Journal of Pioneering Medical Sciences
Received: August 10, 2026 | Accepted: September 05, 2026 | Published: November 15, 2026
Volume 15, Issue S02, Pages 181-187

DOI https://doi.org/10.47310/jpms202615S0220



The Impact of Nurse-Led Asthma Education On Reducing Emergency Department Visits for Children in Tabuk: A Case-Control Study

Abeer Alatawi[1*]

[1]Department of Maternal and Child Health Nursing, Faculty of Nursing, University of Tabuk, P.O. Box 741, Tabuk 71491, Saudi Arabia

*Corresponding author: Abeer Alatawi (e-mail: asalatawi@ut.edu.sa).

©2026 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0

Abstract **Objectives:** Asthma is a common chronic respiratory condition among children. Despite the existence of approved clinical guidelines, suboptimal disease management leads to unnecessary emergency department (ED) visits. Nurse-led educational interventions have demonstrated potential effectiveness in improving health outcomes for children with asthma. **Objective:** To assess associations of nurse-led asthma education with childhood asthma control (C-ACT) and recorded asthma-related emergency department (ED) visits in Tabuk, Saudi Arabia. **Methods:** A non-randomized comparison analyzed 52 children aged 5–12 years (intervention, n = 27; control, n = 25). The nurse-led education program ran from June to November 2025. C-ACT scores and ED visit records were reviewed. An initial pool of 100 was reported, but the disposition of the remaining 48 children was not described. **Results:** Reported follow-up mean C-ACT scores were 18.5 in the intervention group and 16.2 in controls (p = 0.032; statistical test not specified). Aggregate recorded ED visits decreased from 45 to 15 (66.7%) in the intervention group and from 42 to 30 (28.6%) in controls. A statistical comparison of changes in ED visits between groups was not reported. **Conclusion:** Nurse-led asthma education was associated with higher reported C-ACT scores and a larger descriptive reduction in recorded ED visit counts. The small, non-randomized sample and incomplete ED visit analysis limit causal interpretation and generalizability.

Key Words: Childhood Asthma, Asthma Education, Nurse-Led Intervention, Asthma Control, Emergency Department Utilization, Saudi Arabia

INTRODUCTION

Asthma remains one of the most common chronic respiratory diseases affecting children worldwide. Childhood asthma creates a substantial burden for affected families and healthcare services, particularly in the Eastern Mediterranean region, where environmental shifts, urbanization, and varying access to healthcare are contributing to complex disease patterns [1]. In Saudi Arabia, this trend is of particular concern, with epidemiological studies documenting a substantial and regionally variable burden, attracting the attention of both policymakers and healthcare providers [2-3].

Research has revealed unique prevalence patterns and distinct risk factors in different provinces, such as Jazan [4] and the Eastern Province [5], with meta-analyses confirming high overall rates [3]. Tabuk, located in the northwest, has unique epidemiological characteristics shaped by climate, geography, and regional healthcare resources, however, detailed data on asthma management outcomes in this region remain limited. Despite the existence of evidence-based national guidelines, such as the Saudi Initiative for Asthma (SINA) [6], achieving optimal asthma management remains challenging. Research shows high rates of uncontrolled asthma among Saudi children and a significant rate of medication non-adherence [7].

Nurse-led educational programs have emerged as a promising approach to linking guidelines to actual outcomes [8-9]. Randomized controlled trials have demonstrated the effectiveness of nurse-led care in primary and community care settings [10-11], with school and community models proving particularly effective in engaging children and their families in their natural environment [12-13]. Nurses' responsibilities extend beyond clinical education to include engaging caregivers, which is crucial because caregivers'

understanding significantly impacts asthma treatment outcomes [14]. In Saudi Arabia, research has revealed significant gaps in parental knowledge regarding asthma management [15-16]. Initiatives in Madinah have contributed to improved disease management among participating children [17], while the implementation of the CDC's EXHALE strategy has demonstrated a decrease in ED visits and improved asthma control [18]. In Saudi Arabia, a link has been observed between environmental factors and the use of urgent care services [19]. Furthermore, asthma significantly impacts children's quality of life, affecting their physical, social, and psychological well-being [20].

