MEDICO RESEARCH CHRONICLES
ISSN NO. 2394-3971
DOI No. 10.26838/MEDRECH.2023.10.3.702
Contents available at www.medrech.com

ASTHMA MANAGEMENT: A CALL TO ACTION IN A CHANGING ENVIRONMENTAL PARADIGM

Dr. Bindu Jain[1], Dr. Vibhor Kumar Jain*[2]
1. Professor, JK College of Pharmacy, Bilaspur (C. G.), India
2. Professor, JK Institute of Pharmaceutical Education and Research, Bilaspur (C. G.), India

ARTICLE INFO

Article History
Received: April 2023
Accepted: June 2023
Key Words: Asthma, Environmental factors, Air pollution, Allergens, Climate change, Asthma management.

***Corresponding author**
Dr. Vibhor Kumar Jain

ABSTRACT

This review article examines the impact of environmental changes on asthma prevalence and severity, emphasizing the need for proactive management strategies. It explores the various environmental triggers of asthma, including air pollution, allergens, and indoor air quality. Additionally, it discusses the influence of climate change on asthma, specifically addressing the increased pollen season, extreme weather events, and heat-related effects. The article concludes by advocating for environmental policies, public awareness campaigns, healthcare provider guidance, and community engagement as crucial components of a comprehensive approach to asthma management in the face of a changing environmental paradigm.

REVIEW ARTICLE

2023, www.medrech.com

1. INTRODUCTION

1.1 Background of Asthma

Asthma is a chronic respiratory condition that affects people of all ages, causing inflammation and narrowing of the airways. Symptoms can range from mild to severe and include wheezing, coughing, breathlessness, and chest tightness.[1]

The exact cause of asthma is not fully understood, but it is believed to be influenced by both genetic and environmental factors. Individuals with a family history of asthma or allergies are more prone to developing the condition. Additionally, exposure to specific environmental triggers can worsen asthma symptoms.

Common triggers for asthma vary from person to person but can include air pollution, allergens such as pollen, dust mites, pet dander, and mold spores, as well as poor indoor air quality. These triggers can irritate and inflame the airways, leading to constriction and a flare-up of symptoms.

Managing asthma involves controlling symptoms, preventing exacerbations, and improving lung function. This typically includes a combination of medications, lifestyle adjustments, and avoiding triggers. Medications used for asthma include bronchodilators to relieve symptoms and anti-inflammatory drugs to reduce airway inflammation.

Extensive research has been conducted to better understand asthma and improve management strategies. This has resulted in innovative treatments, more effective medications, and personalized care plans for asthma patients.[2]

By gaining a deeper understanding of asthma triggers and their impact on respiratory health, we can take proactive measures to reduce exposure and provide better care for asthma patients. This includes advocating for clean air initiatives, promoting sustainable practices, and educating healthcare providers and the public about the importance of asthma management in our changing environment.[3]

1.2 Link between Environmental Factors and Asthma[4,5]

Asthma is a multifactorial disease influenced by a combination of genetic and environmental factors. While genetics plays a role in an individual's susceptibility to asthma, environmental factors have a significant impact on the development, prevalence, and severity of the condition.

1. Air Pollution:

Air pollution, particularly outdoor air pollution, has been strongly linked to asthma. Fine particulate matter (PM2.5), nitrogen dioxide (NO2), ozone (O3), and other pollutants released from vehicle emissions, industrial activities, and fossil fuel combustion can irritate the airways and trigger asthma symptoms. Long-term exposure to air pollution can lead to chronic inflammation and worsen lung function, making individuals more susceptible to asthma.

2. Allergens:

Allergens are substances that can trigger allergic reactions, including asthma attacks, in susceptible individuals. Common allergens associated with asthma include pollen, dust mites, pet dander, and mold spores. Exposure to these allergens can cause an immune response in the airways, leading to inflammation, airway constriction, and asthma symptoms. Changes in environmental conditions, such as climate change and altered weather patterns, can impact the distribution and abundance of allergens, potentially increasing the risk of asthma.

3. Indoor Air Quality:

Indoor air quality plays a significant role in asthma management, especially considering that people spend a significant amount of time indoors. Poor indoor air quality, caused by factors such as tobacco smoke, volatile organic compounds (VOCs) from household products, and inadequate ventilation, can exacerbate asthma symptoms. Secondhand smoke is particularly harmful and can trigger asthma attacks in both children and adults. Improving indoor air quality through smoke-free environments, proper ventilation, and reduction of indoor allergens is crucial for individuals with asthma.

