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Metered Dose Inhalers (MDI) vs. Nebulizer for Asthma Management: A Comparative Analysis of Adherence and Patient Satisfaction

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Abstract

Introduction: Asthma is a common chronic inflammatory airway disease affecting millions worldwide and represents a significant public health burden, including in Saudi Arabia. Inhaled therapies via devices like MDIs and nebulizers are the cornerstone of treatment as they deliver medication directly to the lungs with minimal systemic effects. Although both have comparable inhalation techniques, adherence is known to significantly influence outcomes. Furthermore, patient satisfaction is strongly linked to adherence, asthma control, and quality of life. Objectives: To compare bronchodilator delivery using MDIs versus nebulizers in adult asthma patients, focusing on adherence and satisfaction. Additionally, the study compared the user-friendliness of MDIs and nebulizers among asthmatic patients. Methodology: A cross-sectional study assessed adherence and satisfaction using an online questionnaire distributed via social media. Adult asthma patients (18–65 years) from the Eastern Province of Saudi Arabia were included, while COPD patients, pediatric cases, non-residents, and DPI users were excluded. Of 303 responses, 273 were analyzed. The questionnaire was adapted from validated tools (ACT, AQLQ, ASUI) with added items on usability, satisfaction, and adherence. Data were analyzed using SPSS version 29 with descriptive statistics and group comparisons. Results: Patients using nebulizers only demonstrated less adherence compared to only MDI users. Difficulty using and discontinuation due to cost were found to be the significant factors. For satisfaction, only MDI users also demonstrated relatively high satisfaction compared to only nebulizer users, particularly due to inhaler portability and confidence in use, which also make the MDI more user-friendly. Meanwhile, patients using both devices showed the highest adherence and satisfaction. Conclusion: Both MDIs and nebulizers are used among asthma patients; however, adherence and satisfaction depend mainly on several factors. Findings suggest usability, cost, and friendly use are found to be the key factors. Using both devices may provide flexibility, allow adjustment and improve consistency of use.

Keywords: *Asthmatic patients, MDI, Nebulizer, Medication Adherence, Patient Satisfaction, Saudi Arabia.*

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Introduction

Overview

Asthma is a chronic airway disease affecting millions worldwide and is characterized by persistent airway inflammation due to bronchial hypersensitivity and increased response to triggers. This leads to variable, recurrent symptoms caused by reversible airflow obstruction in the small airways (1). Globally, asthma remains a major public health issue, with about 260 million people affected and approximately 436,000 deaths reported in 2021 (2). In Saudi Arabia, national data suggest a notable burden, with one study in 2013 reporting a 4% clinical diagnosis rate among adults aged 15 and older (3). More recent findings show higher symptom prevalence, with a study done in 2022, reporting asthma-related symptoms in about 14% of 7,955 adults across 20 regions, indicating an increasing burden over the past decade (4). Several factors such as male sex, old age, low education level, have been associated with an increased risk of asthma. Regarding clinical presentation, common symptoms include recurrent coughing, waking up with chest tightness, and shortness of breath (5).

Asthma Management

Asthma management aims to maintain long-term control and improve quality of life. The primary goals are achieving symptom control and minimizing future risks (6). Pharmacological treatment remains the primary approach for achieving and maintaining asthma control. Inhaled therapies are preferred as they deliver medication directly to the lungs with minimal systemic side effects and reach quicker results (7).

Short-acting beta2-agonists (SABA) are used for rapid symptom relief and as the initial therapy for patients newly diagnosed (8). Although self-administration of SABAs is a simple and effective, excessive use during a severe attack may cause adverse effects and delay seeking medical care (9). Long-acting beta2-agonists (LABAs), provide a long duration of action up to 12 hours (10). They may be beneficial for controlling nocturnal and exercise-induced symptoms (11). Finally, Inhaled corticosteroids (ICS) are considered the first-line treatment for patients with persistent asthma (12). They are the most effective therapy to reduce airway inflammation. Therefore, they prevent exacerbation and may reduce both asthma-related mortality and the irreversible airway remodeling (12).

Inhalation Devices

Inhalation therapy is a fundamental component in asthma management and includes devices such as Metered Dose Inhaler (MDIs), Dry Powder Inhalers (DPIs) , soft mist inhalers, and nebulizers (33). Drug delivery to the lower respiratory tract varies according to device type, particular size, formulation, and patient technique (34).

MDIs are among the most used inhalation devices and require proper coordination between actuation and inhalation to ensure effective drug delivery (34). Proper inhaler, slow inhalation, and breathe holding to improve lung deposition that are shown in (Figure 1).

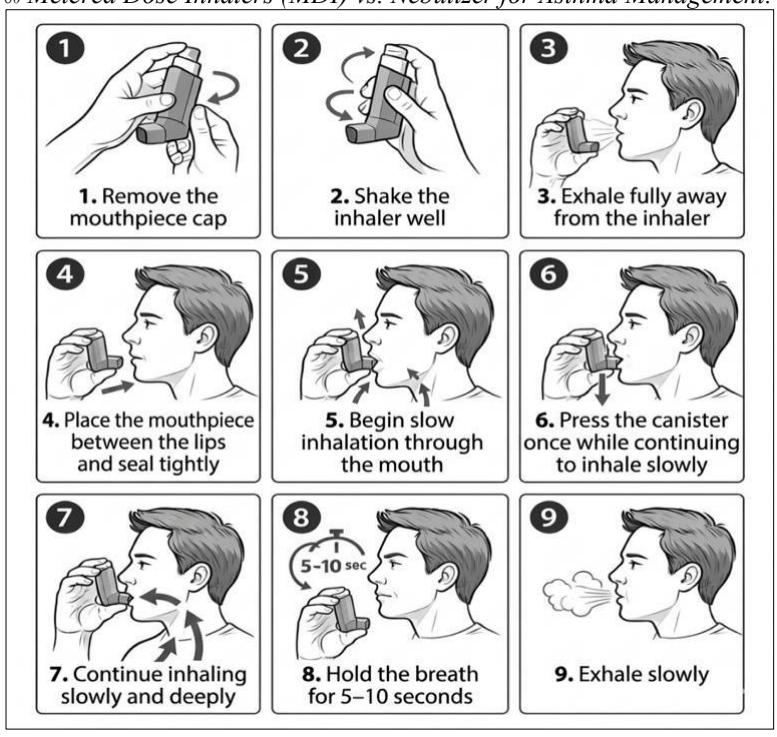

Figure 1. Correct technique for using MDI. the recommended steps for proper MDI use, including shaking the inhaler, exhaling fully, coordinating slow inhalation with actuation, and holding the breath for approximately 5–10 seconds to enhance drug deposition in the lower airways. Adapted from (23).

