

Effect of an Empowerment Program for Mothers and their School-Age Children on Asthma Control during Climate Change

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Abstract

Background: Climate change poses significant challenges to asthma management in school-age children, affecting air quality, allergen exposure, extreme weather, and healthcare infrastructure. **Aim:** To evaluate the effect of an empowerment program for mothers and their school-age children on asthma control during climate change. **Method:** A quasi-experimental design was conducted at Mansoura University Children's Hospital, involving 100 mothers and their school-age children. Data were collected using Asthma Knowledge, Practices, and Climate Change Adaptation Questionnaire and the Childhood Asthma Control Test. **Results:** Before the intervention, 81% of mothers and 98% of children had unsatisfactory knowledge, which improved to 92% and 90%, respectively, and was largely sustained three months later (88% and 83%). Satisfactory practices also increased from 29% of mothers and 20% of children to 90% and 88%, with slight retention at three months (87% and 84%) ($p < 0.01$). Additionally, symptom severity decreased significantly, with mean scores dropping from 8.6 to 5.21 in children and 11.9 to 8.7 in mothers ($p = 0.001$). **Conclusion:** The empowerment program was highly effective in improving knowledge, practices, and asthma control outcomes among mothers and their children, with sustained benefits over time. **Recommendations:** Develop workshops, educational materials, and online resources specifically addressing the link between climate change and asthma.

Keywords: Asthma control, Climate change, Empowerment program, Mothers & School-age children.

Introduction:

Asthma is a global public health issue that carries significant social and economic challenges. According to the Global Asthma Network's 2018 report, approximately 339 million people worldwide suffer from asthma, with an average prevalence of 14%. Similarly, the World Health Organization (WHO) estimates that asthma impacts around 350 million individuals of all ages globally, contributing to roughly 350,000 deaths annually (WHO, 2024). The Centers for Disease Control and Prevention (CDC) predicts that by 2025, the number of people living with asthma will exceed 400 million worldwide (CDC, 2023). In Egypt, the prevalence of asthma among school-aged children in the Nile Delta region is approximately 7.7% (Ghonem, 2022). On a broader scale, the prevalence of asthma among African children under the age of 15 is reported to be 13.9% (Aschalew et al., 2022).

Asthma is ranked 16th among all causes of Disability Adjusted Life Years (DALYs), reflecting its significant impact on health and well-being. This is due to its potential to cause premature death, hospitalizations, reduced productivity, and a lower quality of life (Budolfson & Etzel, 2023; Mohammad & Brough, 2019). For children, asthma often results in missed school days, limited

participation in social activities, and increased healthcare needs. It also affects their families, causing caregivers to lose work and face higher healthcare expenses. These challenges extend beyond the individual, impacting families and the broader community (McDermott-Levy et al., 2023).

Asthma remains a significant public health issue, especially among school-aged children, with its prevalence and severity increasingly tied to environmental factors. Climate change is intensifying these challenges, as highlighted by (Panahandeh et al., 2023). The American Academy of Pediatrics (AAP) emphasized this concern in their 2015 policy statement, "Global Climate Change and Children's Health," noting that climate change threatens human health, safety, and security, with children being particularly vulnerable to its effects (Ahdoot et al., 2015). As global temperatures continue to rise, both the prevalence of asthma and the severity of asthma exacerbations are expected to increase (Rorie & Poole, 2021).

Climate change significantly impacts public health, especially respiratory conditions like asthma. School-age children, whose respiratory systems are still developing, are particularly vulnerable to environmental changes, making the effects of climate change on asthma control especially severe

(Domingo et al., 2024). The connection between climate change and asthma involves understanding how rising temperatures, air pollution, and allergen levels worsen asthma symptoms and complicate its management for this sensitive population (Louisias et al., 2019).

Climate change profoundly affects asthma control in school-age children by intensifying environmental factors that worsen asthma symptoms. Rising global temperatures contribute to increased levels of air pollutants, such as ground-level ozone and particulate matter, which irritate the airways and provoke asthma attacks (Biagioni et al., 2023; Kline & Prunicki, 2023). Higher temperatures and elevated carbon dioxide levels also lead to increased allergen production, resulting in higher pollen counts and longer allergy seasons that exacerbate asthma in sensitive children (Avula et al., 2023). Additionally, extreme weather events like heat waves and storms disrupt asthma management by interfering with medication routines and worsening indoor air quality through humidity and mold growth. Combined with socio-economic disparities, these climate-driven challenges emphasize the urgent need for strategies that address both the environmental and social aspects of asthma control in a warming world (Fathala et al., 2022; Eguiluz-Gracia et al., 2020).

Mothers play a crucial role in caring for their children with asthma, serving as primary caregivers and advocates in overseeing the condition daily. A key aspect of their role is managing medications, ensuring their children adherence to prescribed treatments, such as daily controller medications and rescue inhalers, which are essential for symptom control and preventing severe exacerbations (Rehman et al., 2020). In addition to managing medications, mothers closely monitor their child's symptoms such as wheezing, coughing, and shortness of breath allowing them to recognize early warning signs and make timely decisions, whether by adjusting treatment or seeking medical assistance. This vigilance and proactive care are vital in maintaining their child's health and preventing asthma complications (Fasola et al., 2022).

Mothers play a pivotal role in environmental control to help manage their children's asthma effectively. They take active measures to reduce exposure to asthma triggers, such as allergens, smoke, and air pollution, by using air purifiers, controlling household dust, and maintaining a smoke-free environment (Kashaninia et al., 2018). Their efforts often extend beyond the home, advocating for their child's needs in school and other settings to ensure a safe and supportive environment. Education is a cornerstone of this management, as mothers not only educate themselves about asthma triggers and management

techniques but also involve their children in learning, fostering a collaborative and informed approach to asthma care (Borhani et al., 2012).

Mothers also serve as the primary liaison between their children and healthcare providers. They handle scheduling and attending medical appointments, communicate symptoms and concerns to physicians, and ensure treatment recommendations are followed, providing their children with timely and appropriate care (Alhazmi et al., 2023). Mothers Beyond medical coordination, mothers offer crucial emotional support, helping their children cope with the stress and challenges of living with asthma. This support is the key to maintain their children's psychological well-being and encourage adherence to management strategies (Pelarti et al., 2019). Additionally, mothers often adjust family routines and activities to avoid asthma triggers and create a supportive home environment. Through these efforts, they play a central role in controlling asthma and improving their children's overall quality of life (El-husseiny et al., 2020).

The growing complexity of asthma control in the face of climate change presents new challenges that demand innovative solutions. Empowerment programs for both children and mothers have emerged as a promising way to improve health outcomes by enhancing self-management skills, building resilience, and promoting effective coping strategies (Haugan & Eriksson, 2021). Empowering mothers with in-depth knowledge and practical skills not only boosts their ability to manage their children's asthma but also encourages a proactive and informed approach to handling climate-related triggers. This empowerment can lead to better asthma management, improved adherence to treatment plans, reduced symptom severity, and fewer exacerbations (Rajabi et al., 2016).

