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Original Article

Evaluation of Inhalation Device Technique Among Paediatric Asthma Patients Attending A Tertiary Care Hospital in Rajasthan

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ABSTRACT

Introduction: Asthma, a chronic inflammatory condition of the airways, is marked by recurring episodes of dyspnea, chest constriction, wheezing, and coughing triggered by stimuli like allergens, occupational irritants, pharmaceuticals, and stress.
AIM: To evaluate the inhalation device technique in paediatric asthma patients under the age of 18 years.
Methodology: The present study was planned to evaluate the inhalation device technique among paediatric asthma patients below 18 years of age admitted to the Department of Paediatrics at JLN Medical College and Hospital, Ajmer, Rajasthan, India.
Result: In the present study, only 21.1% of children demonstrated correct inhaler technique, while the majority committed one or more errors, with incorrect usage being more common among younger children, rural residents, and lower socioeconomic groups. MDI was the most commonly used device, doctors were the primary source of inhaler education, and common technique-related errors included inadequate breath-holding, poor mouthpiece or mask seal, and improper inhalation maneuvers.
Conclusion: this study establishes that incorrect inhalation technique is a significant barrier to optimal asthma management in children. Regular monitoring, targeted caregiver education, device-specific training, and incorporation of inhaler technique assessment into routine pediatric asthma care are crucial. Addressing these gaps through clinical, community, and policy-level interventions can greatly enhance treatment outcomes, reduce asthma-related morbidity, and improve the overall quality of life for pediatric patients.

Keywords: Bronchial asthma, Inhalation devices, Inhalation errors.

INTRODUCTION

Asthma, a chronic inflammatory condition of the airways, is marked by recurring episodes of dyspnea, chest constriction, wheezing, and coughing triggered by stimuli like allergens, occupational irritants, pharmaceuticals, and stress.[1] Asthma affects 300 million individuals globally, regardless of age or gender, with around 10% residing in India. In children, asthma exacerbations are a primary cause of hospitalization and contribute significantly to absence in elementary schools.Bronchial asthma is categorized into intermittent, mild persistent, moderate persistent, and severe persistent forms, with treatment customized based on the disease's severity. Asthma management involved both rescue and maintenance inhaler therapies. Inhaled therapy is advised as the primary option due to its superior efficacy in delivering medication to the lungs and its minimal systemic adverse effects.[2] Inhaled drugs constitute the primary treatment for bronchial asthma patients, with inhaler devices serving as the predominant method of administration. The metered dosage inhaler (MDI) is the most prevalent device utilized in daily asthma therapy; it is portable, expedient, and cost-effective[3].The primary advantages of inhaler therapy encompass its non-invasive nature, lower dosage compared to oral and parenteral treatments, reduced systemic side effects, rapid local efficacy, and portability, allowing patients to carry the inhaler at all times.However, A considerable number of individuals experience inadequately managed asthma despite adhering to

prescribed medication and upward titration of the treatment as per Asthma recommendations[4].The inappropriate use of inhalers and inadequate inhaling techniques are frequently observed in clinical practice, leading to heightened inhaler consumption, diminished bronchodilation, decreased patient adherence to treatment protocols, suboptimal drug delivery, and compromised disease management[5]. Inadequate technique results in considerable medication wastage, leading to suboptimal asthma outcomes and unnecessary ill effects from increased oro-pharyngeal drug deposition.Furthermore, studies evaluating device technique in children often lack regional representation, and there is a notable paucity of research from semi-urban and rural areas of India, including Rajasthan[6,7]. Thus, a critical knowledge gap exists in understanding how pediatric patients in specific local settings use inhaler devices, the prevalence and types of technique-related errors, and the impact of demographic and educational variables on device proficiency.[8-10] This study seeks to address this gap by evaluating the inhalation technique among children admitted with asthma, thereby contributing to evidence-based improvements in asthma education and management practices. This study aims to assess the proficiency of inhalation device usage among pediatric asthma patients, identify the frequency and types of technique-related errors, and emphasize the need for routine assessment and targeted instruction. The findings are expected to inform clinical practice and policy decisions regarding asthma education strategies and contribute to the design of child-friendly inhalation devices.

AIM

To evaluate the inhalation device technique in paediatric asthma patients under the age of 18 years admitted in the department of Paediatrics, JLN Medical College and Hospital, Ajmer, Rajasthan, India.