Nebulizers are devices that convert liquid medication into a fine mist. This mechanism makes them suitable for all ages and disease severities (17). They can deliver larger doses than handheld inhales and allow multiple medications to be given at the same time (17). Nebulizers can use either pneumatic or mechanical energy. Jet nebulizers utilize compressed gas to draw liquid medication through a nozzle, producing an aerosol mist. In contrast, ultrasonic and mesh nebulizers employ high-frequency vibrations or vibrating mesh to generate aerosol particles (18). Several clinical studies have demonstrated no significant difference between MDIs (with spacers) and nebulizers in terms of efficacy, peak expiratory flow rate (PEFR), or symptom control (19, 20). Both devices offer advantages that cover patient needs for optimal outcomes. (20, 35). Nebulizers are more appropriate when higher medication doses are required, whereas MDIs can achieve effective drug deposition when properly used (21). MDIs are smaller, portable, and faster than traditional nebulizers, making them convenient for ambulatory patients and in emergency settings (35). However, newer mesh nebulizers offer compact, battery-operated alternatives that improve portability while maintaining effective aerosol generation (20). Nebulizers are more expensive, which may be justified for patients with poor coordination or severe disease requiring larger medication volumes (17, 18).

Therefore, the advantages and limitations of each inhalation modality play a crucial role in device selection, ultimately influencing clinical outcomes through improved patient adherence and satisfaction.

Adherence and Patient Satisfaction

Adherence to asthma management refers to the act of following the prescribed treatment plan, including the correct inhaler use and medication consistency. Maintaining optimal adherence is essential to reduce exacerbation, and the burden of uncontrolled asthma (22). Moreover, several factors influence adherence among asthma patients, including self-efficacy, treatment complexity, and social support, and understanding of inhaler techniques (23, 24). In addition, device-related factors, such as inhaler complexity or incorrect technique, may compromise treatment effectiveness (23, 24). Furthermore, broader clinical and socioeconomic factors, including health insurance coverage, disease control, and quality of life, also affect adherence. Therefore, expanding access to ICS and incorporating asthma medications into health insurance plans may help improve adherence. Patient satisfaction with treatment and inhaler devices has associated with improved asthma control, fewer exacerbations, and better quality of life (25, 26). Finally, education and structured inhaler training provided by healthcare professionals remain essential in promoting inhaler techniques and sustained adherence (27).

Research Gap and Study Rationale

Despite extensive literature addressing asthma prevalence, inhaler satisfaction, and treatment adherence, important gaps remain. The following research gaps surfaced after reviewing the literature:

Limited Data from the Saudi Population, Especially the Eastern Province

Although several studies on asthma management and inhaler use have been conducted in Saudi Arabia, most were restricted to regions such as Riyadh, Al-Qassim, and Al-Ahsa. However, few studies focused on adult asthmatic patients in the Eastern Province or evaluated MDIs vs. nebulizers regarding adherence, satisfaction, and usability (36, 38)

Fragmented Assessment of Adherence and Satisfaction

Most studies evaluate only one aspect, such as asthma control (e.g., ACT) or satisfaction (e.g., TSQM), without combining multiple validated tools. This fragmented approach limits understanding of how device selection, influences adherence and satisfaction, which are the core outcomes aligned with this study's primary objectives.

Lack of Patient-Reported Real-Life Experience

Previous research often depends on clinician-reported outcomes rather than patient-reported experiences. Real-life barriers remain unexplored, including difficulties with correct MDI technique, preference for nebulizers during acute attacks, and fear of side effects. Therefore, additional research is needed to determine whether MDIs or nebulizers are more convenient and better support long-term adherence and satisfaction.

Research Objectives

This study aims to compare asthmatic adult patients who use bronchodilator therapy delivered by a metered dose inhaler (MDI) with those who use treatment delivery by a nebulizer.

Primary objectives: to compare using metered dose inhalers (MDIs) and nebulizers in asthma

treatment, focusing on the impact of patient device selection on patient adherence and satisfaction. **Secondary objectives:** to compare the user-friendliness of MDIs and nebulizers among asthmatic patients.

Methods

This study is a cross-sectional, questionnaire-based to assess patient adherence and satisfaction with asthma treatment devices, MDIs and nebulizers.

Data were gathered using a structured online questionnaire developed through Google Forms and distributed via social media platforms, including WhatsApp, Twitter, and Instagram. This helps to ensure broad participant reach. The first page of the questionnaire included an explanation of the study objectives, and informed consent was obtained electronically from all participants prior to participation.

The study targeted asthmatic adults aged 18–65 years who were using MDIs, nebulizers, or both devices. Participants were mainly recruited from the Eastern Province of Saudi Arabia. Exclusion criteria included patients with chronic obstructive pulmonary disease (COPD), individuals living outside the Eastern Province, pediatric patients, and those using dry powder inhalers (DPIs). A total of 303 responses were initially obtained. After applying the exclusion criteria, 273 participants were included in the final analysis.