In addition, it's crucial to involve both mothers and their school-age children in asthma management. By including children in the empowerment process, the program can boost their self-efficacy and understanding of their condition, leading to better self-management and improved adherence to treatment plans. This combined approach can have a more lasting and comprehensive effects on asthma control (Nichols et al., 2019). Furthermore, pediatric nurses have an important role in supporting both caregivers and children by linking climate change to asthma care. They can contribute to health education, advocate for climate change mitigation and adaptation strategies, and help develop evidence-based approaches to address both climate change and asthma (McDermott-Levy et al., 2023).

In conclusion, by evaluating the effectiveness of this empowerment program, the study aims to offer

valuable insights into how such interventions can improve asthma control in the face of climate change. The findings could help shape targeted strategies and public health policies focused on mitigating the negative impact of climate change on asthma management. Ultimately, this research seeks to improve the quality of life for children with asthma and their families, ensuring more resilient and effective asthma care in an increasingly unpredictable environment.

Significance of the study:

Asthma is a widespread chronic condition that significantly affects children's health, with climate change exacerbating its severity through rising temperatures, increased air pollution, and allergen exposure. Despite the growing impact of environmental factors on respiratory health, many mothers and children lack the necessary knowledge and skills to manage asthma effectively under changing climate conditions. This knowledge gap often leads to poor symptom control, frequent hospital visits, and a lower quality of life.

Empowering mothers and their school-age children with the necessary knowledge and self-management skills is crucial for improving asthma control and reducing symptom severity. By addressing this knowledge gap through targeted educational interventions, and by actively engaging mothers and children in the learning process, the program enhances their ability to cope with climate-related asthma risks, fosters confidence, improves asthma-related practices, significantly reduces symptom severity, and ultimately leads to better long-term health outcomes. This study highlights the importance of equipping mothers and their school-age children with the tools to mitigate climate change-related health risks, thereby reducing hospital visits, improving quality of life, and promoting long-term disease control.

Aim of the study:

This study aimed to evaluate the effect of an empowerment program for mothers and their school-age children on asthma control during climate change.

Research hypothesis:

To achieve the study's aim, the following research hypothesis was developed:

H1: The empowerment program for mothers and their school-age children is expected to have a positive effect on asthma control during climate change.

Operational definitions

Asthma control measures: In this study, asthma control measures refer to the set of practices and assessments used to evaluate and manage asthma symptoms effectively. These include knowledge of

asthma triggers, adherence to prescribed medications, correct inhaler technique, early recognition of symptoms, use of an asthma action plan, and lifestyle modifications to reduce exposure to environmental risk factors, particularly those related to climate change. Asthma control was measured based on symptom severity scores, frequency of exacerbations, and self-reported adherence to management practices.

Empowerment program is a structured educational intervention designed to enhance asthma management among mothers and their school-age children, particularly in the context of climate change. It consists of interactive sessions covering key topics such as asthma physiology, climate-related triggers, the impact of climate change on asthma, proper medication use, symptom monitoring, and self-management strategies. Additionally, it incorporated role-playing exercises, visual aids, and practical demonstrations to reinforce learning. Mothers were trained to monitor their children's symptoms effectively and implement preventive measures, while children were encouraged to take an active role in their own asthma management. By fostering confidence and self-efficacy, the program aimed to equip families with sustainable skills to minimize asthma exacerbations and improve overall health outcomes.

Method:

Research design:

The present study used a quasi-experimental research design, specifically a one-group pretest and posttest approach.

Setting:

This study was conducted at the Allergy and Immunology Clinic and the Allergy and Immunology Unit at Mansoura University Children's Hospital (MUCH) in Mansoura City, Dakahlia Governorate, Egypt.

Subjects and sampling:

A purposive sample of 100 mothers and their school-age children was selected from the previously mentioned settings. The inclusion criteria for the study were as follows: regardless of the mothers' characteristics; children aged between 9 and 14 years, of both genders, who were exclusively diagnosed with bronchial asthma and didn't had any other chronic problems or disabilities. Additionally, the children and their mothers had to be willing to participate in the study.

Sample size calculation:

The sample size calculation for a one group pre-post study with 95% power, using the data provided: From **Pelarti et al. (2019)**, Pre mean: 19.8, SD: 2.4 Post mean: 22.8, SD: 2.9

Using the sample size formula for dependent t-test:

$$n = (Z\alpha/2 + Z\beta) 2 \times \sigma d / d_2$$

Where:

$Z\alpha/2 = 1.96$ for 95% confidence $Z\beta = 1.64$ for 95% power $\sigma d =$ pooled standard deviation $d =$ desired difference to detect (let's use 3)

Therefore, with 95% power to detect a 3-point mean difference, the required sample size is 80 participants. Adding 20 participants for the attrition rate, the final sample size was 100 mothers and children.

Data collection tools:

Tool (1): Asthma Knowledge, Practices, and Climate Change Adaptation Questionnaire:

The questionnaire was developed by the researchers based on a thorough review of recent and relevant literatures (Badawy et al., 2023; Panahandeh et al., 2023; Devani & Gaillard, 2022). It was formulated in Arabic and consisted of the following parts:

Part I: Characteristics of Mothers: This part used to gather information on the mothers' age, educational level, occupation, residence, income, and number of children.

Part II: Children's Characteristics and Clinical Data: This part was collected data on the children's age, sex, educational grade, birth order, severity of asthma, triggers of asthma, number of hospital visits in the past 6 months, previous hospital admissions in the past 6 months, and inhalational therapies used.

Part III: Mothers' and Children's Knowledge about Bronchial Asthma and Climate Change: This part included questions on meaning of asthma, its causes, trigger factors, clinical manifestations, prevention, and management. It also covered aspects related to climate change, including its definition, causes, effects, methods of adaptation, and the relationship between asthma and climate change.

Scoring system:

Each correct answer was assigned one point, while incorrect or "don't know" answers scored zero points. The total knowledge score was calculated, with a score of more than 60% classified as satisfactory knowledge and a score of 60% or less considered unsatisfactory.

Part IV: Mothers' and Children's Reported Practices about Bronchial Asthma Control: This part included items assessing mothers' and children's indoor and outdoor precautionary measures related to asthma control, such as avoiding smoking indoors, limiting the use of candles and incense, ensuring proper ventilation, using exhaust fans and air conditioning, using allergen-proof covers, limiting outdoor activities on days with poor air quality, considering N95 masks during severe air pollution events, encouraging hydration, proper use of inhalers, and implementing measures to reduce allergen exposure.

Scoring system:

Responses were scored as "done" or "not done," with "done" receiving a score of 1 and "not done" receiving a score of 0. The total reported practices score was calculated, converted to a percentage, and classified as unsatisfactory ($\leq 60\%$) and satisfactory ($> 60\%$).

