Original Article

Assessment of asthma control levels in a tertiary hospital

A cross-sectional study

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ABSTRACT

الأهداف: تقييم مستويات السيطرة على الربو لدى مرضى الأطفال الذين تقل أعمارهم عن 12 عامًا والذين يراجعون مستشفى ثالثيًا، باستخدام اختبار السيطرة على الربو لدى الأطفال (C-ACT) واختبار السيطرة على الجهاز التنفسي والربو لدى الأطفال (TRACK).

المنهجية: شملت الدراسة 384 طفلاً. تم جمع البيانات من ديسمبر 2023م إلى يوليو 2024م من العيادات الخارجية، مدينة الأمير سلطان الطبية العسكرية، الرياض، المملكة العربية السعودية. تم استخدام أداتين، C-ACT و TRACK، لقياس السيطرة على الربو.

النتائج: أظهرت النتائج أن 51.2% من الأطفال دون سن 5 سنوات أظهروا ربوًا غير منضبط. بين الأطفال الذين تتراوح أعمارهم بين 5 و 12 عامًا، أظهر 34.5% عدم السيطرة. تم العثور على ارتباط ذي دلالة إحصائية بين الربو غير المنضبط وزيارات غرفة الطوارئ في كلتا الفئتين العمريتين (p<0.001)، حيث سعى 39.7% من الأطفال الأصغر سنًا و 45.6% من الأطفال الأكبر سنًا الذين يعانون من الربو غير المنضبط إلى رعاية طارئة في الأسابيع الأربعة السابقة.

الخلاصة: تؤكد النتيجة على أهمية مراقبة الربو بشكل منتظم و استخدام أدوات معتمدة مثل C-ACT و TRACK لتحسين إدارة الربو وتقليل زيارات غرفة الطوارئ.

Objectives: To assess asthma control levels in pediatric patients under 12 years of age attending a tertiary hospital, utilizing the childhood asthma control test (C-ACT) and the test for respiratory and asthma control in kids (TRACK).

Methods: The study involved 384 children. Data were collected from December 2023 to July 2024 from outpatient clinics, Prince Sultan Military Medical City, Riyadh, Saudi Arabia. A total of 2 tools, C-ACT and TRACK, were employed to measure asthma control.

Results: The results showed that 51.2% of children under 5 years of age exhibited uncontrolled asthma. Among children aged 5-12, 34.5% showed uncontrolled. A statistically significant association was found between uncontrolled asthma and emergency room visits in both age groups (p<0.001), with 39.7% of younger children and 45.6% of older children with uncontrolled asthma seeking emergency care in the previous 4 weeks.

Conclusion: The result underscore the importance of regular asthma monitoring and the use of validated tools such as C-ACT and TRACK to improve asthma management and reduce emergency room visits.

Keywords: childhood asthma, asthma management, asthma control test, inhaler adherence, pediatric asthma

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Asthma is a widespread chronic respiratory condition in children globally that affects daily life and needs meticulous management to avert exacerbations. In pediatric populations, asthma is frequently marked by recurrent episodes of wheeze, dyspnea, and coughing, which can interfere with daily activities and sleep patterns.[1] Efficient asthma management is crucial for decreasing hospitalizations and enhancing the overall quality of life for impacted children.[2] Poorly managed asthma can adversely affect a child's growth, physical development, and academic achievement.[3] Instruments such as the childhood asthma control test (C-ACT) furnish healthcare practitioners with critical information they can use to modify treatment as necessary.[4]

Asthma is among the most common chronic diseases in Saudi Arabia, and its prevalence has

increased in recent decades. Research carried out over the last 30 years indicates that the frequency of asthma among children in Saudi Arabia varies between 8-25%.[5] The geographical disparities among regions in Saudi Arabia result in varying incidence rates of asthma.[6] The differences in asthma rates across different regions, mostly due environmental factors, such as high traffic and proximity to industrial areas in some regions.[7] The highest asthma prevalence rates among Saudi children have been observed in Hofuf (33.7%), Najran (27.5%), and Al-Madinah Al-Munawarah (23.6%), whereas the lowest rates have been recorded in Abha (9%), Qassim (3.2%), and Dammam (3.6%).[6]

