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Effectiveness of Inhaler and Corticosteroid Therapy and Potential Drug–Drug and Food–Drug Interactions in Adult Patients with Asthma: A Systematic Literature Review

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ABSTRACT

Background: Asthma is a chronic inflammatory airway disease characterized by recurrent episodes of wheezing, shortness of breath, coughing, and airflow limitation. Inhaler therapy and corticosteroids remain the cornerstone of asthma management by controlling airway inflammation and preventing disease exacerbations. However, these therapeutic agents may cause adverse effects and are associated with potential drug–drug and food–drug interactions that can compromise treatment efficacy and patient safety.

Objective: This study aimed to evaluate the effectiveness of inhaler and corticosteroid therapy and to identify the potential for drug–drug and food–drug interactions in adult patients with asthma.

Methods: A systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Relevant studies published between 2021 and 2026 were identified through comprehensive searches of PubMed, Scopus, ScienceDirect, SpringerLink, Google Scholar, BioMed Central (BMC), GARUDA, SINTA, Neliti, and the Directory of Open Access Journals (DOAJ). A total of 32 articles were initially identified. After applying predefined inclusion and exclusion criteria, 12 original research articles were included in the final analysis.

Results: The reviewed studies consistently demonstrated that inhaler and corticosteroid therapies effectively improved asthma symptom control, reduced airway inflammation, enhanced pulmonary function, and decreased the frequency of exacerbations. Nevertheless, treatment-related adverse effects and the potential for drug–drug and food–drug interactions remain important clinical concerns, particularly among patients receiving systemic corticosteroids or multiple concomitant medications. Appropriate therapeutic monitoring was consistently associated with improved treatment safety and optimized clinical outcomes.

Conclusion: Inhaler and corticosteroid therapies remain the cornerstone of pharmacological management for adult asthma and provide substantial clinical benefits in controlling disease activity. Nevertheless, careful therapeutic monitoring, rational medication use, and appropriate management of potential drug–drug and food–drug interactions are essential to maximize therapeutic efficacy while minimizing adverse effects.

KEYWORDS: Asthma; Inhaler Therapy; Inhaled Corticosteroids; Drug–Drug Interactions; Food–Drug Interactions; Adult Patients; Systematic Literature Review

INTRODUCTION

Asthma is a chronic inflammatory disease of the airways characterized by recurrent episodes of dyspnea, wheezing, chest tightness, and coughing resulting from reversible airway obstruction. According to the World Health Organization (WHO), approximately **363 million people worldwide** were living with asthma in 2023, and the disease was responsible for an estimated **442,000 deaths** annually. Most asthma-related deaths occur in low- and lower-middle-income countries, where delayed diagnosis and inadequate access to appropriate treatment remain significant public health challenges. In Indonesia, the prevalence of asthma varies across provinces, with reported rates of **3.9% in Bali** and **1.8% in Central Java** (Fadiyah et al., 2022). Asthma pathophysiology is characterized by chronic airway inflammation involving the activation of eosinophils, mast cells, and T lymphocytes, leading to mucosal edema, bronchial hyperresponsiveness, and airflow limitation (Noviyanto et al., 2025).

Pharmacological management of asthma primarily involves the use of **inhaled corticosteroids (ICSs)** as the first-line controller therapy. These medications act directly on the airways to suppress inflammation while minimizing systemic exposure and adverse effects (Lee et al., 2021). During acute asthma exacerbations, systemic corticosteroids administered orally or intravenously are

recommended to achieve rapid control of airway inflammation. **Methylprednisolone** is generally preferred because of its rapid onset of action and relatively low mineralocorticoid activity, whereas **dexamethasone** is prescribed less frequently owing to its prolonged half-life, which may increase the risk of systemic adverse effects (Timur & Novitasari, 2022).

