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Asthma education and its impact on pediatric asthma severity: a prospective cohort study

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ABSTRACT

Objective: Asthma education has been shown to improve asthma control. Our goal was to evaluate the efficacy of asthma education on the frequency of utilization of health-care services, lung function results, degree of asthma severity, and quality of life (QOL) level in children with asthma.

Methods: A single-arm prospective interventional trial was conducted in a tertiary facility. Thirty children with asthma and their parents were recruited for the research. Following an assessment of the participants' and caregivers' knowledge about asthma using an asthma knowledge questionnaire, degree of asthma control using asthma control test, inhaler technique using standardized inhaler technique checklists, and QOL using pediatric asthma QOL questionnaires, they participated in a three-month education program in the form of monthly live interactive sessions followed by weekly phone interviews. Measures taken before and after the intervention were compared.

Results: The educational intervention improved asthma control dramatically including daytime asthma symptoms, night awakenings, and frequency of use of short-acting beta2- adrenergic receptor agonists. Furthermore, the number of emergency department visits and hospitalizations fell considerably after the intervention ($p < 0.001$ for all). Asthma education was also linked to better inhalation technique and lung function ($p < 0.001$). Furthermore, all quality-of-life measures increased ($p < 0.001$ for all).

Conclusions: Implementing an asthma education program that included both children with asthma and their parents improved asthma control levels, lung function measures, and overall quality of life. Furthermore, it increased asthma awareness, decreased the use of health-care resources, and reduced asthma severity, resulting in better asthma management.

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Introduction

Asthma is a serious global health problem (1). The prevalence of asthma has been increasing particularly among children, making it the most common chronic illness in childhood (2). According to the Centers for Disease Control and Prevention (CDC), asthma affects one out of every twelve children, equaling 6.1 million children nationwide. More than half of the children with asthma had at least one asthma attack per year. In addition, asthma was responsible for approximately 1.7 million visits to emergency departments for children and 157 000 hospital admissions. In addition, asthma caused almost 13 million missed school days and 14 million missed work days for caregivers (3,4).

According to the National Asthma Education and Prevention Program (NAEPP) guidelines, patient

education is critical for better asthma control. With each clinic appointment, these guidelines propose that each patient with bronchial asthma must be evaluated for their level of education (5). Asthma education programs must have four components: knowledge on the nature of the disease, patient self-monitoring, regular medical review, and a documented asthma action plan (6). Patient education, proper inhaler technique, medication adherence, and asthma self-management are fundamental aspects in the management of bronchial asthma that can be best achieved via cooperation between asthmatic patients and their health care professionals (7).

Despite the urgent importance of asthma as a major child health problem, most developing countries have reported a dearth of understanding concerning asthma

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conditions (8), and in spite of the development of highly effective guidelines for asthma management and the availability of controller medications for suppressing the underlying inflammatory condition, asthma is still a poorly controlled disease (9). According to many Egyptian studies, asthma prevalence ranged from 6.2% in Upper Egypt to 46.1% in Cairo (10). As a result, novel cost-effective therapies, particularly in low-income nations, may be required to improve asthma management.

Therefore, the current study sought to measure the effectiveness and the feasibility of an asthma education program for asthmatic children and their parents in reducing asthma severity, in terms of asthma control level, frequency of healthcare services utilization, lung function parameters as well as health related quality of life levels in our population.

Materials and methods

Study design and setting

This was a prospective uncontrolled trial using before-and-after measurements to evaluate the effectiveness of an asthma educational intervention. This study was submitted to ClinicalTrials.gov with the following information: (ID: NCT05068986). The research population included thirty patients with asthma (19 males and 11 females) and their parents who were recruited during normal visits to the Pulmonology Department outpatient clinics at Ain Shams University Pediatric Teaching Hospital in Cairo, Egypt, from January 2021 to September 2021. We included individuals aged 1 to 17 years old who had already been diagnosed with bronchial asthma and after checking their medical data before the patients were determined to be qualified.

Ethical approval

The study was authorized by the Research Ethical Committee of Ain Shams University's Faculty of Medicine and Children's Hospital (approval number 000017585). Before being included in the study, caregivers and patients over the age of 8 years old provided written informed permission for data collection, instructional sessions, and access to medical records.

Subjects

All patients who met the inclusion criteria during the study period and approved to participate after taking

their caregivers' informed consents, were enrolled in this study.

Inclusion criteria: (1) confirmed asthma diagnosis (using a strict definition of the Asthma Predictive Index (API) for preschoolers or the NAEPP definition plus demonstration of variable expiratory airflow limitation by spirometry (a post-bronchodilator increase in Forced Expiratory Volume in the First Second (FEV1) of greater than or equal to 12%) for older children and adolescents (11,12; 2) age group: above 1 year and less than 18 years.