The C-ACT is a validated instrument for evaluating asthma management in pediatric patients.[8] This method enables patients and healthcare practitioners to monitor asthma control more efficiently, hence diminishing the likelihood of severe exacerbations.[2] Furthermore, the C-ACT enables healthcare providers to monitor changes over time, facilitating improved long-term asthma management.[9]

Research has shown that implementing the C-ACT in standard clinical practice enhances asthma outcomes in pediatric patients. Identifying patients with inadequate asthma control enables doctors to customize treatment strategies, resulting in improved symptom management and decreased hospitalizations.[3] The utilization of these technologies is particularly vital in pediatric therapy, since unmanaged asthma can result in more severe problems in younger patients.[4]

The objective of this study was to assess asthma control levels in a pediatric population (under 12 years old) attending a tertiary hospital in Riyadh, Saudi Arabia, utilizing the C-ACT and the test for respiratory and asthma control in kids (TRACK). The sample comprised pediatric patients were divided into 2 age groups: pediatric patients under 5 years of age and pediatric patients aged 5-12 years.

Methods. The study population comprised children aged 1 month to 12 years, diagnosed with asthma, who attended the Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia, outpatient clinic. Our objective was to recruit a sample size of 370 patients. The sample size was determined using an expected prevalence of respiratory viruses of 15±7%, a 5% margin of error, and a 95% confidence range, considering the population size of Saudi children.

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The inclusion criteria were extensive, covering all children with asthma attending the PSMMC, Riyadh, Saudi Arabia, outpatient clinic. Nevertheless, specific groups of children were excluded from the study to prevent other medical issues from skewing the results. Children who were immunocompromised due to illnesses, including malignancies, as well as those with aspiration pneumonia, hospital-acquired pneumonia, and chronic lung disorders such as cystic fibrosis, primary ciliary dyskinesia, and chronic lung disease, were excluded. Furthermore, children who required home oxygen therapy and those with neuromuscular disorders were also excluded from the study.

Ethical approval for the project was secured from the PSMMC institutional review board, Riyadh, Saudi Arabia (IRB - E-2210) before the commencement of data collection. Furthermore, individual consent was necessary from the participants or their guardians for inclusion in the study. All obtained data were managed with stringent confidentiality, ensuring that the patients' anonymity was preserved throughout the study.

The C-ACT for children under 5 years (TRACK), is intended to assist caregivers and healthcare professionals in evaluating asthma management in young children. A TRACK score below 80 indicates that the child's asthma may be inadequately controlled, necessitating modifications in medication to enhance symptom management.

The C-ACT for children aged 5-12 years, engages both the child and the caregiver in evaluating the child's asthma management. A score under 19 signifies uncontrolled asthma, indicating the necessity for enhanced care and possible modifications to the child's medication regimen to achieve improved asthma control.

Data collection occurred from December 2023 to July 2024. Data were collected from children diagnosed with asthma who visited the outpatient clinic during this period. The study featured 5 pediatric pulmonology managing clinics, with data collected weekly from 9 pediatric clinics. Data reported for each patient included age and diagnosis. Furthermore, 2 asthma control metrics were obtained: The C-ACT scores and the TRACK scores. The data were preserved in an encrypted Excel spreadsheet on a hospital workstation to maintain privacy.

Statistical analysis. All data were entered and analyzed using the Statistical Package for the Social Sciences, version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables, such as chronic illnesses, emergency room visits, and preventive use of inhalers, are presented as frequencies and percentages. Continuous

variables, such as age, are expressed as means ± standard deviations (SDs), while TRACK and C-ACT scores are presented as medians and interquartile range (IQR). The Kolmogorov-Smirnov test was used to confirm the assumption of a normal distribution, and if the data were not normally distributed, nonparametric tests were used. The internal consistency of the TRACK and C-ACT scales was evaluated using Cronbach's alpha coefficient. A coefficient exceeding 0.7 was deemed indicative of strong internal consistency. Test-retest reliability was determined by calculating the interclass correlation coefficient (ICC, average measure) between the total scores of TRACK and C-ACT. Pearson's Chi-square or Fisher's exact test was used to determine significant associations between categorical variables, depending on whether or not the cell was expected to have a frequency of less than 5. A parametric independent sample t-test was applied to determine the mean significant difference between age and the seasonal uncontrolled and uncontrolled asthma groups. A 2-sided *p*-value of less than 0.05 was considered statistically significant.

