Effect of Climate Change Educational Intervention on Knowledge and Health-related Behaviors of Children with Respiratory Allergic Diseases

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Abstract

Background. Climate change is undisputedly one of the most significant problems in the world. Children's respiratory health can be particularly affected by climate change, which contributes to triggering respiratory allergic diseases through many allergies. **Aim.** This study was conducted to evaluate the effect of climate change educational intervention on knowledge and health-related behaviors of children with respiratory allergic diseases **Design.** A quasi-experimental research design was utilized. **Subjects.** A convenience sample was used including 73 children aged 8 to 15 years diagnosed with respiratory allergic diseases. **Setting.** The study was carried out at allergy and immunology outpatient clinics affiliated to Mansoura University Children's Hospital (MUCH). **Tools of data collection.** Three tools were used for data collection: demographic and clinical data structured interview sheet, children knowledge regarding climate changes questionnaire and children's climate change health-related behaviors questionnaire. **Results**: There was a statistically significant difference between the children's knowledge score and daily health-related behaviors score regarding climate change pre- and post-intervention (P=0.000). There was a positive correlation between children's knowledge and their health-related behaviors pre- and post-educational intervention (p= 026 & 0.021 respectively). **Conclusion.** The study highlights the potential of climate change education in boosting knowledge and health-related behaviors among children with respiratory allergic diseases, thereby promoting a sustainable healthy future. **Recommendation.** This study emphasizes the need for climate education in pediatric healthcare to protect vulnerable children from public health threats, requiring further research for long-term effects and scalability.

Key words: Children, Climate change, Educational intervention, Health-related behaviors, knowledge, Respiratory allergies

Introduction

Climate change (CC) refers to ongoing alterations in the climate system across extensive areas and timeframes, primarily induced by human activities, with a lesser impact from natural processes. This intricate environmental threat has global repercussions on public health, developmental aspects, agriculture, water resources, and energy generation [(1)]. The primary catalysts of CC are greenhouse gases (GHGs), with their concentrations experiencing significant escalation in recent years. These gases encompass carbon dioxide (CO2), the predominant contributor, along with methane, nitrous oxide, chlorofluorocarbons (CFCs), and other compounds. The rise in GHG concentrations underscores their pivotal role in driving climate change, with implications for diverse facets of the planet's well-being and sustainability [(2)].

Presently, the primary contributors to greenhouse gas (GHG) emissions encompass energy production, transportation, food production, housing, industry, agricultural activities, and waste [(3)]. Global warming, a phenomenon leading to a projected 0.5°C temperature increase on Earth by 2030, is intricately connected to alterations in weather patterns, elevated sea surface temperatures, and the potential for damage to both properties and lives [(4)].

In 2019, Egypt ranked 27th globally in energy-related CO2 emissions, with electricity generation constituting 40%, followed by transportation, industry, residential buildings, and other sectors [(5)]. The nation is confronted with significant climate change risks owing to its geographical location, population density, and the Nile Delta's coastal plain. Projections indicate that rising sea levels could lead to the displacement of 2-4 million Egyptians by 2050 [(6)]. Coastal areas are under threat from flash floods and extreme weather events. Additionally, temperature variations are anticipated to increase by 0.5-1.0°C by 2025 and 1.5-2.0°C by 2050 [(7-8-9)].

To address looming threats, Egypt has enacted robust initiatives across various sectors, including energy, industry, agriculture, waste management, water resources, and coastal zone protection, aiming at both mitigating and adapting to climate change [(10)]. In November 2022, Egypt played host to the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change, under the Paris Agreement (COP27). During this event, Egypt represented the challenges, efforts, and priorities of the African continent in confronting the impacts of climate change [(11)].

Climate change is the largest global health threat, affecting Earth's physical, biological, and human systems for public health, and these have been summarized in global terms by the World Health Organization (WHO) as threats to safe drinking water, adequate shelter, stable food source and air quality. Increased natural disasters, changes in rainfall, heat waves, and air quality can cause destruction, displacement, and disease spread, particularly for children especially those with respiratory and cardiovascular disorders [(12,13)]. It affects pollen production, protein composition, and aerobiological processes, potentially affecting allergic disorders, asthma, and lung disease,

contributing to premature mortality and respiratory symptoms [14].

Children are particularly vulnerable to climate change due to their growing bodies and limited control over their environment. Exposure to climate-related stressors, such as outdoor play and school, can have lifelong consequences on learning, physical development, chronic diseases, and allergic reactions. Air pollution may also negatively impact children's health [15]. Climate change is exacerbating allergic diseases in children, who are more susceptible to extreme weather events. Children spend more time outdoors during warm seasons, exposing them to high temperatures. As a dramatic consequence, a child born today will live in a world more than four degrees warmer than the preindustrial average, with CC impacting on their health from infancy throughout life [16]. Respiratory allergic diseases are a significant public health issue, ranking sixth among childhood diseases and accounting for one-third of pediatric chronic diseases. Asthma is the most common, affecting over 5 million school-age children and causing 13 million schooldays lost annually [17]. These chronic conditions cause discomfort, sneezing, nasal congestion, and difficulty breathing due to overreaction to foreign [18].

