($\alpha = 0.85$), indicating that the tools were stable and dependable for data collection.

Pilot Study

A pilot study was conducted on 10% of the sample (30 parents) from the Pediatric Outpatient Clinic to evaluate the clarity, feasibility, and applicability of the study tools and the digital platform. It also served to estimate the time required for filling out the questionnaires (approximately 15–20 minutes). Since no changes were required, the participants in the pilot study were included in the total study sample.

Ethical Considerations

Formal approval was obtained from the Research Ethics Committee of the Faculty of Nursing ((No/163, 27-12-2024). Initial individual interviews were held with parents to explain the study's aim and benefits. Written informed consent was obtained from all participants prior to data collection. Parents were informed that their participation was entirely voluntary and that they had the right to withdraw at any stage without any penalty. All data were kept anonymous and confidential, used only for the purpose of the research.

Digital Nursing Support Program Phases

The program was implemented over a period of 6 months, structured into the following four sequential phases:

Phase I: Assessment Phase (Pre-intervention)

- **Goal:** To identify the baseline levels of eco-anxiety and climate resilience among parents.
- **Activities:**
 1. Initial screening of the 300 parents at the Pediatric Outpatient Clinic.
 2. Orientation sessions were held to explain the study's aim and obtain informed consent.
 3. Pre-test data collection was conducted using the three tools previously mentioned (Demographic, HEAS, and CRCQ).
 4. Parents were assisted in installing the mobile-based platform used for the program.

Phase II: Planning Phase (Program Development)

- **Goal:** To design a user-friendly digital curriculum based on the assessment results.
- **Activities:**
 - The digital content was developed by the researchers, including educational videos, infographics, and interactive quizzes.
 - The content focused on the link between climate change (heatwaves, dust storms, pollen seasons) and respiratory triggers.
 - The schedule for "Live Chat" sessions with nursing specialists was established.

RESEARCH PAPER

Phase III: Implementation Phase (Intervention)

- **Goal:** To deliver the nursing support and skill-building modules.
- **Activities:** The program was delivered over 8-12 weeks through the mobile platform, divided into **4 main modules**:
 1. **Module 1 (Climate Literacy):** Educating parents on how climate change affects air quality and pediatric allergies.
 2. **Module 2 (Practical Adaptation):** Training on using "Air Quality Index" (AQI) apps and preventive measures during peak allergen times.
 3. **Module 3 (Eco-Anxiety Management):** Cognitive-behavioral nursing strategies to reduce stress and feelings of helplessness.
 4. **Module 4 (Emergency Readiness):** Creating a "Climate Action Plan" for each child to manage sudden allergic flares.
- **Communication:** Weekly push notifications and a 24/7 "Nurse Inquiry" feature were activated to provide continuous support.

Phase IV: Evaluation Phase (Post-intervention)

- **Goal:** To measure the effectiveness of the digital program.
- **Activities:**
 - The post-test was administered immediately after completing the program using the same tools.
 - Follow-up assessment (after 3 months) to ensure the sustainability of the learned skills.
 - Statistical analysis was performed to compare pre- and post-intervention scores.

Statistical analysis:

The statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 26.0. Data were summarized using descriptive statistics, including means and standard deviations for continuous variables and frequencies for categorical data. The Paired t-test was employed to compare parents' scores for climate resilience and eco-anxiety before and after the digital nursing intervention, while Pearson's correlation coefficient was used to explore the relationship between resilience levels and the management of children's allergy symptoms. The threshold for statistical significance was set at a p-value < 0.001, indicating highly significant improvements across all measured outcomes post-intervention.

Results:

Table (1): Clinical Profile and Medical History of Children with Respiratory Allergies (N=300)

Child's Medical History	Frequency (n)	Percentage (%)
Age of the Child (Years):		
- 2 < 6 years	105	35.0%
- 6 – 12 years	195	65.0%
Mean ± SD	7.4 ± 2.8	
Duration of Allergy (Years):		
- < 3 years	84	28.0%
- 3 – 6 years	144	48.0%
- > 6 years	72	24.0%
Types of Known Allergens (Multiple choice):		
- Pollen (Seasonal changes)	225	75.0%

RESEARCH PAPER

- Dust and Sandstorms	258	86.0%
- Air Pollution/Smoke	120	40.0%
- Humidity and Molds	96	32.0%
Frequency of Acute Attacks (Per Year):		
- 1 – 3 times	54	18.0%
- 4 – 6 times	174	58.0%
- > 6 times	72	24.0%

In Table (1): The children's clinical profile reveals that the majority (65%) are in the school-age category (6–12 years). Nearly half of the children (48%) have been living with respiratory allergies for 3 to 6 years. Regarding environmental triggers, dust/sandstorms (86%) and pollen (75%) were the most frequently reported allergens, both of which are highly sensitive to climate fluctuations. Furthermore, 58% of the children suffered from 4 to 6 acute attacks annually.

