# Asthma: Comprehensive Overview

## 1 Definition

Asthma is a chronic inflammatory disorder of the airways characterized by reversible airflow obstruction, bronchial hyperresponsiveness, and airway inflammation. It leads to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, often triggered by environmental or genetic factors.

## 2 Etiopathogenesis

Asthma results from a complex interplay of genetic, environmental, and immunological factors:

- **Genetic Factors**: Family history of asthma or atopy (e.g., allergic rhinitis, eczema) increases risk. Polymorphisms in genes like IL-4, IL-13, and ADAM33 are implicated.
- **Environmental Triggers**:
  - Allergens: Pollen, dust mites, pet dander, mold.
  - Irritants: Tobacco smoke, air pollution, chemical fumes.
  - Respiratory infections: Viral infections (e.g., rhinovirus).
  - Other: Cold air, exercise, stress, or medications (e.g., NSAIDs).
- **Immunological Factors**: Type 2 inflammation involving Th2 cells, eosinophils, and IgE production plays a central role. Non-allergic asthma may involve neutrophils or other pathways.
- **Risk Factors**: Obesity, urban living, early-life exposure to pollutants, and reduced microbial exposure (hygiene hypothesis).

## 3 Clinical Manifestations

Asthma presents with variable and episodic symptoms:

- Recurrent wheezing, particularly at night or early morning.
- Shortness of breath or dyspnea.
- Chest tightness or discomfort.
- Cough, often worse at night or with triggers.

- **Complications**: Status asthmaticus (severe, unresponsive asthma), respiratory failure, or pneumothorax.
- **Associated Features**: Allergic rhinitis, eczema, or sinusitis in atopic individuals.

# 4 Pathophysiology

Asthma involves airway inflammation, hyperresponsiveness, and obstruction. The flowchart below illustrates the key mechanisms.

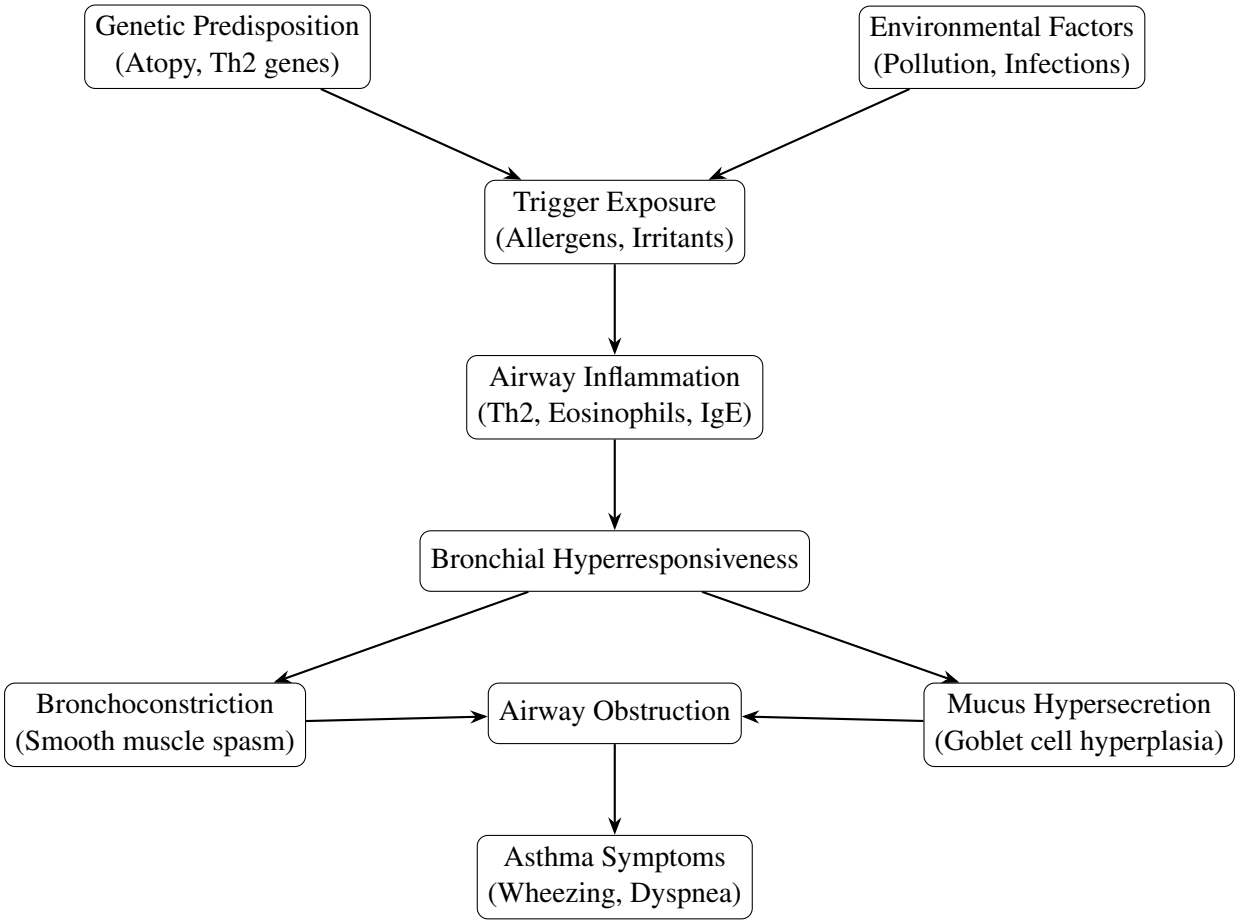


Figure 1: Pathophysiology of Asthma

# 5 Symptoms

- Wheezing (high-pitched whistling sound during expiration).
- Shortness of breath, particularly during exacerbations.
- Chest tightness or pressure.
- Cough, often nocturnal or triggered by exercise/allergens.
- Fatigue during severe episodes.
- In severe cases: Cyanosis, reduced consciousness, or silent chest (ominous sign).

