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Assessment: Component 1 Written Assignment (Asthma)

1. Introduction

The respiratory system facilitates life through gas exchange, where oxygen is taken in and carbon dioxide is eliminated via alveoli in lungs. However, for individuals with asthma, this process is hindered by chronic airway inflammation and bronchoconstriction, often triggered by genetics, pollution or allergens. To manage this condition, health promotion focuses on lifestyle changes such as identifying environmental triggers, maintaining a smoke free home and eating an anti inflammatory diet. By adopting these habits and staying active, people with asthma can reduce lung irritation, improve their respiratory muscle strength and significantly enhance their overall quality of life. (Total Allergy, Asthma & Immunology, 2025).

ASTHMA:

Asthma is a common chronic respiratory disease and children are particularly vulnerable because their developing lungs retain higher levels of pollutants, increasing the risk of impaired lung function and flare ups. Inhalers remain the main treatment, but in UK, puffer substantially enhance to NHS carbon footprint, highlighting needs for more sustainable prescribing. As people age, behaviours such as smoking, vaping and spending time in crowded indoor spaces further strain respiratory health. This quality improvement project explores how environmentally conscious prescribing, particularly shifting from MDIs to lower carbon alternatives can be integrated into routine care while maintaining effective respiratory management (Donaldson and Deaney, 2025).

Risk Factor:

In the UK, allergenic factors are also important, with house dust mite (HDM) sensitisation particularly common among ethnic minority groups in central England, individuals who face a higher prevalence of poor housing and sustained exposure to environmental irritants. Air pollution is a major global health risk and a key contributor to respiratory disease, annually causing deaths around eight million. Outdoor harmful air accounts for over 4.2 million deaths, while indoor pollution causes more than 3.8 million. Pollutants such as dust, smoke, soot, ozone, sulphur dioxide and carbon monoxide are linked to a wide range of asthma outcomes, including increased incidence, hospital admissions and asthma attacks. Pollutant exposure interacts with individual biological factors, influencing the development and worsening of asthma through mechanisms such as oxidative stress, immune disruption and changes to the respiratory microbiome. Modern urban lifestyles and increased time spent indoors have intensified exposure to polluted air, with children in disadvantaged areas experiencing the greatest health impacts. (Chatkin, Correa and Santos, 2021)