Exclusion criteria were as follows: (1) Patients diagnosed with other underlying chronic lung diseases (such as cystic fibrosis). (2) Patients with co-existing major systemic illnesses, such as congenital heart diseases, metabolic diseases, chronic kidney diseases, chronic liver diseases, and chromosomal disorders. (3) Patients who had participated in any previous asthma educational program, and those who did not give written informed consent.

The level of asthma control of the studied patients as well as the severity of the disease; were classified according to Global Initiative of Asthma (GINA) guidelines (13).

Methods

a. Data collection:

Adult caregivers accompanying the asthmatic patients were interviewed by the study physician at the pediatric pulmonology clinic. The following data were collected including age, gender, residence (rural or urban), socioeconomic status by using the Gilani questionnaire (14), passive smoking status, associated asthma symptoms and triggers, asthma comorbidities; family history of any other chest diseases or any atopic diseases, duration of asthma disease, school absenteeism, current medications, type of inhalers used and the correctness of inhalation technique.

The medical records were checked for height, weight, and Body Mass Index (BMI) (kg/m²) of the studied patients, previous asthma action plans, frequency of asthma-related follow-up visits, asthma exacerbations, the total number of emergency department visits including recurrent Emergency Room (ER) visits, the total charges of ER attendance, hospital and intensive care unit admissions, within the last 6 months; Recurrent ER visits were defined as three or more emergency department visits within six months among asthmatic children (15).

b. Study questionnaires: They were provided in a paper form to the study participants.

The questionnaires included:

1. A checklist for evaluating the patients' handling of the controller's devices. First, the patients were asked to demonstrate their inhalation technique, using placebo inhalers provided at the time of the interview, then the patients were evaluated by the study investigator for the correctness of the technique, using standardized inhaler technique checklists. The checklist consisted of 9 steps (potential score 0–9). A score of 9/9 was classified as correct technique (16).
2. The level of asthma control was assessed by using validated Arabic versions of a (5-item questionnaire); Asthma Control Test (ACT) scoring, for children aged more than 11yrs (17), which was completed by the patients, and a seven-item Childhood ACT (C-ACT) for children aged 4–11 (18), which was completed by the patients and the caregivers. A cutoff points of 19 indicated uncontrolled asthma for both questionnaires.
3. Assessment of the level of knowledge by using the validated Arabic version of pre & post-education 21 item Asthma Knowledge Questionnaire (AKQ) (19), and a checklist including allergic, physical, and environmental triggers (20), which was translated into Arabic language using the back-translation technique. AKQ is a Likert-type 5-point scale questionnaire directed for parents of children with asthma. The total score was calculated by the sum of score item responses, ranging from 21 to 105, with higher scores indicating greater knowledge of asthma. The total knowledge was considered satisfactory if the percent score was 60% or more and unsatisfactory if less than 60% (21).

Asthma severity scores, which included: A) **Pediatric clinical asthma severity score (PASS) during exacerbation:** It has been used to assess the severity of exacerbations. The patients were classified into three categories: 0–3 (mild), 4–8 (moderate), and 8–10 (severe) respiratory compromise (22). B) **Pediatric respiratory severity score (PRESS)** which was used to assess tachypnea, wheezing, retraction, oxygen saturation, and feeding difficulties, with each component given a score of 0 or 1, and total scores were classified as mild (0–1), moderate (2–3), or severe (4,5,23). C) **Pediatric asthma symptoms scale** was used to determine the frequency and severity of the asthma symptoms. Total scores

range from 5 to 40, with higher scores indicating more severe and frequent symptoms (24). D) **Pediatric respiratory assessment measure (PRAM)**, which is a 12-point clinical scoring that captures a patient's asthma severity. PRAM was validated in children aged 1 to 17 years old, used for scoring asthma exacerbations, as 0–3 indicate mild, 4–7 moderate, and 8–12 severe exacerbations (25).

4. Quality of life was assessed by using specific questionnaires— a) **Pediatric asthma quality of life questionnaire (PAQLQ)** for children (Arabic version) (26). It is a self-administered instrument, which includes 11 items. It can be used for children older than 7 years. Responses to each item of the PACQLQ are given by the patients on a seven-point scale, ranging from 1 to 7, with the higher scores indicating less impairment. The result was expressed by calculating the mean response to all its items. b) **Pediatric asthma caregivers' quality of life questionnaire (PACQLQ)** (Arabic version) (27). It is a self-administered instrument, which includes 13 items. Responses to each item of the PACQLQ are given by the caregivers on a seven-point scale, ranging from 1 to 7, with the higher scores indicating less impairment. The result was expressed by calculating the mean response to all its items.
5. Assessment of asthma controller's medication adherence among patients with asthma by using Morisky medication adherence score (28), which is an 8-item questionnaire, and was directed to children with asthma older than 8 years or the caregivers. It was translated into the Arabic language using the back-translation technique. The total score is a summation of all 8 items and ranges between 0 and 8, with scores of 8 reflecting high adherence, 7 or 6 reflecting medium adherence, and <6 reflecting low adherence.