4. Climate Change:

Climate change has emerged as a significant concern in relation to asthma. It affects asthma through various mechanisms:

a. Increased Pollen Season: Rising temperatures and altered weather patterns can result in prolonged and more intense pollen seasons. This can worsen symptoms for individuals with allergic asthma.

b. Extreme Weather Events: Climate change contributes to more frequent and severe extreme weather events, such as hurricanes, floods, and wildfires. These events can release harmful pollutants into the air, damage infrastructure, and displace populations, increasing the risk of asthma exacerbations.

c. Heat and Air Quality: Higher temperatures and increased ground-level ozone formation due to climate change can directly impact asthma. Heat can trigger asthma symptoms, while elevated ozone levels can cause airway inflammation and worsen respiratory function.

Understanding the link between environmental factors and asthma is crucial for developing effective prevention and management strategies. Mitigating air pollution, reducing exposure to allergens,

improving indoor air quality, and addressing the impact of climate change are key components in creating a healthier environment for individuals with asthma. Additionally, public awareness, education, and policy initiatives are necessary to drive positive changes and promote respiratory health in the face of changing environmental conditions.

2. Environmental Triggers of Asthma[6]

Air pollution is a significant trigger for asthma, and various sources contribute to its harmful effects on respiratory health.

2.1 Impact of Vehicle Emissions

Vehicle emissions play a major role in air pollution and its association with asthma. Combustion engines release pollutants such as nitrogen oxides (NOx), particulate matter (PM), and volatile organic compounds (VOCs). These substances can irritate the airways and trigger asthma symptoms. Fine particulate matter, specifically PM2.5, is particularly concerning as it can penetrate deep into the lungs, causing inflammation and respiratory distress in people with asthma. Living close to busy roads and areas with high traffic increases the risk of exposure to these harmful pollutants.

2.2 Industrial Activities and Asthma

Industrial activities, including manufacturing, power generation, and construction, contribute significantly to air pollution. These activities release pollutants such as sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter (PM), among others. Living near industrial areas can expose individuals to higher concentrations of these pollutants, increasing the risk of developing and exacerbating asthma. Workers in industrial settings may also develop occupational asthma due to exposure to specific substances or allergens related to their work environment.

2.3 Fossil Fuel Combustion and Asthma

Burning fossil fuels releases pollutants like SO2, NOx, PM, and CO2, contributing to air pollution and asthma exacerbation. Minimizing respiratory health impacts requires reducing air pollution from vehicle emissions, industrial activities, and fossil fuel combustion. Implementing stricter emissions standards, promoting cleaner energy alternatives, and adopting sustainable transportation policies are crucial steps. Public awareness, education, and advocacy for environmental regulations are vital in addressing the harmful effects of air pollution on asthma and promoting respiratory well-being.

3. Allergens and Asthma[7]

Allergens are substances that can trigger an allergic reaction in people who are allergic to them. Common allergens that can trigger asthma include:

3.1 Pollen Allergens[8]

Pollen is a major trigger of asthma. It can cause symptoms such as wheezing, shortness of breath, chest tightness, and coughing. Pollen allergies are most common during the spring and fall, when pollen levels are highest.

3.2 Dust Mites and Asthma

Dust mites are another major trigger of asthma. They are found in all homes, but they are more common in homes with carpets, upholstered furniture, and other soft surfaces. Dust mites can trigger asthma symptoms in people who are allergic to them.

3.3. Pet Dander and Asthma

Pet dander is another common trigger of asthma. It is made up of tiny flakes of skin that are shed by pets. Pet dander can trigger asthma symptoms in people who are allergic to it.

3.4. Mold Spores and Asthma

Mold spores are a less common trigger of asthma, but they can still cause symptoms in some people. Mold spores can grow in damp and humid environments, such as bathrooms, basements, and attics. Mold spores can trigger asthma symptoms in people who are allergic to it.

Reducing Exposure to Allergens

There are a number of things that people can do to reduce their exposure to allergens, such as:

- Avoiding areas with high levels of pollen or mold. This includes staying indoors on days when pollen or mold counts are high.
- Keeping homes clean and free of dust. This includes vacuuming and dusting regularly.
- Removing pets from the home. This is the only way to completely eliminate pet dander from the home.
- Using air purifiers. Air purifiers can help to remove allergens from the air.

By taking these steps, people can help to reduce their risk of developing asthma or having an asthma attack.

4. Environmental Triggers of Asthma[9]

Indoor air quality plays a significant role in asthma management, as exposure to certain pollutants and inadequate ventilation can worsen asthma symptoms and trigger asthma attacks.