METHODOLOGY

The present study was planned to evaluate the inhalation device technique among paediatric asthma patients below 18 years of age admitted to the Department of Paediatrics at JLN Medical College and Hospital, Ajmer, Rajasthan, India. The study was conducted under the Department of Paediatrics after obtaining approval from the Institutional Ethics Committee of JLN Medical College, Ajmer. It was designed as a prospective observational study and was community-based with a cross-sectional approach. The data collection was carried out over a period of 12 months from September 2023 to August 2024, followed by 6 months allocated for data analysis. The study universe included children diagnosed with bronchial asthma who were using any type of inhalation device. A total of 114 children fulfilling the inclusion criteria were included in the study. Children aged more than 1 year and less than 18 years, of either sex, diagnosed with bronchial asthma and using inhalation devices were included after obtaining written informed consent from their parents or guardians. Children below 1 year of age, those with multiple congenital anomalies, active tuberculosis, or co-morbid conditions interfering with the use of inhalation devices were excluded. Patients who expired, left the study, or were on ventilatory support were also excluded from the study.

RESULT

Table 1: Severity of Asthma and Type of Inhalation Device Used among study participants

Severity of Asthma	**Number**	**Percentage**
Mild Intermittent	68	59.6
Mild Persistent	31	27.2
Moderate Persistent	11	9.6
Severe Persistent	4	3.5
Total	114	100.0
Type of inhalation device	**Number**	**Percentage**
DPI	6	5.3
MDI	48	42.1
MDI With Spacer ± Mask	26	22.8
Nebulizer	34	29.8
Total	114	100.0

In the present study, the majority of children 68(59.6%) had mild intermittent asthma, followed by mild persistent asthma in 31(27.2%) children, while moderate persistent and severe persistent asthma were less common, observed in 9.6% and 3.5% cases respectively. Metered Dose Inhaler (MDI) was the most commonly used inhalation device in 48(42.1%) children, followed by nebulizers in 34(29.8%), MDI with spacer ± mask in 26(22.8%), whereas Dry Powder Inhaler (DPI) was the least commonly used device in 6(5.3%) children.

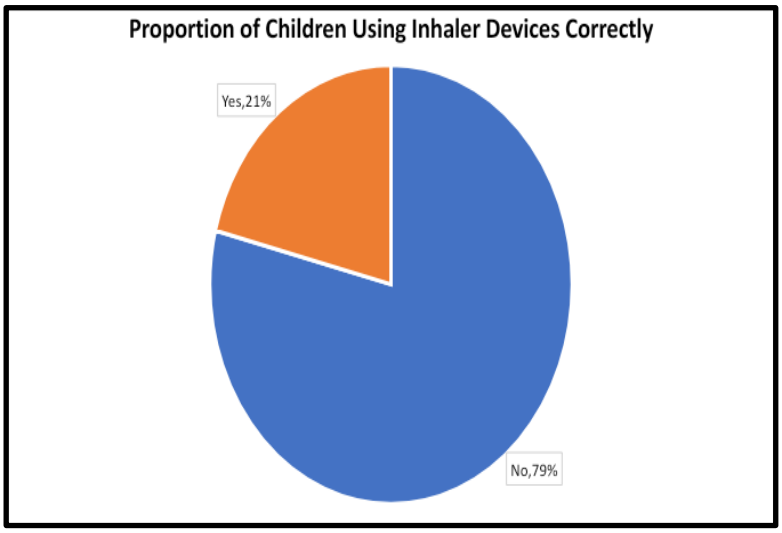
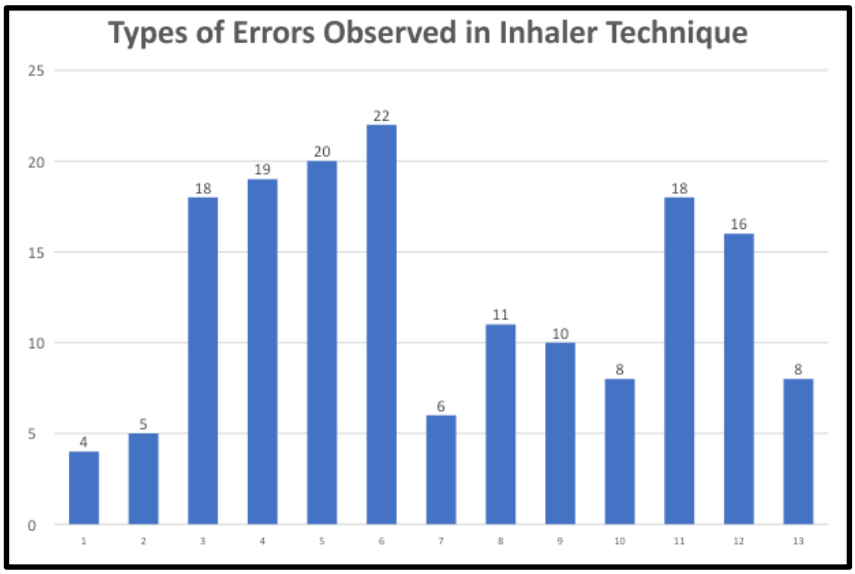