Although corticosteroids are highly effective in controlling asthma symptoms, their use requires careful consideration because of their potential interactions with concomitant medications and dietary factors. For example, concomitant administration with antidiabetic agents may reduce glycemic control and increase blood glucose levels, whereas concurrent use with diuretics may increase the risk of hypokalemia. Furthermore, excessive dietary sodium intake may exacerbate corticosteroid-induced fluid retention and hypertension (Fadiyah et al., 2022). The dosage form of corticosteroids also influences their pharmacokinetic and pharmacodynamic properties. Inhaled formulations provide optimal local therapeutic effects with minimal systemic absorption, whereas oral formulations undergo gastrointestinal absorption and produce broader systemic distribution. Injectable corticosteroids are generally reserved for severe exacerbations requiring rapid therapeutic intervention (Timur & Novitasari, 2022).

Despite the widespread use of inhaler therapy and corticosteroids in asthma management, evidence regarding their clinical effectiveness and the potential for drug–drug and food–drug interactions remains scattered across the literature. A comprehensive synthesis of current evidence is therefore needed to support evidence-based clinical practice and optimize pharmacological management in adult patients with asthma. Accordingly, this systematic literature review aimed to evaluate the effectiveness of inhaler and corticosteroid therapy and to identify the potential drug–drug and food–drug interactions associated with these treatments in adult patients with asthma.

METHODS

This study employed a **Systematic Literature Review (SLR)** design conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)** guidelines. The review focused on original research investigating pharmacological therapy for adult patients with asthma.

A comprehensive literature search was performed using several international electronic databases, including **PubMed, Scopus, ScienceDirect, SpringerLink, Google Scholar,** and **BioMed Central (BMC)**, as well as Indonesian scientific databases, including **GARUDA, SINTA, Neliti,** and the **Directory of Open Access Journals (DOAJ)**. Eligible studies were limited to articles published between **2021 and February 2026** to ensure that the evidence reflected the most recent advances in asthma management.

The literature search employed combinations of Medical Subject Headings (MeSH) terms and free-text keywords, including **"adult asthma," "inhaler," "inhaled corticosteroid," "oral corticosteroid," "injectable corticosteroid," "drug interaction," "food–drug interaction,"** and **"asthma therapy."** Boolean operators (**AND** and **OR**) were applied to optimize the search strategy across all databases.

Study Selection

The study selection process followed the PRISMA framework (Figure 1). Articles were screened independently based on their titles, abstracts, and full texts.

The inclusion criteria were as follows: original research articles, full-text articles published in English or Indonesian, studies involving adult patients with asthma, studies evaluating inhaler therapy and/or corticosteroid therapy, and studies reporting drug–drug interactions, food–drug interactions or both.

The exclusion criteria included: literature reviews, systematic reviews, meta-analyses, conference abstracts, duplicate publications and studies with unclear or inadequately described research methodologies.

Articles meeting all eligibility criteria were included in the final review. The extracted data comprised the **authors**, **year of publication**, **study design**, **type of pharmacological therapy**, **reported drug or food interactions**, and the **main clinical findings** relevant to the review objectives.