4.1 Tobacco Smoke and Asthma:

Tobacco smoke, whether from active smoking or secondhand smoke, is a potent trigger for asthma. The chemicals and particles present in tobacco smoke can irritate the airways, leading to inflammation and constriction. In addition to increasing the risk of developing asthma, exposure to tobacco smoke can worsen existing asthma symptoms and increase the frequency and severity of asthma attacks. It is crucial for individuals with asthma to avoid smoking and minimize exposure to secondhand smoke to maintain optimal respiratory health.

4.2 Volatile Organic Compounds (VOCs) and Asthma:

Volatile organic compounds (VOCs) are chemicals that can be released as gases from various household products, including cleaning supplies, paints, adhesives, and furniture. These compounds can contribute to poor indoor air quality and trigger asthma symptoms. Common VOCs include formaldehyde, benzene, and toluene, which can irritate the airways and cause respiratory distress. Individuals with asthma should be cautious when using or exposed to products containing VOCs, and adequate ventilation should be maintained during their use.

4.3 Inadequate Ventilation and Asthma:

Inadequate indoor ventilation increases indoor air pollutant levels, including asthma triggers. Proper ventilation, such as opening windows, using exhaust fans, and maintaining air conditioning systems, dilutes and removes pollutants, improving air quality. Enhancing indoor air quality is vital for asthma sufferers. Implementing smoke-free environments, avoiding tobacco smoke, using low VOC products, and regular cleaning to reduce allergens contribute to better air quality. Creating a clean and well-ventilated living environment reduces asthma triggers and promotes respiratory health for individuals with asthma.

5. Climate Change and Asthma[10,11]

3.1 Increased Pollen Season and Asthma:

Climate change affects individuals with allergic asthma by altering pollen seasons. Rising temperatures and changed weather patterns lead to longer and more intense pollen seasons. Warmer temperatures increase pollen production, while elevated carbon dioxide levels stimulate plant growth and pollen production. Allergic asthma sufferers may experience more frequent and severe symptoms due to prolonged exposure to allergens.

Managing allergic asthma requires awareness of local pollen seasons, monitoring pollen forecasts, and taking preventive measures. These include staying indoors during peak pollen times, using air purifiers, keeping windows closed, and practicing good personal hygiene. Consulting healthcare professionals and following prescribed medications and preventive strategies are

crucial for managing asthma triggered by increased pollen seasons.

Collective efforts to address climate change are vital in reducing its impact on asthma. Actions such as reducing greenhouse gas emissions, promoting sustainable practices, and supporting climate change policies can alleviate the burden on asthma patients and promote respiratory health. Ongoing research and monitoring of the link between climate change and asthma help inform targeted interventions and improve understanding of how environmental changes affect respiratory health.

Furthermore, climate change increases the frequency and intensity of extreme weather events, which pose unique challenges and exacerbate asthma symptoms. Events like hurricanes, floods, and wildfires can have significant implications for individuals with asthma, necessitating additional preparedness and management strategies.

5.2 Hurricanes and Asthma: [12]

Hurricanes can indirectly impact asthma by disrupting healthcare services and medication availability, promoting mold growth due to high humidity, and releasing pollutants from debris. Individuals with asthma should have an emergency plan, access to medications, and follow evacuation guidelines during hurricanes.

5.3 Floods and Asthma:

Flooding events, whether caused by heavy rainfall or overflowing water bodies, can have adverse effects on individuals with asthma. Floodwaters can lead to the growth of mold and bacteria in buildings, homes, and other affected areas. Inhalation of mold spores and exposure to bacterial contaminants can trigger asthma symptoms and respiratory infections. Moreover, the increased moisture from flooding can contribute to increased humidity levels, which may promote the proliferation of dust mites and other allergens. It is essential to address water damage promptly, remove or dry out affected materials, and ensure proper ventilation to mitigate the risk of mold growth and allergen exposure.

5.4 Wildfires and Asthma:

Wildfires emit smoke and pollutants that can trigger asthma symptoms and worsen respiratory conditions. Individuals with asthma should monitor air quality advisories, stay indoors, and use air purifiers during wildfires. Preparedness, access to medications, and timely evacuation are crucial. Raising awareness, providing information on asthma management during extreme weather events, and ensuring healthcare services are available are important public health measures. Mitigating climate change and reducing the frequency and severity of wildfires are vital for protecting individuals with asthma and promoting respiratory well-being.

5.5 Heat and Air Quality: Implications for Asthma[13]

Rising temperatures associated with climate change have implications for both heat-related illnesses and air quality, both of which can impact individuals with asthma.