The questionnaire was developed based on validated instruments, including the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), and Asthma Symptom Utility Index (ASUI). It also included customized items evaluating device usability, perceived effectiveness, patient satisfaction, and adherence behaviors.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 29. Descriptive statistics were used to summarize the data. Categorical variables were presented as frequencies and percentages. Continuous variables were reported as means and standard deviations. Adherence and satisfaction outcomes were compared across device groups (MDI and nebulizer) using the T-test. Comparisons among MDI, nebulizer, and combined use groups were performed using the one-way ANOVA test. Reverse-coded items were corrected before analysis. Missing data were handled using valid percentages.

Ethical approval was received from the Institutional Review Board (IRB) of Imam Abdulrahman Bin Faisal University. Participation was voluntary. All responses were collected anonymously to maintain confidentiality.

Results

A total of 303 participants completed the survey. A total of 273 remained after excluding 29 dry powder inhaler (DPI) users and 1 non-consenting respondent. Most participants were female (207, 75.8%), while males accounted for 66 (24.2%). The majority were aged 18–30 years (118, 43.2%) and 31–50 years (106, 38.8%). Most participants were from the Eastern region (235, 86.7%) and had college-level education (171, 62.9%). Asthma duration was more than five years in 120 participants (44.3%). A confirmed asthma diagnosis was reported by 218 participants (79.9%), while 32 (11.7%) had COPD. Device use included MDI (119, 43.6%), nebulizer (55, 20.1%), and both (99, 36.3%) (Table 1).

Table 1. Baseline Characteristics of Participants

Variable	Category	N (%)
Gender	Female	207 (75.8%)
	Male	66 (24.2%)
Age	<18 Years	23 (8.4%)
	18–30 Years	118 (43.2%)
	31–50 Years	106 (38.8%)
	>50 Years	26 (9.5%)
Region	Eastern Region	235 (86.7%)
	Western Region	13 (4.8%)
	Central Region	10 (3.7%)
	Southern Region	6 (2.2%)
	Northern Region	7 (2.6%)
Education Level	Primary	12 (4.4%)
	Secondary	75 (27.6%)
	College/University	171 (62.9%)
	Postgraduate	14 (5.1%)
Asthma Duration	<1 Year	68 (25.1%)
	1–3 Years	45 (16.6%)
	3–5 Years	38 (14.0%)
	>5 Years	120 (44.3%)
Asthma Diagnosis	Yes	218 (79.9%)
	No	55 (20.1%)
COPD Diagnosis	Yes	32 (11.7%)
	No	241 (88.3%)
Device Used	MDI	119 (43.6%)
	Nebulizer	55 (20.1%)
	Both (MDI + Nebulizer)	99 (36.3%)

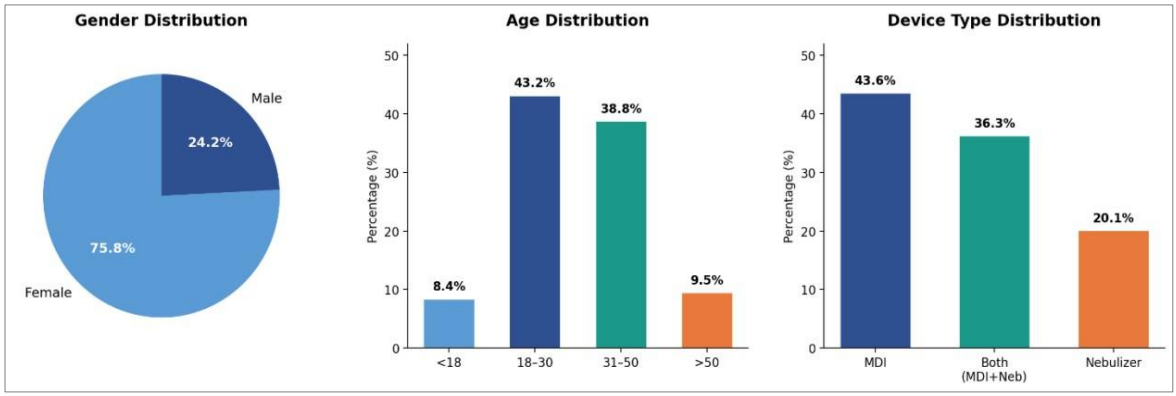

Figure 2. Demographic Distribution: Gender, Age, and Device Type

Adherence Patterns

Table 2 shows adherence to inhaler therapy among adult asthma patients. Forgetfulness was commonly reported. Most participants stated that they sometimes forgot to use inhalers (91, 33.3%), while only 12 (4.4%) always forgot. A notable proportion discontinued treatment when feeling well. A total of 48 participants (17.6%) always stopped inhalers, while 40 (14.7%) mostly stopped them. Similarly, during vacations or weekends, 81 (29.7%) sometimes and 26 (9.5%) always discontinued medication. Emotional factors also contributed to adherence behavior. A total of 76 participants (27.8%) sometimes discontinued inhalers when nervous or sad. Fear of side effects also affected adherence, with 78 (28.6%) sometimes stopping treatment. Additionally, 76 (27.8%) sometimes used fewer doses than prescribed. Cost-related non-adherence was less noticeable. A total of 169 participants (61.9%) reported never stopping treatment due to cost.

Table 2. Adherence Patterns and Inhaler Use Behaviors

Item	Never	Rarely	Sometimes	Mostly	Always
Forget inhalers (general)	77 (28.2%)	67 (24.5%)	91 (33.3%)	25 (9.2%)	12 (4.4%)
Stop when feeling good	65 (23.8%)	41 (15.0%)	78 (28.6%)	40 (14.7%)	48 (17.6%)
Stop on vacation/weekends	85 (31.1%)	55 (20.1%)	81 (29.7%)	25 (9.2%)	26 (9.5%)
Stop when nervous/sad	107 (39.2%)	59 (21.6%)	76 (27.8%)	17 (6.2%)	13 (4.8%)
Stop due to side effects fear	116 (42.5%)	40 (14.7%)	78 (28.6%)	21 (7.7%)	17 (6.2%)
Stop (perceived uselessness)	150 (54.9%)	35 (12.8%)	65 (23.8%)	15 (5.5%)	7 (2.6%)
Take fewer doses than prescribed	114 (41.8%)	55 (20.1%)	76 (27.8%)	14 (5.1%)	13 (4.8%)
Stop due to lifestyle interference	142 (52.0%)	35 (12.8%)	73 (26.7%)	13 (4.8%)	9 (3.3%)
Stop due to cost	169 (61.9%)	25 (9.2%)	58 (21.2%)	14 (5.1%)	6 (2.2%)