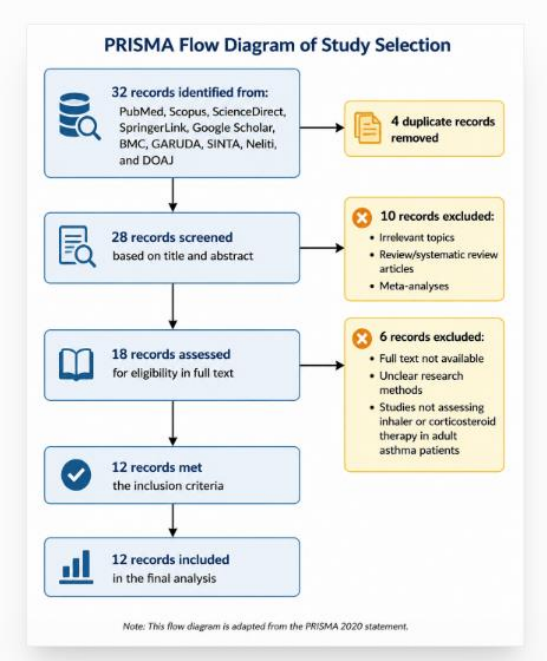

Figure 1. PRISMA Flow Diagram of the Study Selection Process

RESULTS AND DISCUSSION

The literature search yielded **32 potentially relevant articles**. Following a rigorous screening process based on the predefined inclusion and exclusion criteria, **12 original research articles** were deemed eligible and included in the final systematic literature review. In addition, **10 studies** that only partially fulfilled the eligibility criteria were retained as supporting references to provide complementary evidence. **Four articles** were excluded because they fell outside the specified publication period, whereas **six articles** were excluded after eligibility assessment due to meeting one or more exclusion criteria. The complete study selection process is illustrated in **Figure 1**.

Table 1. Summary of Literature Review

No.	Author (Year)	Study Design & Sample	Drugs / Interventions	Mechanism / Type of Drug Interaction	Study Findings
1	Nurwulan Adi Ismaya et al. (2025)	Retrospective quantitative descriptive study; 142 outpatient asthma patients	Dexamethasone, Prednisone, Triamcinolone, Methylprednisolone, Pulmicort (Budesonide), Budesma, Seretide	Pharmacodynamic (therapeutic duplication of corticosteroids): concurrent use of oral and inhaled corticosteroids increases cumulitive steroid dose and the risk of systemic adverse effects.	Appropriateness of drug selection was 80.99% and appropriateness of dosage was 74.65%. Risk of systemic adverse effects was identified due to duplication of steroid therapy.
2	Marghli et al. (2022)	Randomized controlled trial (RCT); 50 patients with severe acute asthma	Hydrocortisone hemisuccinate IV + Nebulized Budesonide	Pharmacodynamic synergism: systemic and local anti-inflammatory effects act complementarily.	The combination therapy accelerated improvement in lung function and reduced hospitalization needs without increasing adverse effects.
3	Chipps et al. (2023)	Phase 3, double-blind RCT; 1,001 patients with mild to moderate asthma	Albuterol + Budesonide inhaler	Pharmacodynamic synergism: albuterol enhances bronchodilation, while budesonide suppresses airway inflammation.	Improved lung function and reduced the risk of exacerbations compared with albuterol monotherapy.
4	Setyoningsih et al. (2025)	Retrospective observational study; 42 hospitalized patients	Salbutamol, Aminophylline, Methylprednisolone, Combivent, Ventolin Nebulizer	Pharmacodynamic synergism and ADR: enhanced bronchodilation, but increases the risk of adverse drug reactions such as palpitations and gastrointestinal disturbances.	Effective in reducing bronchospasm, but associated with an increased risk of adverse drug reactions.
5	Momcilovic et al. (2025)	Retrospective study; 60 patients with severe asthma	Budesonide, Beclomethasone, Fluticasone, Ciclesonide, Prednisone, Methylprednisolone, Salbutamol, Formoterol, Omalizumab, Mepolizumab, Benralizumab, Reslizumab	Pharmacodynamic: β2-agonists combined with diuretics/theophylline increase the risk of hypokalemia. Pharmacokinetic: oral corticosteroids with calcium salts reduce corticosteroid bioavailability.	High prevalence of drug interactions (86.67%), particularly in patients with polypharmacy.