Pulmonary function tests (PFTs) measurements were performed by a pulmonologist in the respiratory laboratory unit using (JAEGGER Apparatus, Care Fusion Germany, 2011), using standardized spirometry for cooperative patients older than 5 years with average mentality, according to European Respiratory Society (ERS) guidelines (29).

- c. The structure of asthma education program:

The program provided educational sessions presented in the pulmonary clinic during the routine visits by

a well-trained research investigator who obtained excellent asthma education session training with a pediatric pulmonologist and a respiratory therapist for three months before the study. Each individual family received three face-to-face patient education interactive sessions in a separate room in the specialized chest clinic once a month for three months. Each session lasted around 60 minutes. The sessions were based on the National Asthma Council Australia 2019 guidelines (30), which was translated into Arabic utilizing a back-translation technique using standardized teaching resources such as education booklets, spacers, and placebo inhalers for demonstration reasons. The same investigator led the monthly sessions. The sessions covered the following topics: what asthma is, the chronic nature of the disease and what its symptoms are, the pathophysiology of asthma, asthma signs and symptoms, environmental control and how to avoid asthma triggers, the importance of controller adherence, indications of relievers, inhalation technique assessment, and correcting any incorrect steps. Asthma safety information was also supplied. At the end of the sessions, each patient received written information about the session topic, a written individualized Arabic pediatric asthma action plan, as well as a separate plan for the child's school and a daycare center.

For three months, the instructional sessions were followed by weekly 20-minute phone interviews to ensure the intervention adherence. Patients were appraised in each interview based on their level of asthma control, adherence to controller drugs, asthma action plan, justifications for seeking medical counsel, and the importance of using a spacer with a metered-dose inhaler. Furthermore, if possible, any potential problem has been resolved.

d. Data management:

The primary outcome measures of the study were the level of asthma control (as assessed by ACT score); and frequency of health care services utilization, including asthma-related ER visits, the average costs of ER attendance, chest clinic visits, and hospital admissions at our center. Secondary outcome measures were the magnitude of asthma knowledge, lung function parameters, correct inhaler technique, controller medications adherence, level of asthma severity, and quality of life for asthmatic patients and their caregivers. All outcomes were assessed before the education sessions and reevaluated in the following 6 months after intervention by the same rater.

Statistical analysis

The collected data were analyzed by Statistical Package of Social Services (IBM SPSS) version 23. The quantitative data with parametric distribution were presented as mean, standard deviations, and ranges. The non-parametric were presented as median with inter-quartile range (IQR). Also, qualitative variables were presented as numbers and percentages. Quantitative data were compared by the *t*-test for paired samples or by the Wilcoxon rank test. A *t*-test was performed to compare pre-intervention and post-intervention data. Pearson's correlation confidence (*r*) was used to analyze the linear association between continuous variables. In all the tests, a *p* values of ≤ 0.05 was considered significant.

Using PASS 11.0 for sample size calculation, a sample size of 30 patients achieved a power of 80% to detect a significant difference in asthma knowledge score before and after the educational program, assuming an Alpha error of 0.05 and a Beta error of 0.2.

Results

This short-term single-arm intervention study was carried out at a single tertiary educational hospital. Thirty participant pairs (i.e., children with asthma ($n=30$) and their parents ($n=30$), were recruited.

Clinical and sociodemographic profile of the recruited patients

Among our 30 patients who had bronchial asthma disease, (63.3%) of them were males. The mean age of the individuals was 7.18 ± 3.37 years which is ranged from 1 to 15 years. The mean duration of asthma disease was 3.46 ± 3.097 years at the time of the interview. Allergic rhinitis was the most common comorbidity presented among (46.7%) of the patients. According to the Gilani questionnaire, (53.3%) of patients had a middle socioeconomic status. (73.4%) of patients were diagnosed with moderate to severe asthma. The ACT scores over the last month indicated that the (50.0%) of the patients had poorly controlled asthma symptoms (score ≤ 19), whereas, (23.3%) reported not using inhaled corticosteroids (ICS). The frequency of short-acting beta2 -adrenergic receptor agonist (SABA) use was 17.47 ± 4.00 over last month, while, the frequency of systemic steroids use was 4.00 ± 1.31 in the last 6 months. Only, (40%) of the patients, had a written asthma action plan. The general characteristics of the patients at baseline are summarized in Table 1.

Table 1. Demographic and clinical characteristics among the studied patients.