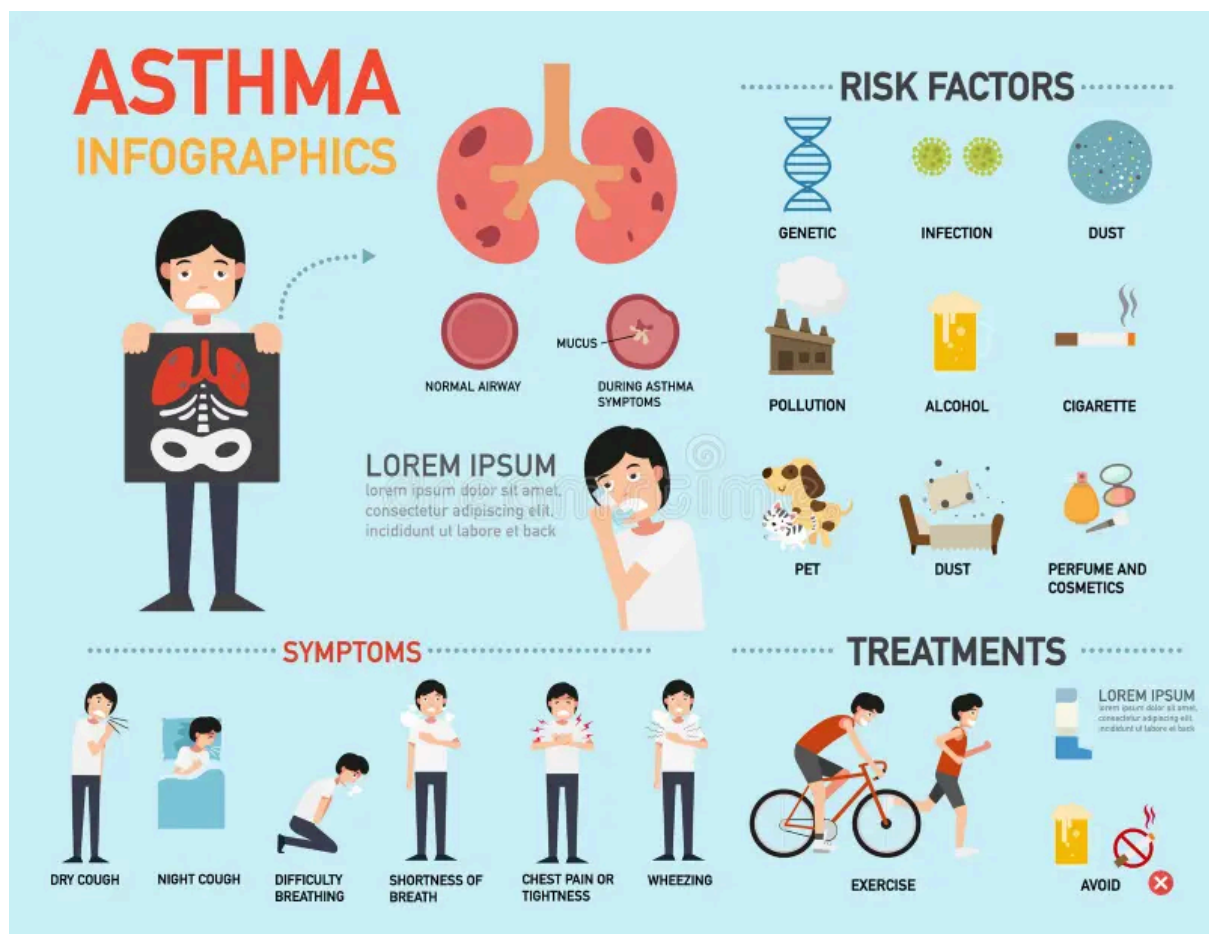


Figure 1: Asthma Diagram (Dreamstime, 2019)

2. Structure of the respiratory system

The mechanical respiration process

Mechanical respiration depends on coordinated action of the lower airways, lung tissue and respiratory muscles to move air and support gas exchange. To represent this process, a full lower tracheobronchial architecture (G0) to alveoli (G23) has been developed to simulate spontaneous breathing. The model combines fluid solid interaction to capture how pressure changes deform lung tissue with computational fluid dynamics to reproduce airflow patterns and ventilation volumes consistent with clinical observations. The mechanical behaviour of lung tissue, including its response to pressure fluctuations during breathing, is central to this simulation. Recent respiratory modelling has typically focused on small, local airway segments and has simulated autonomous breathing using a top down computational approach. This study instead developed full lower airway models from generations G0 to G23 and applied boundary conditions from the alveoli upward. Fluid solid coupling was used to capture pressure driven deformation in the alveolar region, while airflow through the rigid bronchi was analysed using computational fluid dynamics. The simulations produced spontaneous breathing outcomes including ventilation volumes, internal airflow patterns and lung tissue mechanics that closely aligned with clinical and experimental findings. This

comprehensive model provides quantitative insight into lower-airway respiratory mechanics and offers a foundation for future investigations, including studies of force induced tissue changes, cell differentiation, tumour development and the creation of disease specific pathological models. (Ou et al., 2025)