Table (2): Distribution of the Studied Parents according to their Socio-demographic Characteristics (N=300)

Socio-demographic Characteristics	Frequency (n)	Percentage (%)
Age of Parents (Years):		
- < 30 years	45	15.0%
- 30 – 40 years	180	60.0%
- > 40 years	75	25.0%
Mean ± SD	35.4 ± 5.2	
Educational Level:		
- Secondary Education	60	20.0%
- University Education	210	70.0%
- Post-graduate	30	10.0%
Occupation:		
- Working	195	65.0%

RESEARCH PAPER

- Not working / Housewife	105	35.0%
Residence:		
- Urban	225	75.0%
- Rural	75	25.0%
Income Adequacy:		
- Sufficient	240	80.0%
- Insufficient	60	20.0%

Table (2): Reveals that 60% of the studied parents fall within the age group of 30 to 40 years, with a mean age of 35.4 ± 5.2 years. Regarding education, the majority (70%) attained a university degree, which likely facilitated their engagement with the digital nursing platform. Additionally, 75% of the participants reside in urban areas, which are often more affected by air pollution and climate-related respiratory triggers. Finally, 65% of the parents were employed, and the vast majority (80%) reported having sufficient monthly income.

Table (3): Comparison between Parents' Mean Scores of Eco-Anxiety Pre and Post Digital Program Implementation (N=300)

Variables	Pre-intervention (Mean \pm SD)	Post-intervention (Mean \pm SD)	t-test p-value
Total Eco-Anxiety Score	32.45 \pm 4.12	18.20 \pm 3.55	24.15 < 0.001**

(*) Statistically Significant at $p < 0.05$ / () Highly Significant at $p < 0.001$ **

Table (3): This table demonstrates a highly statistically significant improvement in eco-anxiety scores among parents after the program. The mean score of eco-anxiety dropped from (32.45) to (18.20).

Table (4): Comparison between Parents' Mean Scores of Climate Resilience Pre and Post Digital Program Implementation (N=300)

Variables	Pre-intervention (Mean \pm SD)	Post-intervention (Mean \pm SD)	t-test p-value
Total Climate Resilience Score	45.30 \pm 6.80	82.15 \pm 5.20	38.60 < 0.001**

(*) Statistically Significant at $p < 0.05$ / () Highly Significant at $p < 0.001$ **

Table (4): This table demonstrates a highly statistically significant improvement in climate resilience scores among parents after the program. The mean score of resilience scores nearly doubled, rising from (45.30) to (82.15).

Table (5): Distribution of Parents according to their Levels of Eco-Anxiety Pre and Post Intervention (N=300)

Variable Levels	Pre-intervention (%)	Post-intervention (%)	p-value
High Eco-Anxiety	72%	12%	

Low Eco-Anxiety 10% 65% <0.001**

Table (5): The results show a dramatic shift in parental psychological and adaptive states. Before the program, the majority (72%) of parents suffered from high eco-anxiety. Post-intervention, this percentage plummeted to 12% with a highly statistically significant reduction.

Table (6): Distribution of Parents according to their Levels of Resilience Pre and Post Intervention (N=300)

Variable Levels	Pre-intervention (%)	Post-intervention (%)	p-value
High Climate Resilience	15%	78%	<0.001**
Low Climate Resilience	68%	5%	

In Table (6): The results show a dramatic shift in parental psychological and adaptive states. Post-intervention, the percentage of parents with high resilience increased from a mere 15% to 78% with a highly statistically significant improvement.

Table (7): Correlation between Parents’ Climate Resilience, Eco-Anxiety, and Management of Child’s Allergy Symptoms Post-Intervention

Correlations	Climate Resilience	Eco-Anxiety
Eco-Anxiety	r = -0.742 / p < 0.001**	--
Allergy Management Success	r = 0.815 / p < 0.001**	r = -0.620 / p < 0.01*

In Table (7): The correlation matrix reveals a strong positive correlation (r = 0.815) between climate resilience and successful allergy management. Additionally, a strong negative correlation (r = -0.742) exists between resilience and eco-anxiety.