Results. The study included a total of 123 patients, all under the age of 5. The mean age of the patients was calculated to be 3.61±1.76 years and 261 patients between 5-12 years and the mean age of the patients was calculated to be 9.01±2.31 years. Among the patients, 30.1% were identified as ill, while 69.9% were not. In the previous 4 weeks, 24.4% of the patients had visited the emergency room due to asthma attacks, and 7.3% had been admitted to the intensive care unit. Additionally, 39.0% of the patients had used a preventive inhaler 1-2 times, 20.3% had used one more than 5 times, and the remaining 40.7% had never used a preventive spray. Over the previous 3 months, 43.9% of patients had consistently adhered to preventive asthma treatments, 28.5% had adhered most of the time, 21.1% had adhered some of the time, and 6.5% had never adhered to preventative treatments. Further details can be found in Table 1 & Table 4.

Table 2 shows that 51.2% of patients showed uncontrolled asthma, per the TRACK test, while 48.8% of patients exhibited controlled asthma.

After the analysis, a Pearson's Chi-square test was applied to investigate the association between patients who experienced uncontrolled and controlled asthma and their respective characteristics. The results indicated a statistically significant association ($p<0.001$) between emergency room visits in the past 4 weeks and uncontrolled asthma. Specifically, 39.7% of patients visited the emergency room due to uncontrolled asthma, while 8.3% visited due to controlled asthma. Moreover, 60.3% of patients with uncontrolled asthma did not visit the emergency room, while 91.7% of patients with controlled asthma did not visit the emergency room as shown in Table 3.

Table 5 shows that 34.5% of patients showed uncontrolled asthma, per the C-ACT test, while 65.5% of patients exhibited controlled asthma.

Following the completion of the analysis, a Pearson's Chi-square test was employed to explore the relationship between patients who had experienced controlled and uncontrolled asthma and their respective characteristics. The findings revealed a statistically significant correlation ($p<0.001$) between visits to the emergency room in the previous 4 weeks and uncontrolled asthma. Specifically, 45.6% of patients sought emergency care due to uncontrolled asthma, while 9.9% sought care for controlled asthma. Additionally, 54.4% of patients with uncontrolled asthma did not seek emergency care, whereas 90.1% of patients with controlled asthma similarly did not seek such care as shown in Table 6.

Discussion. The study included 2 groups of children with asthma: those under 5 years old and those

Table 1 - Demographic and clinical characteristics of patients at baseline (asthma control level in children aged less than 5 years [N=123]).

Variables	n (%)
Age (years), mean±SD	3.61±1.76
Does the child have another chronic illness?	
Yes	37 (30.1)
No	86 (69.9)
During the past 4 weeks has the child visited the emergency room for an asthma attack?	
Yes	30 (24.4)
No	93 (75.6)
During the past 4 weeks, has your child been admitted to intensive care for an asthma attack?	
Yes	9 (7.3)
No	114 (92.7)
During the past 4 weeks, how many times did you not use your preventive spray?	
Never	50 (40.7)
Once or twice	48 (39.0)
More than 3 times	25 (20.3)
Over the past 3 months, how would you describe your child's adherence to preventive asthma treatments?	
Always committed	54 (43.9)
Committed most of the time	35 (28.5)
Committed some of the time	26 (21.1)
Not committed	8 (6.5)

Values are presented as numbers and percentages (%).
SD: standard deviation

Table 2 - Distribution of patient responses to test for respiratory and asthma control in kids.