Figure 1,2– Proportion of Children Using Inhaler Devices Correctly and Types of Errors Observed in Inhaler Technique



Out of the total 114 participants, only 24(21.1%) children were able to use their inhaler devices correctly, while the majority 90(78.9%) demonstrated incorrect inhalation techniques. Common errors observed included insufficient inhalation effort and inadequate breath-holding among DPI and MDI users, poor mouthpiece or mask seal among MDI with spacer and nebulizer users, delayed inhalation after actuation, and failure to maintain deep breathing during nebulization therapy.

Table 2– Association of age group and sex of children with correct use of inhaler device

		Correct use of inhaler devices	
		Yes	**No**
Age group (Years)	1-5 years	2(7.1)	26(92.9)
	6-10 years	9(18.8)	39(81.3)
	>10 years	13(34.2)	25(65.8)
Sex	Female	10(20.4)	39(79.6)
	Male	14(21.5)	51(78.5)

In the current study, correct inhaler usage increased significantly with age, with only 7.1% of children aged 1–5 years using the device correctly compared to 18.8% in the 6–10 years group and 34.2% among children above 10 years (p=0.025). However, no statistically significant association was observed between sex and correct inhaler usage, as 20.4% of females and 21.5% of males demonstrated proper inhalation technique.

Table 3– Association of Residential area and SES with correct use of inhaler devices

		Correct use of inhaler devices

		Yes	No
Residential area	Rural	6(10.9)	49(89.1)
	Urban	18(30.5)	41(69.5)
Socioeconomic status	Upper Middle	6(46.2)	7(53.8)
	Middle	9(26.5)	25(73.5)
	Lower Middle	6(21.4)	22(78.6)
	Lower	3(7.7)	36(92.3)

In our study, children residing in urban areas had a higher proportion of correct inhaler usage (30.5%) compared to those from rural areas (10.9%). This association was statistically significant ($p<0.05$) correct inhaler use was highest among children from upper middle-class families (46.2%), followed by middle (26.5%), lower middle (21.4%), and lowest in the lower SES group (7.7%). The association between SES and correct use was found to be statistically significant ($p = 0.027$).

Table 4– Association of type of inhalation device and type of health educator with correct use of inhaler devices

	Correct use of inhaler devices		
		Yes	**No**
Type of inhalation device	DPI	1(16.7)	5(83.3)
	MDI	10(20.8)	38(79.2)
	MDI With Spacer ± Mask	7(26.9)	19(73.1)
	Nebulizer	6(17.6)	28(82.4)
Health Educator	Doctor	18(25.4)	53(74.6)
	Hospital staff	6(15)	34(85)
	Self	-	3(100)

In the current study, the highest proportion of correct inhaler usage was observed among children using MDI with Spacer ± Mask (26.9%), followed by MDI (20.8%), nebulizer (17.6%), and DPI (16.7%); however, the association between device type and correct technique was not statistically significant ($p>0.05$). Children educated by doctors showed the highest rate of correct inhaler use (25.4%), followed by those instructed by hospital staff (15%), whereas none of the self-taught users demonstrated correct technique, although this association was also statistically non-significant ($p=0.291$).

DISCUSSION

In the present study, the majority of children (59.6%) were diagnosed with mild intermittent asthma, followed by 27.2% with mild persistent asthma. Moderate persistent and severe persistent asthma were less commonly observed, accounting for 9.6% and 3.5% of cases, respectively.

With respect to inhaler training, it was found that doctors were the primary educators, instructing 62.3% of the patients, followed by hospital staff (28.9%), pharmacists (6.1%), and self-learning in only 2.6% of the cases. In contrast, Gupta Vitull et al[11] reported that a majority of patients (71.5%) learned inhaler use on their own, with only a small proportion being educated by doctors (6.2%).

Out of 114 participants, only 24 children (21.1%) demonstrated correct use of their inhalation devices, whereas a large majority—90 children (78.9%)—made one or more errors while using their prescribed inhalers.

The types and frequency of errors varied by the type of inhalation device used. Among Dry Powder Inhaler (DPI) users (n=6), two prominent errors were noted: insufficient acceleration during inhalation (83.3%) and not inhaling quickly enough (66.7%).