(N) Frequency, (%) Percentages

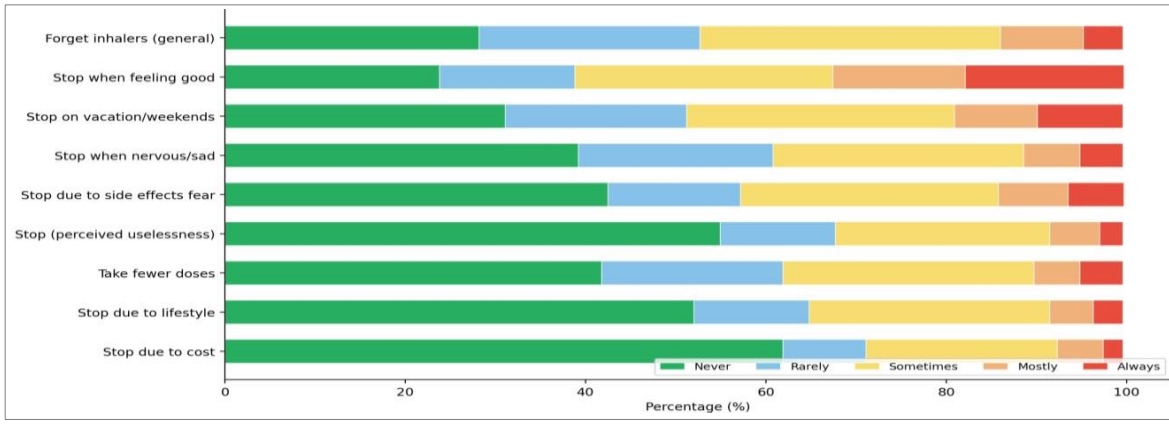

Figure 3. Adherence patterns and inhaler use behaviors. Non-adherence was primary caused by patient-related factors, especially forgetfulness and stopping medication when symptoms improved. In contrast, cost had little impact.

Patient Satisfaction

Table 3 and Figure 4 present the overall patient perceptions toward asthma medications and inhaler devices. Most participants expressed confidence in symptom control, with 85 (31.1%) agreeing and 89 (32.6%) strongly agreeing. Similarly, 145 participants (53.1%) agreed or strongly agreed that they would feel satisfied continuing their medication. Device portability was highly evaluated, with 179 (65.5%) agreeing or strongly agreeing that inhalers fit easily in pockets or purses. Confidence in inhaler use was also high (148, 54.2% agree/strongly agree). However, concerns persisted, as 129 (47.3%) agreed to some extent that they worried about insufficient medication delivery. Additionally, 177 (64.8%) expressed a desire for easier medication use.

Table 3. Patient Perceptions and Satisfaction

Item	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
Happy to continue medication	13 (4.8%)	10 (3.7%)	13 (4.8%)	52 (19.0%)	39 (14.3%)	62 (22.7%)	83 (30.4%)
Confidence in symptom control	5 (1.8%)	4 (1.5%)	10 (3.7%)	41 (15.0%)	38 (13.9%)	85 (31.1%)	89 (32.6%)
Bad taste (Reverse)	14 (5.1%)	20 (7.3%)	27 (9.9%)	74 (27.1%)	51 (18.7%)	45 (16.5%)	41 (15.0%)
Fits in pocket/purse	8 (2.9%)	4 (1.5%)	12 (4.4%)	32 (11.7%)	37 (13.6%)	73 (26.7%)	106 (38.8%)
Easy to remember	6 (2.2%)	11 (4.0%)	16 (5.9%)	70 (25.6%)	51 (18.7%)	64 (23.4%)	54 (19.8%)

Wrong inhaler (Reverse)	61 (22.3%)	54 (19.8%)	16 (5.9%)	56 (20.5%)	26 (9.5%)	35 (12.8%)	24 (8.8%)
Affects voice (Reverse)	43 (15.8%)	35 (12.8%)	27 (9.9%)	80 (29.3%)	36 (13.2%)	27 (9.9%)	24 (8.8%)
Confidence using inhaler	6 (2.2%)	6 (2.2%)	13 (4.8%)	57 (20.9%)	42 (15.4%)	69 (25.3%)	79 (28.9%)
Multiple inhalers hassle (Reverse)	11 (4.0%)	25 (9.2%)	24 (8.8%)	62 (22.7%)	48 (17.6%)	55 (20.1%)	47 (17.2%)
Worry about insufficient dose	17 (6.2%)	32 (11.7%)	26 (9.5%)	68 (24.9%)	54 (19.8%)	45 (16.5%)	30 (11.0%)
Would recommend inhaler	14 (5.1%)	13 (4.8%)	13 (4.8%)	48 (17.6%)	42 (15.4%)	73 (26.7%)	69 (25.3%)
Wish medication easier	11 (4.0%)	16 (5.9%)	11 (4.0%)	57 (20.9%)	44 (16.1%)	53 (19.4%)	80 (29.3%)