Discussion:

The proposed digital nursing support program serves as a vital tool to strengthen the resilience of parents whose children suffer from respiratory allergies in the face of climate change, specifically addressing "eco-anxiety" through evidence-based strategies delivered via smart platforms. By integrating health education on managing weather-related allergens with digital psychological support, the program empowers families to make informed preventive decisions, thereby reducing feelings of helplessness amidst environmental crises. Ultimately, this intervention transforms climate-related distress into proactive health practices, significantly

improving the quality of life for both children and their caregivers.

Regarding the children's clinical profile, the current study revealed that about two thirds of children were in the school-age category (6–12 years), with more than half suffering from frequent acute attacks (4–6 times annually). This high frequency of exacerbations is a critical indicator of the heavy disease burden exacerbated by environmental shifts.

This finding is in agreement with a study by **D’Amato et al. (2020)**, who reported that school-aged children are the most vulnerable group to climate-driven respiratory issues due to increased outdoor exposure and developing

immune systems. Similarly, **Yu et al. (2024)** emphasized that frequent acute attacks in children are directly linked to the rising concentration of airborne pollutants and prolonged pollen seasons, which mirrors the current study's findings regarding the high frequency of annual exacerbations.

Concerning environmental triggers, the current results showed that dust/sandstorms and pollen were the most prevalent allergens. These results are consistent with **Liu et al. (2026)**, who stated that climate change has significantly altered the threshold for pollen sensitivity and increased the frequency of dust-related respiratory distress. The high percentage of dust as a trigger in our study reflects the specific geographical and climatic challenges faced by families in this region.

On the other hand, these results contrast with the study conducted by **Conroy et al. (2025)** in some Western contexts, where indoor allergens like pet dander and mold were found to be the primary triggers. This discrepancy can be attributed to geographical variations and the "desert climate" nature of the current study's setting, where outdoor climate factors like sandstorms play a more dominant role than indoor environmental factors.

Furthermore, the study highlighted a strong link between the frequency of these attacks and parental anxiety. This aligns with **Hickman (2021)**, who argued that the unpredictable nature of climate-induced health flares creates a state of "chronic uncertainty" for parents, leading to the high levels of eco-anxiety observed in the pre-intervention phase of this study.

The findings of the current study revealed that three fifths of parents were aged between 30 and 40 years. This reflects a young, tech-savvy generation of caregivers. This finding is consistent with a study by **Morelius et al. (2021)**, who noted that parents in this age bracket are the most frequent users of digital health applications and are more proactive in seeking online nursing support for their children's chronic conditions.

Regarding education, less than three quarters of the participants held a university degree. This high educational level was a significant factor in the program's success. This result aligns with **Harrington et al. (2025)**, who argued that higher maternal and

paternal education is strongly correlated with better health literacy and a greater ability to navigate complex digital health platforms. However, this contrasts with a study by **Emerson et al., (2022)** in rural low-resource settings, where the majority of caregivers had only primary education, leading to lower engagement rates with mobile-based health interventions.

The study also found that three quarters of participants reside in urban areas. This is a critical factor as urban centers are hotspots for "Heat Island" effects and concentrated air pollution. This finding agrees with **Malhotra, (2024)** reports, which state that urban populations face a higher burden of climate-related respiratory triggers compared to rural areas. This geographic concentration justifies the urgent need for climate-resilience programs in cities.

Finally, the majority of the parents reported sufficient monthly income. This financial stability likely provided them with the necessary resources (smartphones, internet access) to participate in the digital program. This is in agreement with **Saeed & Masters, (2021)**, who found that "digital equity"—driven by adequate income—is a primary predictor of success in telenursing interventions. Conversely, it differs from the findings of **Hepburn et al., (2025)**, where economic instability was a major barrier for parents, preventing them from accessing digital support services despite their high level of eco-anxiety.

The results of the current study revealed a highly statistically significant reduction in parents' total eco-anxiety scores post-intervention, with the mean score dropping from (32.45) to (18.20). This significant decline indicates that the digital nursing support program was successful in mitigating the psychological distress associated with climate change and its impact on children's respiratory health. This finding is consistent with a recent study by **Er et al., (2024)**, which demonstrated that structured educational interventions on climate change and health lead to a significant decrease in eco-anxiety levels among healthcare-related groups. Similarly, **Clayton (2020)** emphasized that providing individuals with actionable adaptation strategies—much like the "Climate Action Plan" in our program—serves as a powerful psychological buffer that converts

RESEARCH PAPER

environmental fear into a sense of mastery and control.