The Respiratory System

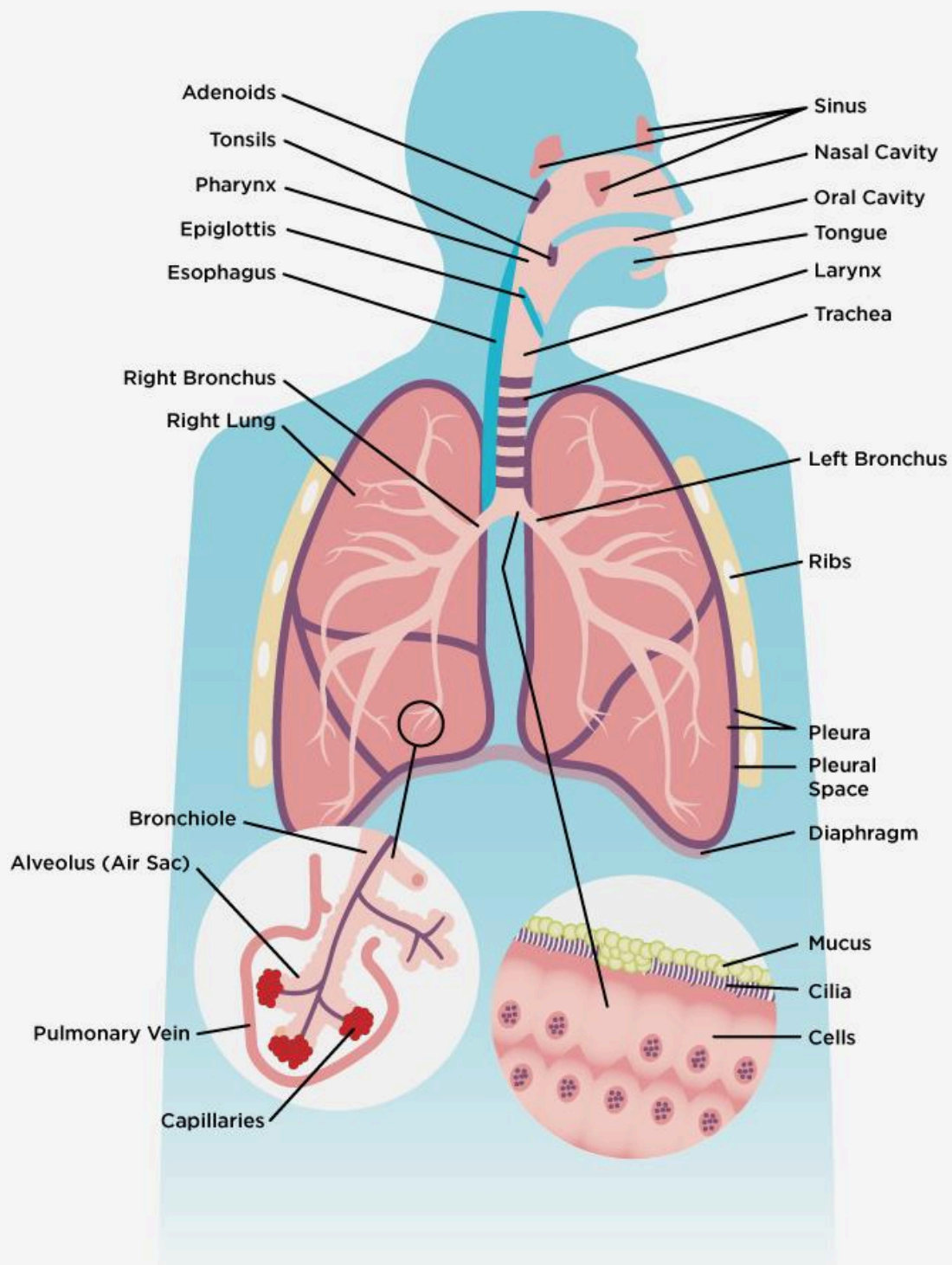


Figure 2: Respiratory System (artpictures, 2023)

3. Gas exchange in lungs

How oxygen is absorbed into the blood and carbon dioxide is released into the alveoli.