(N) Frequency, (%) Percentages

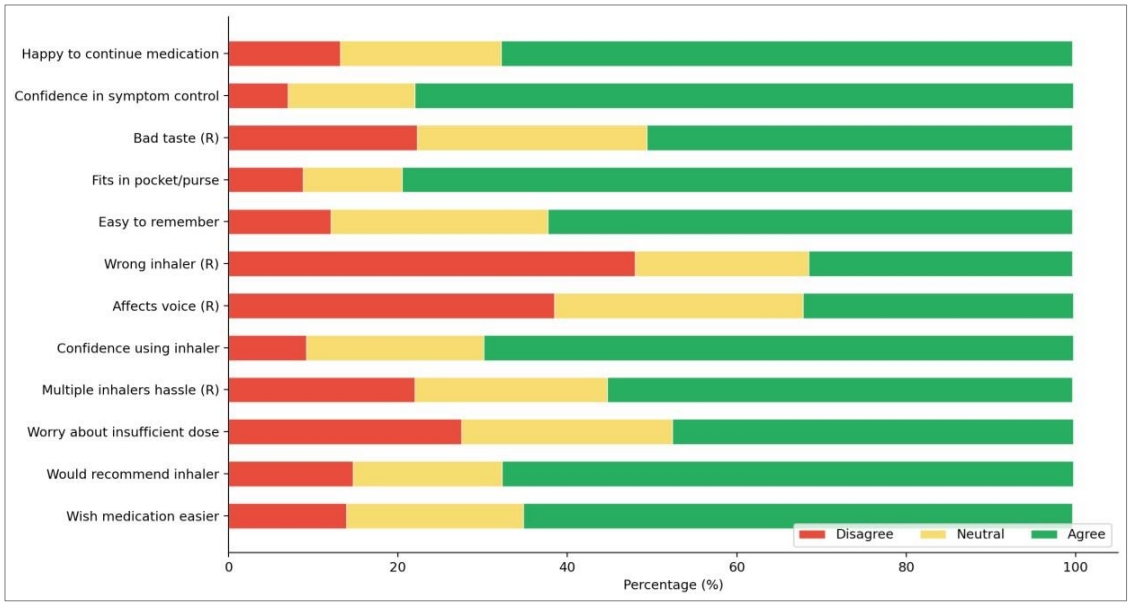

Figure 4. Patient satisfaction with asthma medications (n=273). Overall patient satisfaction was high, with most participants reporting confidence in symptom control and willingness to continue treatment, although concerns about ease of use and medication

Adherence by Device Types

Table 4 shows differences in adherence behaviors across inhaler device types, focusing on MDI and nebulizer users, using mean scores. Patients using nebulizers generally demonstrated higher

mean scores in several non-adherence behaviors, including difficulty using inhalers (1.44±0.57) and stopping due to cost (1.20±1.16). MDI-only users showed moderate adherence, with higher scores in stopping when feeling well (2.00±1.38).

Table 4. Adherence Behaviors by Device Types (MDI vs. Nebulizer users)

Item	MDI (n=119)	Nebulizer (n=55)	P-value (T-test)
Difficulty using inhaler	1.24 (0.50)	1.44 (0.57)	0.0201
Forgot inhaler (last 7 days)	1.10 (1.24)	1.15 (1.24)	0.8050
Forget inhaler (general)	1.42 (1.16)	1.47 (1.00)	0.7831
Stop when feeling good	2.00 (1.38)	1.85 (1.33)	0.5011
Stop on vacation/weekend	1.57 (1.31)	1.51 (1.15)	0.7709
Stop when nervous/sad	1.23 (1.19)	1.24 (1.09)	0.9579
Stop due to side effects	1.37 (1.34)	1.49 (1.27)	0.5774
Stop (perceived uselessness)	0.88 (1.13)	1.18 (1.14)	0.1063
Take fewer doses	1.19 (1.31)	1.11 (0.98)	0.6871
Stop due to lifestyle	0.94 (1.20)	1.24 (1.09)	0.1166
Stop due to cost	0.77 (1.14)	1.20 (1.16)	0.0226

Values presented as Mean (SD)

In contrast, as shown in figure 5 and table 5, an important observation in this study was that patients who used both MDI and nebulizer devices showed higher overall adherence than those relying on a single device. The patients in this category showed comparatively lower mean scores across most non-adherence domains, such as forgetting inhalers in the last 7 days (0.82±0.99) and stopping due to side effects (0.84±1.02).

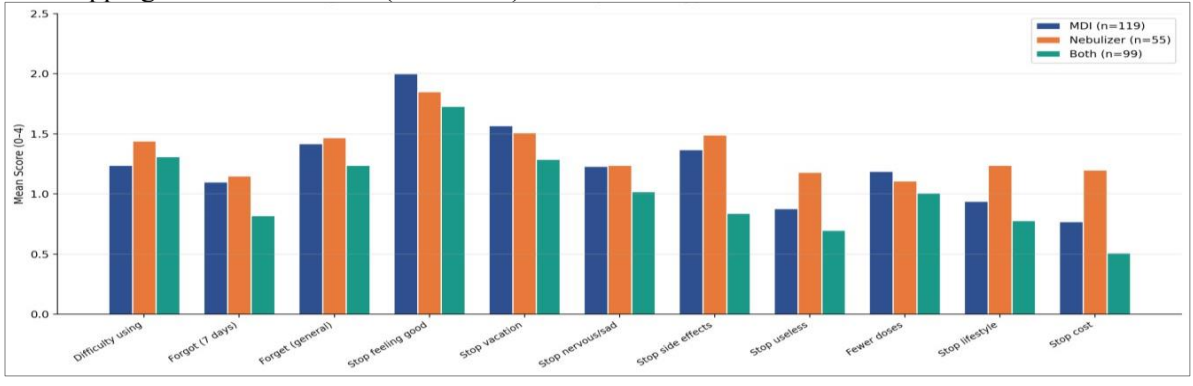

Figure 5. Adherence behaviors by device type — mean scores (n=273). Non-adherence was generally higher among nebulizer users, while combined device users (MDI + nebulizer) showed more favorable adherence patterns across most behaviors.