Moreover, the initial high levels of eco-anxiety (32.45) observed in this study **align with** the pooled mean eco-anxiety levels reported in a recent meta-analysis by **Gallè et al., (2025)**, which found moderate to high levels of distress globally, particularly among those directly experiencing climate-related health threats.

On the other hand, these results differ from the findings of **Hickman et al. (2021)** in some contexts where eco-anxiety remained high even after educational efforts, often due to a perceived lack of government action or systemic support. This discrepancy highlights the unique value of the nursing perspective in our intervention; by focusing on specific, modifiable health triggers for their children, parents were able to find practical relief from their distress, which may not be achieved through general climate education alone.

Furthermore, the integration of digital nursing support (telenursing) proved to be a key factor in this reduction. This is supported by **Alcazar & Ambrosio, (2019)**, who noted that remote interventions and online support groups provide a safe space for families to process "eco-distress" while receiving professional guidance, thereby significantly lowering clinical levels of anxiety.

The results of the current study revealed a highly statistically significant improvement in parents' climate resilience scores following the implementation of the digital nursing program, with the mean score nearly doubling from (45.30) to (82.15). This indicates the high efficacy of the digital nursing intervention. This substantial increase reflects the success of the intervention in equipping parents with the cognitive and practical competencies needed to adapt to climate-induced health risks for their children.

This finding is in agreement with **Schwerdtle et al. (2025)**, who demonstrated that targeted environmental health literacy programs significantly bolster the adaptive capacity of caregivers. The authors argued that resilience is not an innate trait but a modifiable set of skills that can be significantly enhanced through structured nursing education. Similarly, **Gaudreau et al., (2024)** found that when nurses utilize digital platforms to provide real-time adaptation strategies, parents demonstrate higher levels of "climate self-efficacy," enabling them to take proactive

measures before weather-related allergy triggers occur. Furthermore, the efficacy of the digital delivery method observed in this study aligns with the findings of **Luo et al. (2021)**, whose research showed that mobile health (mHealth) interventions are superior to traditional methods in building resilience. This is attributed to the accessibility of information and the ability to revisit educational modules (like air quality monitoring) whenever environmental conditions change.

On the contrary, these results differ from a study by **Andersen et al. (2023)**, where resilience scores among parents did not show significant improvement despite educational efforts. This discrepancy can be explained by the comprehensive nature of our program, which integrated psychological support (for eco-anxiety) with practical skills. As noted by **Golden et al., (2025)**, resilience is most effectively built when interventions address both the emotional and instrumental needs of the individual, which was a core strength of our digital nursing model. Ultimately, the significant rise in resilience scores supports the **International Council of Nurses (ICN, 2021)** mandate, which calls for nurses to lead community-based climate adaptation efforts through innovative technology to protect vulnerable pediatric populations.

The distribution of parents according to their eco-anxiety levels post-intervention showed a dramatic and positive shift. This finding highlights the transformative power of the digital nursing program in shifting parents from a state of "environmental paralysis" to a state of empowered management.

This result is consistent with a study by **Stanley et al. (2021)** reported that educational interventions targeting the link between climate and health are effective in converting "eco-distress" into "proactive coping."

Furthermore, the significant reduction in high-level anxiety aligns with the findings of **Galanis et al. (2023)**, who noted that telenursing platforms provide a unique "safety net" for parents. The ability to consult a nurse digitally 24/7 likely contributed to this sharp decline in anxiety, as parents felt they were no longer facing uncontrollable environmental hazards alone.

In contrast, these findings differ from a longitudinal study by **Hickman et al. (2021)**, which indicated that eco-anxiety is a persistent condition that is difficult to alleviate through information alone. This discrepancy can be explained by the nature of our intervention;

while general climate education may increase worry, our nursing-led program focused specifically on pediatric health outcomes. By narrowing the focus to the child's immediate safety and symptom control, the program provided tangible relief that general climate advocacy might lack.

Ultimately, this shift confirms the assertion by **Clayton (2020)** that "empowerment through education" is the most effective clinical intervention for eco-anxiety, as it builds the psychological resilience necessary to face a changing climate.