Patients' characteristics (n = 30)	
Age, y (Mean $\pm$ SD)	7.18 $\pm$ 3.37
Male (%)	19(63.3)
Residency	
Urban (%)	16(53.3)
Rural (%)	14(46.7)
Gilani score ^a (Mean $\pm$ SD)	47.3 $\pm$ 13.47
Consanguinity (%)	7(23.3)
Family history of atopy (%)	25(83.3)
Passive smoking (%)	12(40)
Body mass index kg/ m2 (mean $\pm$ SD)	16.76 $\pm$ 3.03
Asthma severity (%)	
Intermittent	3(10)
Mild persistent	5(16.7)
Moderate persistent	11(36.7)
Severe persistent	11(36.7)
Level of asthma control (%)	
Well controlled	3(10.0)
Not well controlled	12(40.0)
Uncontrolled	15(50.0)
Asthma controllers ^b (%)	23(76.6)
Frequency of SABA ^c /the last month	17.47 $\pm$ 4.00
Frequency of systemic steroids/6 months	4.00 $\pm$ 1.31
Range	2–6
Have asthma action plan (%)	12(40.0)

a: a socioeconomic status scale which has 7 domains with a total score of 84, b: Inhaled corticosteroids, combined inhaled steroids and inhaled long-acting beta2-agonists. c; Short-acting beta2 -adrenergic receptor agonist.

Postintervention clinical outcomes

Primary outcome measures

After the intervention, there was a highly statistically significant improvement in the level of asthma control measured by ACT (22.27 $\pm$ 1.84) versus (19.03 $\pm$ 1.79) preintervention with the percentage of improvement of (16.67%) ($p < 0.001$). Significantly, the median

frequency of asthma exacerbations, emergency department (ED) presentations and chest clinic visits decreased in the postintervention period than in the preintervention period (5 (4–6), 3 (3–4), 3 (2–3) times vs 2 (1–2), 2 (1–2), 2 (1–2) times, ($p < 0.001$) with a percentage of improvement of (60%, 50%, 50%) respectively. Recurrent ER visits were reported by (83.3%) of the patients' preintervention which decreased to (26.7%) postintervention ($P < 0.001$) with a percentage of improvement of (68%). Furthermore, there was a significant reduction in the total cost of ER attendance among the studied patients within 6 months post educational program ($P < 0.001$).

Also, there was a highly significant difference in the median hospitalization rate in the last 6 months pre 2 (1–2) and post asthma education 0 (0–1) with a percentage of improvement of (66.67) ($p = < 0.001$). The same was true for the proportion of patients before and after the educational intervention using the proper inhalation technique when using metered dose inhalers (14 (46.7%) vs. 26 (86.7%) with a percentage of improvement of (40.0%) ($p = 0.001$). In addition, the post-education level of controller's adherence using Morisky adherence score (6.33 $\pm$ 1.24) significantly improved compared to pre-education level (4.37 $\pm$ 1.07) ($p < 0.001$), with a percentage of improvement of (45%). Moreover, PAQLQ, PACQLQ significantly improved post-intervention (5.53 $\pm$ 0.45), (5.23 $\pm$ 0.25) than preintervention (4.28 $\pm$ 0.33), (3.63 $\pm$ 0.22) with a percentage of improvement of (29.99%), (43.47%) ($p < 0.001$). All these data are summarized in Table 2.

Table 2. Primary and secondary outcomes prior to and after the educational intervention.

Variables	Pre-intervention	Post-intervention	T test	P value
Asthma control test (mean $\pm$ SD)	19.03 $\pm$ 1.79	22.27 $\pm$ 1.84	–13.857	<0.001**
Uncontrolled	19 (63.3%)	0 (0.0%)		
Partially controlled	11 (36.7%)	25 (83.3%)	29.444	
Controlled	0 (0.0%)	5 (16.7%)		
Asthma exacerbations, median (IQR) Frequency	5 (4–6)	2 (1–2)	–4.859	<0.001**
Severity				
Mild	2 (1–2)	1 (1–2)	–2.995	0.003**
Moderate	2 (1–2)	1 (0–1)	–4.134	<0.001**
Severe	1 (1–2)	0 (0–0)	–4.767	<0.001**
Emergency room visits, median (IQR)	3 (3–4)	2 (1–2)	16.276	<0.001**
Recurrent ER ^a visits (%)	25 (83.3%)	8 (26.7%)	19.461	<0.001**
Chest clinic visits, median (IQR)	3 (2–3)	2 (1–2)	11.050	<0.001**
Hospital admissions, median (IQR)	2 (1–2)	0 (0–1)	–4.540	<0.001**
Inhalation technique, n (%)				
Correct	14 (46.7)	26 (86.7)	10.800	0.001**
Morisky medication adherence scale (Mean $\pm$ SD)	4.37 $\pm$ 1.07	6.33 $\pm$ 1.24	–10.103	0.001**
PAQLQ ^b (Mean $\pm$ SD) (n = 25)	4.28 $\pm$ 0.33	5.53 $\pm$ 0.45	11.754	0.001**
PACQLQ ^c (Mean $\pm$ SD)	3.63 $\pm$ 0.22	5.23 $\pm$ 0.25	26.032	<0.001**
Total ER visits costs (\$), Median (IQR)	13.500 (8000–21000)	1000 (1000–4000)	15.411	<0.001**
Asthma knowledge questionnaire	61.03 $\pm$ 7.07	69.43 $\pm$ 5.20	8.181	<0.001**
Range	50–75	61–82		