This study developed a virtual agent was employed to simulate, using digital flow analysis improve predictions inhaled CO₂ levels and alveolar gas-exchange efficiency, supporting more effective indoor ventilation design. The model integrates physiological processes such as metabolic heat release and alveolar CO₂ exchange, enabling detailed simulation of CO₂ dispersion around the body. By incorporating both upper and lower airways, the CSP more accurately estimates alveolar CO₂ partial pressure and metabolically generated CO₂ emission rates, including reductions associated with decreased tidal volume in poor-quality indoor air. The findings also show that inhaled CO₂ concentrations vary with airflow patterns around the body. Gas exchange itself occurs across the thin air blood barrier, where oxygen penetrates into pulmonary blood vessels and carbon dioxide disperses into alveoli for intake. Efficiency of this process depends on the structural integrity of the terminal respiratory units, as abnormalities can impair oxygen uptake and CO₂ removal (Kuga et al., 2022).

Impact of respiratory irritants on lung tissue inflammation and breathing efficiency

Respiratory environment in adults is characterised by chronic exposure to irritants such as pollutants, chemicals and microbes, which can reach the alveoli, the key site of gas exchange. Because excessive inflammation in these structures can impair lung function, tightly regulated immune responses are required to clear harmful agents and repair damaged tissue. This repair process depends on coordinated activity between immune cells, cytokines and key signaling molecules, such as fibroblast growth factor 10 (Fgf10), a major regulator of organ development and tissue repair. Evidence suggests a bidirectional relationship between inflammation and Fgf10 but the mechanisms involved both during development and in disease remain poorly understood. This review summarises current knowledge on how Fgf10 interacts with inflammatory pathways in the lung and highlights priorities for future research (Marega, Chen and Bellusci, 2021)

