Effect of Nursing Intervention in Reducing Climate-Related Exacerbations among Patients with Asthma

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Abstract

Background: Asthma is directly threatened by climate change. Exacerbations of asthma pose a serious health risk and are frequently made worse by climate change-related variables like increased exposure to allergens, air pollution, and extreme weather events**. Aim:** The study aimed to evaluate the effect of nursing interventions in reducing climate-related exacerbations among patients with asthma. **Design:** A quasi-experimental research design was used. **Setting:** The study was conducted at the respiratory outpatient clinic at Kasr El Aini University Hospital, affiliated with Cairo University, Cairo, Egypt. **Subjects:** A convenient sample of 120 adult male and female patients with asthma. **Tools:** Five tools were used to gather data. **Tool I:** Structured Interview Questionnaire for Patients with Asthma. This tool consists of three parts: **Part 1**, Patient's Socio-Demographic Characteristics; **Part 2**, Asthma Severity Assessment. **Tool II**, Knowledge about Climate-Related Asthma Triggers. **Tool III:** Perception about Climate-Related Asthma triggers. **Tool IV**: Asthma Control Test**, and Tool V:** Environmental exposure assessment. **Results:** There was a high improvement in patient knowledge in the pre-, post-, and follow-up after implementation of the nursing intervention program. The severity of asthma symptoms decreased by 25.0%, 5.0%, to 3.3**.** Asthma exacerbation decreased by 50%, from 16.7% to 8.3%. and emergency hospital visits is significantly decreasing by 50%, 5%, to 3.3%, respectively pre, post, and follow up. **Conclusion:** According to the study's findings, patients with asthma who received the nursing intervention program had a positive effect in reducing climate-related exacerbations and improved overall disease management. **Recommendation:** Healthcare providers in the respiratory department must hold educational workshops regarding how the climate can exacerbate asthma.

Keywords: Asthma, Climate-related exacerbations, Nursing intervention

Introduction

Asthma is a chronic inflammatory disease of the airways. With a frequency of 12.6% and over 339 million individuals globally, the burden of asthma is increasing. By 2025, it is projected to reach 400 million **(WHO, 2025).** More than 461,000 people died from asthma in 2019, primarily in low- and middle-income (LMIC) nations where it is still difficult to get an early diagnosis and receive proper treatment. In Egypt, it is more common in men than women (1.2:1), accounting for about 6.7% of the overall population **(Hosny et al., 2022 & Ishak et al., 2020)**

Frequent episodes of coughing, chest tightness, wheezing, and dyspnea are symptoms of asthma. It is typified by inflammation, mucus overproduction, and hyperresponsiveness of the airways, which impede airflow which are leads to difficulty breathing **(NHS, 2024).** Asthma attacks of different intensities can be triggered by a variety of factors, such as allergies, respiratory infections, exertion, and environmental pollution. Even while asthma can be controlled with the right medicine, lifestyle changes, and avoidance of triggers, it is nevertheless a major public health issue that lowers the quality of life and increases hospitalizations. In urban regions with high pollution levels and shifting climate patterns, the prevalence of asthma is on the rise **(Global Initiative for Asthma, 2024).**

Healthcare systems must address climate change and its worldwide effects since it poses a serious threat to human health. According to **Ghazy and Fathy (2023),** it is among the biggest worldwide health issues of the twenty-first century. Because rising global temperatures, more air pollution, and extreme weather events exacerbate respiratory symptoms, climate change has a substantial effect on asthma exacerbations. Heat waves and higher temperatures raise ground-level ozone and particulate matter levels, which are strong airway irritants that can cause asthma episodes.

Furthermore, elevated carbon dioxide levels encourage the development of plants that cause allergies, leading to longer and more intense pollen seasons, which exacerbate asthma symptoms. The frequency and intensity of asthma flare-ups are increased by airborne pollutants, mold spores, and other respiratory irritants released by wildfires, hurricanes, and flooding. Variations in temperature and humidity also increase the risk of respiratory infections, which are important asthma triggers **(Kelly et al., 2023).**

By offering patient-centered care, education, and preventive measures, nursing interventions are essential in lowering asthma exacerbations, especially in light of climate change. Through organized education

programs, nurses can assist patients in recognizing and managing climate-related asthma triggers, such as allergens, excessive temperatures, and air pollution. Asthma control can be greatly enhanced by teaching patients how to track air quality indices, identify early exacerbation symptoms, and modify their activity accordingly. The nurse helps patients avoid severe attacks by encouraging medication adherence by making sure they take inhalers and other recommended medicines as directed **(Alexandre-Sousa et al., 2024)**