This study aims to evaluate the association of a structured nurse-led asthma education program with C-ACT scores and recorded asthma-related ED visits among children with asthma in Tabuk.

The study considered asthma control and recorded ED utilization as distinct outcomes. Improved symptom-control scores do not necessarily establish a reduction in healthcare use, and a change in visit counts alone does not demonstrate a causal intervention effect.

Literature Review

Asthma in Children: Asthma is the most common chronic inflammatory disease among children worldwide. It is characterized by inflammation of the airways, increased bronchial responsiveness, and fluctuating airflow obstruction, causing symptoms including wheezing, shortness of breath, chest tightness, and coughing.

In Saudi Arabia, a comprehensive meta-analysis by [3] reported a physician-diagnosed prevalence of asthma among Saudi children of 28.9%, with a higher prevalence among males than females. Alomary *et al.* [2] investigated asthma prevalence among children and adolescents across the Kingdom and revealed significant regional differences, particularly in the southern region, which recorded the highest prevalence at 25.1%. In the Jazan region, Gohal *et al.* [4] reported a prevalence of 28.0% for chronic wheezing and 30.9% for exercise-induced wheezing. In the Eastern Region, Yaqoob *et al.* [5] reported that 26.9% of children aged 8 to 13 years were diagnosed with childhood asthma, which is significantly affected by environmental triggers.

Health Education About Asthma Led by Nurses

Nurses play a pivotal role in asthma education across diverse settings, including schools, primary healthcare centers, hospitals, and community programs [11,21-22]. Chen *et al.* [8] conducted a systematic review and meta-analysis of 21 randomized controlled trials, focusing exclusively on nurse-led education versus standard care. A prospective review by Kindi *et al.* [9] also investigated the effects of nurse-led asthma interventions on children's health outcomes and noted consistent improvements in asthma management, quality of life, and health care utilization indicators.

Nurse-led interventions in schools and communities have shown potentially beneficial findings in selected settings. A systematic review by Isik *et al.* [12] highlighted the importance of providing asthma education in relaxed, non-clinical settings. A randomized controlled follow-up study by Isik *et al.* [13] showed that a school nurse-led asthma intervention significantly improved self-management practices. Rossi *et al.* [23] investigated the contribution of community nursing to asthma management strategies in school-aged children. Nurse-led intervention models have been evaluated in diverse contexts. Bousema *et al.* [10] conducted a randomized controlled trial evaluating nurse-led care in primary healthcare settings, demonstrating significant improvements in asthma management. Gao *et al.* [11] investigated a nurse-led educational program for children with asthma transitioning from outpatient to home care, showing improved medication adherence and reduced healthcare utilization. Mathiazhakan *et al.* [22] evaluated a nurse-led educational program on caregiver stress and quality of life, revealing substantial improvements. Chichi and Foluso [21] implemented a nurse-led educational initiative based on the Global Asthma Initiative (GINA) guidelines, demonstrating improved practice. Wu *et al.* [24] investigated technology-enhanced nurse-led interventions through a WeChat mini-program, showing significant progress in disease management.

Patient Education

Asthma education has been associated with improvements in selected outcomes, although the strength of evidence depends on study design and outcome measurement. Arıkan-Ayyıldız *et al.* [25] evaluated an asthma education initiative in children with uncontrolled asthma, and their results showed significant improvements in asthma control rates and a reduction in symptom days. Liu and He [26] also conducted a systematic review and meta-analysis of community nursing interventions for children with asthma.

Studies suggest that caregiver-inclusive education can support asthma self-management, effects on hospital admissions and ED visits should be interpreted according to each study's design and follow-up period. This highlights the critical role of caregivers in asthma management [12,16]. In the context of Saudi Arabia, Al-Zalabani and Almotairy [15] studied asthma management and its relationship to caregivers' knowledge, revealing a strong correlation between caregivers' knowledge and improved asthma control. Similarly, AlOtaibi and AlAteeq [16] examined the understanding and behaviors of parents and guardians in Riyadh, revealing significant deficits in both knowledge and practical skills for managing the disease. Nyaga *et al.* [14] conducted a systematic review assessing the impact of caregivers' knowledge on health outcomes in low- and middle-income countries, discovering important links between informed caregiving and improved child health. Alfaleh *et al.* [20] conducted a multi-method study to assess the quality of life of school-aged children with asthma in Saudi Arabia, revealing diverse impacts on physical, social, and psychological well-being. Gebresilassie *et al.* [27] also studied an asthma health

education program in northern Ethiopia, demonstrating significant improvements in knowledge and disease control outcomes.