Tool (2): The Childhood Asthma Control Test(C-ACT)

The C-ACT, adopted from Liu et al. (2007), is designed for children aged 4-11 years. It includes seven questions, divided into two domains: the child domain and the parent domain. The child with asthma answers four questions regarding their symptoms, such as how their asthma is on the current day, symptoms during physical activity, frequency of coughing due to asthma, and how often asthma disrupts their sleep. The parent or guardian answers three additional questions about the number of days in the past month that the child experienced daytime symptoms, wheezing, and nighttime awakenings due to asthma. The total score ranges from 0 to 27, categorized as follows: well-controlled 20–27, not well-controlled 13–19, and very poorly controlled 0–12.

Validity and reliability:

The data collection tools were evaluated by a panel of three experts in the Pediatric Nursing field at the Faculty of Nursing, Mansoura University, to assess the construct and content validity. The experts reviewed the arrangement of items, their suitability, and the clarity of the sentences. Based on their feedback, the tools were modified accordingly. Additionally, the reliability of the tools was statistically tested to ensure their internal consistency using the Cronbach's alpha test. The Cronbach's alpha values for the participants' knowledge and reported practices were 0.807 and 0.821, respectively, while the C-ACT tool had a reliability value of 0.876, indicating high internal consistency.

Pilot study:

To assess the understandability, practicality, and potential challenges of the study tools, a pilot study was conducted involving 10 mothers and their school-age children, representing 10% of the main study sample. This pilot phase allowed for necessary adjustments and refinement of the tools. The data collected from the pilot participants were excluded from the main study to ensure the validity of the final results.

Ethical considerations:

Ethical approval for the study was obtained from the Research Ethical Committee at the Faculty of Nursing, Mansoura University (Ref. No. P. 0574). Official permissions were granted by the director of the MUCH and the head of outpatient clinics after a detailed explanation of the study's objectives, purpose, and expected outcomes. Prior to the study's initiation, formal written consent was obtained from

each mother, and informed assent was collected for their children's participation, following a clear explanation of the study's purpose. Participants were assured that their involvement was entirely voluntary, all collected data would be kept confidential, and they could withdraw from the study at any time without any consequences.

Procedure:

Data collection was conducted between January and June 2024 and was structured into four main phases: assessment, planning, intervention, and evaluation.

Assessment phase:

In the waiting area of the clinic, researchers approached mothers and their school-age children who met the inclusion criteria. The study's aim was explained, and informed consent was obtained from each participant. Researchers also recorded the mothers' contact details for follow-up purposes. Data collection took place at the study locations on Saturdays and Tuesdays from 9:00 AM to 2:00 PM. The process began with the researchers introducing themselves to the participants. Each mother and her child were then individually interviewed to gather baseline data, including demographic details, clinical history, knowledge about bronchial asthma and climate change, and reported asthma control practices. This data was collected using Tool 1. Additionally, children's asthma control levels were assessed before the intervention using Tool 2. The interview process lasted approximately 20 to 30 minutes per participant.

Planning phase:

Based on the initial assessment findings and a review of relevant literature, the researchers developed an easy-to-understand empowerment program in Arabic, featuring engaging and colorful educational materials. The program was tailored to address the specific knowledge gaps and practical needs of mothers and children in managing asthma within the context of climate change.

Intervention phase:

Mothers and their children were divided into ten groups, with each group participating in a structured educational program consisting of three theoretical sessions and one practical session. Sessions were conducted in the conference hall of the Allergy and Immunology Unit on Saturdays and Tuesdays from 11:00 AM to 12:00 PM.

Theoretical sessions

Each theoretical session lasted one hour and focused on a key aspect of asthma and climate change:

Session 1: Understanding bronchial asthma (60 minutes)

This session provided foundational knowledge about asthma, including its definition, causes, triggers, symptoms, prevention, and management. Various

teaching methods were used, such as interactive lectures, audiovisual presentations, case studies, questions and answers discussions, and printed educational materials to enhance comprehension and engagement.

Session 2: Climate change and its impact on health (60 minutes)

This session explored the causes of climate change and its direct and indirect effects on children's respiratory health. Topics covered included greenhouse gas emissions, deforestation, air pollution, and changes in weather patterns. Participants engaged in multimedia presentations, video-based learning, and group discussions to connect scientific concepts with real-world experiences.

Session 3: The link between climate change and asthma (60 minutes)

This session highlighted how environmental changes contribute to worsening asthma symptoms. Participants learned about climate-related asthma triggers such as air pollution, pollen, and extreme weather events. Teaching methods included presenting epidemiological data, brainstorming sessions to identify local asthma triggers, and role-playing exercises to practice asthma management under different weather conditions.

Practical session

The practical session reinforced the knowledge gained in the theoretical sessions by focusing on skill development and real-life application. Participants engaged in hands-on training, role-playing exercises, and demonstrations to ensure they could effectively implement asthma management strategies.

Key activities included:

- Correct use of inhalers and medications.
- Recognizing early asthma symptoms and knowing when to seek medical help.
- The importance of adhering to prescribed treatment plans.
- Strategies to minimize exposure to allergens and air pollution.
- Training on home modifications, such as improving ventilation and using allergen-proof covers.
- Encouraging children to participate in safe physical activities while managing their asthma triggers.
- Developing and utilizing personalized asthma action plans.

To ensure lasting knowledge retention, these sessions were spaced out over several weeks, allowing participants to gradually absorb and apply what they learned. Educational materials were also provided for home use, and follow-up support was available during clinic visits.

At the conclusion of the program, researchers provided a summary of key lessons and encouraged participants to ask questions and share their experiences. An open discussion allowed them to

express their thoughts and clarify any remaining concerns.

Evaluation phase:

The effectiveness of the program was assessed through a post-intervention evaluation conducted immediately after the final session, using Tool 1 to measure changes in knowledge and practices. A follow-up assessment was conducted three months later to determine whether improvements in asthma management were sustained. Throughout the three-month follow-up period, researchers monitored the children's asthma control levels using Tool 2.

The findings indicated significant and lasting improvements in asthma knowledge, self-management practices, and symptom control, confirming the program's success in enhancing asthma management within the context of climate change.

Statistical analysis:

The data collected during the study were entered into SPSS and coded for analysis. Before proceeding, the data were checked for any errors or outliers. Quantitative data were summarized using appropriate measures, such as the mean and standard deviation. The Chi-square test was employed to assess differences between categorical variables. Cochran's Q test was used to compare qualitative data at pre-, post-, and follow-up time points within the same group. A paired sample t-test was applied to compare quantitative data before and after the intervention. The correlation coefficient was calculated to measure the strength of the linear relationship between two variables. Statistical significance was determined at a p-value of ≤ 0.05 .