6	Han & Wang (2026)	Retrospective cohort study; 237 patients with persistent asthma	Budesonide, Fluticasone, Formoterol, Salmeterol	Pharmacodynamic synergism (ICS–LABA): reduces inflammation and enhances bronchodilation.	Improved asthma control, reduced emergency visits, and decreased exacerbation rates.
7	Lee et al. (2021)	Observational study; 53 adult asthma patients	Budesonide/Formoterol and Fluticasone Propionate/Salmeterol	Pharmacodynamic: irregular use of ICS leads to suboptimal inflammation control and increases the risk of exacerbations.	Irregular use of ICS increases the risk of asthma attacks, hospitalization, and oral corticosteroid use.
8	Noviyanto et al. (2025)	Retrospective study; 57 outpatient asthma patients	Oral Methylprednisolone	Pharmacodynamic: long-term corticosteroid use increases the risk of osteoporosis, hypertension, diabetes mellitus, obesity, and muscle weakness.	Therapy was appropriate; however, long-term use increases the risk of systemic adverse effects.
9	Al-Ahmad & Webb (2022)	Prospective study; 239 adult asthma patients	Fluticasone Propionate/Formoterol pMDI and Fluticasone Propionate/Salmeterol DPI	Pharmacodynamic synergism (ICS–LABA): enhances anti-inflammatory effects and bronchodilation.	Improved asthma control and lung function, reduced exacerbations, and decreased use of acute systemic corticosteroids.
10	Riska Resti et al. (2025)	Retrospective cohort study; 61 patients with moderate persistent asthma	Fluticasone Propionate/Salmeterol and Budesonide/Formoterol Fumarate	Pharmacodynamic synergism (ICS–LABA): ICS increases β2-receptor sensitivity, LABA enhances asthma control.	The ICS–LABA combination was more effective than ICS monotherapy in controlling asthma.
11	Hasti et al. (2025)	Retrospective study; 100 outpatient medical records of asthma patients	Methylprednisolone, Dexamethasone, Fluticasone, Budesonide, Salbutamol, Ipratropium Bromide, Theophylline, Aminophylline, Cetirizine	Pharmacodynamic: salbutamol + methylprednisolone increases the risk of hypokalemia. Pharmacokinetic: lansoprazole + theophylline reduces theophylline serum levels.	A total of 412 drug interaction events were identified; the majority had moderate severity (61.4%).
12	Tezcan & Yaban (2024)	Retrospective study; 96 patients with asthma/COPD	Fluticasone, Budesonide, Beclomethasone, Mometasone, Salbutamol, Salmeterol, Formoterol, Ipratropium, Tiotropium, Theophylline, Methylprednisolone, Montelukast, antihypertensives, antidiabetics, antihistamines, and PPIs	Pharmacodynamic: ipratropium + tiotropium increases anticholinergic effects; fluticasone/salmeterol + propranolol reduces the bronchodilator effect of β2-agonists. Pharmacokinetic: escitalopram + umeclidinium/vilanterol increases the risk of QT prolongation.	A total of 81 potential drug interactions were identified. The risk was higher in patients with multiple comorbidities and greater number of medications.