Asthma Management in Saudi Arabia

The Saudi Initiative for Asthma (SINA) oversees asthma management in Saudi Arabia. Al-Moamary *et al.* [6] released the SINA-2024 update, which provides age-specific guidelines, emphasizing the importance of combining medication, health education, self-management support, and structured follow-up. Despite these guidelines, significant gaps remain in their practical implementation. National programs have demonstrated the potential for launching structured educational initiatives. De Asis *et al.* [18] implemented the Centers for Disease Control and Prevention's EXHALE strategy in the Taif region. In Medina, Alhazmi *et al.* [17] study evaluated an asthma education initiative involving 804 children with asthma and showed a significant decrease in ED visits, length of hospital stay, and pediatric intensive care unit admissions.

Numerous research studies have been conducted on medication adherence. Alghamdi *et al.* investigated medication adherence among sick children in Riyadh hospitals and found significant non-adherence linked to inadequate asthma control. Yousef *et al.* [19] investigated the relationship between environmental factors and emergency medication use in the Eastern Province, highlighting the importance of identifying asthma triggers. Yoon *et al.* [28] conducted a systematic review highlighting the steady progress in asthma knowledge, self-management practices, and health outcomes.

Despite these achievements, significant challenges remain, such as the low level of documentation of asthma action plans, inadequate medication adherence, and limited understanding among caregivers. Addressing these gaps through structured, nurse-led educational programs is crucial, particularly in areas like Tabuk, where such initiatives are still not systematically evaluated. This study addresses this important gap by examining the association between nurse-led asthma education, asthma-control scores, and recorded pediatric ED visits in Tabuk, adding to the growing body of evidence on asthma management strategies in Saudi Arabia.

The cited evidence includes randomized trials, observational studies, and reviews addressing different endpoints. These designs provide different levels of evidence, and improved asthma-control scores should be distinguished from changes in recorded emergency healthcare utilization.

METHODS

Study Design

The study was reported as a retrospective case-control comparison of children receiving nurse-led asthma education (intervention group) and those not receiving a structured education program (control group). Because education was delivered during June–November 2025, the timing of group selection and the distinction between intervention delivery and retrospective record review were not fully documented. No randomized allocation was reported.

Participants

Participants were selected from healthcare facilities in Tabuk, Saudi Arabia, representativeness of all children with asthma in Tabuk was not established. One hundred children aged 5–12 years, along with their primary caregivers, were reported as initially recruited from healthcare facilities in Tabuk. The final analysis included 52 children (27 in the intervention group and 25 controls), the reasons for the difference between the reported initial and final sample sizes were not specified.

Sample Size

Sample size was calculated using the Fleiss formula for case-control studies, a technique commonly used to determine sample size in epidemiological studies [29]. The calculation, using the site (https://www.openepi.com/SampleSize/SSCC.htm) yielded a minimum of 58 individuals per group. Due to limited resources and participant availability during the recruitment phase, 52 children were included in the final analysis (27 in the intervention group and 25 controls). The final analytical sample (27 in the intervention group and 25 controls) was substantially smaller than the calculated target of 58 per group, adequate statistical power cannot be assumed without a revised calculation.

Data Collection

The research was conducted over 14 months, from January 2025 to February 2026. Participant recruitment took three months (March–May 2025), during which time children underwent a systematic assessment to determine their eligibility based on inclusion criteria. A nurse-led asthma education program was provided to the study group for six months (June–November 2025). This research used the Childhood Asthma Control Test (C-ACT) scale as a reliable, self-reporting tool for identifying children aged 4 to 11 years with poorly managed asthma [31-34]. Data, including the C-ACT and an examination of ED records, were collected over two months (December 2025–January 2026).