Results:

Table (1): Distribution of mothers according to their characteristics (n=100)

Mothers' characteristics	n	%
Age in years:		
20 - <30	24	24
30 - <40	51	51
40 - 50	25	25
Mean \pm SD	35.1 \pm 8.64	
Educational level:		
Read and write	6	6
Basic	21	21
Secondary	43	43
Bachelor	30	30
Occupation:		
Working	19	19
Housewife	81	81
Residence:		
Rural	41	41
Urban	59	59
Income:		
Sufficient	22	22
Insufficient	78	78
Number of children:		
1	29	29
2	30	30
3	32	32
4	9	9

Table (2): Distribution of children according to their characteristics (n=100)

Children's characteristics	n	%
Age in years:		
9 - <12	39	39
12 - 14	61	61
Mean± SD	9.22±2.4	
Sex:		
Male	40	40
Female	60	60
Educational grade:		
Primary	65	65
Preparatory	35	35
Birth order:		
First	42	42
Second	23	23
Third	27	27
Fourth	8	8

Table (3): Distribution of children according to their clinical data (n=100)

Children's clinical data	n	%
Asthma severity:		
Mild	7	7
Moderate	59	59
Severe	34	34
Asthma triggers: *		
Temperature	42	42
Humidity	77	77
Drought	95	95
Rainfall	94	94
Infection	76	76
Food	45	45
Air contaminants	96	96
Extreme weather	89	89
Smoking	78	78
Domestics pets	42	42
Dust	61	61
Number of hospital visits in the past 6 months:		
0	7	7
1	23	23
2 or more	70	70
Number of hospital admissions in the past 6 months:		
0	36	36
1	44	44
2 or more	20	20
Inhalational therapies:		
Yes	93	93
No	7	7

* More than one answer was selected.

Table (4): Mean scores for the severity of symptoms reported by children and their mothers according to C-ACT scale (n=100)

Items	Pre- test	3 months post test	Test of significance	
	Mean (SD)	Mean (SD)	t- test	P value
Severity of symptoms (Children domain)	8.6 (2.0)	5.21 (1.9)	8.098	0.002**
Severity of symptoms (Parent domain)	11.9 (3.1)	8.7 (2.9)	8.222	0.009**
Total score of C-ACT	20.5 (5.8)	13.91 (4.6)	9.128	0.001**

** Statistical significance at $p \leq 0.05$ **Table (5): Distribution of children according to total C-ACT scale (n=100)**

C-ACT Level	Pre-test		3 months post test		χ^2 / t-test	P value
	n	%	n	%		
Well controlled	16	16	45	45	8.997	0.003**
Not well controlled	28	28	30	30		
Very poorly controlled	56	56	25	25		
Total score of C-ACT	20.5 (5.8)		13.91 (4.6)		9.128	0.001**

 χ^2 : Chi – square,** Statistical significance at $p \leq 0.05$ **Table (6): Distribution of mothers and children according to their knowledge about bronchial asthma and climate change pre, immediately post and post 3 months of intervention (n=100)**

Items	Mothers Knowledge				Children knowledge			
	Pre	Immediately post	Post 3months	P value	Pre	Immediately post	Post 3months	P value
	N (%)	N (%)	N (%)		N (%)	N (%)	N (%)	
Asthma related knowledge								
The definition of asthma	50	93	90	<0.01**	30	85	80	<0.01**
Causes	20	90	87	<0.01**	10	83	77	<0.01**
Trigger factors	55	97	93	<0.01**	40	92	85	<0.01**
Clinical manifestations	48	96	94	<0.01**	40	95	89	<0.01**
Prevention and management	20	90	88	<0.01**	10	80	77	<0.01**
Climate change related knowledge								
Definition of climate change	35	98	90	<0.01**	45	93	90	<0.01**
Causes	15	88	80	<0.01**	33	90	87	<0.01**
Effects of climate change	12	95	90	<0.01**	10	90	85	<0.01**
Methods of adaptation to climate change	19	92	88	<0.01**	5	89	80	<0.01**
The relationship between asthma and climate change.	18	96	90	<0.01**	12	90	82	<0.01**

N for correct answers, ** Statistical significance at $p \leq 0.05$

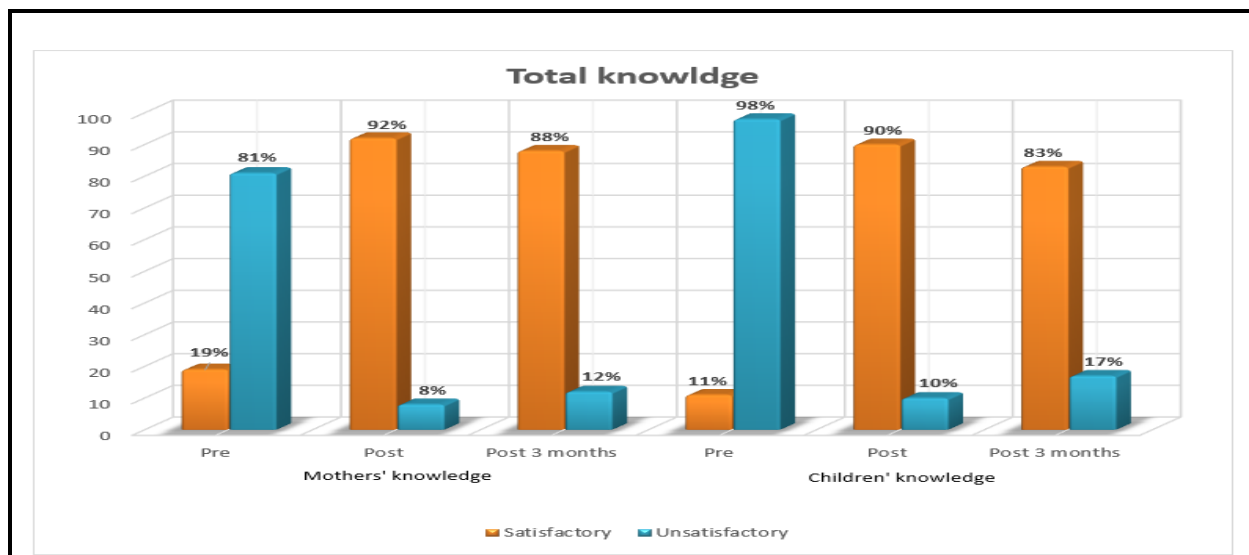


Figure (1): Distribution of mothers’ and children’s total knowledge regarding bronchial asthma and climate change pre, immediately post and post 3 months of intervention (n=100)

Table (7): Distribution of mothers’ and children’s reported practices about bronchial asthma control during climate change pre, immediately post and post 3 months of intervention (n=100)

Items	Mother's practice				Children practice			
	Pre	Immediately post	Post 3months	P value	Pre	Immediately post	Post 3months	P value
	N (%)	N (%)	N (%)		N (%)	N (%)	N (%)	
Avoid smoking indoors	34	93	90	<0.01**	30	90	83	<0.01**
Limit the use of candles and incense	42	90	87	<0.01**	32	86	80	<0.01**
Ensure proper ventilation	46	95	92	<0.01**	40	90	85	<0.01**
Correct use of inhalers	89	100	100	<0.01**	78	100	97	<0.01**
Use exhaust fans and air conditioning to circulate and filter indoor air	38	97	91	<0.01**	37	95	90	<0.01**
Use allergen-proof covers on pillows and mattresses	16	80	77	<0.01**	10	80	77	<0.01**
Limit outdoor activities especially strenuous exercise	14	76	70	<0.01**	12	70	63	<0.01**
Consider N95 masks to filter out fine particulate matter during severe air pollution events	24	79	75	<0.01**	15	79	73	<0.01**
Encourage child to drink plenty of water to soothe irritated airways	30	90	88	<0.01**	22	88	85	<0.01**
Take measures to reduce exposure to allergens	12	80	76	<0.01**	9	77	70	<0.01**