Climate change can prevent or minimize health outcomes through social factors, improved weather forecasting, and research on children's impact. Education is crucial in the fight against climate change, as it helps children understand its causes and effects, encourages sustainable behaviors, develops knowledge and skills, empowers them to act and become leaders in the fight against climate change, informs policy decisions, and builds global cooperation. By educating children about sustainable practices and technologies such as reducing waste, conserving energy, and using sustainable transportation options [19]. Therefore, it is crucial to evaluate the understanding and health-related behaviors of children affected by respiratory allergic diseases concerning climate change (CC), as this group is particularly sensitive. Given that children are the future leaders and possess a long-time horizon, addressing their vulnerability to the prolonged impacts of CC becomes paramount. Engaging children in climate actions is essential due to their susceptibility to the long-term consequences. Consequently, the implementation of educational interventions aimed at children holds significant importance.

Significance of the study

Overall, the prevalence of respiratory allergies among children in Egypt underscores the importance of awareness, early diagnosis, and effective management strategies. Respiratory allergies, including asthma and allergic rhinitis, are prevalent among children in Egypt, with asthma estimated at 8.2% among children**.** The prevalence of asthmatic children is reported to be 20.6%, allergic rhinitis at 24.8%, and atopic dermatitis at 19.8% [20]. Common sensitizing aeroallergens contribute to respiratory allergies are common among school-age Egyptian children.

Childhood respiratory allergies in Egypt can lead to poor disease control, affecting up to 1 in 4 children's regular school attendance [21-22]. Climate change is affecting human health systems, including allergic disease

and asthma, by altering aeroallergen distribution, increasing ozone pollution, and deteriorating air quality. This increases the risk of worsening disease, symptomatic days, and reduced quality of life, with the disease burden directly linked to climate change [23].

Nurses caring for atopic and asthmatic children must employ prevention strategies to minimize disease burden. Despite awareness of climate change impacts on children's health, their knowledge is incomplete. Nurses should actively educate children and families about climate change, taking action to protect the next generation from adverse health effects. The magnitude and type of health impacts due to climate change will depend on improved understanding of the relationship between climatic variables, multiple allergen factors, and allergic disease. Improved public health strategies especially for children such as adequate humidity control, optimum air filtration and ventilation, and improved anticipatory children health messaging will be critical to adaptation [24].

Aim of the study

To evaluate the effect of climate change educational intervention on knowledge and health-related behaviors of children with respiratory allergic diseases.

Research hypothesis

Children's level of knowledge and their health-related behaviours are expected to improve after the implementation of climate changes educational intervention.

Subject and Methods

Research design: A quasi-experimental research design was utilized to fulfill the aim of this study.

Setting: The study was conducted at the allergy and immunology outpatient clinic affiliated to Mansoura University Children's Hospital, Egypt. The clinic works two days/week and receives children with respiratory allergies with different diagnoses and disease severity.

Participants:

A Convenience sample included (73) children aged 8 to 15 years, who diagnosed with respiratory allergic diseases, at the previously mentioned setting.

Inclusion Criteria:

Children with confirmed diagnosis of respiratory allergic diseases including (asthma, allergic rhinitis, bronchitis, or bronchiolitis).

Exclusion Criteria:

Children with severe cognitive or developmental impairments that prevent their understanding of educational intervention.

Sample size calculation

Based on data from the literature **(Wypych-Ślusarska et al., 2022)** [25], total number of population at the study previously mentioned setting in the last year (2022) was 2450 child (Hospital statistical record), considering the level of significance of 5%, and power of study of 80%, the sample size can be calculated using the following formula:

$$n = \frac{N \times p\,(1-p)}{(N-1)x\left(\frac{d^2}{z^2}\right)+p(p-1)}$$

Where, n=sample size; N, studied total population; d = error percentage (=0.05); P= prevalence or proportion of event of interest for the study; $Z_{\alpha/2}$ =1.96 (for 5% level of significance). Therefore,

$$n = \frac{2450 \times 0.88\,(1-0.88)}{(2450-1)x\left(\frac{0.073^2}{1.96^2}\right)+0.5(1-0.5)} = 72.8$$

Accordingly, the sample size required is 73.

Tools for Data Collection:

Three tools were used to collect the data in this study.