The dates defining pre-program and post-program ED visit observation windows were not fully documented. Therefore, whether the observation periods were equivalent across groups could not be established for the present analysis.

Urban and rural participation was mentioned in the original study description, but the distribution by group was not reported, representativeness therefore cannot be established from the available data. The selected age group of 5 to 12 years is considered vital for development, as children in this range can engage in self-management of asthma with the need for substantial support from caregivers, consistent with similar pediatric asthma studies [2-3].

The C-ACT was developed and validated primarily for children aged 4–11 years. Because the analytical sample included some 12-year-old children, use of an age-appropriate instrument in that subgroup was not sufficiently documented.

Statistical Analysis Procedure

Statistical analyses were performed using SPSS (Statistical Package for the Social Sciences). The analysis followed a multi-stage approach, beginning with descriptive statistics to determine the demographic characteristics of the participants. Descriptive statistics clarified sample characteristics, such as age, gender, and baseline asthma severity.

A p-value was reported for the C-ACT comparison, but the specific statistical test was not identified. No between-group inferential test of changes in ED visit counts was reported, therefore, these count changes are interpreted descriptively.

RESLTS AND DISCUSSION

Demographic Information

The final analysis included 52 children: 27 in the intervention group, who received nurse-led asthma education, and 25 in the control group, who did not receive a structured educational program. Table 1 presents the reported participant characteristics.

The demographic characteristics show an even distribution of age and gender between the two study groups (the intervention and control groups). Most participants (52%) were between 8 and 10 years old, while 35% were between 5 and 7 years old, and 13% were between 11 and 12 years old. The gender distribution was also nearly equal, with males comprising 52% and females 48%. Although the descriptive distributions were broadly similar, they do not establish baseline equivalence or exclude confounding in this small, non-randomized sample [2-3]. This age distribution is consistent with the findings of similar research on childhood asthma in Saudi Arabia, which typically focuses on school-aged children who are able to manage their asthma independently and who require support from caregivers [4-5]. The majority of children aged 8 to 10 years represent the typical age group for school-associated asthma initiatives, and underscore the need to focus on this population in educational efforts.

Baseline asthma severity was assessed using the C-ACT and clinical classification based on the Saudi Asthma Initiative (SINA) guidelines [6]. The mean baseline C-ACT scores were 12.4 in the intervention group and 12.8 in the control group, indicating uncontrolled asthma (C-ACT score <20) in both groups prior to intervention [26,30]. The distribution of disease severity was similar between the two groups, with moderate persistent asthma being the predominant classification in both. The groups had broadly similar descriptive characteristics, but this does not exclude unmeasured differences in baseline severity, treatment, or healthcare access [2-3]. This age distribution is consistent with similar studies on childhood asthma in Saudi Arabia, which typically focus on school-aged children who are capable of self-managing their asthma but require support from caregivers [4-5].

Asthma Control Test Measurement

The C-ACT was administered to assess asthma control status in each group. Table 2 shows the mean C-ACT scores and the statistical significance of the reported follow-up differences between intervention and control groups.

The group that received nurse-led asthma education showed a significantly higher reported follow-up mean C-ACT score (18.5) compared to the control group (16.2), with, a p-value less than 0.05, indicating statistical significance. The reported between-group follow-up difference does not

Table 1: Reported Baseline Characteristics of Participants (Total, n = 52)

Variable	Intervention Group (n = 27)	Control Group (n = 25)	Total (n = 52)	Percentage
Age				
5–7 years	10	8	18	35%
8–10 years	12	15	27	52%
11–12 years	5	2	7	13%
Gender				
Male	15	12	27	52%
Female	12	13	25	48%
Baseline Asthma Severity				
Severity category not specified	6	5	11	21.2%
Mild Persistent	8	7	15	28.8%
Moderate Persistent	9	10	19	36.5%
Severe Persistent	4	3	7	13.5%
Mean Baseline C-ACT Score (SD)	12.4 (2.1)	12.8 (2.3)	12.6 (2.2)	—

The original first severity category could not be identified from the reported data. Mean baseline C-ACT values are reported as mean (SD), the percentage column is not applicable to this row

Table 2: Reported follow-up C-ACT Scores of Both Groups (Total, n = 52)