Abbreviations: ICS, inhaled corticosteroid; LABA, long-acting β2-agonist; pMDI, pressurized metered-dose inhaler; DPI, dry powder inhaler; ADR, adverse drug reaction; COPD, chronic obstructive pulmonary disease; PPI, proton pump inhibitor; IV, intravenous; RCT, randomized controlled trial.

Basic Concepts of Asthma and Airway Inflammation

Asthma is a chronic inflammatory disease of the airways characterized by recurrent episodes of **dyspnea, wheezing, coughing, and chest tightness** (Otavianingsih & Oktianti, 2022). This chronic condition often persists throughout an individual's lifetime, with varying degrees of severity across all age groups. Asthma may develop from childhood through adulthood and is influenced by a combination of environmental and host-related factors. Environmental risk factors include exposure to allergens, cigarette smoke, air pollution, weather changes, excessive physical activity, and emotional stress. Host-related factors, such as obesity, nutritional status, and genetic predisposition, also contribute to the development and progression of asthma (Fitria & Saftarina, 2021). Among men, asthma is frequently associated with cigarette smoking, as tobacco smoke damages the respiratory epithelium and promotes bronchial hyperresponsiveness (Hasti et al., 2025).

The pathophysiology of asthma is characterized by persistent airway inflammation involving the infiltration of inflammatory cells and damage to the airway epithelium. This inflammatory response results in mucosal edema, excessive mucus secretion, bronchial smooth muscle dysfunction, and subsequent airflow limitation. Prolonged inflammation may lead to **airway remodeling**, including fibrosis, mucus hypersecretion, epithelial injury, and angiogenesis. Environmental triggers, such as allergens, cigarette smoke, and viral infections, can further aggravate airway inflammation and bronchial hyperresponsiveness, ultimately resulting in bronchoconstriction (Fitria & Saftarina, 2021). The inflammatory process occurs in three sequential stages. The first stage is **sensitization**, during which an individual is initially exposed to allergens or other triggering factors. The second stage involves the

development of airway inflammation following repeated exposure to these triggers. Finally, subsequent exposure to the same triggers elicits the characteristic clinical manifestations of asthma, including dyspnea, wheezing, coughing, and chest tightness (Fitria & Saftarina, 2021).

The clinical manifestations of asthma commonly include wheezing, shortness of breath, coughing, and chest tightness, with symptoms typically worsening during the early morning or at night. Asthma symptoms may be triggered by viral respiratory infections, changes in weather conditions, exposure to vehicle exhaust, or strong odors. Recurrent symptoms can impair sleep quality, cause daytime fatigue, and reduce daily activities and work productivity. The primary goals of asthma management are to achieve optimal symptom control, prevent exacerbations, and reduce asthma-related morbidity and mortality. Corticosteroids play a central role in suppressing airway inflammation and maintaining long-term asthma control. Nevertheless, careful consideration should be given to the potential for **drug–drug** and **food–drug interactions**, as these interactions may compromise therapeutic effectiveness and increase the risk of adverse clinical outcomes.

Use of Inhaler Therapy in Patients with Asthma

Inhalers are drug delivery devices designed to administer medications directly into the respiratory tract through inhalation, enabling rapid drug delivery to the lungs and a faster onset of therapeutic action in patients with asthma. The most commonly used inhaler devices include **metered-dose inhalers (MDIs)**, **dry powder inhalers (DPIs)**, and **nebulizers**, each requiring different administration techniques depending on the patient's clinical condition and ability to use the device correctly (Widyastiwi et al., 2021). One of the most frequently prescribed inhaled bronchodilators is **salbutamol (albuterol)**, marketed under brand names such as **Ventolin**. Salbutamol acts by stimulating β₂-adrenergic receptors on bronchial smooth muscle, resulting in bronchodilation and rapid relief of bronchospasm. Because of its rapid onset of action, salbutamol is widely used as a rescue medication during acute asthma exacerbations (Kasrin et al., 2022). In addition, **inhaled corticosteroids (ICSs)** play a pivotal role in suppressing airway inflammation, improving asthma control, and enhancing the quality of life of patients with persistent asthma (Renzi-Lomholt et al., 2023).

The effectiveness of inhaler therapy is influenced by several factors, including the choice of medication, proper inhaler technique, and patient adherence to treatment. Inhaled drug administration delivers medication directly to the lungs, resulting in a rapid onset of action while minimizing systemic exposure compared with oral therapy. In **ICS–LABA** combination therapy, inhaled corticosteroids suppress airway inflammation, whereas **long-acting β₂-agonists (LABAs)** provide sustained bronchodilation and improve symptom control. Among LABAs, **formoterol** has a more rapid onset of action than **salmeterol** because it diffuses more rapidly to β₂-adrenergic receptors (Melviani et al., 2023). Despite their proven efficacy, inhaled medications may cause adverse effects, including tremor, palpitations, headache, dry mouth, and hoarseness, particularly in patients receiving salbutamol or nebulized Ventolin therapy (Setyoningsih et al., 2023). Therefore, comprehensive patient education on correct inhaler technique is essential to ensure optimal drug deposition in the lungs and maximize therapeutic outcomes.