Nurses must imperatively combine their roles in environmental health and health intervention through plans for patients to enhance indoor air quality. Nurses can urge patients to use air purifiers, keep windows closed on days with heavy pollution, and limit their exposure to allergens like mold and dust. Furthermore, stress is a need for adequate nutrition and hydration to preserve respiratory health, particularly during dry seasons and heat waves. Additionally, nurses can create individualized action plans for patients with asthma that help them react quickly to exacerbations, which lowers the number of emergency hospital visits **(Sebastião et al., 2023).**

In addition to providing individualized patient care, nurses can support public health initiatives that address how climate change affects respiratory health. Nurses support larger initiatives to reduce climate-related health hazards by taking part in community health initiatives, advocating for climate-conscious healthcare practices, and increasing public understanding of the link between environmental changes and asthma. Nursing practitioners are crucial in empowering patients, enhancing asthma outcomes, and modifying healthcare procedures to meet the demands of climate change through these interventions **(Sebastião et al., 2023).**

Significance of the Study

Asthma flare-ups, heat waves, extreme weather events, and poor air quality is all consequences of climate change that are happening more frequently and with greater severity. An estimated 262 million individuals worldwide suffer from asthma, and the condition claimed 455,000 lives. According to **Elsadee et al. (2024)**, the prevalence of bronchial asthma in Egypt was 6.09%, with the prevalence being higher in urban regions than in rural ones (6.58 and 5.34%, respectively). Finding strategies to lessen these exacerbations is crucial to avoiding needless ER visits and hospital stays, enhancing patient outcomes, and cutting expenses **(Goshua et al., 2023)**

Nurses play a pivotal role in asthma management through patient education, environmental control strategies, medication adherence, and self-management support. By focusing on climate-related factors that exacerbate

asthma, nursing interventions can be tailored to address the unique needs of individuals with asthma living in climate-impacted environments. Therefore, the study aims to evaluate the effectiveness of nursing interventions in reducing climate-related exacerbations among patients with asthma and improving their overall disease management. **Aim of the study:** to evaluate the effect of nursing interventions in reducing climate-related exacerbations among patients with asthma and improving their overall disease management.

Operational Definitions:

Climate-related exacerbations refer to the worsening of asthma symptoms or attacks triggered by environmental factors associated with climate change (**Makrufardi, et al., 2023**).

Research hypotheses of the study:

H_1. Patients with asthma may exhibit improvement in their knowledge and perception post-implementation of the nursing intervention program regarding climate-related exacerbations.

H_2. Patients with asthma may exhibit improvement in their asthma severity post-implementation of the nursing intervention program regarding climate-related exacerbations.

II. Subjects& method:

Study design:

A quasi-experimental design (pre and post-test) was used to accomplish this study.

Setting:

The study was conducted at the Kasr El Aini University Hospital's respiratory outpatient clinic, affiliated with Cairo University, Cairo, Egypt. The clinic is composed of 2 rooms prepared for the assessment of patients with respiratory diseases and a waiting area. It is located in the outpatient building at the entrance of Al Kasr El Aini University Hospital.

Subjects:

The study subjects comprised one group, a convenient sample of 120 adult male and female patients with asthma. They can communicate effectively and follow instructions.

Sample size calculation: The program was used to calculate the sample size by applying the following parameters: Population size = 180, Expected frequency = 50%, Acceptable error = 5%, Confidence coefficient = 95%, Minimum sample size = 123

Tools for data collection: To fulfill the objective of the study, five tools were used for data collection.

Tool 1: Structured Interview Questionnaire:

This tool was developed by the researchers after reviewing the related literature (**Hinkle et al.,2021**) to collect baseline data. It was divided into three parts as the following:

Part 1: Patient's socio-demographic characteristics, including age, gender, smoking status, level of education, occupation, residence, family history of

asthma, presence of comorbidities, and duration of asthma diagnosis.

Part 2: Asthma severity assessment, including duration of asthma diagnosis, presence of comorbidities, and frequency of exacerbations in the past 6 months. Adopted from **Global Initiative for Asthma, 2023).**

Scoring system:

Asthma severity is categorized into four levels based on symptom control and treatment requirements:

-Intermittent: Symptoms ≤2 days/week, nighttime awakenings ≤2 times/month, SABA use ≤2 days/week, no activity limitation.

-Mild Persistent: Symptoms >2 days/week but not daily, nighttime awakenings 3–4 times/month, minor activity limitation.

-Moderate Persistent: Daily symptoms, nighttime awakenings >1 time/week, SABA use daily, some activity limitation.