Group	Mean follow-up C-ACT	SD	p-value
Intervention Group	18.5	3.2	0.032
Control Group	16.2	2.8	

Means are presented as reported follow-up C-ACT scores. The manuscript reports p = 0.032 but does not identify the statistical test or a confidence interval for the difference

Table 3: Recorded Asthma-Related ED Visits Before and After Education (Aggregate Counts)

Group	Before program (visits)	After program (visits)	Reduction
Intervention Group	45	15	66.7%
Control Group	42	30	28.6%

Values are aggregate counts of recorded ED visits, not the number of children attending the ED or visit rates. The observation-period lengths and a between-group test of change were not reported

Table 4: Descriptive Comparison of Asthma Education Studies with Different Outcome Measures (Not A Pooled Analysis)

Study	Country	Method	Participants	Key Findings
Current	Saudi Arabia	Retrospective case-control	52 children with asthma (27 cases, 25 controls)	66.7% descriptive reduction in recorded ED visit counts
Bousema et al. [10]	Netherlands	Cluster randomised controlled trial	90 children (51 nurse-led care, 39 usual care) aged 6–12 years	Median nurse review visits were 2 (range 0–6) per child
Gebresilassie et al. [27]	Ethiopia	Quasi-experimental	204 participants, comprising 102 individuals in the intervention group and 102 in the control group at baseline	Asthma control levels significantly improved in the intervention group, with a 19.4% increase compared to 0.6% in the control group
De Asis et al. [18]	Saudi Arabia	Tailored approach to meet the specific needs of pediatric asthma patients as per the EXHALE strategy	Children with asthma (number is not specified)	There was a 60.61% reduction in the monthly average visits to the ED for asthma-related issues
Alhazmi et al. [17]	Saudi Arabia	Cross-sectional study	804 asthmatic children patients	The average ACT and TRACK scores were significantly higher in the Post-education group.

The listed studies differ in design and endpoints (asthma control, nurse reviews, and ED utilization), this comparison is descriptive and is not a formal meta-analysis

its own, establish a statistically significant between-group difference in change from baseline or a causal intervention effect. The ACT is a reliable tool for assessing asthma management in children, with scores of 20 or higher indicating good asthma control [26,30]. The mean C-ACT score in the intervention group (18.5) is within the partially controlled range (15-19) and shows significant improvement compared to the control group (16.2) [26,30]. Although the mean was higher than that of controls, it remained below the stated threshold of 20 for well-controlled asthma, the clinical significance of this difference requires careful interpretation. The higher reported follow-up C-ACT score in the intervention group is broadly consistent with improvements described in some previous education studies. Alhazmi *et al.* [17] found a significant improvement in ACT scores among children who received asthma education in Madinah, with mean scores increasing from 14.8 to 20.3 after the educational intervention. Similarly, Arıkan-Ayyıldız *et al.* [25] demonstrated that asthma education initiatives significantly improved asthma management in children with uncontrolled asthma, with ACT scores increasing from 15.2 to 21.4 after a structured educational program. The reported follow-up group difference can be considered alongside the findings of Chen *et al.* [8], who observed a mean difference of 4.20 points in ACT scores in favor of nurse-led interventions in their meta-analysis of 21 randomized controlled trials involving 4,742 participants.

Emergency Visits Evaluation

Aggregate counts of recorded asthma-related ED visits were compared before and after the educational intervention for both groups. Table 3 shows the number of ED visits and the percentage reduction observed in each group.

Recorded asthma-related ED visits decreased from 45 to 15 in the intervention group, a descriptive reduction of 30 visits (66.7%). In the control group, recorded visits decreased from 42 to 30, a reduction of 12 visits (28.6%). These values are aggregate visit counts rather than participant-level rates. Because a formal between-group test of changes was not reported, the difference in the reductions should not be described as statistically significant.