Compared with orally administered medications, **food–drug interactions** involving inhaled medications are relatively uncommon because inhaled drugs largely bypass gastrointestinal absorption. Nevertheless, clinically relevant interactions may still occur at the metabolic and pharmacodynamic levels, particularly when inhaled bronchodilators are administered concomitantly with other medications that exert similar sympathomimetic effects. Excessive consumption of caffeinated beverages, including coffee, tea, and energy drinks, may potentiate the stimulant effects of β₂-agonists, thereby increasing the risk of tremor and palpitations. Furthermore, long-term use of inhaled corticosteroids may cause local adverse effects such as throat irritation and dysphonia; therefore, patients should be advised to rinse their mouths thoroughly after each inhalation to reduce these complications. Monitoring of inhaler therapy should include regular assessment of inhaler technique, medication adherence, therapeutic response, and treatment-related adverse effects to ensure optimal efficacy and safety in patients with asthma (Marghli et al., 2022).

Use of Oral Corticosteroids in Patients with Asthma

Oral corticosteroids are systemic anti-inflammatory agents widely used to control airway inflammation in patients with asthma, particularly during **moderate to severe exacerbations**. Commonly prescribed oral corticosteroids include **methylprednisolone, prednisone, dexamethasone,** and **triamcinolone** (Ismaya et al., 2025). Methylprednisolone exerts its therapeutic effects by suppressing the release of inflammatory mediators and reducing bronchial hyperresponsiveness, thereby alleviating respiratory symptoms and improving airflow. Oral corticosteroid therapy has also been shown to enhance pulmonary function and accelerate recovery in patients experiencing acute asthma exacerbations (Marghli et al., 2022). According to the **Global Initiative for Asthma (GINA) 2024** guidelines, systemic corticosteroids are effective in preventing the progression of acute asthma exacerbations and reducing the risk of relapse following an exacerbation (GINA, 2024).

The clinical effectiveness of oral corticosteroids has been demonstrated by improved asthma control and a reduced frequency of exacerbations among patients with persistent asthma (Chipps et al., 2023). Previous studies have also reported a high level of appropriateness in both treatment indications and medication selection for hospitalized and outpatient asthma populations (Timur & Novitasari, 2022). Nevertheless, prolonged use of oral corticosteroids requires careful monitoring because it may result in adverse

effects, including **hyperglycemia, hypokalemia, gastrointestinal disturbances, palpitations,** and **dysphonia** (Fadiyah et al., 2022; Setyoningsih et al., 2025). From a pharmacokinetic perspective, oral corticosteroids are absorbed through the gastrointestinal tract, metabolized primarily in the liver, and subsequently eliminated by the kidneys. The bioavailability of oral corticosteroids may be reduced when administered concomitantly with calcium supplements, particularly **calcium carbonate**, because calcium can interfere with intestinal drug absorption, thereby decreasing systemic drug exposure and potentially reducing therapeutic efficacy (Momcilovic et al., 2025).

Drug–drug and food–drug interactions involving oral corticosteroids occur predominantly during the **absorption phase**. For example, the concomitant administration of **methylprednisolone (4–16 mg)** or **prednisone (5–20 mg)** with **calcium carbonate supplements (500–1,000 mg)**, which are commonly prescribed for patients with osteoporosis, may significantly reduce corticosteroid absorption when both agents are taken within **less than two hours** of each other (Momcilovic et al., 2025). At the metabolic level, pharmacokinetic interactions are frequently observed in elderly patients and in individuals with comorbid conditions such as **diabetes mellitus, hypertension,** and **cardiovascular disease**, where polypharmacy may alter hepatic drug metabolism and elimination. In addition, food-related pharmacodynamic interactions should be considered. Consumption of high-fat foods, such as deep-fried foods or coconut milk–based dishes, may increase the risk of gastric irritation associated with corticosteroid therapy. Likewise, excessive intake of sugar-rich foods and sweetened beverages may potentiate the hyperglycemic effects of long-term corticosteroid treatment. Therefore, routine therapeutic monitoring should include periodic assessment of **blood glucose levels, serum calcium concentrations,** and regular clinical evaluation to ensure treatment effectiveness and patient safety (Muliani et al., 2025).