Tool I: Demographic and clinical data structured interview sheet: It was developed by the researchers after review of related literature [16-17-21] and consisted of two parts:

Part 1: Children's characteristics: such as age, gender, educational level and residence.

Part 2: Children's allergic disease clinical data: as a type of respiratory allergic disease, severity, first time of signs and symptoms appearance, triggers (smoking, indoor allergens), climate factors affecting children's health and frequency of follow-up visits.

Tool II: Children Knowledge regarding Climate Changes Questionnaire (pre/post): It is developed by the researchers after reviewing relevant recent literature [1-2-8] and used pre/post the educational intervention and composed of two parts.

Part 1: Children's knowledge regarding climate change. It included questions about definition of terms related to climate change (7 items), causes of climate change (7 items), effects of climate change (8 items), methods of adaptation to climate change (7 items) and allergic disease and its relationship with climate change (4 items).

Scoring system: Correct answer awarded one mark and incorrect awarded zero. A total knowledge was categorized into three levels (poor less than 50 % of total, fair from 50 % to less than 65%, and good from 65% and more).

Part 2: Children's Sources of Information related to Climate Change.

Tool III: Children's Climate Change Health-related Behaviors Questionnaire (pre/post): The questionnaire adapted from [26] and developed by the researchers, it included 11 statements assessing children's indoor daily behaviors related to climate change and 8 statements evaluating their outdoor daily behaviors. Respondents used a 3-point Likert scale to answer each item.

Scoring system: Responses were scored on the Likert scale, where "Always" equated to a score of 2, "Sometimes" to a score of 1, and "Never" to a score of 0. Reverse coding was applied for inappropriate behaviors. The total behavior score was summed up, converted to a percentage, and categorized as unsatisfactory (≤65%) or satisfactory (>65%).

Validity and Reliability of the Study Tools: Five pediatric nursing and community nursing experts reviewed tools for content validity. The tools' reliability was tested through Cronbach's alpha test for tool II and tool III (α= 0.862 & 0.79).

Pilot Study: Before initiating data collection, a pilot study involving 10% of

the overall sample (8 children) was executed. The purpose was to assess the feasibility, clarity, applicability, and simplicity of the tools used. Any necessary adjustments were made based on the findings of this pilot study, and the participants involved were subsequently excluded from the main study sample.

The educational intervention:

The educational intervention regarding climate change was divided into four stages: Assessment, planning, implementation, and evaluation.

Assessment phase:

The data was collected by the previously mentioned tools through interviewing the children in the pre-determined setting to collect the baseline data as a pre-assessment.

Planning phase: started by designing the climate change educational intervention by the researchers based on the results of the pre-test.

Educational Intervention Objectives:

General objectives:

The educational intervention was conducted to improve the knowledge, health-related behaviors depending on daily life reported behaviors of the children with respiratory allergic diseases regarding their knowledge about weather and climate, the causes of climate change, the effects of climate change and the methods of adaptation to climate change. Correspondingly, improves the children's knowledge about the relation between respiratory allergic diseases and climate change.

Contents:

- Definitions of the terms e.g., climate change, allergy, respiratory allergies, health-related behaviors.
- Causes of climate change
- Common respiratory allergic diseases
- Triggers of respiratory allergic episodes
- How climate change affects air quality and allergen exposure.
- The relation between climate change, respiratory allergies and healthy-related behaviors.
- Potential effects of climate change on children with respiratory allergic diseases
- Methods of adaptation to climate change either indoors or outdoors:

- Indoor health-related behaviors concerning their health and climate change as; maintaining indoor air quality by using air purifiers to minimize indoor allergens, avoiding indoor tobacco exposure, adhering to prescribed allergy medications as directed by healthcare professionals, consuming adequate amount of water, consuming a healthy diet, dispose of waste properly, limit exposure to domestic animals, avoid exposure to insects killing aerosol, avoid household cleaning products, get adequate sleeping hours and seek medical help for abnormal symptoms.
- Outdoor health-related behaviors concerning their health and climate change as; avoiding exposure to extreme heat especially in summer, reducing time spent outdoors during peak allergen seasons, avoiding physical activities outdoors during

periods of high temperature, increasing hydration during exercise and outdoor activities, wearing mask during extreme weather, reduction in consumption of packaged and fast foods, track symptoms written notes anywhere and carry allergy medication while outdoor as prescribed.

Booklet content preparation:

- The educational intervention included age-appropriate educational materials; an educational booklet designed by a researcher with a simple Arabic language tailored to the comprehension level of the participants and act as informative materials for children that convey key messages about respiratory allergies, climate change, and health-related behaviors.
- Consider that the materials are engaging, easy to understand, and culturally sensitive.