These findings are consistent with the meta-analysis by Chen *et al.* [8], which reported a 32% reduction in ED visits for children who participated in nurse-led education programs. The recorded 66.7% reduction in this study cannot be attributed solely to the education program because differences in baseline ED use, medication, seasonality, and other care changes were not assessed. Similarly, De Asis *et al.* [18] observed a 60.61% decrease in the average monthly ED visits after the implementation of the CDC's EXHALE strategy at a university hospital in Saudi Arabia. In addition, Alhazmi *et al.* [17] study demonstrated a significant decrease in ED visits for children in Medina who received asthma education, with visits dropping from 110 before the intervention to 45 afterward. These studies offer relevant context, although differences in design, follow-up and measurement preclude direct comparison of effectiveness with the systematic review by Kindi *et al.* [9] and the meta-analysis by Liu and He [26]. Furthermore, Bousema *et al.* [10] reported a 40% reduction in emergency care interactions following the implementation of nurse-led care in primary healthcare centers.

Comparison with Other Educational Interventions

Table 4 compares the findings of the current study with those of four other studies that evaluated asthma education programs—whether structured or nurse-led—across various healthcare settings and countries. The studies report different

designs, follow-up periods and outcomes, consequently, these figures are presented as descriptive context rather than directly comparable estimates of intervention effectiveness.

Table 4 shows that the results of this study align with the broader literature on nurse-led asthma education programs. The 66.7% reduction in recorded visit counts in the current study and the reported 60.61% reduction in average monthly visits in De Asis *et al.* [18] use different outcome units and should not be compared as equivalent effect estimates. Furthermore, the observed improvement in asthma management (based on C-ACT scores) is consistent with findings by Alhazmi *et al.* [17], Bousema *et al.* [10], and Gebresilassie *et al.* [27].

Studies from Tabuk, Taif and Madinah provide useful Saudi-context evidence on asthma education, but the designs and endpoints differ. The current findings suggest that further assessment of nurse-led programs is warranted, they do not by themselves establish scalability or effectiveness across all Saudi healthcare settings.

Limitations

This study has important limitations. The analytical sample of 52 children (27 in the intervention group and 25 controls) did not meet the stated target of 58 participants per group, limiting precision and power. The manuscript also reports 100 children initially recruited without sufficient detail on how the final analytical cohort was selected. The non-randomized group comparison may be affected by differences in baseline asthma severity, prior ED use, medication, caregiver support, and healthcare access. The intervention curriculum, delivery frequency, caregiver participation and fidelity were not fully described. ED visits were summarized using aggregate counts, without a documented between-group inferential test or confirmation of equivalent observation periods and complete capture of visits. The reported C-ACT comparison also lacks a stated statistical test and a baseline-adjusted between-group change estimate, the instrument's use in participants aged 12 years requires verification. These constraints, together with the single-region setting, limit causal interpretation and generalizability.

CONCLUSIONS

In this sample of children with asthma in Tabuk, the group receiving nurse-led education had a higher reported follow-up mean C-ACT score than controls (18.5 versus 16.2, reported $p = 0.032$). Aggregate recorded asthma-related ED visits decreased from 45 to 15 (66.7%) in the intervention group and from 42 to 30 (28.6%) in the control group. The ED visit differences are descriptive because an appropriate between-group comparison of visit changes was not reported. The small, non-randomized sample, uncertain recruitment flow, and incomplete outcome reporting prevent firm causal conclusions. Larger, adequately powered studies with clearly documented intervention procedures, validated age-appropriate outcome measures, and standardized follow-up are needed before recommending wider implementation.

Competing interests

The author declares no competing interests.

Data availability

Data are available upon a reasonable request from the corresponding author.

REFERENCES

[1] Taherian, M.R. *et al.* "Prevalence of asthma among children and adolescents in WHO's Eastern Mediterranean Region: a meta-analysis of over 0.5 million participants." BMC Public Health, vol. 24, no. 1, 2024, article 2148. https://doi.org/10.1186/s12889-024-18716-2

[2] Alomary, S.A. *et al.* "The burden of asthma among children and adolescents in Saudi Arabia: a national cross-sectional survey." Journal of Allergy and Clinical Immunology: Global, vol. 1, no. 4, 2022, pp. 241–247. https://doi.org/10.1016/j.jacig.2022.07.006

[3] Alzayed, A. "Childhood asthma in Saudi Arabia: insights from a meta-analysis on its prevalence." Children, vol. 11, no. 12, 2024, article 1550. https://doi.org/10.3390/children11121550