-Severe Persistent: Symptoms throughout the day, frequent nighttime awakenings, SABA use multiple times daily, severe activity limitation

Tool II: Knowledge about climate-related asthma triggers: This part was designed to assess the patient's knowledge regarding asthma. It includes awareness of climate-related triggers (humidity, pollen, temperature change, and air pollution). It was adapted from (**Koster, & Raaijmakers, 2023).**

Scoring system:

Knowledge contains three domains assessed (Awareness of climate impact (7 questions), Knowledge of pollution effects (5 questions), and understanding weather changes (4 questions) with a total of 16 questions. Each correct answer gives 1, and each incorrect answer gives 0.

The total grades were summed and converted into %, and the level of patient's knowledge was divided into:

- High > 75% of the total score
- Moderate=50%-75% of the total score
- Low < 50% of the total score

Tools III: Perception about climate-related asthma triggers: It is designed to assess the patient's perception and awareness regarding asthma risks. It includes 4 statements about how the weather affects asthma symptoms, how air pollution worsens asthma, can reduce asthma triggers, and how climate change increases the risk. It was adapted from **Watts et al. (2019).**

Scoring system:

It is a 5-point Likert scale (1=Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree). Interpretation of overall score (1–5 Scale):

Final Score (1–5)	Perception Level
1.0 – 2.9	Low perception
3.0 – 3.9	Moderate perception
4.0 – 5.0	High perception

Tool IV: Asthma Control Test (ACT): to assess the level of asthma control before and after nursing interventions. This test helps healthcare

professionals understand how well asthma symptoms are under control. It provides a numeric score to help standardize asthma control.

ACT considers how symptoms affect patients' daily life activities. It affects patients' symptoms over the past 4 weeks. It can also help doctors assess how treatments are working. It was adopted from **Murphy & Zeiger (2014) & Gill (2025). It is** standardized **5-questions**, with 5 Likert scale points from 1-5 (Not controlled at all [1], Poorly controlled [2], Somewhat controlled [3], Well-controlled [4], and completely controlled [5])

Scoring system:

 It scored from 5 to 25

≥20: Well-controlled asthma

16–19: Partially controlled asthma

≤15: Poorly controlled asthma

Tools V: Environmental Exposure Assessment: to monitor climate-related factors affecting asthma symptoms. It was designed to evaluate a patient's **exposure to environmental triggers** that may contribute to asthma exacerbations**.** It was adopted from **Barnes & Portnoy (2024).** It provides an understanding of the relationship between **air quality, weather conditions, and patient-reported symptoms,** allowing for targeted interventions. It contains patient-reported Exposure to triggers. Patients' responses are analyzed to identify **patterns between environmental**

exposure and symptom severity. It is a standardized tool that contains 4 questions. Each question uses a 0-3 Likert scale.

Scoring System

 Use a **0-3 Likert scale** for each item:

0 = No exposure/issue

1 = Mild exposure/occasional trigger

2 = Moderate exposure/frequent trigger

3 = Severe exposure/constant trigger

Score Interpretation	Risk Level	Recommended Action
0 – 4	Low Risk	Minimal impact of environment on asthma
5 – 8	Moderate Risk	Consider lifestyle adjustments & trigger avoidance
10 – 12	High Risk	Environmental control measures needed

Ethical consideration:

It was approved by the Research Ethics Committee at the Faculty of Nursing, Helwan University, before the beginning of the actual work. After describing the aim, methods, and significance of the study, the hospital director's official approval was approved and obtained from the directors of the respiratory department to get their permission to conduct the study. Furthermore, after explaining the purpose of the study to the studied patients, written & oral agreement was obtained. They received guarantees about the privacy of the information gathered. The studied patients were

informed of their right to participate in the study or not, as well as their right to withdraw from it at any moment. Tools were developed and revised.

Content validity:

A panel of five professors from the Medical Surgical Department. Faculty of Nursing, Damanhour University and Helwan University, reviewed the tools for clarity, relevance. Comprehensiveness, understanding, and applicability.

Reliability:

The reliability of the added question was assessed by using a test-retest for a group of 12 patients who were asked to answer the questions and were asked to answer the same questions after two weeks. The answers in the two tests were analyzed and computed for reliability. It reaches 85% (r = 0.85), which is considered reliable.

Pilot study:

It was performed to test the practicality and applicability of the tools and to determine any obstacles that may be encountered during the period of data collection. It was conducted on 10% of patients accordingly, and needed modification was done. Pilot study from patients was excluded from the study sample.