Variables	n (%)
During the past 4 weeks, how often has your child been bothered by symptoms of shortness of breath, such as wheezing or coughing?	
1 or 2 attacks within 4 weeks	56 (45.5)
2 or 3 shifts per week	10 (8.1)
4 or more episodes per week	3 (2.4)
Not at all	37 (30.1)
One shift per week	17 (13.8)
During the past 4 weeks, how often did your child wake up during sleep with symptoms of shortness of breath, such as wheezing or coughing?	
1 or 2 times every 4 weeks	40 (32.5)
2 or 3 times a week	13 (10.6)
4 or more times per week	6 (4.9)
Not at all	58 (47.2)
Once a week	6 (4.9)
During the past 4 weeks, how much did your child's symptoms of shortness of breath, such as wheezing or coughing, limit his/her ability to play, go to school, or do the usual activities that a child your son/daughter's age should do?	
In abundance	11 (8.9)
moderately	19 (15.4)
Not at all	48 (39.0)
To a small extent	43 (35.0)
Very much	2 (1.6)
During the past 3 months, how often did your child need treatment for respiratory symptoms such as wheezing and coughing with bronchodilator medications such as Ventolin?	
2 or 3 times a week	15 (12.2)
4 or more times per week	10 (8.1)
Not at all	28 (22.8)
Once a week	16 (13.0)
2 times every 3 months	54 (43.9)
During the past 12 months, how often has your child needed to take oral corticosteroids for symptoms of difficulty breathing that could not be controlled by other medications?	
4 times or more	15 (12.2)
It never happened	60 (48.8)
once	29 (23.6)
3 times	10 (8.1)
twice	9 (7.3)
Track scale, median (IQR)	75 (90-60)
Track controlled and uncontrolled asthma	
Uncontrolled asthma (track score <80)	63 (51.2)
Controlled asthma (track score ≥80)	60 (48.8)

Values are presented as numbers and percentages (%). IQR: interquartile range

aged 5-12 years. In the younger group, a significant portion of patients had chronic illnesses, had visited the emergency room, or had been admitted to intensive care due to asthma attacks. A large percentage of these children did not consistently use preventive treatments. The TRACK scale revealed that more than half of the children exhibited uncontrolled asthma.

In the older group, similar issues were observed, with many patients experiencing asthma symptoms such as wheezing, coughing, and nighttime awakenings. The C-ACT showed that approximately one-third of the children had uncontrolled asthma. The study highlighted a statistically significant correlation between emergency room visits and uncontrolled asthma, emphasizing the need for improved asthma management. Across both age groups, inconsistent use of preventive medications and the need for frequent treatment with bronchodilators were notable.

The 2021 revision of the Saudi Initiative for Asthma provides comprehensive guidelines for asthma management, emphasizing the need for individualized treatment strategies based on factors such as age, severity of illness, and other underlying conditions.[10] Our findings align with these recommendations, particularly the need for personalized care, as evidenced by higher intensive care unit admission rates and poorer asthma management in younger children. The differences in medication adherence between age groups, particularly

Table 3 - Examining the association between uncontrolled and controlled asthma and the clinical characteristics of patients.

Variables	Uncontrolled asthma (track score <80)	Controlled asthma (track score ≥80)	*P*-values
Does the child have another chronic illness?			
Yes	16 (25.4)	21 (35.0)	0.246
No	47 (74.6)	39 (65.0)	
Age (years), mean±SD	3.71±2.13	3.50±1.26	0.506
During the past 4 weeks has the child visited the emergency room for an asthma attack?			
Yes	25 (39.7)	5 (8.3)	<0.001*
No	38 (60.3)	55 (91.7)	
During the past 4 weeks, has your child been admitted to intensive care for an asthma attack?			
Yes	5 (7.9)	4 (6.7)	0.787
No	58 (92.1)	56 (93.3)	
During the past 4 weeks, how many times did you not use your preventive spray?			
Never	22 (34.9)	28 (46.7)	0.415
Once or twice	27 (42.9)	21 (35.0)	
More than 3 times	14 (22.2)	11 (18.3)	
Over the past 3 months, how would you describe your child's adherence to preventive asthma treatments?			
Always committed	21 (33.3)	33 (55.0)	0.091
Committed most of the time	21 (33.3)	14 (23.3)	
Committed some of the time	17 (27.0)	9 (15.0)	
Not committed	4 (6.3)	4 (6.7)	

*Statistically significant correlation between emergency room visits and uncontrolled asthma. Values are presented as numbers and percentages (%). SD: standard deviation

Table 4 - Demographic and clinical characteristics of patients at baseline (asthma control level in children aged 5-12 years [N=261]).