[4] Gohal, G. *et al.* "Prevalence and risk factors of childhood asthma in Jazan Region, Saudi Arabia." Journal of Asthma and Allergy, 2024, pp. 33–43. https://doi.org/10.2147/JAA.S443759

[5] Yaqoob, M.J. *et al.* "Prevalence of asthma symptoms and environmental triggers among school-aged children in the Eastern Province of Saudi Arabia." Cureus, vol. 17, no. 4, 2025. https://doi.org/10.7759/cureus.82893

[6] Al-Moamary, M.S. *et al.* "The Saudi initiative for asthma–2024 update: guidelines for the diagnosis and management of asthma in adults and children." Annals of Thoracic Medicine, vol. 19, no. 1, 2023, pp. 1. https://doi.org/10.4103/atm.atm_248_23

[7] Alghamdi, N.A. *et al.* "The adherence to asthma medication for hospitalized children with asthma: a cross-sectional study in a tertiary hospital in Riyadh, Saudi Arabia." Annals of Thoracic Medicine, vol. 19, no. 3, 2024, pp. 228. https://doi.org/10.4103/atm.atm_24_24

[8] Chen, L. *et al.* "Exclusively nurse-led interventions for pediatric asthma: a systematic review and meta-analysis of randomized controlled trials." Archives de Pédiatrie, vol. 33, no. 4, 2026, article 105481. https://doi.org/10.1016/j.arcped.2026.105481

[9] Kindi, Z.A. *et al.* "Impact of nurse-led asthma intervention on child health outcomes: a scoping review." The Journal of School Nursing, vol. 38, no. 1, 2022, pp. 84–97. https://doi.org/10.1177/10598405211003303

[10] Bousema, S. *et al.* "Nurse-led care for children with asthma in primary care: results of a randomised controlled trial." ERJ Open Research, vol. 12, no. 4, 2026, pp. 01399–02025. https://doi.org/10.1183/23120541.01399-2025

[11] Gao, G. *et al.* "A randomized controlled trial of a nurse-led education pathway for asthmatic children from outpatient to home." International Journal of Nursing Practice, vol. 26, no. 3, 2020, article e12823. https://doi.org/10.1111/ijn.12823

[12] Isik, E. *et al.* "School and community-based nurse-led asthma interventions for school-aged children and their parents: a systematic literature review." Journal of Pediatric Nursing, vol. 44, 2019, pp. 107–114. https://doi.org/10.1016/j.pedn.2018.11.007

[13] Isik, E. *et al.* "A school nurse-led asthma intervention for school-age children: a randomized control trial to improve self-management." The Journal of School Nursing, vol. 37, no. 6, 2021, pp. 480–490. https://doi.org/10.1177/1059840520902511

[14] Nyaga, E.M. *et al.* "Influence of caregiver knowledge of home asthma management on health outcomes of children in low-and middle-income countries: a systematic review." Journal of Pediatric Nursing, vol. 84, 2025, pp. 217–225. https://doi.org/10.1016/j.pedn.2025.06.019

[15] Al-Zalabani, A.H. and Almotairy, M.M. "Asthma control and its association with knowledge of caregivers among children with asthma: a cross-sectional study." Saudi Medical Journal, vol. 41, no. 7, 2020, pp. 733. https://doi.org/10.15537/smj.2020.7.25167

[16] AlOtaibi, E. and AlAteeq, M. "Knowledge and practice of parents and guardians about childhood asthma at King Abdulaziz Medical City for National Guard, Riyadh, Saudi Arabia." Risk Management and Healthcare Policy, 2018, pp. 67–75. https://doi.org/10.2147/RMHP.S143829

[17] Alhazmi, J. *et al.* "Impact of asthma education program 2020–2021 on asthma control among bronchial asthma children in Madinah City, Saudi Arabia." Cureus, vol. 15, no. 6, 2023. https://doi.org/10.7759/cureus.40571

[18] De Asis, J. *et al.* "Enhancing childhood asthma control and reducing emergencies through the implementation of the Centers for Disease Control and Prevention's EXHALE strategy." Patient Safety, vol. 7, no. 2, 2025. https://doi.org/10.33940/001c.134044