Field of work:

The data was collected from the beginning of July 2024 to the end of December 2024 at the Respiratory outpatient clinic at Al Kaser Al Ani Hospital, affiliated with Cairo University, Cairo, Egypt. Patients were interviewed in the respiratory outpatient clinic department 2 days per week (Monday, & Thursday) in the morning shift from 9 am to 12 am. Data were collected at three time periods: first visit at the outpatient clinic (pre-intervention), after 3 months (post-intervention), and after 3 months (follow-up). The study was conducted through four phases: assessment, planning, implementation, and evaluation.

Assessment phase:

Researchers conducted an initial assessment through individual interviews with each studied patient to assess baseline data about sociodemographic characteristics, asthma severity assessment, level of knowledge, and perception about climate triggers, asthma control test (ACT), and environmental exposure assessment, using tools I, II, III, IV, V. A simple introduction about the aim and duration of the study was done; it took between 10 and 15 minutes.

Planning phase:

-An Arabic booklet regarding climate-related exacerbations for patients with asthma. It contains asthma triggers (such as allergies, irritants, weather changes, and respiratory infections). Inhaler techniques, the importance of adherence to medications, when to seek help, lifestyle modifications (exercises, asthma, stress management), preventing respiratory infection (hand

hygiene, vaccination) monitoring and regular checkups, and emergency preparedness.

-Giving one theoretical teaching session for all patients.

-The teaching session was developed by researchers based on studied patients' needs identified during the assessment phase.

Implementation phase:

-The nursing intervention program was given in simplified Arabic language, to all patients to clarify the objectives of the study. It was developed to teach patients how to control asthma symptoms and exacerbation. It contains one theoretical session to discuss the following items (asthma exacerbations, asthma triggers, how to use inhaler medications, the importance of adherence to medications, when patients seek help, lifestyle modification to cope with asthma, prevention respiratory infection, the importance of regular follow-up, and emergency preparedness).

-Each session takes 20 minutes. It contains 8-10 patients.

Evaluation phase:

The researchers evaluate the effect of implementing nursing intervention programs regarding Climate-related asthma exacerbation pre-intervention and post (3 months), and follow-up (3 months) to evaluate the patient's retention of the knowledge and perception of asthma severity and control.

Statistical analysis:

Results were tabulated and statistically analyzed using a standard computer program using the SPSS V.24 program. Categorical variables were described by number and percent (N, %), whereas continuous variables were described by mean and standard deviation (Mean, SD). The chi-square test, ANOVA, and Fisher exact test used to compare between categorical variables $p < 0.05$ was considered statistically significant.

Results:

Table (1): Shows percentage distribution of the studied patients according to socio-demographic characteristics. The results revealed that studied patients aged 31-50 years were 50 %. Also, 53.3% of them were female, and 80% were not smokers. Regarding residence, 58.3% of them were urban residents. Concerning education level shows that a significant portion of the studied patients have a secondary school education 41.6%. While 36.6% of studied patients have manual work. In addition, 60% of them have a history of asthma.

Table (2): Represents the percentage distribution of the studied patients according to their asthma severity over time. Observed reduction in severe persistent asthma cases from 25.0% 5.0, 5.0, to 3.3% respectively in pre-, post, and follow-up. It is a significant finding. While an increase in intermittent asthma cases from 8.3% to

33.3, to 50.0% as more patients moved to a less severe category.Which reflects the significant improvement in asthma severity.

Table (3): Percentage distribution of the studied patients according to asthma exacerbation over 6 months & emergency hospital visits highlights the reduction in asthma exacerbations following the intervention. The table shows the decrease in the frequent exacerbations (≥4 per year) from 50.0% 20 to 8.3% respectively pre-, post, and follow-up. Additionally, there is an increase in patients with 0-1 exacerbation from 16.7%, 50, to 66.7%, further underscoring the success of the intervention in improving asthma control. Percentage distribution of the studied patients according to their emergency hospital visits due to asthma exacerbations pre-,post, and follow-up. This table provides strong evidence of the reduction in emergency hospital visits following the intervention. There is a decrease in patients with 3+ hospital visits from 50% to 5 to 3.3% is a significant improvement. Also, there is an increase in patients with 0 hospital visits from 16.7% to 75% to 83.3%, further supporting the effectiveness of the intervention

Figure (1): Overall patients' satisfactory level of knowledge pre-, post-, and follow-up

postimplementation of the nursing intervention. It shows the significant increase in patient level of knowledge about climate-related asthma triggers over time in pre-, post-, and follow-up post-implementation of the nursing intervention program.