N for done practices,

*Significant at p <0.05

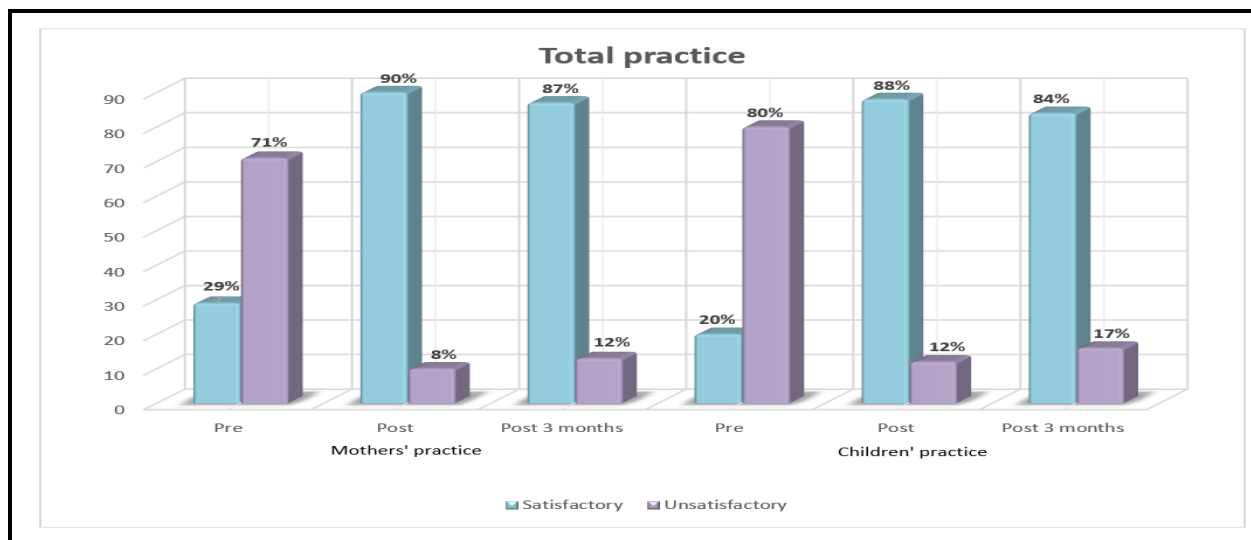


Figure (2): Distribution of mothers' and children's total reported practices about bronchial asthma control during climate change pre, immediately post and post 3 months of intervention (n=100)

Table (8): Correlation matrix between studied variables at 3 months post intervention

Variable		Total mothers' knowledge	Total mothers' practice	Total children' knowledge	Total children' practice
Total mothers' knowledge	r				
	p				
Total mothers' practice	r	0.698			
	p	<0.01**			
Total children' knowledge	r	0.467	0.402		
	p	<0.01**	<0.01**		
Total children' practice	r	0.423	0.564	0.628	
	p	<0.01**	<0.01**	<0.01**	
C-ACT score	r	0.399	0.403	0.502	0.540
	p	<0.01**	<0.01**	<0.01**	<0.01**

r: Pearson correlation coefficient test, ** Statistically significant at $p \leq 0.05$

Table (9): The average change of the targeted outcomes in relation to the implementation of empowerment program for mothers' and their school-age children on asthma control during climate change

Children's clinical data	Pre		Post 3months		Test of significance	
	n	%	n	%	χ^2	P value
Asthma severity					6.815	<0.01**
Mild	7	7	47	47		
Moderate	59	59	38	38		
Severe	34	34	15	15		
Number of hospital visits					8.730	<0.01**
0	7	7	38	38		
1	23	23	21	21		
2 or more	70	70	41	41		
Number of hospital admissions					6.557	<0.01**
0	36	36	58	58		
1	44	44	30	30		
2 or more	20	20	12	12		
Inhalational therapies					4.845	<0.01**
Yes	93	93	64	64		
No	7	7	36	36		

χ^2 : Chi - square, ** Statistical significance at $p \leq 0.05$

Table (1): Shows that the mothers' ages ranged from 20 to 50 years, with an average age of 35.1 ± 8.64 years. Regarding education, 43% of mothers had completed secondary education. The majority of the mothers (81%) were housewives. In terms of residence, 59% of them are living in urban areas. A significant proportion of mothers (78%) reported having insufficient income. Additionally, 32% of the mothers had three children.

Table (2): Reveals that children's ages ranged from 9 to 14 years, with an average age of 9.22 ± 2.4 years and 60% of them were females. Regarding educational grade, 65% of the children were in primary school. In terms of birth order, 42% of the children were firstborn.

Table (3): Indicates that more than half (59.0%) of the studied children experienced moderate asthma severity. The most common asthma triggers reported were dust (61%), drought (95%), and extreme weather (89%). Regarding hospital visits in the past 6 months, 70% of children had visited the hospital two or more times. In terms of previous hospital admissions, 44% of the children had one admission, and 20% had two or more admissions. The majority of the children (93.0%) were receiving inhalational therapies.

Table (4): Demonstrates a significant reduction in symptom severity as reported by both children and mothers following the intervention. The mean scores decreased from 8.6 to 5.21 for children and from 11.9 to 8.7 for mothers. These improvements were statistically significant ($p=0.001$), indicating that the intervention was effective in managing symptoms. The total C-ACT score also showed a marked improvement, further reinforcing the success of the intervention ($p\text{-value}=0.003$).

Table (5): Shows a significant increase in the percentage of children with well-controlled asthma, rising from 16% in the pre-test to 45% in the post-test. Meanwhile, the percentage of children with very poorly controlled asthma decreased from 56% to 25%. These results demonstrate a statistical significance positive shift in asthma control following the intervention.

Concerning mothers and children knowledge levels regarding asthma and climate change **Table (6)** shows significant improvement across all items immediately post-intervention, with most percentages exceeding 90%. For instance, knowledge about the definition of asthma increased from 50% to 93% for mothers and from 30% to 85% for children. This improvement was maintained at the three-month follow-up, highlighting the lasting impact of the intervention ($p\text{-value}=0.01$).

Figure (1): Shows that before the intervention, 81% of mothers and 98% of children had unsatisfactory

knowledge regarding climate change and asthma. After the intervention, 92% of mothers and 90% of children demonstrated satisfactory knowledge. Three months post-intervention, 88% of mothers and 83% of children had satisfactory knowledge.

Table (7): Illustrates significant improvements in all listed practices, as well as in the overall practices of mothers and their children ($p < 0.01$). This indicates the intervention's effectiveness in improving asthma control during climate change. Although there is a slight decline at three months, the practices remain significantly higher than baseline, suggesting sustained behaviour changes.