a; Emergency room, b; pediatric Asthma Quality of life Questionnaire, c; Pediatric Asthma Caregivers Quality of life Questionnaire, P**; Highly significant.

Secondary outcome measures

Asthma knowledge level

There was a highly significant improvement in the degree of asthma knowledge post-education than pre-education ($p = <0.001$), where, the post educational mean score of asthma knowledge questionnaire (69.43 ± 5.20) (61–82) achieved a satisfactory percentage of (66.1%) of the total score was higher than the pre-educational level (61.03 ± 7.07) (50–75) with an unsatisfactory percentage of (58.2%) of the total score with a percentage of improvement of (12.7%) as presented in Table 2.

Lung function results

Figure 1 shows that there was a significant improvement in the pulmonary function parameters post asthma education program ($n=25$) ($p=0.001$), where, forced expiratory volume 1 (FEV1) % of predicted, FEV1/forced vital capacity (FVC) ratio, and maximum mid expiratory flow (MMEF) 75/25% of predicted significantly improved post education (96.73 ± 13.89), (84.17 ± 9.32), (70.55 ± 17.38) than pre-education (85.36 ± 18.38), (74.45 ± 12.29), (51.23 ± 15.54) with a percentage of improvement of (15.63%), (10.45%), (41.33%) ($P=0.006$, 0.003 , <0.001).

Asthma severity scores

There was a significant improvement in asthma severity scores post asthma education program, where, the

means of pediatric clinical asthma severity score during exacerbation; pediatric respiratory severity score, pediatric asthma symptoms scale, and pediatric respiratory assessment measure were significantly lower post asthma education (1.53 ± 0.86), (1.33 ± 0.66), (9.87 ± 2.47), and (0.97 ± 1.47), respectively; than pre asthma education (4.20 ± 2.51), (2.87 ± 1.33), (17.63 ± 4.75), and (3.07 ± 2.57), respectively; with a percentage of improvement of (60%, 50%, 44.72%, 94.44%) ($p=0.001$ for all) indicating less asthma severity post-education as shown in Table 3 and Figure 2.

Correlations between asthma knowledge and outcome measures

Figure 3 shows that level of asthma knowledge, measured by the asthma knowledge questionnaire post-education, was positively correlated with the level of asthma control as measured by ACT score (4a) and Gilani score for socioeconomic status (4b); and negatively correlated with the frequency of asthma exacerbations(4c) and total ER visits (4d) ($P=0.015$, 0.004 , 0.016 , 0.005).

Discussion

This is the first study to address the feasibility and efficacy of an asthma education intervention for children with bronchial asthma and their parents in our center. Our study showed that intensive individualized