Table 5. Adherence Behaviors by Device Types (MDI, Nebulizers, and both -devices users)

Item	MDI (n=119)	Nebulizer (n=55)	Both (n=99)	P value (ANOVA)
Difficulty using inhaler	1.24 (0.50)	1.44 (0.57)	1.31 (0.51)	0.062
Forgot inhaler (last 7 days)	1.10 (1.24)	1.15 (1.24)	0.82 (0.99)	0.124
Forget inhaler (general)	1.42 (1.16)	1.47 (1.00)	1.24 (1.13)	0.368
Stop when feeling good	2.00 (1.38)	1.85 (1.33)	1.73 (1.46)	0.364
Stop on vacation/weekend	1.57 (1.31)	1.51 (1.15)	1.29 (1.30)	0.258
Stop when nervous/sad	1.23 (1.19)	1.24 (1.09)	1.02 (1.14)	0.341
Stop due to side effects	1.37 (1.34)	1.49 (1.27)	0.84 (1.02)	0.001
Stop (perceived uselessness)	0.88 (1.13)	1.18 (1.14)	0.70 (1.04)	0.036
Take fewer doses	1.19 (1.31)	1.11 (0.98)	1.01 (1.04)	0.520
Stop due to lifestyle	0.94 (1.20)	1.24 (1.09)	0.78 (1.05)	0.054
Stop due to cost	0.77 (1.14)	1.20 (1.16)	0.51 (0.90)	0.001

Satisfaction by Device Type

Table 6 shows differences in patient satisfaction and perceptions across inhaler device types, focusing on comparing between MDI and nebulizer users. MDI-only users also demonstrated relatively high satisfaction, particularly in inhaler portability (5.79±1.44) and confidence in use (5.52±1.45). In contrast, nebulizer-only users consistently showed lower scores across several domains, including confidence using inhalers (4.64±1.67) and ease of remembering medication (4.62±1.59). Concerns such as bad taste and worry about insufficient dosing were relatively similar across groups.

Table 6. Patient Satisfaction by Device Type (MDI vs. Nebulizer users)

Item	MDI (n=119)	Nebulizer (n=55)	P-value (T-test)
Happy to continue medication	5.22 (1.73)	4.73 (1.91)	0.0947
Confidence in symptom control	5.58 (1.47)	5.20 (1.56)	0.1218
Bad taste (Reverse)	4.32 (1.63)	4.36 (1.59)	0.8796
Fits in pocket/purse	5.79 (1.44)	4.96 (1.68)	0.0010
Easy to remember	5.16 (1.48)	4.62 (1.59)	0.0302
Wrong inhaler (Reverse)	3.22 (1.97)	3.24 (1.79)	0.9490
Affects voice (Reverse)	3.47 (1.75)	3.84 (1.68)	0.1909
Confidence using inhaler	5.52 (1.45)	4.64 (1.67)	0.0005

Multiple inhalers hassle (Reverse)	4.64 (1.75)	4.62 (1.60)	0.9427
Worry about insufficient dose	4.18 (1.71)	4.20 (1.60)	0.9418
Would recommend inhaler	5.00 (1.81)	4.85 (1.61)	0.5997
Wish medication easier	5.03 (1.72)	5.11 (1.66)	0.7734

Values presented as Mean (SD)

Interestingly, as figure 6 and table 7 shows, a notable finding of this study was that patients using both MDI and nebulizer generally reported the highest satisfaction scores, including greater willingness to continue medication (5.58±1.45) and higher confidence in symptom control (5.92±1.15).

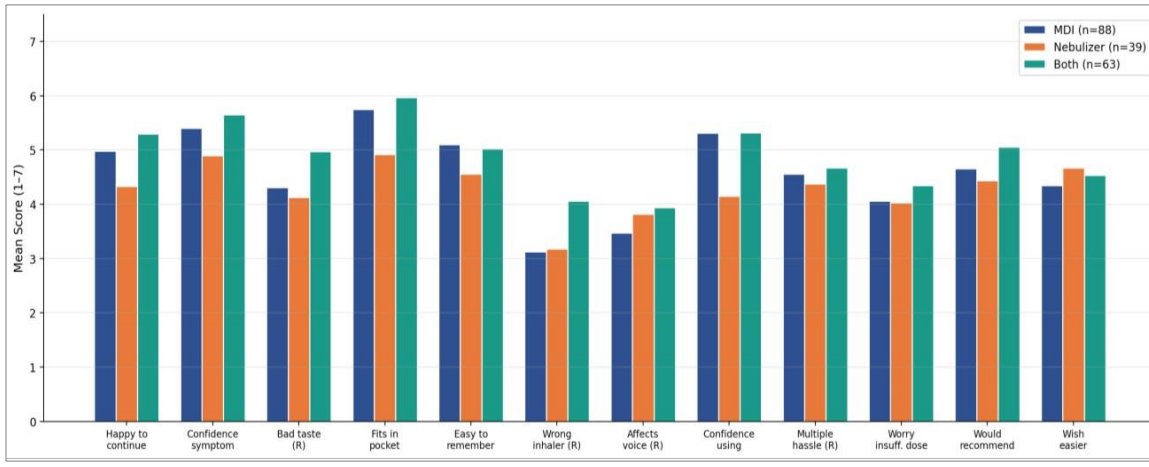

Figure 6. Patient satisfaction by device type — mean scores (n=273). Combined device users (MDI + nebulizer) demonstrated the highest satisfaction levels, whereas nebulizer-only users consistently reported lower satisfaction across multiple domains.