Use of Injectable Corticosteroids in Patients with Asthma

Injectable corticosteroids are commonly administered to patients with asthma during **moderate to severe acute exacerbations**, particularly when patients present with severe dyspnea requiring immediate treatment in the emergency department. These agents exert systemic anti-inflammatory effects by suppressing airway inflammation, reducing bronchial mucosal edema, and enhancing bronchodilator responsiveness, thereby facilitating rapid control of asthma symptoms. One of the most frequently prescribed injectable corticosteroids is **dexamethasone**, which possesses potent anti-inflammatory activity and a prolonged duration of action. Dexamethasone acts by inhibiting the release of inflammatory mediators, including prostaglandins and leukotrienes, while suppressing the activity of inflammatory cells within the respiratory tract. Marghli et al. (2022) demonstrated that the combination of **intravenous systemic corticosteroids** with **nebulized budesonide** significantly accelerated improvements in pulmonary function and reduced hospitalization rates among patients with severe acute asthma compared with systemic corticosteroid monotherapy. Similarly, Setyoningsih et al. (2025) reported that the combination of **methylprednisolone** and bronchodilator therapy effectively reduced bronchospasm and airway inflammation in hospitalized patients with asthma.

In routine clinical practice, injectable corticosteroids are frequently combined with inhaler or nebulizer therapy to achieve more rapid symptom relief and improve the control of airway inflammation during acute asthma exacerbations. Compared with oral corticosteroids, injectable formulations have a **faster onset of action** because they are delivered directly into the systemic circulation, making them particularly suitable for emergency management. In contrast, oral corticosteroids are generally preferred for long-term treatment because they are more convenient and are associated with fewer complications than repeated corticosteroid injections. Nevertheless, Noviyanto et al. (2025) reported that prolonged use of systemic corticosteroids is associated with an increased risk of **osteoporosis, hypertension, diabetes mellitus, obesity,** and **muscle weakness**. Furthermore, long-term concomitant use of systemic and inhaled corticosteroids may lead to cumulative corticosteroid exposure, thereby increasing the likelihood of systemic adverse effects. Consequently, careful therapeutic monitoring is essential to optimize treatment efficacy while minimizing potential risks.

Drug interactions involving injectable corticosteroids primarily occur **after systemic absorption**, particularly during the **distribution**, **metabolism**, and **pharmacodynamic** phases. Because injectable corticosteroids are administered intravenously or intramuscularly, they bypass gastrointestinal absorption and therefore are not subject to the absorption-related interactions commonly observed with oral formulations. Hasti et al. (2025) reported a pharmacodynamic interaction between **salbutamol** and **methylprednisolone**, which may increase the risk of **hypokalemia**. Likewise, Tezcan and Yaban (2024) found that concomitant administration of **β_2-adrenergic agonists** with certain medications may reduce bronchodilator efficacy and increase the risk of systemic adverse effects. Dietary factors should also be considered during systemic corticosteroid therapy. Diets high in **sugar** and **sodium** but low in **calcium** may exacerbate corticosteroid-induced hyperglycemia, fluid retention, and loss of bone mineral density. Therefore, therapeutic monitoring should include regular assessment of **blood glucose levels, blood pressure, electrolyte balance**, and potential drug interactions throughout the course of injectable corticosteroid therapy.

Drug Interactions Between Inhaler Therapy and Corticosteroids

The combination of inhaled bronchodilators and corticosteroids is widely used in asthma management because these agents exert complementary therapeutic effects in controlling both respiratory symptoms and airway inflammation. Inhaled bronchodilators

relieve bronchoconstriction by relaxing bronchial smooth muscle, thereby providing rapid symptom relief, whereas corticosteroids suppress chronic airway inflammation and reduce bronchial hyperresponsiveness (Setyoningsih et al., 2025). According to Otavianingsih and Oktianti (2022), the combination of **β₂-adrenergic agonists** and corticosteroids represents one of the most commonly prescribed therapeutic regimens for asthma, serving both as a **reliever therapy** for acute symptom relief and as a **controller therapy** for long-term disease management.