Figure (2): Highlights the improvement in mothers' and children's total reported practices over time, emphasizing the intervention's success in enhancing asthma management practices. Before the intervention, only 29% of mothers and 20% of children had satisfactory practices. Post-intervention, this increased significantly to 90% of mothers and 88% of children. At the three-months follow-up, 87% of mothers and 84% of children maintained satisfactory practices.

Table (8): Highlights significant positive correlations between knowledge, practices, and clinical outcomes. For example, mothers' total knowledge is strongly correlated with their practices ($r = 0.698$, $p < 0.01$), while children's practices are positively correlated with their C-ACT scores ($r = 0.540$, $p < 0.01$). These results highlight the strong link between education, behaviour, and health outcomes. In the context of the study, when mothers and children receive proper education about asthma and climate change, they adopt better asthma management practices (behavior), leading to improved asthma control and reduced symptom severity (health outcomes).

It was observed from **Table (9)** that the clinical data revealed significant improvements in children's asthma management following the intervention ($p < 0.01$). Asthma severity improved, with mild cases increasing from 7% pre-intervention to 47% at three months, while severe cases decreased from 34% to 15%. Hospital visits were also reduced, with the percentage of children having two or more visits dropping from 70% to 41%, and those with no visits were rising from 7% to 38%. Similarly, hospital admissions decreased, as the percentage of children with no admissions increased from 36% to 58%, and those with two or more admissions fell from 20% to 12%. Additionally, the use of inhalational therapies declined from 93% pre-intervention to 64% at three months. These results demonstrate the intervention's effectiveness in reducing asthma severity, hospital visits, and reliance on inhalational therapies.

Discussion:

Asthma is a prevalent chronic condition among school-age children, significantly influenced by environmental factors such as climate change. Empowering mothers and their children with knowledge and skills to manage asthma effectively is crucial for improving health outcomes, especially during periods of climatic change. The current study aimed to evaluate the effectiveness of an empowerment program designed to enhance mothers' and their children's knowledge, practices, and clinical outcomes related to asthma control amidst climate change challenges.

The present study found a significant improvement in both mothers' and children's knowledge about bronchial asthma and climate change after participating in the empowerment program. Before the intervention, most mothers and children had unsatisfactory knowledge, but this increased to satisfactory levels post-intervention and remained relatively high even three months later, with statistical analysis confirming the significance of these changes. This underscores the effectiveness of educational interventions in equipping families with the necessary knowledge to better understand the complex relationship between climate change and pediatric asthma, potentially leading to improved asthma control and better health outcomes for children. Additionally, the intervention resulted in significant improvements in asthma management practices, with positive effects that were sustained three months after the program, demonstrating its lasting impact. The findings also revealed strong positive correlations between mothers' and children's knowledge, practices, and C-ACT scores, suggesting that those with a deeper understanding of asthma management are more likely to adopt practices that enhance asthma control. This highlights the important link between education, behavior (practices), and health outcomes, as higher knowledge levels were associated with better asthma management and higher C-ACT scores in children.

From the researchers' point of view, these results underscore the critical role of targeted educational programs in enhancing disease management. Empowering families with relevant knowledge not only improve health outcomes but also fosters resilience against environmental challenges such as climate change. This study highlights the necessity for integrating such empowerment initiatives into public health strategies to combat chronic diseases effectively.

Recent research highlights the positive impact of empowerment programs on asthma management. For example, **Ng et al. (2021)**, in their randomized controlled trial "A Nurse-Led Web-Based Home

Asthma Education Program for Children and Their Families," found that a nurse-led, web-based asthma education program significantly improved caregivers' knowledge, attitudes, and asthma management practices in the intervention group compared to the control group. Additionally, their study reported a notable reduction in unscheduled hospital visits for asthma exacerbations among children who participated in the program. From the researchers' point of view, these results underscore the potential of educational interventions in enhancing caregiver competence and reducing healthcare utilization among pediatric asthma patients. The significant improvements observed suggest that such programs can effectively bridge educational gaps.

The study by **Rajabi et al. (2016)** assessed the impact of a family-centered empowerment model on the knowledge, attitudes, and self-efficacy of mothers caring for children with asthma. The results indicated that, prior to the intervention; there were no significant differences between the two groups concerning demographic characteristics or baseline scores on knowledge, attitudes, and self-efficacy. However, post-intervention assessments revealed that the intervention group exhibited significant improvements in all these areas compared to the control group. Specifically, the intervention group demonstrated enhanced knowledge about asthma and its management, more positive attitudes toward asthma care, and increased self-efficacy in managing their child's condition. These findings suggest that implementing family-centered empowerment programs can effectively enhance mothers' understanding, attitudes, and confidence in managing their children's asthma, leading to better health outcomes for the children.

The study by **Pelarti et al. (2019)** evaluated the impact of family-centered education based on the Health Belief Model on the knowledge and attitudes of parents with children suffering from asthma. The findings indicated that, prior to the intervention, there were no significant differences between the two groups concerning demographic characteristics or baseline scores on knowledge, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy. However, post-intervention assessments revealed that the intervention group exhibited significant improvements in all these areas compared to the control group. Specifically, the intervention group demonstrated enhanced knowledge about asthma and its treatments, a better understanding of perceived susceptibility and severity, increased recognition of the benefits of preventive measures, reduced perceived barriers, and improved self-efficacy in managing asthma. These results underscore the

effectiveness of family-centered education programs based on the Health Belief Model in enhancing parental knowledge and attitudes toward asthma management. These findings suggest that implementing such educational programs can empower parents with the necessary knowledge and attitudes to manage their children's asthma more effectively. By addressing the cognitive and emotional aspects of asthma care, these interventions can lead to better health outcomes for children with asthma.

In an Egyptian study by **Abdel-Khalek et al. (2023)** titled "Effect of an Educational Intervention Program on Improving Self-Care Practices of Asthmatic Children", the researchers evaluated the impact of an educational program on the knowledge and self-care practices of school-aged children with bronchial asthma. Prior to the intervention, all participants exhibited unsatisfactory levels of knowledge and self-care practices related to asthma management. Following the educational program, there was a significant improvement: 95% of the children achieved satisfactory knowledge levels, and 95% demonstrated satisfactory self-care practices. However, at a three-month follow-up, these figures declined to 60% for knowledge and 70% for self-care practices, respectively. Additionally, the frequency of asthma attacks decreased, leading to reduced hospitalizations and fewer school absences. The study concluded that educational interventions effectively enhance children's understanding and management of asthma, though ongoing education is recommended to maintain these improvements.

In line with the findings of the current research, **Dardouri et al. (2021)** conducted a randomized controlled trial to evaluate the impact of a family empowerment program on asthma control and medication use in children with asthma. The study demonstrated that children in the intervention group achieved significantly higher asthma control scores compared to those in the control group. Additionally, there was a notable reduction in the reliance on emergency medications, as well as fewer unscheduled visits to healthcare facilities. These findings highlight the program's effectiveness in equipping families with knowledge and skills to better manage asthma symptoms, ultimately improving health outcomes. From the researchers' perspective, these results underscore the critical role of family involvement in managing chronic conditions like asthma. Empowering families not only enhances children's clinical outcomes but also reduces healthcare burdens. This study reinforces the value of integrating family-centered programs into routine pediatric care, suggesting a sustainable and impactful approach to asthma management.