Implementation phase:

- This study was carried out over 6 month's period from the beginning of March 2023 to the end of August 2023.
- The children classified into four groups, each group similar approximately in age, diagnosis and time of follow-up visit.
- The educational intervention consisted of 3 sessions conducted two days per week for each group of children on Saturday and Tuesday at Allergy and immunology outpatient clinic at the end of their follow-up visits.
- The time of the session was about 30 to 45 minutes in every session.
- In the beginning of the sessions, the researchers greeted the children, introduced herself, gave a summary about the benefits and components of the educational interventions and asked the children to cooperate for their benefit.
- The first session cleared the definitions of the terms e.g., climate change, allergy, respiratory allergies, health-related behaviors, common respiratory allergic diseases, and causes of climate change.
- The second session emphasized the triggers of respiratory allergic episodes, how climate change affects air quality and allergen exposure, the relation between climate change, respiratory allergies and healthy-related behaviors.
- The third session discussed the potential effects of climate change on children with respiratory allergic diseases. In addition, the session highlighted the methods of adaptation to climate change either indoors or outdoors.
- Active participation and engagement was encouraged, through discussions and real-life scenarios.

Provide Feedback and Reinforcement:

Positive feedback and reinforcement to children was offered when they reported to encourage or demonstrate the desired behaviors. This included verbal praise, or small rewards.

Any misconceptions or challenges children may face in understanding or implementing these behaviors was addressed.

Feedback from participants to ensure understanding of the educational intervention was ensured during discussions.

Evaluation phase:

After the educational intervention by 3 months, the study tools (tool II and tool III) re-administered for the participant to evaluate the educational intervention by comparing the level of knowledge and health-related behaviors of children with respiratory allergic diseases over a long period of time pre and post educational intervention.

Ethical Consideration

The ethical approval to conduct this study was obtained from the Research Ethics Committee of the Faculty of Nursing – Mansoura University (Ref. No. p. 0410). Administrative agreement was attained from the hospital manager. A parent or the caregiver of eligible children are contacted and provided with detailed information about the study, including its purpose. They are asked to provide informed consent for their child participation in the study. They assured us that their participation in the study was voluntary, and the collected data was treated confidentially and only used for the purpose of the study. They have the right to withdraw at any time from their studies without giving any reason.

Statistical Analysis

The data underwent sorting, coding, organization, and categorization before being transformed into specially designed formats. The analysis was conducted using SPSS (Statistical Product and Service Solutions) version 20.0. Descriptive statistics, such as frequencies and percentages, were employed to present the data. For continuous variables, the arithmetic mean ± standard deviation was utilized, while percentages were used for categorical variables. The comparison between two paired groups for quantitative variables involved the use of the T-test. Qualitative variables were compared using the chi-square and Fisher exact tests. A significance level of $P < 0.05$ was considered statistically significant. Pearson correlation coefficients were employed to estimate the correlation between the study variables.

Results

Table (1) shows that the mean age of studied children was 9.56 (2.74) years, 50.7% of them are male. Regarding educational level, 74% were at primary school. Moreover, 68.5 % of them were living in urban areas and 46.6% of them their houses near air pollution.

Table (2) illustrates that 53.4% of studied children were exposed to smoking. 27.5% and 26.1% of them suffered from asthma and rhinitis respectively. Moreover, 67.1% of them had moderate disease severity. The same table reveals that the most common climate change factors affecting studied children were extreme weather and droughts (91.8%, and 80.8%) respectively.

Children's knowledge level related to climate change pre and post-educational intervention portrays in **Table (3).** It was observed that no one of studied children had good knowledge related to climate change with a mean of 11.6 (2.48) pre-educational intervention. However, post-educational intervention 82.2% of them had good knowledge with a mean of 30.11(2.14). There were highly statistically significant differences between all knowledge items pre and post educational intervention (p=0.000).

Table (4) reveals that improving in all indoor daily activities regarding climate change post educational intervention. There was a highly statistical difference between pre, and post-educational intervention (p=0.000) related to total indoor daily behaviors.

Table (5) reveals improving in all outdoor activities regarding climate change post-educational intervention. There was a highly statistical difference between pre, and post educational intervention (p=0.000) related to total outdoor behaviors.

Figure (1) clarifies that 4.1% of studied children had a satisfactory level of behaviors regarding climate change pre-educational intervention. While 78.1% of them had satisfactory level of behaviors post-educational intervention. There was a highly statistical difference between pre, and post-educational intervention (p=0.000) related to total daily behaviors related to climate change.

Figure (2) clarifies that the main source of children's information related to climate changes gained from school (90.4%). In addition to 63 % and 57.5 % obtained information related climate change from internet and TV respectively.