Variables	n (%)
Age (years), mean±SD	9.01±2.31
Does the child have another chronic illness?	
Yes	83 (31.8)
No	178 (68.2)
During the past 4 weeks has the child visited the emergency room for an asthma attack?	
Yes	58 (22.2)
No	203 (77.8)
During the past 4 weeks, has your child been admitted to intensive care for an asthma attack?	
Yes	8 (3.1)
No	253 (96.9)
During the past 4 weeks, how many times did you not use your preventive spray?	
Once - twice	92 (35.2)
More than 3 times	77 (29.5)
Not once	92 (35.2)
Over the past 3 months, how would you describe your child's adherence to preventive asthma treatments?	
Always committed	100 (38.3)
Committed most of the time	82 (31.4)
Committed some of the time	60 (23.0)
Not committed at all	19 (7.3)

Values are presented as numbers and percentages (%). SD: standard deviation

the lower adherence in older children, highlight the importance of educating caregivers and ensuring close monitoring, as outlined by Al-Moamary et al.[10] Additionally, the Global Initiative for Asthma guidelines are relevant here.[13] These recommend inhaled corticosteroids as the primary treatment and emphasize regular follow-ups to adjust therapy based on symptom control. Our study found poor adherence to inhalers in both age groups, with older children showing greater inconsistency (p=0.0009), reinforcing the importance

Table 5 - Distribution of patient responses to the childhood asthma control test for children 4-12 years of age.

Variables	n (%)
Q1: How are you doing today with asthma?	
Very bad	4 (1.5)
Bad	34 (13.0)
Good	109 (41.8)
Very good	114 (43.7)
Q2: Does asthma cause you problems while playing, running, or exercising?	
It's a big problem. I can't do what I want to do.	33 (12.6)
It is a problem and I don't like it.	62 (23.8)
It's a simple problem and I'm fine.	125 (47.9)
I have no problem.	41 (15.7)
Q3: Do you cough because of asthma?	
Yes, at all times.	17 (6.5)
Yes, most of the time.	76 (29.1)
Yes, but sometimes.	138 (52.9)
I never cough at any time.	30 (11.5)
Q4: Do you wake up at night because of asthma?	
Yes, at all times.	8 (3.1)
Yes, most of the time.	34 (13.0)
Yes, but sometimes.	115 (44.1)
No, it never happened.	104 (39.8)
Q5: During the past 4 weeks, how many days has your child had daytime asthma symptoms?	
11-18 days	31 (11.9)
4-10 days	56 (21.5)
1-3 days	105 (40.2)
Never happened	69 (26.4)
Q6: During the past 4 weeks, how many days has your child suffered from symptoms of wheezing during the day?	
11-18 days	22 (8.4)
4-10 days	38 (14.6)
1-3 days	87 (33.3)
Never happened	114 (43.7)
Q7: During the past 4 weeks, how many nights did your child wake up at night due to asthma symptoms?	
11-18 days	17 (6.5)
4-10 days	38 (14.6)
1-3 days	85 (32.6)
Never happened	121 (46.4)
Childhood asthma control test	
Uncontrolled asthma (C-ACT <19)	90 (34.5)
Controlled asthma (C-ACT ≥19)	171 (65.5)

Values are presented as numbers and percentages (%).
C-ACT: asthma control test

of patient education to improve adherence and prevent exacerbations.

Furthermore, studies by Zeru et al[11] in Ethiopia and Alansari et al[9] in Saudi Arabia both found a strong relationship between asthma control and medication adherence, similar to our findings. Our results underscore the need for programs focused on improving adherence to medication to prevent exacerbations and improve quality of life. Poor adherence in older children in particular suggests a need for greater caregiver involvement and education, as previously highlighted by other researchers.

Additionally, Serebrisky et al[14] emphasized that pediatric asthma is a global epidemic, characterized by insufficient management and rising hospitalization rates among children. Our study corroborates their findings, particularly in younger children, where we observed significant emergency department visits and intensive care unit hospitalizations. This reinforces the urgent need for improved asthma management strategies, particularly for younger age groups. Costa et al[15] also highlighted the impact of poorly managed asthma on caregivers, which our findings support, especially with the burden placed on caregivers dealing with children exhibiting frequent daytime symptoms (p=0.03).

Chu et al[16] validated the C-ACT across various populations, and our study confirms its utility in identifying children with poorly controlled asthma, particularly those with frequent physical activity limitations and nocturnal symptoms. Liu et al[17] further validated the C-ACT's effectiveness, and our findings similarly show that a significant proportion of children reported "very bad" asthma control, reinforcing the need for improved symptom management.