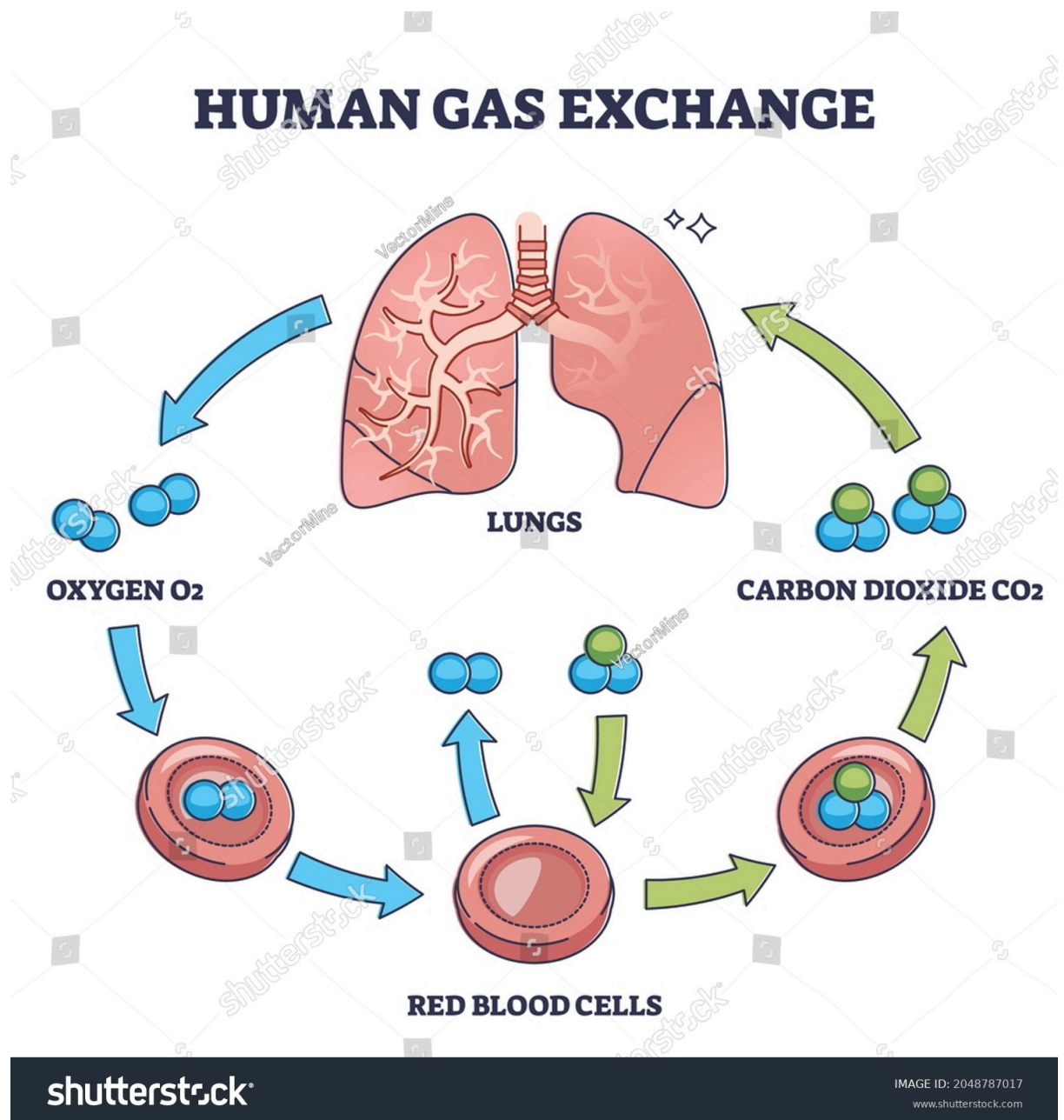


FIGURE 3: Gas Exchange In Lungs (Alexander_P, 2021)

4. Recording and tracking respiratory functions

Recording and tracking lung flow measurement help asthma condition monitoring and control

Monitoring expiratory flow (PEF) readings gives people with asthma an objective way to assess their lung function and manage their condition more safely. Because PEF provides a measurable indicator of airway narrowing, it can support timely self-management decisions and help clinicians adjust treatment when needed. This is especially valuable since relying only on symptoms can be subjective and may vary

widely based on individual perception. Asthma is the most common long term condition in children making regular monitoring crucial for timely self management and informed clinical decisions. Traditional approaches symptom tracking and peak expiratory flow (PEF) are limited by subjective perception, poor correlation with true asthma activity and low adherence among young people. Earlier mechanical tools aimed to improve objectivity but were impractical for daily use. Newer wearable sensor based mHealth technologies offer automated and continuous monitoring, addressing many limitations of conventional methods, though most remain in early development. More research is needed to determine their health value, accessibility and prolong effect on paediatric asthma management (Rhee and Katchamat, 2025).

Importance of monitoring respiratory functions in clinical settings

Monitoring respiratory function is vital in both acute and chronic conditions because it enables early detection of deterioration and timely intervention. In acute respiratory failure, non-invasive respiratory support can reduce breathing effort and prevent intubation, but inadequate monitoring risks muscle fatigue, cardiovascular strain and worsening oxygenation, making close assessment of respiratory drive, effort and imaging essential. In progressive neuromuscular diseases, weakening muscles reduce lung capacity, so practical pulmonary monitoring is key to identifying declining airway clearance and emerging respiratory failure. Lung function is typically assessed through measures of volume, flow, pressure and gas exchange and tracking multiple parameters over time provides the most accurate clinical picture. This manuscript reviews the most practical tests used in routine care and how they support evaluation of disease status, respiratory morbidity and patient management (Miller and Mayer, 2020).