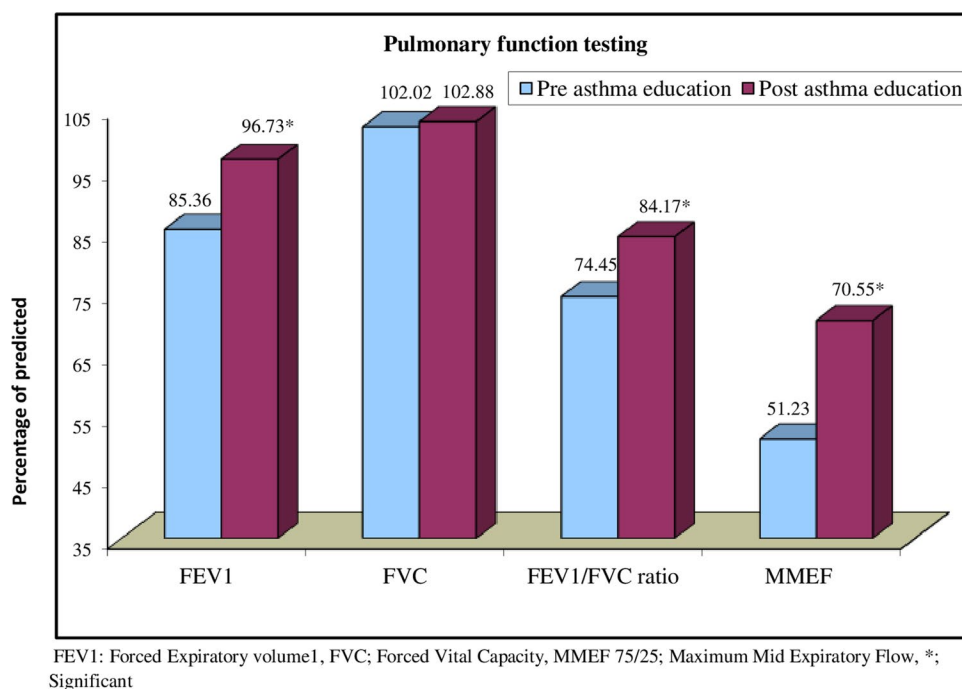
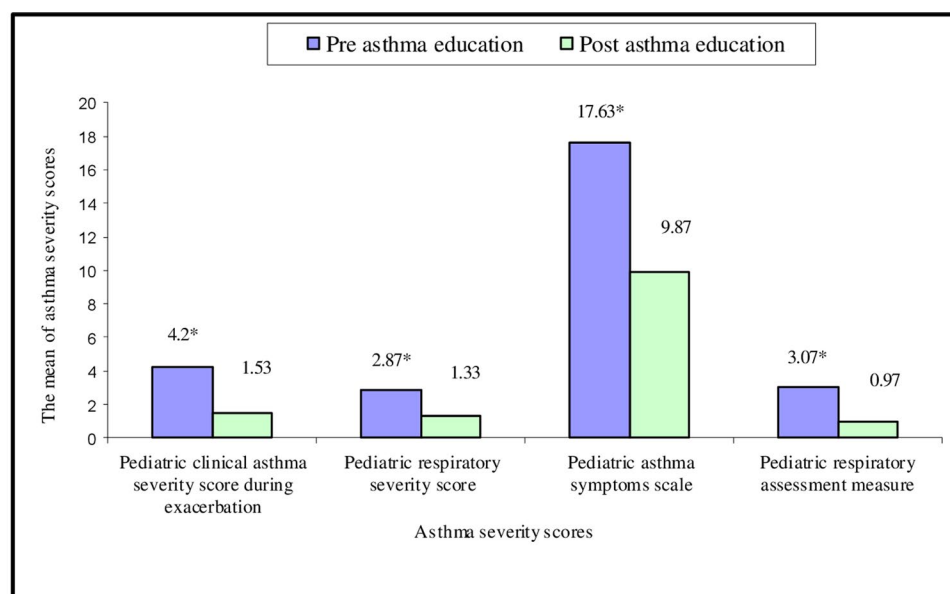


Figure 1. Pulmonary function testing parameters pre and post asthma education.

Table 3. Asthma severity scores prior to and after asthma education.

Asthma severity scores	Pre asthma education	Post asthma education	Test value	P-value
Pediatric clinical asthma severity score				
Mean $\pm$ SD	4.20 $\pm$ 2.51	1.53 $\pm$ 0.86	-5.820	<0.001**
Range	1-10	0-3		
Pediatric Respiratory Severity Score				
Mean $\pm$ SD	2.87 $\pm$ 1.33	1.33 $\pm$ 0.66	-6.073	<0.001**
Range	1-5	0-3		
Pediatric asthma symptoms scale				
Mean $\pm$ SD	17.63 $\pm$ 4.75	9.87 $\pm$ 2.47	-12.363	<0.001**
Range	8-26	7-16		
Pediatric Respiratory Assessment Measure				
Mean $\pm$ SD	3.07 $\pm$ 2.57	0.97 $\pm$ 1.47	-4.132	<0.001**
Range	0-9	0-5		

P**; Highly significant.



*, Significant

Figure 2. Asthma severity scores pre and post asthma education.

asthma education program in our tertiary center leads to decreased health care utilization, reduced ER visitations, hospitalization rate, as well as improved asthma control, and quality of life among children with asthma and their caregivers. To our knowledge, this is one of the few studies that has been conducted in our society evaluating the effect of asthma education on disease morbidity and severity.

The current study revealed that there was a significant difference in the post-education level of asthma control as measured by ACT on the positive end of the scale compared to pre-education level ($P < 0.001$) (Table 2), which comes in agreement with the previous literature, which revealed a significant improvement in asthma control after asthma educational intervention (31–33). However, Larson et al., reported that the mean asthma control score improved but was not statistically significant (32). Our findings highlighted the importance of asthma education in

reducing asthma symptoms and improving asthma control.