# 6 Diagnosis

Diagnosis is based on clinical history, physical examination, and objective tests:

- **History**: Recurrent respiratory symptoms, trigger exposure, and family history of atopy.
- **Physical Examination**: Wheezing on auscultation, prolonged expiratory phase.
- **Spirometry**: Demonstrates reversible airflow obstruction (FEV1/FVC <0.7, improvement >12% post-bronchodilator).
- **Peak Expiratory Flow (PEF)**: Variability >20% suggests asthma.
- **Allergy Testing**: Skin prick tests or serum IgE to identify triggers.
- **Other Tests**: Fractional exhaled nitric oxide (FeNO) for eosinophilic inflammation; chest X-ray to rule out other conditions.
- **Classification**: Mild, moderate, severe, or intermittent based on symptom frequency and severity (per GINA guidelines).

# 7 Nonpharmacological Management

Nonpharmacological strategies are essential for asthma control and focus on reducing triggers and improving overall health:

- **Trigger Avoidance**:
  - Use allergen-proof bedding (e.g., dust mite covers).
  - Remove pets from sleeping areas or use air purifiers for pet dander.
  - Avoid tobacco smoke and limit exposure to air pollution.
  - Use masks or scarves in cold air to prevent exercise-induced symptoms.
- **Patient Education**: Develop an asthma action plan to recognize and manage exacerbations, including peak flow monitoring.
- **Diet and Weight Management**: Maintain a BMI of 18.5–24.9 kg/m$^2$ to reduce airway inflammation; include anti-inflammatory foods (e.g., fruits, vegetables).
- **Physical Activity**: Encourage 150 minutes/week of moderate exercise (e.g., walking, swimming) with pre-exercise bronchodilator use if needed.
- **Breathing Techniques**: Teach pursed-lip or diaphragmatic breathing to manage dyspnea during episodes.
- **Vaccinations**: Annual influenza vaccination and pneumococcal vaccine to prevent respiratory infections.
- **Environmental Control**: Maintain good indoor air quality (e.g., HEPA filters, humidity control to prevent mold).

# 8 Pharmacological Management

Pharmacological treatment is divided into relievers (for acute symptoms) and controllers (for long-term management), following a stepwise approach based on asthma severity and control (e.g., GINA guidelines):

- **Relievers (Acute Symptom Management)**:
  - **Short-Acting Beta-Agonists (SABA)**: E.g., albuterol (90–180 mcg/inhalation, 2 puffs every 4–6 hours as needed). Relaxes bronchial smooth muscle for rapid symptom relief.
  - **Short-Acting Anticholinergics**: E.g., ipratropium bromide (18 mcg/inhalation, 2–4 puffs as needed). Used in combination with SABA for severe exacerbations.
  - **Systemic Corticosteroids**: E.g., prednisone (40–60 mg/day for 5–7 days) for acute exacerbations unresponsive to inhalers.
- **Controllers (Long-Term Management)**:
  - **Inhaled Corticosteroids (ICS)**: E.g., budesonide (200–800 mcg/day) or fluticasone (100–500 mcg/day). First-line therapy to reduce airway inflammation.
  - **Long-Acting Beta-Agonists (LABA)**: E.g., salmeterol or formoterol, always used with ICS (e.g., budesonide/formoterol). Improves bronchodilation.
  - **Leukotriene Receptor Antagonists**: E.g., montelukast (10 mg/day). Effective for allergic asthma and exercise-induced bronchoconstriction.
  - **Biologics**: For severe asthma:
    - Omalizumab (anti-IgE, dosed by weight and IgE levels) for allergic asthma.
    - Mepolizumab or benralizumab (anti-IL-5) for eosinophilic asthma.
  - **Long-Acting Muscarinic Antagonists (LAMA)**: E.g., tiotropium (2.5 mcg/day) as add-on therapy for uncontrolled asthma.
  - **Theophylline**: Rarely used due to side effects; low-dose for persistent symptoms.
- **Stepwise Approach**:
  - Step 1: SABA as needed for mild intermittent asthma.
  - Step 2: Low-dose ICS for persistent asthma.
  - Step 3: Low-dose ICS + LABA or medium-dose ICS.
  - Step 4: Medium/high-dose ICS + LABA, consider LAMA or biologics.
  - Step 5: High-dose ICS + LABA + oral corticosteroids or biologics for severe asthma.
- **Monitoring**: Adjust therapy based on symptom control, lung function (FEV1), and exacerbation frequency.