Figure (2): Percentage destitution of perception of climate-related risks (Pre, Post, follow up) displays increased patient awareness regarding weather (50%, 80 %,85%), air pollution (55%,83%,88%), reducing asthma triggers (45%,82%,87%), and climate change (30%,75%,82%), which reflects improved overall patient perception about climate risks and their impact on asthma.

Table (4): provides strong evidence of the improvement in asthma control following the intervention. It shows that there is an increase in well-controlled asthma cases from 20%,66.7% to 75% is a significant finding, indicating that the intervention had a substantial positive impact on asthma management. There is a decrease in poorly controlled asthma cases from 46.7% to 10% to 8.3% further supports the effectiveness of the intervention.

Figure (3): Displays the decrease in patient-reported exposure to asthma triggers (pollution, humidity, pollen, temperature changes) in pre-post, follow-up, and post-implantation nursing intervention programs.

Table (5): shows that there is a highly statistically significant improvement in patient knowledge over time (p>0.001) with a large effect size ($\eta^2 = 0.69$)**.**

Table (6): Mentions that there is a highly statistically significant correlation between asthma exacerbation and emergency hospital visits. This indicates a very strong positive correlation (r = 0.81) between asthma exacerbations and emergency hospital visits, indicating that more exacerbations lead to more hospital visit

Table (1): Percentage distribution of the studied patients according to socio-demographic characteristics (N=120)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
21–30	30	25%
31–50	60	50%
50-60	30	25%
Gender		
Male	56	46.7%
Female	64	53.3%
Smoking Status		
Smoker	24	20%
Non-Smoker	96	80%
Residence		
Urban	70	58.3%
Rural	50	41.7%
Educational level		
Can't read or write	40	33.4 %
Read and write	20	16.6%
Secondary school	50	41.6%
Higher education	10	8.4 %
Occupation		
Not working/housewife	34	28.4%
Manual work	44	36.6%
Professional work	42	35%%
Family history		
There is a history of asthma	72	60%
No history of asthma	48	40%

Table 2: Percentage distribution of the studied patients according to their asthma severity (N = 120)

Severity Level	Pre-Intervention (n, %)	Post-Intervention (n, %)	Follow-up (n, %)
Intermittent	10 (8.3%)	40 (33.3%)	60 (50.0%)
Mild Persistent	30 (25.0%)	44 (36.7%)	40 (33.3%)
Moderate Persistent	50 (41.7%)	30 (25.0%)	16 (13.3%)
Severe Persistent	30 (25.0%)	6 (5.0%)	4 (3.3%)

Table (3): Percentage distribution of the studied patients according to asthma exacerbation over 6 months & emergency hospital visits (N=120)