Our results have showed also that asthmatic attacks were less frequent with less severe with reduced frequency of chest clinic visits, ER visits, and hospital admissions post asthma education ($P < 0.001$) (Table 2). Regarding the cost benefits of the study, there was a significant reduction in the average cost of an ER attendance among the studied patients post intervention (Table 2). This is consistent with the results of a systematic review of 36 randomized controlled trials where there was also a reduction in the frequency of asthma exacerbations requiring unscheduled chest clinic visits, asthma-related ER visits, or hospital admissions after an optimal asthma education program (6). Moreover, various studies have suggested that proper asthma education significantly decreased the number of asthma days per month and daytime asthma symptoms (34).

However, Larson et al., and Oliveira et al., found no change in the number of outpatient clinic visits for asthma review or in the number of hospital admissions after asthma education. These findings could be explained by the presence of more severe asthma and more associated comorbidities among the studied patients (35,36).

Therefore, based on our findings, implementing a proper asthma education program may effectively reduce the unnecessary use of ED and could be a cost-effective measure to save the limited ER resources especially in low-income countries.

Our study reported that the level of the controller's adherence and the correct inhaler technique significantly improved after the educational intervention ($P < 0.001$) (Table 2). This result is in agreement with a previous publications using different educational interventions (32,37–40) which reported a significant improvement in the adherence to asthma controller medications, correct use of inhalers, and a decrease in the number of emergency room visits after a short-term asthma education program.

The current study found that the level of quality of life (QOL) improved in a significant way among children with asthma and their caregivers after the intervention that was done across the study ($p < 0.001$) (Table 2). These results are similar to a previous study conducted by Urek et al. which reported that asthma education improved QOL and asthma control during three months of follow-up (41). On the same hand, previous different studies have revealed a significant improvement in the QoL scores post asthma education (32,42,43).

According to our results, asthma education was found to be an efficient factor in improving the quality of care among patients with asthma and their families through reducing asthma symptoms, the rates of ER visits, and hospital admissions leading to better asthma management.

Our study revealed that there was a highly significant improvement in the degree of the parent's and child's asthma knowledge post-education ($p < 0.001$) (Table 2). On the same hand, Prabhakaran et al. found a positive impact on patient's knowledge of asthma after asthma education (44). Moreover, this is consistent with Barton et al. findings, as he observed that the parents become more knowledgeable about asthma after education as well as their children and adolescents' knowledge (45).

According to our results, we proved that the asthma education program significantly improved the asthma severity scores in children with asthma (Table 3, Figure 2) ($P < 0.001$) which goes parallel with Ja and Hyang-In et al. (46). Elbanna et al. (47) who declared that there was a highly significant improvement in

patients' day symptoms and nocturnal symptoms post asthma education. Additionally, Shackelford and Bachman demonstrated that asthma education improved symptom scores (48). However, our study does not agree with Urek et al., who revealed no significant difference between the education group and non-education group in the daily average number of day-time and nighttime symptoms (41).

Our results also detected that the increased level of asthma knowledge post education was significantly associated with improved level of asthma control ($r = 0.439$, $p = 0.015$), less frequent asthma exacerbations ($r = -0.435$, $p = 0.016$), and less ED presentations, ($r = -0.495$, $p = 0.005$) (Figure 3). In agreement with the present study, Costa and colleagues found that a five-day educational camp program for asthmatic children had led to a positive impact on knowledge and improvement in asthma management skills (49).

Another study done by Angelini and colleagues reported that increased knowledge about asthma disease after participation in an asthma education program was associated with clinical improvement in patients with moderate or severe persistent asthma (50). Moreover, multiple studies (32,51,52) demonstrated that increased level of asthma knowledge post asthma education was significantly associated with lower rates of ER visits for asthma. On the other hand, Gajanan et al. found that improved knowledge alone did not improve asthma control level (53).

The current study added also that increased asthma knowledge post-education was observed in the participants with higher socioeconomic status ($P = 0.018$) (Figure 3), which can be attributed to that higher paternal educational level may leads to better understanding of the presented program and in turn a better compliance among the children with asthma under their supervision.

Our study revealed also that there was a highly significant improvement in the pulmonary function parameters, before and after the educational intervention (Figure 1) which agrees with Marabini and colleagues who found that FEV1 was significantly higher among the educated patients versus their match non-educated patients (54). Similarly, Rodrigues and his colleagues (32) reported that the bronchial asthma education program improved pulmonary function. However, a study done by Janson et al. showed that the asthma education did not affect the FEV1% during the intervention period which may be due to the severity of the disease among the studied patients (42).