[19] Yousef, A.A. *et al.* "Evaluating the impact of air quality on pediatric asthma-related emergency room visits in the Eastern Province of Saudi Arabia." Journal of Clinical Medicine, vol. 14, no. 13, 2025, article 4659. https://doi.org/10.3390/jcm14134659

[20] Alfaleh, A. *et al.* "Quality of life among asthmatic schoolchildren in Saudi Arabia: a mixed-method study." European Journal of Pediatrics, vol. 185, no. 7, 2026, article 465. https://doi.org/10.1007/s00431-026-07126-8

[21] Chichi, C.C.C. and Foluso, O. "Nurse-led educational program on practice of asthma management using Global Initiative for Asthma guideline." Saudi Journal of Nursing and Health Care, vol. 6, no. 11, 2023, pp. 378–388. https://doi.org/10.36348/sjnhc.2023.v06i11.001

[22] Mathiazhakan, U. *et al.* "Effectiveness of a nurse-led educational intervention on caregiver's burden and quality of life in pediatric asthma at a tertiary care center in Tamil Nadu, India." Journal of Family and Community Medicine, vol. 32, no. 4, 2025, pp. 310. https://doi.org/10.4103/jfcm.jfcm_132_25

[23] Rossi, A. *et al.* "Asthma control strategies in school-aged children: the role of community nursing." Journal of Paediatrics and Child Health, vol. 2, no. 1, 2025, pp. 23–28. https://doi.org/10.33545/30810582.2025.v2.i1.A.10

[24] Wu, J. *et al.* "Effectiveness of specialist nurse-led WeChat mini program management for disease control in asthma: a randomized controlled study." Journal of Pediatric Nursing, vol. 79, 2024, pp. e93–e99. https://doi.org/10.1016/j.pedn.2024.10.004

[25] Arıkan-Ayyıldız, Z. *et al.* "Efficacy of asthma education program on asthma control in children with uncontrolled asthma." The Turkish Journal of Pediatrics, vol. 58, no. 4, 2016, pp. 383–388. https://doi.org/10.24953/turkjped.2016.04.006

[26] Liu, C. and He, F. "Effectiveness of community-based nursing intervention for asthmatic children: a systematic review and meta-analysis." Iranian Journal of Public Health, vol. 52, no. 10, 2023, pp. 2025. https://doi.org/10.18502/ijph.v52i10.13840

[27] Gebresilassie, T.G. *et al.* "Effect of asthma education intervention on self-management knowledge and control level in Tigray, Northern Ethiopia: a quasi-experimental study." BMC Pulmonary Medicine, vol. 25, no. 1, 2025, article 120. https://doi.org/10.1186/s12890-025-03574-4

[28] Yoon, J. *et al.* "Effects of school nurse-led asthma interventions for students: a systematic review." The Journal of School Nursing, vol. 42, no. 3, 2026, pp. 242–259. https://doi.org/10.1177/10598405241311464

[29] Fleiss, J.L. *et al.* Statistical methods for rates and proportions. John Wiley & Sons, 2013.

[30] Schatz, M. *et al.* "Asthma Control Test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists." Journal of Allergy and Clinical Immunology, vol. 117, no. 3, 2006, pp. 549–556.

[31] AlTeneiji, M. *et al.* "Cross-sectional study assessing the performance of the Arabic translated childhood asthma control test." NPJ Primary Care Respiratory Medicine, vol. 28, no. 1, 2018, article 41.

[32] Chen, H.-H. *et al.* "Reliability and validity of childhood asthma control test in a population of Chinese asthmatic children." Quality of Life Research, vol. 17, no. 4, 2008, pp. 585–593.

[33] Liu, A.H. *et al.* "Development and cross-sectional validation of the Childhood Asthma Control Test." Journal of Allergy and Clinical Immunology, vol. 119, no. 4, 2007, pp. 817–825. https://doi.org/10.1016/j.jaci.2006.12.662

[34] Ouali, H. *et al.* "Childhood asthma control test: validation of the Arabic Tunisian dialect version in 51 patients." European Respiratory Society, 2014.