The consequences with out tracking and recording of a patient with asthma

Insufficient tracking and documentation in asthma management can negatively affect both patient outcomes and healthcare system efficiency. Without consistent monitoring, clinicians lack the longitudinal data needed to assess symptom patterns, lung function and treatment adherence factors essential for optimising treatment decisions. Evidence also shows that structured data collection and digital communication tools can support timely specialist referral, guide treatment adjustments such as biologic therapy initiation and reduce staff workload by automatically identifying patients who require follow up. In the absence of such systems, healthcare teams face greater administrative burden and increased operational

costs. This study examined both sexes admitted for asthma exacerbations receive different hospital care. Clear sex differences were found in COPD management, with females receiving more specialist input and certain treatments, alongside lower mortality. In asthma, in hospital care was similar between sexes, but females both adults and children were more likely to be readmitted. (Whittaker et al., 2025)

5. Recommendations

Evidence Based Strategies And Health Promotion, Recommendations Within Health And Social Care proposed

Evidence based strategies for UK health and social care prioritise improving end of life care, strengthening evidence based practice and reducing health inequities through coordinated policy and service delivery. In the end of life care specifically, recommendations emphasise initiating treatment planning conversations early by a span of professionals or by patients rather than waiting for ideal moment. They also call for standardised records of care preferences and advanced communication training for key staff to ensure discussions are high quality and aligned with patient wishes. Together, these proposals offer practical, consensus driven actions for policymakers, educators and practitioners involved in end of life care planning. Despite national guidance on the good end of life care, delivery across the UK remains inconsistent. This study explored the factors influencing advance care planning in areas where evidence based practice is lacking, using surveys, interviews and a large consensus building exercise involving individuals in the final stage, those close to them and healthcare professionals. They also identified priority elements for a formalised record of care preferences, key staff groups needing advanced communication training and the communication skills that should be emphasised. The findings offer practical, actionable recommendations for improving end of life care, relevant to policymakers, educators and frontline practitioners. (Wu et al., 2024)

Enhancing The Overall Quality Of Life For Asthma Patients By Implementing Transformational Lifestyle Changes Via Controlling Environmental Triggers And Adopting Balance Daily Routines

Improving the health and well being of people with asthma can be supported through lifestyle changes that address several factors at the same time. Combination of lifestyle interventions typically involving healthier eating, increased physical activity and stopping smoking have been shown to benefit respiratory conditions by reducing symptoms, improving quality of life, enhancing exercise capacity and supporting healthier body weight. Although much of the

evidence comes from COPD research, the same principles apply to asthma, where changes in diet and activity can help lower inflammation, improve airway function and strengthen overall fitness. These approaches complement medical treatment and may contribute to more stable long term asthma control by targeting the broader behavioural and physiological factors that influence respiratory health. Healthy lifestyle behaviours help protect against asthma and COPD and support better disease management. This review examined CLIs targeting at least two lifestyle factors and identified 56 studies: nine on asthma and 47 on COPD, with none focused on prevention. Most interventions combined diet and physical activity and in COPD often included smoking cessation. Across studies, CLIs improved standard of life, breathing difficulties and level of physical fitness, while limited behavioural data showed gains in diet and activity levels. Overall, the findings show that CLIs are successful in managing asthma and COPD and highlight the need to extend such strategies to people at increased risk of developing these conditions. (Born et al., 2024)

6. Conclusion

Asthma remains a complex chronic respiratory condition shaped by a combination of genetic susceptibility, environmental exposures and behavioural risk factors, all of which interact with the physical and performance characteristics of the respiratory system. Because effective gas exchange depends on the integrity of the conducting airways and alveolar units, any inflammation driven narrowing or obstruction can significantly impair oxygen uptake and carbon dioxide removal, contributing to the clinical manifestations of asthma. Accurate assessment of respiratory function through symptom monitoring, spirometry, peak flow measurements and emerging sensor-based technologies plays a critical role in detecting early deterioration and guiding timely intervention. Evidence based strategies to improve asthma outcomes emphasise comprehensive risk factor reduction, personalised management plans, optimisation of inhaler technique and the integration of healthy habit adjustment such as quitting smoking, improved diet and increased physical activity. Collectively these approaches underscore the importance of combining physiological understanding, systematic monitoring and targeted behavioural interventions to enhance disease control and support long term respiratory health.

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