The previous data show that the asthma education program has decreased the utilization of medical resources, improved the level of asthma knowledge,

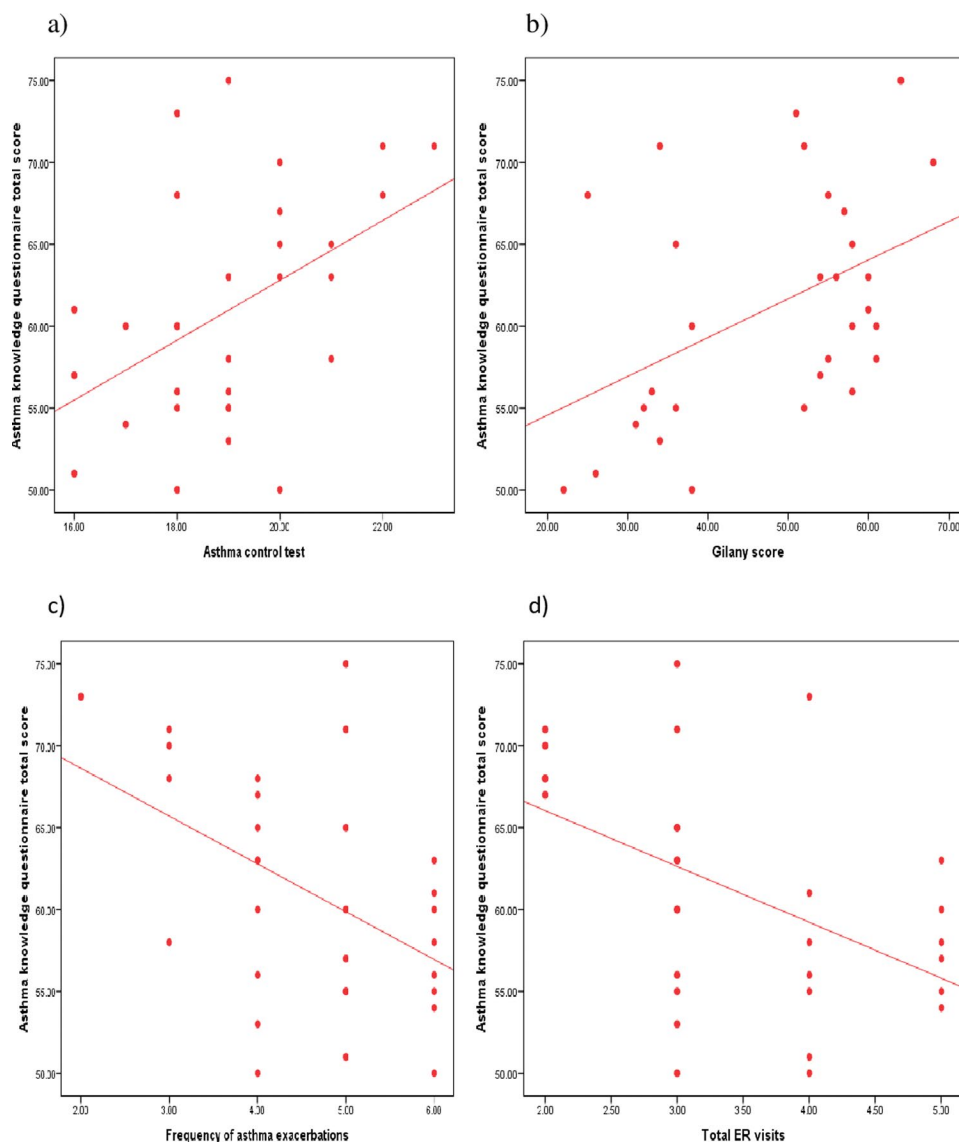


Figure 3. Correlations between asthma knowledge questionnaire post education and a) asthma control test score, b) Gilani score, c) frequency of asthma exacerbations, and d) total ER visits.

asthma control, and quality of life among patients with asthma and their caregivers in a significant way. In addition, the intervention was generally accepted for both program deliverers, and program recipients, extremely needed in our population, easily applied, practical, cost-effective, and previously adapted in other populations. Thus, the implementation of a bronchial asthma education program could be efficacious, feasible, and economical measure to improve the outcomes of bronchial asthma and reduce its severity.

Limitations of the study

There are some limitations to the current study. First, the sample size was relatively small. Second, the design as it was a single center study. As a result,

larger-scale longitudinal studies with a bigger sample size are required to generalize our findings, as a longer patient follow-up period may be needed to assess the effectiveness and practicality of educational programs in other demographic and seasonal situations. Third, several questionnaires have been included in the study which depend on the patients' response, however, the study findings relied mainly on objective measures to avoid any response bias. Finally, the seasonal variation may affect the asthma status accounting for our findings. To the best of our knowledge, this study is one of the few studies in our culture that investigated the positive effect of asthma education on asthmatic patients and their families and established its efficacy among the studied group.

Conclusion

Asthma education may be considered as both a vital and cost-effective component of a comprehensive asthma management plan, particularly in the developing countries. Furthermore, asthma education programs should be provided in all clinical settings, including high-risk patients in the emergency department or those confined to the hospital.

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Declaration of interest

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