	Pre-Intervention (n, %)	Post-Intervention (n, %)	Follow-up (n, %)
Exacerbations (Last Year)			
0–1	20 (16.7%)	60 (50.0%)	80 (66.7%)
2–3	40 (33.3%)	40 (33.3%)	30 (25.0%)
≥4	60 (50.0%)	20 (16.7%)	10 (8.3%)
Hospital Visits			
0	20 (16.7%)	90 (75%)	100 (83.3%)
1–2	40 (33.3%)	24 (20%)	18 (13.3%)
3+	60 (50%)	6 (5%)	4 (3.3%)
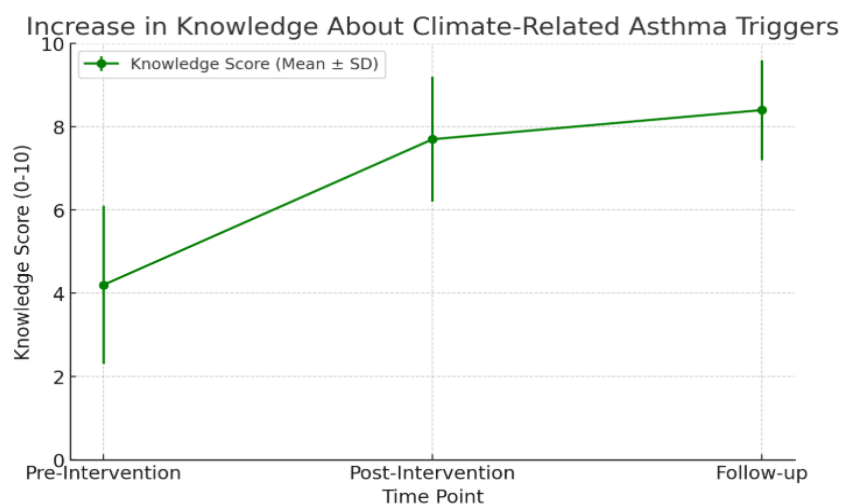
Figure (1): Overall patients' satisfactory level of knowledge pre-, post-, and follow-up post-implementation of the nursing intervention program (N=120)
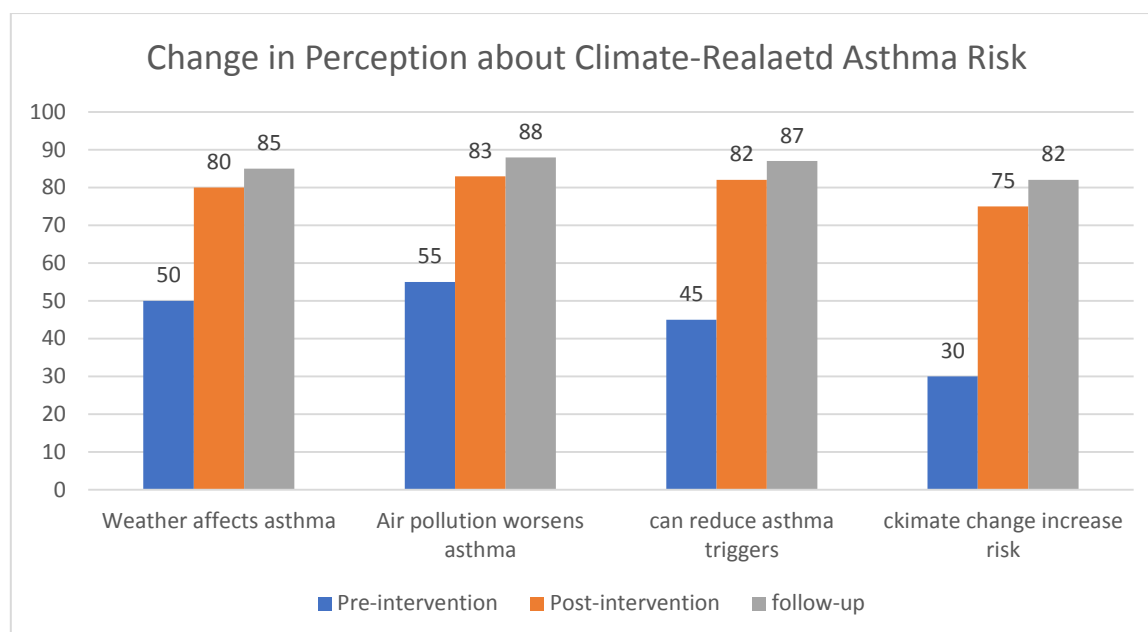
Figure (2): Percentage destitution of perception of climate-related risks (Pre, Post, Follow-up) (N=120)

Table (4): Percentage distribution of the studied patients according to Asthma Control Test (ACT) Scores pre-, post, and follow-up (N=120)

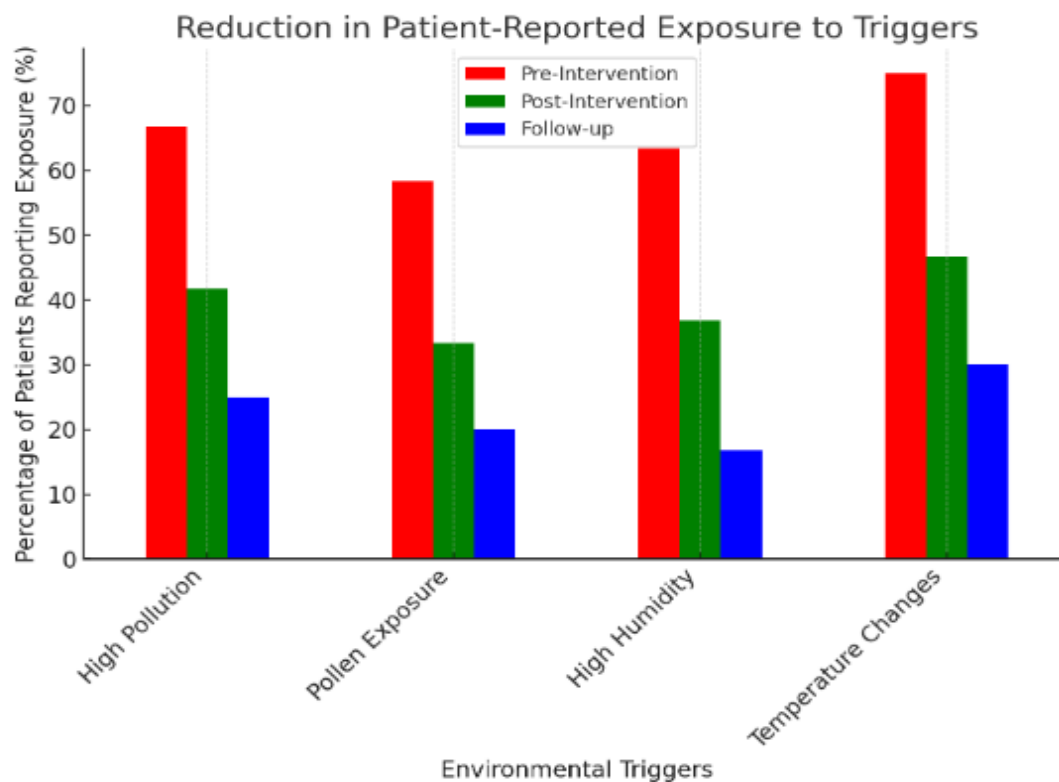| ACT Score Category	Pre-Intervention (n, %)	Post-Intervention (n, %)	Follow-up (n, %)
Well-Controlled (≥20)	24 (20%)	80 (66.7%)	90 (75%)
Partially Controlled (16–19)	40 (33.3%)	28 (23.3%)	20 (16.7%)
Poorly Controlled (≤15)	56 (46.7%)	12 (10%)	10 (8.3%)