Table (6) portrays the correlation between knowledge and health-related behaviors. There was a positive correlation between knowledge and behaviors pre and post educational intervention p= 026 & 0.021 respectively.

Table 1. Children's Demographic Characteristics

Items	N = (73)	(%)
		Age
From 8 to 10 years	41	56.2
From 11 to 15 years	32	43.8
$\overline{X}$ **(SD)**	**9.56 (2.74)**	
Gender		
Male	37	50.7
Female	36	49.3
Educational level		
Primary	54	74
Preparatory	19	26
Residence		
Urban	50	68.5
Rural	23	31.5
		Housing near air pollution
Yes	34	46.6
No	39	53.4

Table 2. Clinical Data of Children's Allergic Disease

Items	N = (73)	(%)
Type of respiratory allergic disease		
Asthma	20	27.5
Rhinitis	19	26.1
Sinusitis	11	15
Bronchiolitis	9	12.3
Bronchitis	8	10.9
Pneumonitis	6	8.2
Diseases severity		
Mild	18	24.7
Moderate	49	67.1
Severe	6	8.2
First time of signs and symptoms appearance		
Infancy	9	12.3
Early childhood	58	79.5
Late childhood	6	8.2
Exposure to smoking		
Yes	39	53.4
No	34	46.6
Indoor allergens *		
Dust mites	55	75.3
Domestics pets such as cats and dogs	22	30.1
Mice	8	11
Insects such as cockroaches	46	63
Climate factors affecting children's health *		
Temperature	46	63
Humidity	50	68.5
Drought	59	80.8
Rainfall	31	42.5
Infection	52	71.2
Water and food	46	63
Air contaminants	51	69.9
Extreme weather	67	91.8
Frequency of follow-up visits		
Every week	16	22
Every two weeks	10	13.7
Every one month	22	30.1
Every two months	25	34.2

*More than one answer was allowed

Table 3. Children's Knowledge Level Regarding Climate Change Pre and Post 3 months of the Educational intervention

Knowledge level	Test time N = 73				Significance	P value*
	Pre		Post 3 months			
	N	%	N	%		
Awareness about climate and weather						
Good	2	2.8	64	87.7	$\chi 2$=113.16	0.000
Fair	5	6.8	5	6.8		
Poor	66	90.4	4	5.5		
$\overline{X}$ (SD)	6.11(1.02)		12.18(1.08)		t=23.222	0.000
Causes of climate change						
Good	5	6.8	62	84.9	$\chi 2$=93.4	0.000
Fair	5	6.8	4	5.5		
Poor	63	86.4	7	9.6		
$\overline{X}$ (SD)	2.01(1.34)		6.12(1.12)		t=20.22	0.000
Effect of climate change						
Good	00	0	64	87.7	$\chi 2$=120.48	0.000
Fair	3	4.1	4	5.5		
Poor	70	95.9	5	6.8		
$\overline{X}$ (SD)	1.48(1.08)		6.75(1.66)		t=21.225	0.000
Methods of adaptation to climate change						
Good	0	0	58	79.4	$\chi 2$=101.14	0.000
Fair	10	13.7	7	9.6		
Poor	63	86.3	8	11		
$\overline{X}$ (SD)	2.29(1.12)		6.58(0.85)		t=27.808	0.000
Allergic diseases and its relation with climate change						
Good	11	15.1	66	90.4	$\chi 2$=83.75	0.000
Fair	20	27.4	4	5.5		
Poor	42	57.5	3	4.1		
$\overline{X}$ (SD)	1.14(0.89)		3.64(0.63)		t=18.152	0.000
Total knowledge						
Good	0	0	60	82.2	$\chi 2$=113.68	0.000
Fair	5	6.8	8	11		
Poor	68	93.2	5	6.8		
$\overline{X}$ (SD)	11.6(2.48)		30.11(2.14)		t=49.856	0.000

Children's Climate Change Health-Related Behaviors:

Table 4. Children's Indoor Health-related Behaviors Pre and Post 3 Months of the Educational Intervention