Table 7. Patient Satisfaction by Device Type (MDI, Nebulizer, and both-devices users)

Item	MDI (n=119)	Nebulizer (n=55)	Both (n=99)	P value (ANOVA)
Happy to continue medication	5.22 (1.73)	4.73 (1.91)	5.58 (1.45)	0.011
Confidence in symptom control	5.58 (1.47)	5.20 (1.56)	5.92 (1.15)	0.008
Bad taste (Reverse)	4.32 (1.63)	4.36 (1.59)	4.98 (1.66)	0.008
Fits in pocket/purse	5.79 (1.44)	4.96 (1.68)	5.95 (1.37)	0.001

Easy to remember	5.16 (1.48)	4.62 (1.59)	5.15 (1.44)	0.060
Wrong inhaler (Reverse)	3.22 (1.97)	3.24 (1.79)	3.95 (2.10)	0.016
Affects voice (Reverse)	3.47 (1.75)	3.84 (1.68)	4.07 (1.94)	0.049
Confidence using inhaler	5.52 (1.45)	4.64 (1.67)	5.62 (1.31)	0.001
Multiple inhalers hassle (Reverse)	4.64 (1.75)	4.62 (1.60)	4.83 (1.68)	0.654
Worry about insufficient dose	4.18 (1.71)	4.20 (1.60)	4.62 (1.71)	0.126
Would recommend inhaler	5.00 (1.81)	4.85 (1.61)	5.51 (1.57)	0.029
Wish medication easier	5.03 (1.72)	5.11 (1.66)	5.33 (1.71)	0.424

Values presented as Mean (SD)

User-Friendliness by Device Type

Table 8 demonstrates significant differences in user-friendliness between only MDI users and only nebulizer users. Only MDI users reported greater convenience and portability, particularly for fitting in a pocket or purse (5.79±1.44 vs. 4.96±1.68, p=0.0010). They also reported better ease of remembering regular medication use (5.16±1.48 vs. 4.62±1.59, p=0.0302) and higher confidence in inhaler use (5.52±1.45 vs. 4.64±1.67, p=0.0005). Overall, only MDI users were perceived as more user-friendly and practical compared to only nebulizer users.

Table 8. User- friendliness by device types (MDI vs. Nebulizer users)

Item	MDI (n=119)	Nebulizer (n=55)	P value (T-test)
Fits in pocket/purse	5.79 (1.44)	4.96 (1.68)	0.0010
Easy to remember	5.16 (1.48)	4.62 (1.59)	0.0302
Confidence in using inhale	5.52 (1.45)	4.64 (1.67)	0.0005

Values presented as Mean (SD)

Discussions

Adherence Patterns

This study found that non-adherence to inhaler therapy among adult asthma patients is influenced mainly by behavioral, perceptual, and contextual factors, with patient-related barriers being more prominent than structural factors such as medication cost.

Unintentional non-adherence, particularly forgetfulness, was one of the most frequently reported barriers. Poor integration of inhaler use into daily routines may contribute significantly to missed

doses. In asthma, the intermittent nature of symptoms may reduce perceived necessity for regular controller therapy, leading to inconsistent use (30, 32).
Intentional non-adherence was also evident among patients who discontinued therapy when feeling well. This reflects a low perceived necessity for maintenance treatment and misconceptions regarding its preventive role. Similar findings have been reported in previous literature, where symptom-driven use and low illness perception were associated with poorer adherence (31).
Overall, the findings suggest that non-adherence is largely driven by modifiable patient-related factors. Therefore, improving adherence may require multifaceted interventions, including patient education, reminder systems, behavioral support, and counseling aimed at correcting misconceptions and strengthening long-term self-management.

Patient Satisfaction

This study demonstrated generally high levels of patient satisfaction with asthma medications and inhaler devices. Many participants expressed confidence in symptom control and willingness to continue their medication, indicating a positive perception of treatment effectiveness. These findings are consistent with previous literature suggesting that patient satisfaction is strongly associated with perceived symptom relief and ease of medication use (30, 32).
Device-related factors such as portability and convenience appeared to play a significant role in patient satisfaction. Participants reported that inhalers were easy to carry and use in daily life, consistent with previous studies indicating that portable and user-friendly devices, such as MDIs, enhance patient preference and satisfaction (25, 33).
Despite the overall positive perceptions, some concerns were identified such as worrying about insufficient medication delivery and difficulties related to inhaler complexity and training. These concerns may negatively influence satisfaction and highlights the importance of proper inhaler technique education (31, 32). Similarly, managing multiple inhalers and device-related difficulties have been reported as barriers to satisfaction among asthma patients (23).
Finally, the findings suggest that satisfaction with asthma treatment is influenced by device convenience, confidence in medication effectiveness, and ease of use. Therefore, addressing patient concerns through education and individualized device selection may further improve the general satisfaction outcomes.

Adherence by Device Types

The findings of this study demonstrate differences in adherence behaviors among adult asthma patients based on inhaler device type, as presented in (Table 4). Overall, only nebulizers users showed higher levels of non-adherence compared to other groups, particularly in relation to difficulty using the inhaler and discontinuation due to cost (Table 4). Notably, difficulty using the inhaler was significantly higher among nebulizer-only users ($p = 0.0201$), identifying it as a key factor influencing adherence (Table 4). This may be explained by practical challenges associated with nebulizer therapy, including longer administration time and more complex device handling, which have been reported as barriers affecting adherence in asthma patients (17, 23).
Similarly, discontinuation due to cost was also found to be significantly higher among only nebulizer users ($p = 0.0226$), indicating that economic burden represents another key factor affecting adherence (Table 4). These findings are consistent with previous literature highlighting those financial constraints can negatively impact medication adherence, particularly in long-term therapies (23, 32).

In contrast, patients using both MDIs and nebulizers demonstrated lower levels of non-adherence across most domains, as illustrated in (Figure 5). Although these differences were not statistically significant, this pattern may reflect a shift in patient behavior rather than inherent adherence differences. It is possible that a proportion of these patients were previously non-adherent when using a single device, particularly nebulizers, due to factors such as inconvenience, cost, and time-consuming administration (Table 4). The introduction of an alternative device, such as MDIs, may have provided a more practical and accessible option for regular use, thereby improving adherence.

This suggests that switching between devices or using them complementarily may help overcome barriers associated with single-device use. For example, patients may rely on MDIs for quick and convenient daily use, while reserving nebulizers for more severe symptoms, resulting in a more manageable and acceptable treatment routine. Similar findings have been reported in previous studies emphasizing that patient-centered approaches, including device flexibility and individualized treatment strategies, can enhance adherence outcomes (21, 22).