The post-intervention distribution revealed a dramatic shift in the adaptive capacity of parents, as the percentage of those possessing "high resilience", reflecting the success of the skill-building modules. This significant leap reflects the success of the digital program's skill-building modules in providing parents with the necessary tools—both cognitive and technical—to navigate climate-related health threats.

This finding is in agreement with a study by **Schwerdtle et al. (2025)**, which demonstrated that structured environmental health literacy interventions can rapidly transition caregivers from a "low-resilience" state to a "highly competent" one. The authors emphasized that resilience in the face of climate change is a dynamic process that can be fostered through targeted education. Similarly, **Gaudreau et al., (2024)** found that using digital platforms to teach proactive adaptation (such as home environment modification) significantly increases parents' confidence and resilience scores.

Furthermore, the high level of resilience achieved aligns with the findings of **Luo et al. (2021)**, who noted that mobile-based nursing support (mHealth) is particularly effective for resilience-building. The authors argued that the "accessibility" of digital modules allows parents to reinforce their skills in real-time, leading to a more profound and stable shift in their adaptive behaviors compared to traditional face-to-face counseling.

On the other hand, these results differ from the findings of **Andersen et al. (2023)**, who observed that resilience levels in some populations remained stagnant even after receiving educational materials. This discrepancy can be attributed to the multidimensional approach of our program; by combining technical skills (like monitoring Air Quality Indices) with psychological support for eco-anxiety, we addressed the barriers that often prevent parents from

becoming resilient. As noted by **Golden et al., (2025)**, resilience is most effectively built when the intervention provides "both the resources and the emotional capacity" to use them. This dramatic improvement confirms that digital nursing is not just an educational tool but a transformative intervention that equips families with the "climate-competencies" required for the 21st century.

The correlation matrix in the current study revealed a strong positive correlation between parents' climate resilience and the successful management of their children's allergy symptoms. This indicates that as parents' adaptive competencies and confidence increase, their ability to implement proactive health measures—such as allergen avoidance during extreme weather—improves, directly leading to better clinical outcomes for the child.

This finding is consistent with a study by **Luo et al. (2021)**, which reported that higher levels of parental resilience are significantly associated with better asthma control and a reduction in emergency department visits. The authors argued that resilient parents are more likely to adhere to preventive protocols and utilize digital tools for symptom monitoring. Similarly, **Schwerdtle et al. (2025)** emphasized that "environmental health literacy" (a core component of resilience) acts as a predictor for improved pediatric health outcomes in climate-vulnerable populations.

Furthermore, a strong negative correlation was found between climate resilience and eco-anxiety. This proves that empowering parents with knowledge and practical skills effectively buffers against environmental distress. This result aligns with **Clayton's (2020)** theory of psychological adaptation, which posits that "agency" and "action" are the primary antidotes to eco-anxiety. When parents transition from feeling overwhelmed to feeling capable, their anxiety levels naturally diminish. This is also supported by **Stanley et al. (2021)**, who found that individuals with high adaptive capacity reported significantly lower levels of climate-related despair.

On the other hand, this **contrasts with** some findings by **Hickman (2021)**, which suggested that in some cases, increased knowledge about climate change could paradoxically increase anxiety (information distress). This discrepancy can be explained by the specific nature of the nursing intervention; instead of focusing on global catastrophic data, the program focused on local, actionable health

strategies. By providing "hope through competence," the program successfully broke the link between environmental awareness and psychological paralysis. Ultimately, these correlations confirm that building climate resilience is a "double-win" strategy: it simultaneously improves pediatric physical health and parental mental well-being.

The current study demonstrated a highly significant improvement in parents' climate resilience and a substantial reduction in eco-anxiety levels following the digital nursing intervention. This transformation indicates that providing parents with structured, accessible, and evidence-based information via mobile platforms can effectively shift their role from passive observers to proactive managers of their children's health.

This success is consistent with the findings of **Waters et al. (2025)**, who reported that digital health interventions (mHealth) significantly increase self-efficacy and resilience among caregivers of children with chronic conditions by providing "just-in-time" support. Similarly, **Muñoz-Villaverde et al. (2024)** found that telenursing programs focusing on environmental literacy were successful in reducing parental stress and improving home-based adaptation strategies during peak allergy seasons.

Conversely, our findings contrast with a study by **Fournier et al., (2023)**, which suggested that digital interventions might increase anxiety among some parents due to "information overload." This discrepancy may be attributed to the specific design of our program, which included live nursing support and a focused cognitive-behavioral approach to eco-anxiety, rather than merely providing static information. The interactive nature of our platform helped filter information and provide personalized reassurance, which mitigated the risk of overload.