Behaviors	Test time				χ^2	P value*
	Pre		Post 3 months			
	N	%	N	%		
Maintain indoor air quality by using air purifiers to minimize indoor allergens						
Never	13	17.8	0	0	**17**	0.000
Sometimes	39	53.4	37	50.7		
Always	21	28.8	36	49.3		
Avoid indoor tobacco exposure						
Never	23	31.5	0	0	**36.13**	0.000
Sometimes	37	50.7	35	47.9		
Always	13	17.8	38	52.1		
Adhere to prescribed allergy medications as directed by healthcare professionals						
Never	13	17.8	0	0	**15.5**	0.000
Sometimes	37	50.7	39	53.4		
Always	23	31.5	34	46.6		
Consume an adequate amount of water						
Never	18	24.7	0	0	**45.97**	0.000
Sometimes	50	68.5	35	47.9		
Always	5	6.8	38	52.1		
Consume a healthy diet						
Never	57	78.1	22	30.1	**36.47**	0.000
Sometimes	16	21.9	41	56.2		
Always	0	0	10	13.7		
Dispose of waste properly						
Never	30	41.1	7	9.6	**25.45**	0.000
Sometimes	36	49.3	41	56.2		
Every time	7	9.6	25	34.2		
Limit exposure to domestic animals						
Never	41	56.2	0	0	**58.5**	0.000
Sometimes	24	32.8	46	63		
Always	8	11	27	37		
Avoid exposure to insects killing aerosol						
Never	69	94.5	0	0	**131.39**	0.000
Sometimes	4	5.5	43	58.9		
Always	0	0	30	41.1		
Avoid household cleaning products						
Never	31	42.4	3	4.1	**34.43**	0.000
Sometimes	34	46.6	44	60.3		
Always	8	11	26	35.6		
Get adequate sleeping hours						
Never	32	43.8	2	2.8	**44.14**	0.000
Sometimes	37	50.7	45	61.6		
Always	4	5.5	26	35.6		

Seek medical help for abnormal symptoms						
Never	41	56.2	0	0	**64.05**	0.000
Sometimes	29	39.7	46	63		
Always	3	4.1	27	37		
Total indoor health-related behaviors						
Unsatisfactory	67	91.8	15	20.5	**FE[a]**	0.000
Satisfactory	6	8.2	58	79.5		
$\overline{X}$ **(SD)**	7.6(2.71)		16.3(2.07)		**T=22.25**	0.000

Table 5. Children's Outdoor Health-related Behaviors Pre and Post 3 Months of the Educational intervention

Behaviors	**Test time**				χ^2	**P value***
	Pre		**Post 3 months**			
	N	**%**	**N**	**%**		
Avoid exposure to extreme heat especially in summer						
Never	37	50.7	8	11	**12.21**	0.000
Sometimes	15	20.5	32	43.8		
Always	21	28.8	33	45.2		
Reduce time spent outdoors during peak allergen seasons						
Never	0	0	0	0	**FE[a]**	0.3
Sometimes	44	60.3	38	52.1		
Always	29	39.7	35	47.9		
Avoid physical activities outdoors during periods of high temperature						
Never	7	9.6	0	0	**7.97**	0.000
Sometimes	25	34.2	23	31.5		
Always	41	56.2	50	68.5		
Increasing hydration during exercise and outdoor activities						
Never	11	15.1	0	0	**24.6**	0.000
Sometimes	55	75.3	45	61.6		
Always	7	9.6	28	38.4		
Wearing mask during extreme weather						
Never	68	93.2	0	0	**127.85**	0.000
Sometimes	5	6.8	49	67.1		
Always	0	0	24	32.9		
Reduction in consumption of packaged and fast foods						
Never	34	46.6	0	0	**52.22**	0.000
Sometimes	34	46.6	44	60.3		

Every time	5	6.8	29	39.7		
Track symptoms written notes anywhere						
Never	71	97.3	36	49.3	**42.87**	0.000
Sometimes	2	2.7	36	49.3		
Always	0	0	1	1.4		
Carry allergy medication while outdoor as prescribed						
Never	59	80.8	4	5.5	**85.07**	0.000
Sometimes	12	16.5	50	68.5		
Always	2	2.7	19	26		
Total outdoor health-related behaviors						
Unsatisfactory	71	97.3	38	52.1	**FE[a]**	0.000
Satisfactory	2	2.7	35	47.9		
$\overline{X}$ **(SD)**	5.99(1.7)		10.34(1.53)		**T=17.42**	0.000