Figure (3): Percentage of patients reported Exposure to environmental triggers

Table 5: ANOVA for knowledge score over time

F-Statistic	p-Value	Effect Size (η²)
45.2	<0.001	0.69 large effect)

Statically significant P>0.5　　　　　** highly statistically significant P>0.001

Table (6): Correlation between asthma exacerbations and emergency hospital visits for studied patients

Pearson Correlation Coefficient (r)	p-value	Interpretation
r = 0.81	p < 0.001	Very strong positive correlation (more exacerbations lead to more hospital visits)

Statically significant P>0.5　　　　　** highly statistically significant P>0.001

Discussion

Asthma and respiratory health are greatly impacted by climate change. Increased air pollution, including elevated levels of allergens like pollen and ground-level ozone, is a result of warming temperatures and shifting weather patterns **(D'Amato et al., 2016).** These alterations in the surroundings have the potential to exacerbate pre-existing problems and cause symptoms of asthma **(El-Afandy et al., 2024).**

Asthma restricts daily activities for many people in addition to causing health issues. To help people with asthma live healthier lives and lessen the overall effects of their condition, effective management and further research are crucial. The thorough information and assistance given to patients demonstrate the substantial impact of nursing intervention in loweringclimate-related exacerbations among asthma patients. By educating patients about climate triggers and practical self-management techniques. **(Kapri and others, 2023).** The study aims to evaluate the effect of nursing interventions in reducing climate-related exacerbations among patients with asthma and improving their overall disease management.

According to the current study, the demographic details of the 120 adult patients under study indicate a varied population that highlights the difficulty of managing asthma. The age range of 31 to 50 years old, which is frequently linked to higher asthma morbidity because of exposure to environmental triggers and occupational hazards, accounted for half of the participants. Since smoking is known to exacerbate asthma, it is noteworthy that the majority of participants did not smoke. This suggests that the sample may reflect a community that is more concerned with managing their health. Furthermore, over half of the sample was urban dwellers, which is indicative of the health inequalities between urban and rural areas that are frequently observed in respiratory disorders. This is probably because metropolitan areas have greater

Less than half of the participants in the study had completed secondary school, indicating a range of educational backgrounds that may have an impact on health literacy and care access. Furthermore, more than half of the participants had a family history of asthma, supporting the idea that the condition is genetic. Comorbidities, such as the fact that more than half of the patients have allergic rhinitis, point to the necessity of integrated care approaches.

In terms of the severity of asthma, the current study found that the number of cases with severe persistent asthma decreased from one-fourth of the study's patients to less than four studied patients, this indicating a significant benefit of the nursing intervention. This

result is consistent with earlier research showing that structured therapies can considerably reduce cases of severe asthma, such as **Zeitouni et al., (2022).** Although such improvements are encouraging, **Kuder et al., (2021)** warn that the small fraction that still falls into the severe group raises questions about how long these effects will last. This result emphasizes how well-targeted therapy and education techniques can help individuals with severe symptoms better control their asthma.

According to the current study, the number of patients who experience frequent exacerbations (≥ 4 per year) has significantly decreased from half of patients to less than one-tenth after the intervention, which is an impressive result. This outcome is consistent with recent research conducted by **Jackson et al., (2022),** which showed that thorough asthma treatment regimens can dramatically lower the frequency of exacerbations. **However, Ali et al., (2025)** warn that such reductions may not be sustainable in the long run. They point out that several outside variables, such as seasonal shifts and environmental triggers, can cause those variations in exacerbation rates. This emphasizes the need for ongoing observation and assistance after the initial intervention phase to sustain the favorable results attained.