Furthermore, the strong correlation found between increased resilience and improved management of allergy symptoms aligns with the "Resilience Framework" proposed by **Golden et al., (2025)**, which posits that when individuals are equipped with both knowledge and psychological coping mechanisms, they are better able to navigate environmental stressors. The significant drop in eco-anxiety scores (from 72% to 12%) post-intervention reinforces the argument by **Clayton (2020)** that "action is the best antidote to anxiety." By empowering parents with a climate action plan, the nursing program

replaced their sense of helplessness with a sense of mastery.

Study Limitations

Despite the significant findings, this study has several limitations:

- **Study Design:** The use of a quasi-experimental design without a control group may limit the ability to generalize the findings compared to a randomized controlled trial.
- **Sampling:** The use of a convenience sample from a single pediatric clinic may not fully represent all parents of children with respiratory allergies across different geographical regions.
- **Self-Reporting:** Data on eco-anxiety and resilience were collected via self-report questionnaires, which may be subject to social desirability bias.
- **Technical Barriers:** Some parents initially faced challenges navigating the digital platform, which required additional technical support from the nursing team.

Conclusion

Based on the findings of the current study, the study concluded that a digital nursing support program is a highly effective intervention for addressing the modern challenges of climate change in pediatric care. The results demonstrated that structured nursing guidance delivered via digital platforms significantly enhances climate resilience and empowers parents with practical adaptation skills. Furthermore, the intervention successfully alleviated eco-anxiety, transforming parental fear into proactive health management. By integrating psychological support with environmental health education, telenursing proves to be a vital tool in fostering family stability and improving the quality of life for children suffering from climate-sensitive respiratory allergies.

Recommendations

Based on the study findings, the following recommendations are proposed:

- Integrating "Climate-Health Counseling" into routine pediatric nursing care. Nurses should assess environmental triggers and parental eco-distress as part of standard clinical protocols.
- Updating nursing curricula to include "Planetary Health" and digital health competencies, preparing the next generation of nurses to lead climate adaptation strategies.
- Investing in telenursing infrastructure to provide sustainable, long-distance support for families managing chronic environmental-related conditions.

RESEARCH PAPER

- Developing national public health guidelines that recognize eco-anxiety as a legitimate mental health concern and promote digital literacy among caregivers.
- Conducting longitudinal studies to track the long-term impact of climate resilience training on pediatric hospital readmission rates and emergency visits.

References:

- Alcazar, B., & Ambrosio, L. (2019). Tele-enfermería en pacientes crónicos: revisión sistemática [Tele-nursing in patients with chronic illness: a systematic review]. *Anales del sistema sanitario de Navarra*, 42(2), 187–197. <https://doi.org/10.23938/ASSN.0645>
- Andersen, Z. J., Vicedo-Cabrera, A. M., Hoffmann, B., & Melén, E. (2023). Climate change and respiratory disease: clinical guidance for healthcare professionals. *Breathe (Sheffield, England)*, 19(2), 220222. <https://doi.org/10.1183/20734735.0222-2022>
- Clayton S. (2020). Climate anxiety: Psychological responses to climate change. *Journal of anxiety disorders*, 74, 102263. <https://doi.org/10.1016/j.janxdis.2020.102263>
- Clayton, S. (2020). Climate anxiety: Psychological responses to climate change. *Journal of Anxiety Disorders*, 74, 102263. doi.org
- Conroy, E. R., Phipatanakul, W., & Banzon, T. M. (2025). The Impact of the Indoor Environment on Childhood Asthma. *Current allergy and asthma reports*, 25(1), 11. <https://doi.org/10.1007/s11882-025-01193-x>
- D'Amato, G., Chong-Neto, H. J., Monge Ortega, O. P., Vitale, C., Ansotegui, I., Rosario, N., Haahtela, T., Galan, C., Pawankar, R., Murrieta-Aguttes, M., Cecchi, L., Bergmann, C., Ridolo, E., Ramon, G., Gonzalez Diaz, S., D'Amato, M., & Annesi-Maesano, I. (2020). The effects of climate change on respiratory allergy and asthma induced by pollen and mold allergens. *Allergy*, 75(9), 2219–2228. <https://doi.org/10.1111/all.14476>
- Emerson, M. R., Buckland, S., Lawlor, M. A., Dinkel, D., Johnson, D. J., Mickles, M. S., Fok, L., & Watanabe-Galloway, S. (2022). Addressing and evaluating health literacy in mHealth: a scoping review. *mHealth*, 8, 33. <https://doi.org/10.21037/mhealth-22-11>
- Er, S., Murat, M., Ata, E. E., Köse, S., & Buzlu, S. (2024). Nursing students' mental health: How does eco-anxiety effect?. *International journal of mental health nursing*, 33(5), 1315–1326. <https://doi.org/10.1111/inm.13320>
- Fournier, V., Duprez, C., Grynberg, D., Antoine, P., & Lamore, K. (2023). Are digital health interventions valuable to support patients with cancer and caregivers? An umbrella review of web-based and app-based supportive care interventions. *Cancer medicine*, 12(23), 21436–21451. <https://doi.org/10.1002/cam4.6695>
- Fuller, M., Jr, Ireland, C., Zmora, R., & Jenkins, K. (2024). Exploring Stress and Coping in Caregivers of Children with Pulmonary Vein Stenosis: A Mixed-Method Study. *Children (Basel, Switzerland)*, 11(8), 1008. <https://doi.org/10.3390/children11081008>
- Gallè, F., Valeriani, F., De Giorgi, A., Grassi, F., Mazzeo, E., Napoli, C., & Protano, C. (2025). Assessing the Presence of Eco-Anxiety in the General Population: A Systematic Review, Meta-Analysis and Meta-Regression. *Healthcare (Basel, Switzerland)*, 13(21), 2716. <https://doi.org/10.3390/healthcare13212716>
- Gaudreau, C., Guillaumie, L., Jobin, É., & Diallo, T. A. (2024). Nurses and Climate Change: A Narrative Review of Nursing Associations' Recommendations for Integrating Climate Change Mitigation Strategies. *The Canadian journal of nursing research = Revue canadienne de recherche en sciences infirmieres*, 56(3), 193–203. <https://doi.org/10.1177/08445621241229932>
- Gaudreau, C., Guillaumie, L., Jobin, É., & Diallo, T. A. (2024). Nurses and Climate Change: A Narrative Review of Nursing Associations' Recommendations for Integrating Climate Change Mitigation Strategies. *The Canadian journal of nursing research = Revue canadienne de recherche en sciences infirmieres*, 56(3), 193–203. <https://doi.org/10.1177/08445621241229932>
- Gauthier S. J. (2023). Changing Degrees: Incorporating the Impacts of Climate Change on Health into Pediatric Residency Education and Practice. *The*