FE: Fisher Exact for 2 ×2

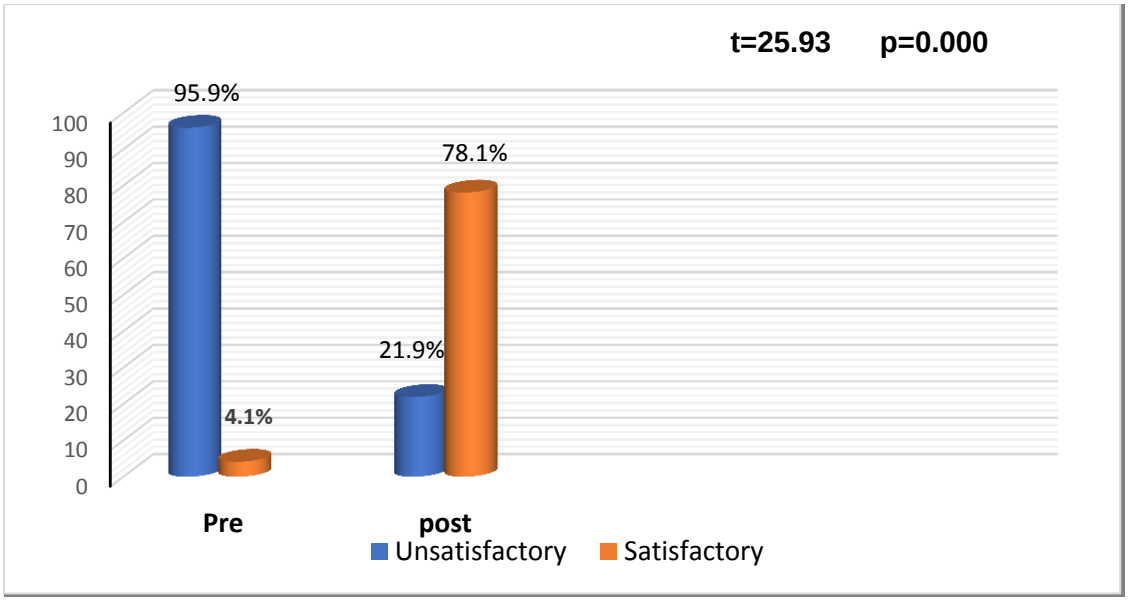

Figure 1. Children's Total Score of Health-related Behaviors Regarding Climate Change Pre and Post 3 Months of the Educational intervention

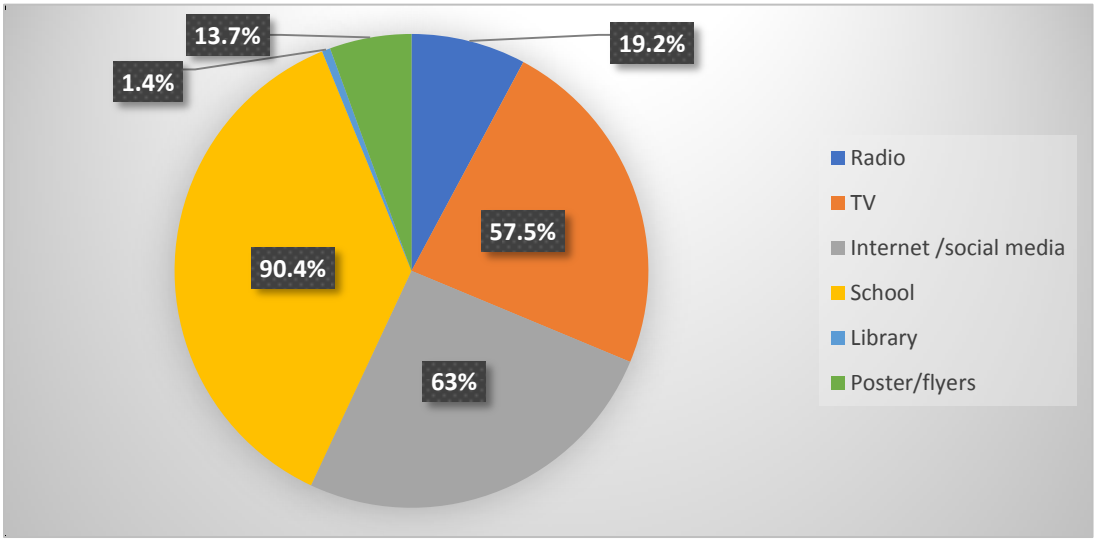

Figure 2. Children's Sources of Information about Climate Change

Table 6. Correlation between Children's Total Knowledge Score and Total Health-related Behaviors Score Regarding Climate Change Pre and Post 3 Months Educational intervention.

Items	Total knowledge score			
	Pre		Post	
	r	P	R	p
Total health-related behaviors score	0.26	**0.026***	0.27	**0.021***

Discussion

Climate change poses a significant risk to human health, particularly children, making it imperative for healthcare systems to confront this issue and its worldwide repercussions. Recognized as one of the most pressing global health challenges of the 21st century, climate change impacts livelihoods sensitive to climate conditions and exacerbates prevalent health issues. In this context, the healthcare workforce assumes a crucial role in addressing the health effects of climate change [27].

Focusing on enhancing climate literacy among children is a crucial approach to encourage adaptive behaviors and tackle challenges associated with climate change. Specifically, concerning the impact of climate change on children with respiratory illnesses, it is essential to prioritize addressing social inequalities. Raising awareness about the necessity for additional efforts to support the most disadvantaged individuals is imperative [28]. Identifying gaps in children's understanding of this field is crucial for fostering meaningful involvement.