According to the current study, there has been a significant improvement in

asthma management as the proportion of patients who only experienced 0–1 exacerbation raised from less than one-fifth to more than two-thirds of the patients. Effective asthma therapy not only lowers the frequency of exacerbations but also improves overall health outcomes, according to **Qin et al. (2020),** which supports this finding. On the other hand**, Stanford et al. (2012)** mentioned that, against being overly optimistic about this rise in low exacerbation rates, pointing out the dangers of asthma recurrence and delay after hospitalization or emergency visits. Their viewpoint emphasizes the necessity of continuing management techniques to maintain the gains made.

The number of patients with three or more hospital visits has dramatically decreased in the current trial, going from 50% before the intervention to just 5% following treatment and then down to 3.3% at follow-up. This notable decrease demonstrates how well the intervention works to stop severe asthma attacks, which usually result in several trips to the emergency room. The previous findings were in the same line with **Hosny et al. (2022)** discovered that by giving patients the resources they require for proactive disease management, comprehensive asthma management programs can lower hospitalization rates. This strategy not only improves patients' quality of life because frequent hospital stays can be upsetting and unpleasant,

but it also significantly lowers healthcare costs because emergency room visits are typically far more costly than normal care.

The effectiveness of educational initiatives in improving participants' comprehension of how climate factors can exacerbate asthma symptoms is thus demonstrated by Figure 1), which shows a significant increase in the satisfactory level of knowledge scores regarding climate-related asthma triggers over time. "The increase in knowledge is not just a statistic; it reflects a transformative change in how patients perceive their condition, **Ystaas et al. (2023),** in agreement with this conclusion. People are better able to make wise judgments when they are aware of how climate affects how they manage their asthma. This demonstrates how important education is in enabling patients to better control their health.

The current study mentioned significantly improving patient awareness regarding weather and air pollution, reducing asthma triggers, and climate change post-intervention programs. Which reflects improved overall patient perception of climate risks and their impact on asthma? The previous finding was supported by **Alhazmi, et al., (2023).** They emphasize that asthma education programs significantly improve patient perception of triggers by enhancing awareness of environmental factors and

actionable management strategies. Studies demonstrate at Madina, Saudi Arabia. The present study shows a notable decrease in patient-reported exposure to asthma triggers, such as pollution, humidity, pollen, and temperature changes. This reduction is significant because less exposure to these factors can lead to better asthma control and fewer exacerbations. This is aligned with **Lizzo et al. (2024)** found that patients with lower exposure to outdoor pollutants experienced fewer asthma attacks and needed less medication. These findings emphasize the importance of ongoing efforts in patient education and the development of environmental health policies to effectively support asthma patients.

The current study indicates that the efficiency of the educational interventions is demonstrated by the highly statistically significant differences in knowledge ratings across the various time points before, during, and after the intervention. **Maulood et al., (2023)** provide evidence for this, stating that "such highly statistically significant results reinforce the effectiveness of educational interventions in enhancing knowledge." Overall, the results highlight how the intervention improved participants' comprehension of asthma triggers connected to climate change.

Asthma exacerbations and emergency hospital visits have a substantial positive connection ($r = 0.81$, $p < .001$)

in the current study, suggesting that a higher frequency of hospital visits is linked to an increase in exacerbations. According to **Mohamed et al. (2022),** "this strong correlation underscores the importance of managing asthma exacerbations effectively," as they are a critical predictor of hospital usage. This conclusion is consistent with their studies. All of these findings highlight the critical need for efficient asthma treatment strategies that reduce exacerbations, lessen the demand for emergency services, and improve patient outcomes.

Conclusion:

The finding of the study concluded that patients with asthma who received the nursing intervention program had a positive effect in reducing climate-related exacerbations and improved overall level of knowledge and perception, decreased asthma symptoms, asthma exacerbation, and emergency hospital visits and disease management.

Recommendations:

The following suggestions are made in light of the current study's findings: -Healthcare providers in the respiratory outpatient department must provide an educational session regarding asthma exacerbations due to climate change.

- It is recommended that respiratory nurses participate in recurring in-service training sessions to enhance their knowledge of asthma exacerbations linked to climate change.

-Patients with asthma should have access to a simplified, comprehensive, and illustrated pamphlet and posters that address climate-related asthma exacerbations in healthcare settings.
- To get more generalizable results, it is advised that the current research be replicated using a bigger statistical sample size that is chosen from different geographic areas and with a longer follow-up.

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