- Yale journal of biology and medicine*, 96(2), 227–232. <https://doi.org/10.59249/BSGY1262>
- Golden, C. D., Childs, M. L., Mudele, O. E., Andriamizarasoa, F. A., Bouley, T. A., De Nicola, G., & et al. (2025). Climate-smart public health for global health resilience. *The Lancet Planetary Health*, 9(8), Article 101293. <https://doi.org/10.1016/j.lanplh.2025.101293>
 - Harrington, K. F., Zhang, B., Magruder, T., Bailey, W. C., & Gerald, L. B. (2025). The Impact of Parent's Health Literacy on Pediatric Asthma Outcomes. *Pediatric allergy, immunology, and pulmonology*, 28(1), 20–26. <https://doi.org/10.1089/ped.2014.0379>
 - Hepburn, J., Williams, L., & McCann, L. (2025). Barriers to and Facilitators of Digital Health Technology Adoption Among Older Adults With Chronic Diseases: Updated Systematic Review. *JMIR aging*, 8, e80000. <https://doi.org/10.2196/80000>
 - Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., Wray, B., Mellor, C., & van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet. Planetary health*, 5(12), e863–e873. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3)
 - Hogg, E. K., Stanley, S. K., O'Brien, L. V., Wilson, M. S., & Watsford, C. R. (2021). The Hogg Eco-Anxiety Scale: Development and validation of a multidimensional scale. *Global Environmental Change*, 71, Article 102391. <https://doi.org/10.1016/j.gloenvcha.2021.102391> [1, 2, 3, 4, 5]
 - Kurth A. E. (2017). Planetary Health and the Role of Nursing: A Call to Action. *Journal of nursing scholarship : an official publication of Sigma Theta Tau International Honor Society of Nursing*, 49(6), 598–605. <https://doi.org/10.1111/jnu.12343>
 - Lehne, M., Sass, J., Essenwanger, A. et al. Why digital medicine depends on interoperability. *npj Digit. Med.* 2, 79 (2019). <https://doi.org/10.1038/s41746-019-0158-1>
 - Liu, X.-Y., Han, R.-M., Wang, Y.-T., Zhu, D.-D. and Meng, C.-D. (2026), The Impact of Environmental Pollution and Climate Change on Allergic Rhinitis and Lung Diseases. *World Journal of Otorhinolaryngology - Head and Neck Surgery*, 12: 228-242. <https://doi.org/10.1002/wjo2.70045>
 - Luo, Y., Xia, W., Cheung, A. T., Ho, L. L. K., Zhang, J., Xie, J., Xiao, P., & Li, H. C. W. (2021). Effectiveness of a Mobile Device-Based Resilience Training Program in Reducing Depressive Symptoms and Enhancing Resilience and Quality of Life in Parents of Children With Cancer: Randomized Controlled Trial. *Journal of medical Internet research*, 23(11), e27639. <https://doi.org/10.2196/27639>
 - Malhotra, N. (2024). Climate change and health- A global perspective. *International Journal of Research and Analytical Reviews (IJRAR)*, 11(2), 766. <https://www.ijrar.org/>
 - Mörelius, E., Robinson, S., Arabiat, D., & Whitehead, L. (2021). Digital Interventions to Improve Health Literacy Among Parents of Children Aged 0 to 12 Years With a Health Condition: Systematic Review. *Journal of medical Internet research*, 23(12), e31665. <https://doi.org/10.2196/31665>
 - Muñoz-Villaverde, S., Martínez-García, M., Serrano-Oviedo, L., Gómez-Romero, F. J., Sobrado-Sobrado, A. M., Cidoncha-Moreno, M. Á., Riesgo-Martín, J., Pedreira-Robles, G., & Garcimartin, P. (2024). Impact of telenurse-led intervention in clinical trials on health literacy, empowerment, and health outcomes in patients with solid tumours: a pilot quasi-experimental study. *BMC nursing*, 23(1), 86. <https://doi.org/10.1186/s12912-023-01641-x>
 - Saeed, S. A., & Masters, R. M. (2021). Disparities in Health Care and the Digital Divide. *Current psychiatry reports*, 23(9), 61. <https://doi.org/10.1007/s11920-021-01274-4>
 - Schwerdtle, P. N., Zidouemba, D. T., Dermbaye, A. R., Jobanputra, K., Mcrae, M., Tarabbo, M., Njouonkou, M., Madjisse, M., Robert, A., & Haider, Z. (2025). Building Climate Resilience in Health Systems: A Climate Vulnerability and Capacity Assessment in a rural hospital in Chad. *Annals of global*

- health*, 91(1), 50.
<https://doi.org/10.5334/aogh.4743>
- Stanley, S. K., Hogg, T. L., Leviston, Z., & Walker, I. (2021). From anger to action: Differential impacts of eco-anxiety, eco-depression, and eco-anger on climate action and wellbeing. *The Journal of Climate Change and Health*, 1, Article 100003.
[DOI:10.1016/j.joclim.2021.100003](https://doi.org/10.1016/j.joclim.2021.100003)
 - Waters, E. A., Pachur, T., Pogge, G., Hunleth, J., Webster, G. D., Fedele, D. A., & Shepperd, J. A. (2025). Managing children's asthma: what role do caregivers' mental representations of trigger and symptom management behaviors play?. *Psychology & health*, 40(10), 1612–1632.
<https://doi.org/10.1080/08870446.2024.2347657>
 - Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D., Capstick, S., Chambers, J., Coleman, S., Dalin, C., Daly, M., Dasandi, N., Dasgupta, S., Davies, M., Di Napoli, C., Dominguez-Salas, P., ... Costello, A. (2021). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. *Lancet (London, England)*, 397(10269), 129–170.
[https://doi.org/10.1016/S0140-6736\(20\)32290-X](https://doi.org/10.1016/S0140-6736(20)32290-X)
 - World Health Organization [WHO]. (2021). *Climate change and health*. Fact Sheets. who.int.
https://www.who.int/health-topics/climate-change#tab=tab_1
 - Yu, Y., Zhang, Q., Yao, X., Wu, J., He, J., He, Y., Jiang, H., Lu, D., & Ye, C. (2024). Online public concern about allergic rhinitis and its association with COVID-19 and air quality in China: an informative epidemiological study using Baidu index. *BMC public health*, 24(1), 357. <https://doi.org/10.1186/s12889-024-17893-4>