In the Metered Dose Inhaler (MDI) group (n=48), a wide range of technique-related mistakes were observed. The most frequent was absence or short duration of breath-holding after inhalation (45.8%), a critical step necessary to allow the medication to settle in the lower airways. This was followed by failure to exhale before actuation (41.7%), which limits the inhalation volume and affects deposition of the drug. Additionally, poor seal around the mouthpiece (39.6%) and not

shaking the inhaler before use (37.5%) were also frequently seen. These errors suggest poor understanding of the sequential and coordinated actions required during MDI use.

Children using MDI with Spacer ± Mask (n=26) demonstrated slightly better technique overall but still showed notable errors. The most common was poor seal around the mouthpiece or mask (42.3%), which can allow medication to escape before inhalation. This was followed by a long delay between actuation and inhalation (38.5%), and stopping inhalation at the time of device actuation (30.8%), all of which reduced the efficacy of drug delivery.

For nebulizer users (n=34), the most frequent error was failure to maintain deep breathing throughout the treatment (52.9%). Deep, steady breathing is essential to ensure that aerosolized particles reach the distal bronchioles. Poor mask fitting (47.1%) and incorrect dosing of medication (23.5%) were also identified.

These observations align with a wide body of literature. Arora P et al.[12] reported that over 80% of patients committed one or more errors while using inhalers, with the highest error rate among MDI users (94.3%). Common errors included no or short breath-hold, not exhaling before actuation, poor seal, and not shaking the inhaler—very similar to findings in our study.

In the present study, age emerged as an important determinant; only 7.1% of children aged 1–5 years used the inhaler correctly, compared to 18.8% in the 6–10 years group, and 34.2% among those above 10 years of age. The association between increasing age and correct inhaler usage was statistically significant ($p = 0.025$).

The study found no statistically significant association between sex and correct inhaler use ($p = 0.932$), with 21.5% of males and 20.4% of females demonstrating correct technique. This finding is in line with results from Arora P et al[12], who also reported no significant gender difference in error rates.

Residential status, however, was significantly associated with inhaler technique. Children from urban areas had a higher rate of correct inhaler use (30.5%) than those from rural areas (10.9%), with the difference being statistically significant ($p = 0.020$). Arora P et al[12] similarly reported that error rates were significantly higher among rural residents (89.9%) compared to their urban counterparts (72.5%), further emphasizing the urban–rural divide in health literacy and access to quality asthma education.

Socioeconomic status (SES) was another critical factor. Children from upper middle-class families had the highest rate of correct technique (46.2%), followed by middle (26.5%) and lower middle classes (21.4%), while the lowest rate was seen among those from the lower class (7.7%). This association was statistically significant ($p = 0.027$).

While the type of inhalation device influenced the frequency of errors, the association between device type and correct usage was not statistically significant in this study ($p > 0.05$). Still, the highest correctness was seen with MDI with spacer ± mask (26.9%), followed by MDI (20.8%), nebulizer (17.6%), and DPI (16.7%). Spacers, especially with masks, reduce the complexity of coordination required and are generally recommended for younger children to enhance drug deposition and minimize technique-related errors. Several studies, including those by Kumari S et al[13] and Akhoon N et al[14], have supported this finding, showing improved technique proficiency with spacers and nebulizers compared to standalone MDIs or DPIs.

Interestingly, the role of health educators in influencing inhaler technique did not reach statistical significance in this study ($p = 0.291$). Nonetheless, the highest correctness was observed in children who were educated by doctors (25.4%), followed by hospital staff (15.0%), while none of the self-taught users demonstrated correct technique. These findings highlight the pivotal role of trained medical professionals in delivering inhaler education, although the quality and consistency of instruction remain areas of concern. A study conducted in Spain reported that only 15% of nurses and 28% of physicians could correctly demonstrate MDI usage, indicating knowledge gaps even among healthcare providers.[15]

CONCLUSION

This study was conducted to evaluate the correctness of inhalation device technique and identify the types of errors associated with various inhalation devices among pediatric asthma patients. The findings revealed a high prevalence of incorrect inhaler use among children, with only 21.1% of participants demonstrating correct technique, while the remaining 78.9% exhibited one or more critical errors.

We found that improper inhalation technique was significantly more common in younger children, those from rural areas, and those belonging to lower socioeconomic strata. The study also highlighted that while doctors were the primary source of inhaler education, this alone was insufficient in ensuring correct technique, as a large proportion of children trained by healthcare providers still committed basic errors. Moreover, device-specific challenges were evident, with distinct patterns of errors noted for MDIs, spacers, DPIs, and nebulizers—emphasizing the importance of tailoring education according to the device prescribed.

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