Only MDI users showed moderate adherence patterns (Table 4). A tendency to discontinue medication when symptoms improved was observed; however, this finding was not statistically significant. This behavior is commonly reported among asthma patients, where perceived symptom improvement leads to premature discontinuation of therapy despite guideline recommendations (22).

Overall, while most differences between groups were not statistically significant, the significant findings related to inhaler difficulty and cost highlight key modifiable barriers to adherence (Table 4). These results support previous evidence indicating that device usability, patient-related factors, and economic burden play a critical role in influencing adherence outcomes in asthma management (23, 32).

Satisfaction by Device Types

Furthermore, this study demonstrated that patient satisfaction varied according to the type of inhalation device used among adult asthma patients (Table 5). Overall, most satisfaction domains were comparable between only MDI users and only nebulizer users, suggesting that both devices provide similar perceived effectiveness in asthma management. This aligns with previous studies reporting comparable clinical outcomes across inhalation devices when used correctly (19, 20).

However, significant differences were observed in specific domains related to usability and convenience. Portability (fits in pocket/purse) was significantly higher among only MDI users ($p = 0.0010$), emphasizing the role of convenience in shaping patient satisfaction. Similarly, ease of remembering medication use was significantly better among only MDI users ($p = 0.0302$), suggesting that simpler and more practical devices may enhance both satisfaction and treatment experience.

In contrast, only nebulizer users tended to report lower satisfaction across several domains, although most differences were not statistically significant. This trend may reflect the longer administration time and greater treatment burden associated with nebulizer therapy. Previous studies have similarly shown that, despite effective drug delivery, nebulizers may be less preferred due to reduced portability and interference with daily activities (17, 18).

Interestingly, patients using both MDIs and nebulizers demonstrated higher satisfaction across multiple domains, particularly confidence in using their inhaler devices, which was significantly greater in this group ($p = 0.0005$). This may reflect greater familiarity with multiple devices and increased flexibility in adjusting treatment according to symptom severity.

Despite these differences, domains such as confidence in symptom control and willingness to continue medication did not differ significantly between groups, suggesting that overall treatment effectiveness is perceived similarly regardless of device type (19, 20). This pattern is further illustrated in (Figure 6), where combined-device users showed consistently higher satisfaction scores across most domains.

Overall, these findings highlight that although both MDIs and nebulizers are commonly used, device-related factors such as convenience, ease of use, and familiarity play an important role to make the device friendly-user, which directly related to patient satisfaction. Therefore, individualized device selection based on patient preference may improve satisfaction and support adherence (21, 23, 32).

Conclusion

This study demonstrated that both metered-dose inhalers (MDIs) and nebulizers are effective methods for delivering asthma medications among adult patients; however, patient satisfaction and adherence vary significantly depending on the type of device used. Patients using both MDIs and nebulizer reported the highest levels of satisfaction, particularly in terms of willingness to continue medication and confidence in symptom control, suggesting that combining devices may provide greater flexibility and improved patient experience.

Only MDI users also showed relatively high satisfaction, especially regarding portability, convenience, and ease of use, which may support better adherence in daily life. In contrast, only nebulizer users exhibited lower satisfaction across several domains, likely due to longer administration time and greater treatment burden.

Overall, the findings highlight that while clinical effectiveness between devices may be comparable, patient-related factors such as device usability, convenience, and perceived effectiveness play a crucial role in determining satisfaction and adherence. Therefore, individualized device selection, along with proper patient education and training on inhaler technique, is essential to optimize treatment outcomes and enhance long-term asthma management in adult patients.

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Appendix:

Survey Instrument Description

This study questionnaire was adapted from previously validated instruments and supporting literature assessing medication adherence and patient satisfaction with asthma treatment devices. The instrument consisted of two principal domains: medication adherence (adapted primarily from the Test of Adherence to Inhalers [TAI]) and treatment satisfaction (adapted from the Satisfaction with Inhaled Asthma Treatment Questionnaire).

Items were reviewed and modified to align with the study objectives and target population.

- Response Formats:
- Adherence items used 3-point or 5-point ordinal response scales.
- Satisfaction items used a 7-point Likest scale from Strongly Disagree (1) to Strongly Agree (7).
- Reverse-scored items were recoded prior to analysis.

Table A1. Medication Adherence Items

Item	Questionnaire Item	Scale
Q1	Difficulty of using inhaler	3-point Likert
Q2	Forgot inhalers during past 7 days	5-point Likert
Q3	Forget to take inhalers	5-point Likert
Q4	Stop inhalers when feeling well	5-point Likert
Q5	Stop inhalers during weekends/vacations	5-point Likert
Q6	Stop inhalers when nervous or sad	5-point Likert
Q7	Stop inhalers due to fear of side effects	5-point Likert
Q8	Stop inhalers believing they are useless	5-point Likert
Q9	Use fewer inhalations than prescribed	5-point Likert
Q10	Stop inhalers due to interference with daily life	5-point Likert
Q11	Stop inhalers due to cost difficulties	5-point Likert

Table A2. Treatment Satisfaction Items

Item	Questionnaire Item	Scale
Q1	Happy to continue current asthma medication	7-point Likert
Q2	Confident medication controls symptoms	7-point Likert
Q3	Medication leaves bad taste*	7-point Likert
Q4	Inhaler fits easily in purse or pocket	7-point Likert
Q5	Easy to remember taking medication	7-point Likert
Q6	Sometimes leave home with wrong inhaler*	7-point Likert

Q7	Medication affects voice*	7-point Likert
Q8	Confident using inhaler(s)	7-point Likert
Q9	Using more than one inhaler is a hassle*	7-point Likert
Q10	Worry inhaler does not deliver enough 7-point Likert medication	
Q11	Would recommend inhaler(s) to others	7-point Likert
Q12	Wish asthma medication were easier to use	7-point Likert

*Reverse-scored items

Scoring Notes

Higher adherence scores indicate better adherence.

Higher satisfaction scores indicate greater treatment satisfaction. Reverse-coded items were adjusted prior to statistical analysis.

Instrument Sources Adherence:

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