The study by **El-Moaty Sheha et al. (2023)** evaluated the impact of a web-based asthma self-care program on the quality of life of school students in a rural community. The study found that the implementation of the self-care program significantly improved the students' knowledge, self-management skills, and overall quality of life. Participants reported better control of asthma symptoms, reduced frequency of asthma attacks, and enhanced ability to participate in daily activities. The findings highlighted that web-based educational interventions are effective in empowering students with chronic conditions, such as asthma, by providing them with accessible and practical self-care knowledge. This study underscores the importance of integrating web-based health education into rural school programs to address healthcare disparities and improve health outcomes for students. The findings indicated that the program effectively enhanced students' knowledge, improved their inhaler techniques, and led to a better quality of life post-intervention. The researchers think these results highlight the potential of implementing such programs can bridge educational gaps and empower children to manage their asthma more effectively.

Furthermore, in an Egyptian study titled "Effect of Climate Change Educational Intervention on Knowledge and Health-related Behaviors of Children with Respiratory Allergic Diseases" by **Badawy et al. (2023)**, the authors evaluated the impact of an educational program on children's understanding and behaviors related to climate change and its effects on respiratory health. The findings revealed a significant improvement in the children's knowledge and health-related behaviors post-intervention. Specifically, there was a notable increase in awareness about how climate change influences respiratory allergic diseases and the importance of adopting protective behaviors. The study underscores the effectiveness of targeted educational interventions in enhancing health literacy and promoting proactive health behaviors among children with respiratory conditions.

In the 2019 study by **Kocaaslan & Akgün Kostak**, titled "Effect of Disease Management Education on the Quality of Life and Self-Efficacy Levels of Children with Asthma," the researchers investigated the impact of a structured educational intervention on children aged 10 to 18 diagnosed with asthma. The study employed a quasi-experimental design with a one-group pretest-posttest approach, involving 60 participants. Initially, assessments were conducted to gauge the children's quality of life and self-efficacy levels. Subsequently, each child received individualized asthma management education, supplemented by an educational booklet. Two months post-intervention, a re-evaluation revealed a

statistically significant enhancement in both quality of life and self-efficacy scores ($p = 0.014$). Further analysis identified factors influencing these outcomes: maternal age, number of siblings, household size, physical activity status, frequency of asthma symptoms, and the child's proficiency in using inhalers independently were linked to quality of life. Meanwhile, the child's age, awareness of asthma triggers, and ability to self-administer medication were associated with self-efficacy levels. The findings underscore the effectiveness of tailored asthma education programs in improving disease management among children. The authors advocate for the implementation and continuity of such educational initiatives by nursing professionals to bolster both quality of life and self-efficacy in pediatric asthma patients.

Similarly, a study by **Kashaninia et al. (2018)** evaluated the impact of a family empowerment program on asthma control in school-age children. The findings demonstrated significant improvements in asthma management among children whose families participated in the program. Post-intervention, the mean asthma control test (ACT) score in the experimental group increased from 15.57 ± 2.57 at baseline to 23.40 ± 1.76 , indicating a marked enhancement in asthma control. In contrast, the control group showed no statistically significant change in ACT scores (baseline: 15.40 ± 2.65 ; post-intervention: 15.67 ± 2.54). The study concluded that family empowerment is an effective strategy for improving asthma control, as it fosters better awareness, skills, and practices among family members, ultimately leading to better health outcomes for children. These findings highlight the critical role of family-centered interventions in chronic disease management.

In the article by **McDermott-Levy et al. (2023)**, the authors explore the intersection of asthma and climate change, focusing on the implications for children's health. The study emphasizes that climate change has exacerbated environmental factors, such as air pollution, allergens, and extreme weather events, which in turn worsen asthma symptoms in children. The authors highlight the increasing prevalence of asthma exacerbations and hospitalizations due to these environmental changes. They argue that there is an urgent need to address both the environmental and social determinants of asthma through a combination of public health policies, education, and interventions to protect children's health. The article also underscores the critical role of healthcare providers in educating parents and caregivers about the link between climate change and asthma, and in advocating for policies that mitigate the environmental factors contributing to poor asthma

control. By promoting awareness and effective management strategies, the authors suggest that the impact of climate change on children's asthma can be mitigated, leading to better health outcomes for affected children.

The study by **Fathala et al. (2022)** focused on evaluating the effect of parents' empowerment on the quality of life (QoL) among school-aged children with bronchial asthma. The researchers assessed how empowering parents impacts their knowledge, practices, and QoL of their asthmatic children. Prior to the intervention, a significant majority of parents demonstrated inadequate knowledge and suboptimal practices regarding asthma management. Correspondingly, 87.5% of the children had a poor QoL. Following the empowerment intervention, there was a significant improvement in children's QoL. Specifically, parents demonstrated enhanced knowledge and practices regarding asthma management, which directly correlated with reduced asthma-related symptoms and fewer exacerbations in their children. This led to better physical functioning, emotional well-being, and overall QoL in the children. The researchers think these findings suggest that empowering parents through targeted educational interventions can significantly enhance both their competence in managing their children's asthma and the children's overall QoL.

Similarly, a study conducted by **Fouda et al. (2015)** aimed to evaluate the effect of family empowerment on the quality of life (QoL) of school-aged children with asthma attending outpatient clinics at Tanta University and El-Mehalla El-Koubra Chest Hospital. The findings revealed significant improvements in the QoL of children whose families participated in the empowerment program. Domains such as physical functioning, emotional well-being, and symptom management showed marked enhancements post-intervention. Furthermore, the study reported a reduction in the frequency and severity of asthma exacerbations, alongside improved adherence to treatment protocols among the children. The researchers think these results highlight the importance of involving families in asthma management programs. Empowering families not only enhances their ability to provide better care but also directly contributes to better health outcomes and QoL for children with asthma. Such interventions should be considered integral components of pediatric asthma management strategies, particularly in resource-limited settings.

The study by **Abd-El Aziz et al. (2023)** examined the effect of an educational program based on the PRECEDE-PROCEED model on improving mothers' performance in caring for children with asthma. The study found that after the intervention, there was a

significant improvement in mothers' asthma management practices. The educational program enhanced mothers' knowledge about asthma, its triggers, and proper care strategies, which led to better asthma control in their children. The findings emphasized the importance of structured educational interventions in empowering caregivers, particularly mothers, to manage asthma more effectively. The PRECEDE-PROCEED model proved to be an effective framework for guiding the educational program, as it systematically addressed various factors influencing asthma care, including environmental, behavioural, and educational determinants. The study concluded that providing mothers with relevant, targeted education on asthma management can significantly improve both the caregivers' performance and the health outcomes for children with asthma.