The current study specifically targeted the knowledge and health-related actions of children dealing with respiratory allergies. The aim was to enhance their understanding of climate change and encourage their active participation in environmental initiatives as a means to address the challenges posed by climate change.

About two thirds of the studied children stay in urban areas and about half of them are with housing near air pollution. This finding is congruent with the report of **UNFCCC, (2023)** [29] **titled "Egypt's First Updated Nationally Determined Contributions";** that stated that air pollution has been a problem for Egyptians for decades, particularly in large cities. As levels of air pollution pose the greatest risk to people's health are several times higher than the levels the World Health Organization (WHO) recommends. Egypt's ministry of health reports that large countries, seek medical treatment for respiratory problems related to poor air quality. This finding correlated and linked to the combustion processes from transport, industry, little planting, and other human activities in urban than rural regions.

The present study findings indicate that asthma, followed by allergic rhinitis, constitutes the most prevalent respiratory allergic diseases. This finding reflected at the light of the scientific fact that the alterations in air quality have the potential to impact the occurrence of cardiovascular and respiratory ailments. Additionally, climate change (CC) exacerbates certain allergic conditions [29]. **Elsharkawy's study (2023)** [30] reveals that slightly more than half of the participants identified cardiovascular and respiratory issues as adverse effects of CC on health, aligning with the findings of **Ibrahim et al. (2018)** [8]. In China, air quality-related illnesses were reported as the predominant health concern by students, as indicated by **Liao et al. (2018)** [31].

Most children had a poor level of knowledge pre-implementation of the educational intervention. Nevertheless, their knowledge level about the relation between respiratory allergic diseases and climate change is approximately at the good and fair level respectively in about half of them. This may return to their urgent need to understand their disease and

its precipitating and alleviating factors in the environment and try to cope with it. This finding goes with **Breidy & Kobaidze, (2023)** [32] who found that more than half of children perceive the immediate impacts of climate change on illness

Nevertheless, post implementation greatly improved. This finding matched with **Newsome, et al., (2023)** [33], as they studied teaching and learning climate change and stated that learning about climate change is essential for children to understand its impact on their future and develop the skills and knowledge needed to create a sustainable future. It also empowers children to act and become responsible global citizens. In the study of **Choi, (2021)** [34], the impacts were assessed by a climate change literacy questionnaire, and they concluded that students' perceptions and understanding of climate change was improved after attending the educational intervention.

The study findings reveals that children's indoor and outdoor health-related behaviors related to climate change pre-educational intervention were unsatisfactory, this finding is congruent with the study of **Friel, 2022** [35] about climate change, society, and health inequities which stated that climate change is already affecting vulnerable populations disproportionately. The researchers agree with this point of view as children are less able to mitigate against the various impacts of climate change, in terms of modifications to their lifestyle, cannot afford more climate friendly diets, organic produce, adaption to their dwellings, cannot afford investment in air conditioning, air purifiers, insulation, or flood proofing and extra drainage in their homes, or the ability to move to less impacted locations.Children health related behaviors post application of the educational intervention improved to somewhat satisfactory, specifically indoor health related behaviors improved greater than the outdoor one. This finding may be interpreted as inside the home children's parents are more able to adapt to the environment around their children and control their health-related behaviors. This is consistent with the study of **Elsharkawy, (2023)** [30] and **Williams (2021)** [36]**,** they emphasized the need to develop scientific facts, thinking skills, and positive pro-environmental behaviors that gained from integrating children awareness and understanding with behaviors and practices.

In conclusion, the study highlights the potential of climate change education in boosting knowledge and health behaviors among children with respiratory allergic diseases, thereby promoting a sustainable healthy future by equipping these children with knowledge and skills to navigate an environment affected by climate change; that can contribute to better health outcomes and a more sustainable future.

Recommendations

Based on the findings, the current study recommends the following:

- Integrate climate change educational interventions into school curricula.
- Develop immersive and interactive learning experiences that educate children on the core principles of climate change and how to decrease this change.
- Organize regular workshops and follow-up visits on sustainable practices, where professionals in sustainability offer

hands-on lessons on ecofriendly habits and practices.

- Offer training for children affected with respiratory allergic diseases on climate change education and sustainable practices.
- Nurses can use the follow-up opportunity to educate children and their families about the environmental factors affecting health, encouraging them to make informed choices.

Implication to practice:

The findings of this study have several important implications:

1. Integrating climate change education into pediatric healthcare can serve as a novel approach to health promotion.
2. Enhancing the environmental health literacy of children empowers them to become advocates for their own well-being through raising knowledge and driving positive change at the community and societal levels.
3. Collaboration between healthcare providers, educators, and environmental scientists is essential in creating effective educational interventions. The success of such interventions relies on expertise from multiple fields to deliver accurate, up-to-date information.

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