García-Marcos et al[18] carried out a global study on asthma control, which underscored the widespread issue of inadequate asthma management across different regions. Their results align with our findings, particularly regarding poor adherence to inhalers in older children, as well as the need for standardized treatment approaches. Finally, Song et al[19] and Ramsey et al[20] both emphasized the importance of prioritizing asthma as a global health issue and utilizing digital interventions to enhance asthma management, especially in underprivileged areas, which could address some of the adherence issues observed in our study.

Gold et al[21] investigated asthma management and healthcare use in Asia-Pacific countries, finding significant variability in asthma management, with many children requiring emergency care due to poor asthma control. This is reflected in our findings of increased emergency room visits and intensive care unit hospitalizations among pediatric asthma patients.

Alahmadi et al[22] identified risk factors for pediatric asthma, including environmental and genetic influences, and stressed the importance of early diagnosis and continuous treatment to prevent severe complications. The higher intensive care unit admission rates in younger children seen in our study (p=0.002) support their conclusions, indicating that younger children may be more vulnerable to severe asthma exacerbations due to inconsistent management.

Table 6 - Investigating the association between uncontrolled and controlled asthma and the clinical characteristics of patients.

Variables	Uncontrolled asthma (C-ACT <19)	Controlled asthma (C-ACT ≥19)	*P*-values
Age (years)			
≤9	50 (55.6)	103 (60.2)	0.275
>9	40 (44.4)	68 (39.8)	
Does the child have another chronic illness?			
Yes	30 (33.3)	53 (31.0)	0.700
No	60 (66.7)	118 (69.0)	
During the past 4 weeks, has the child visited the emergency room for an asthma attack?			
Yes	41 (45.6)	17 (9.9)	<0.001*
No	49 (54.4)	154 (90.1)	
During the past 4 weeks, has your child been admitted to intensive care for an asthma attack?			
Yes	6 (6.7)	2 (1.2)	0.014*
No	84 (93.3)	169 (98.8)	
During the past 4 weeks, how many times did you not use your preventive spray?			
Once - twice	30 (33.3)	62 (36.3)	0.441
More than 3 times	31 (34.4)	46 (26.9)	
Not once	29 (32.2)	63 (36.8)	
Over the past 3 months, how would you describe your child's adherence to preventive asthma treatments?			
Always committed	25 (27.8)	75 (43.9)	0.063
Committed most of the time	35 (38.9)	47 (27.5)	
Committed some of the time	24 (26.7)	36 (21.1)	
Not committed at all	6 (6.7)	13 (7.6)	

*Statistically significant correlation between emergency room visits, admission to intensive care, and uncontrolled asthma. Values are presented as numbers and percentages (%). C-ACT: asthma control test

Lastly, Moral et al[23] suggested that nonadherence to asthma medication, weather due to noncompliance or poor inhaler technique, is the main reason for poor asthma control. In our study, only 33.3% of patients less than 5 years of age and 27.8% of patients 5-12 years of age with uncontrolled asthma were committed and in compliance with their medication in the 3 months before answering the questionnaire. Taking into account that our data did not examine the inhaler technique, compliance with medication was still significantly correlated with asthma control level.

The level of asthma control impacts not only on the health of the child but also on the quality of life of the child's parent or caregiver, as was stated by Costa et al[24] in their systemic review of 294 articles investigating the influence of poor asthma on the total quality-of-life scores of parents or relatives of children and adolescents with asthma.

Study limitations. Its cross-sectional design and short study duration that did not encompass a complete seasonal change. Additionally, as this sample was carried out in a tertiary center in Riyadh, Saudi Arabia, it does not reflect or represent the entire Kingdom.

Though we showed a minor improvement from 45% to 34.5%, our findings regarding the poor level of asthma control in younger age groups are quite alarming. Further study on the level of asthma control is highly needed in Saudi Arabia.

In conclusion, this study highlights the persistent challenges in achieving effective asthma control in children under 12 years of age, with significant portion of children experienced uncontrolled asthma. These findings emphasize the critical importance of personalized asthma management, improved adherence to preventive medications, and regular monitoring to reduce asthma exacerbations and hospital visits. Implementing structured asthma management programs could significantly improve the outcomes and quality of life for children suffering from asthma. Future research is highly recommended in this area.

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