Similarly, a study by **Alhazmi et al. (2023)** titled "Impact of Asthma Education Program 2020-2021 on Asthma Control Among Bronchial Asthma Children in Madinah City, Saudi Arabia" evaluated the effectiveness of an asthma education program on improving asthma control among children. The results revealed a significant improvement in asthma control post-intervention. Before the program, the majority of participants exhibited poor asthma management, with frequent symptoms, emergency visits, and limitations in daily activities. Following the educational intervention, there was a marked decrease in the frequency of asthma symptoms, emergency room visits, and hospitalizations. Moreover, children demonstrated improved adherence to prescribed medications and inhaler techniques. Caregivers reported increased confidence in managing their child's condition and a greater understanding of asthma triggers and preventive measures. The study highlights the critical role of educational programs in empowering families, improving asthma outcomes, and reducing the healthcare burden associated with poorly controlled asthma.

McClure et al. (2017) examined the effectiveness of an academic-practice partnership in enhancing pediatric asthma care and nursing education. The results revealed that the partnership significantly improved both nursing students' knowledge and clinical skills related to pediatric asthma management. Specifically, students who participated in the program demonstrated a better understanding of asthma pathophysiology, pharmacological treatments, and asthma management strategies. Additionally, the partnership fostered improved communication and collaboration between academic and clinical settings, which enhanced the overall quality of asthma care provided to pediatric patients.

In terms of patient outcomes, the study observed that children who received care through this partnership had improved asthma control, as evidenced by better adherence to prescribed medications, fewer asthma-related hospital visits, and enhanced self-management skills. These positive outcomes were attributed to the integration of evidence-based asthma care into nursing education and clinical practice, which emphasized patient-centered approaches, early intervention, and effective asthma education.

Comparably, the study by **Hu et al. (2022)**, a systematic review of epidemiological evidence was conducted to evaluate climate change adaptation measures for childhood asthma. The results highlighted that various climate change-related factors, such as increased air pollution, higher temperatures, and more frequent extreme weather events, significantly exacerbate childhood asthma symptoms. The review found that adaptation measures, including reducing exposure to environmental pollutants, improving indoor air quality, and enhancing asthma management programs, played a key role in mitigating the impact of climate change on children with asthma. Several studies included in the review demonstrated that targeted interventions, such as increasing access to asthma education, promoting the use of preventive treatments, and ensuring adequate healthcare infrastructure, contributed to better asthma control and fewer asthma-related hospitalizations. The evidence also suggested that climate change adaptation strategies that focus on both the physical environment and the healthcare system can provide effective relief for children with asthma, improving their quality of life and reducing the burden of the disease. The study concluded that while significant progress has been made in identifying climate change-related risks and adaptation strategies, further research and policy implementation are necessary to optimize these measures and ensure widespread access for vulnerable populations.

Likewise, the study by **Al-Muhsen et al. (2015)** found that poor asthma education and inadequate medication adherence were significantly linked to increased emergency department (ED) visits among children with asthma. The researchers found that children whose caregivers had limited knowledge about asthma and its management, as well as those who did not consistently follow prescribed medication regimens, were more likely to experience asthma exacerbations that required emergency care. These findings underscore the critical importance of proper asthma education and medication compliance in preventing asthma-related emergencies. The study emphasizes that improving caregivers' understanding of asthma management and ensuring adherence to

medication can play a key role in reducing the frequency of ED visits and improving overall asthma control in children.

As well, the study by **Antonogeorgos et al. (2022)** explored how parental education affects the relationship between indoor moisture environments and asthma in adolescents. The researchers found that higher levels of parental education moderated the negative effects of moisture exposure in the home, potentially reducing the risk of asthma exacerbations in adolescents living in such environments. Specifically, parents with better asthma-related knowledge were more likely to implement effective strategies, such as improving indoor ventilation or reducing moisture-related allergens, which helped manage their children's asthma symptoms. This suggests that educating parents about asthma management can play a significant role in mitigating the impact of environmental factors, such as indoor moisture, on asthma outcomes in adolescents. The study highlights the importance of parental education as a protective factor in asthma management, particularly in environments that may exacerbate respiratory conditions.

The study by **Al-Zalabani & Almotairy, (2020)** explored the relationship between asthma control and caregivers' knowledge among children with asthma. The findings showed that a higher level of knowledge about asthma management among caregivers was significantly associated with better asthma control in children. Caregivers who understood the importance of medication adherence, recognizing early symptoms, and managing triggers were more likely to implement effective asthma control strategies, leading to fewer asthma-related complications and hospital visits for their children. The study highlighted the critical role of caregiver education in improving asthma outcomes, suggesting that enhancing caregivers' understanding of asthma can play a key role in achieving better asthma control and reducing the burden of the disease on children. These findings emphasize the need for targeted educational interventions for caregivers to improve asthma management and overall health outcomes for children with asthma.

In the published doctoral dissertation by **Sommerer (2020)**, the relationship between parents' asthma knowledge, their control over their child's asthma, and their QoL was examined. The study found that parents with better asthma knowledge were more effective in managing their child's asthma, leading to improved asthma control and fewer exacerbations. This, in turn, positively impacted the parents' quality of life, as they felt more confident in their ability to manage their child's condition and reduce the emotional and physical strain of asthma-related

challenges. The research highlighted the importance of providing parents with comprehensive asthma education, as it not only enhances the child's asthma management but also improves the overall well-being of the parents. The study suggests that improving asthma knowledge among parents should be a key focus of interventions aimed at improving asthma outcomes for children and enhancing the quality of life for families affected by asthma.

Overall, this study highlights the crucial role of improving both knowledge and practices of mothers and children with asthma to achieve better asthma control outcomes. By enhancing mothers' and children's understanding of asthma, encouraging positive health behaviours, and creating a supportive environment for asthma management, interventions can significantly contribute to better asthma control and improved respiratory health for children with asthma. The present study's findings underscore the importance of adopting comprehensive, multifaceted approaches to asthma management that equip caregivers with the necessary tools and resources to effectively manage pediatric asthma at home, ultimately leading to improved health outcomes for children.

Conclusion:

This study highlights the effectiveness of an empowerment program in improving asthma control among school-age children. The program enhanced knowledge and practices, reduced symptom severity, and led to fewer hospital visits and less reliance on inhalers. Strong links between education, behavior, and health outcomes emphasize the value of tailored interventions in managing asthma amid climate change.

Recommendations:

1. Implement empowerment programs in healthcare settings to improve asthma management, especially for vulnerable populations affected by climate change.
2. Integrate climate change awareness into health education to enhance understanding of its impact on respiratory health.
3. Expand access to asthma education, particularly in underserved rural and remote areas.
4. Encourage cross-sector collaboration among healthcare providers, environmental agencies, and educational institutions.
5. Promote ongoing follow-up and support through regular interventions and refresher sessions.
6. Advocate for policy changes to prioritize asthma management and prevention in the context of climate change.

7. Conduct further research on the long-term effectiveness of empowerment programs across diverse populations and environments.

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