The predominant interaction observed between inhaled bronchodilators and corticosteroids is **pharmacodynamic** in nature. Salbutamol promotes bronchodilation through stimulation of **β₂-adrenergic receptors**, while corticosteroids suppress airway inflammation and reduce bronchial hyperresponsiveness, resulting in a synergistic therapeutic effect. In contrast, **pharmacokinetic interactions** between these agents are relatively uncommon because inhaled medications act primarily within the respiratory tract, whereas corticosteroids may exert either local or systemic effects depending on their route of administration. The dosage form also influences therapeutic performance. Inhaled formulations provide direct pulmonary drug delivery, resulting in a more rapid onset of action and lower systemic exposure than oral or injectable corticosteroid formulations (Setyoningsih et al., 2025).

Although combination therapy with inhaled bronchodilators and corticosteroids has demonstrated substantial clinical benefits, treatment-related adverse effects may still occur. Common adverse events include **palpitations, tremor, dry mouth or throat, dysphonia**, and **gastrointestinal disturbances** (Setyoningsih et al., 2025). The likelihood of adverse drug reactions may increase in patients receiving multiple concomitant medications. Therefore, patients receiving combination therapy should undergo regular therapeutic monitoring, including assessment of clinical symptoms, frequency of inhaler use, treatment response, medication adherence, and the occurrence of adverse effects throughout the course of treatment (Chipps et al., 2023).

Effectiveness and Safety of Combination Therapy

The combination of **inhaled corticosteroids (ICSs)** and **systemic corticosteroids** has been shown to be highly effective in controlling asthma symptoms and preventing acute exacerbations. Noviyanto et al. (2025) reported that the appropriateness of both the indication and dosage of **oral methylprednisolone** reached **100%** among outpatient asthma patients. Despite these favorable outcomes, treatment safety requires careful attention because prolonged systemic corticosteroid therapy may increase the risk of **hyperglycemia, hypokalemia,** and **hypertension**. Consequently, routine monitoring of **blood glucose levels** and **serum electrolytes** is strongly recommended throughout treatment (Fadiyah et al., 2022).

Patient adherence remains one of the most important determinants of successful asthma management. Lee et al. (2021) demonstrated that poor adherence to inhaler therapy significantly increased the risk of severe asthma exacerbations requiring hospitalization. Therefore, comprehensive patient education should emphasize the correct inhaler technique, appropriate medication schedules, and adherence to prescribed treatment regimens. In addition, patients receiving corticosteroid therapy should be advised to limit excessive dietary sodium intake to minimize the risk of corticosteroid-induced fluid retention and hypertension (Timur & Novitasari, 2022). Such educational interventions are essential for optimizing therapeutic outcomes while minimizing treatment-related complications.

CONCLUSIONS

Based on the findings of this **Systematic Literature Review**, inhaler therapy and corticosteroid treatment have been demonstrated to be effective in managing asthma among adult patients by improving symptom control, reducing airway inflammation, enhancing pulmonary function, and decreasing the frequency of asthma exacerbations. Inhaled therapy offers several clinical advantages, particularly its ability to deliver medications directly to the airways, resulting in a rapid local therapeutic effect while minimizing systemic adverse effects compared with oral or injectable corticosteroid formulations.

Despite these clinical benefits, inhaler and corticosteroid therapies remain susceptible to **drug–drug** and **food–drug interactions** that may compromise treatment effectiveness and patient safety, particularly among patients receiving systemic corticosteroids or multiple concomitant medications. The identified interactions include both **pharmacodynamic** and **pharmacokinetic** mechanisms, which may either increase the risk of adverse drug reactions or reduce therapeutic efficacy.

Therefore, appropriate therapeutic monitoring, rational prescribing practices, patient education regarding correct inhaler technique, and dietary counseling aimed at minimizing potential food–drug interactions are essential to optimize treatment outcomes and ensure the safe and effective management of adult patients with asthma.

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