High temperatures can exacerbate asthma symptoms and increase the risk of asthma attacks. Heat and humidity can lead to increased airway inflammation and bronchoconstriction, making it more challenging for individuals with asthma to breathe. Additionally, extreme heat can contribute to the formation of ground-level ozone, a pollutant that can irritate the airways and worsen respiratory conditions. The combination of heat and poor air quality can create a challenging environment for individuals with asthma.

To mitigate the impact of heat and air quality on asthma, it is important for individuals with asthma to take necessary precautions during hot weather conditions. These may include:

1. Staying hydrated: Drinking plenty of fluids helps maintain proper hydration and can help alleviate symptoms.

2. Avoiding outdoor activities during the hottest times: Limiting exposure to extreme heat can reduce the risk of heat-related asthma symptoms.

3. Seeking cool environments: Spending time in air-conditioned spaces or using fans can help alleviate discomfort caused by heat.

4. Monitoring air quality: Paying attention to air quality alerts and avoiding outdoor activities on days with poor air quality, high pollution levels, or increased ozone levels can help reduce exposure to triggers.

5. Following asthma management plan: Adhering to prescribed medications and preventive strategies outlined in an asthma management plan is crucial in mitigating the impact of heat and air quality on asthma.

Public health efforts should focus on raising awareness about the effects of heat and air quality on asthma, providing education on preventive measures, and ensuring access to cool environments during extreme heat events. Additionally, measures to reduce greenhouse gas emissions and improve air quality can help mitigate the impact of climate change on respiratory health, ultimately benefiting individuals with asthma.

6. Call to Action in Asthma Management[14,15]

A comprehensive approach to asthma management requires the implementation of environmental policies aimed at preventing and reducing asthma triggers. The following strategies can be instrumental in improving air quality and minimizing the impact of environmental factors on asthma:

6.1 Reducing Air Pollution:

Air pollution worsens asthma and respiratory health. To prevent and manage asthma, reducing air pollution is crucial. This involves regulating industrial emissions, promoting clean transportation, and encouraging renewable energy. Efforts should target harmful pollutants like particulate matter and nitrogen oxides that trigger asthma symptoms. Collaborative action by government, industries, and communities is necessary to develop and enforce effective policies for air pollution reduction.

6.2 Promoting Clean Energy Alternatives:

Transitioning to clean energy benefits asthma management. Renewable sources like solar and wind power produce minimal air pollution. Promoting clean energy reduces pollutants that worsen asthma symptoms. Government incentives, research funding, and public awareness campaigns can drive clean energy adoption, improving air quality and reducing asthma triggers.

6.3 Stricter Emissions Standards:

Implementing stricter emissions standards for industries, vehicles, and other pollution sources can significantly contribute to asthma prevention. By setting more stringent limits on pollutant emissions, such as sulfur dioxide, nitrogen oxides, and particulate matter, governments can help reduce the overall pollution levels in the environment. This can have a direct impact on air quality, leading to improved respiratory health for individuals with asthma. Collaboration between regulatory agencies, industry stakeholders, and environmental organizations is necessary to establish and enforce these standards effectively.

6.4 Public Awareness and Education

Public awareness and education are key components in the effective management and prevention of asthma. By increasing understanding of the link between the environment and asthma, promoting preventive measures, and encouraging sustainable practices, we can empower individuals and communities to take proactive steps in reducing asthma triggers and promoting respiratory health.

6.4.1 Understanding the Link between Environment and Asthma:

Raising awareness about the relationship between environmental factors

and asthma is crucial in helping individuals understand how their surroundings can impact their respiratory health. Educational campaigns, community workshops, and healthcare provider initiatives can provide information on common environmental triggers, such as air pollution, allergens, and climate change, and their specific effects on asthma. By fostering understanding, individuals can make informed decisions and take appropriate actions to minimize exposure to triggers and manage their asthma effectively.

6.4.2 Preventive Measures for Asthma Management:

Promoting preventive measures is essential in reducing asthma exacerbations and improving overall asthma control. Education initiatives should emphasize the importance of adhering to prescribed asthma medications, following an asthma action plan, and regularly monitoring asthma symptoms. Individuals should be educated on identifying and avoiding known triggers, practicing good indoor air quality habits, and taking preventive steps during extreme weather events. Empowering individuals with the knowledge and tools to proactively manage their asthma can help reduce the frequency and severity of asthma attacks, leading to better health outcomes.

6.4.3 Promoting Sustainable Practices:

Sustainable practices play a vital role in asthma prevention and management. Public awareness campaigns can educate people about energy conservation, waste reduction, and responsible chemical use, all of which contribute to better respiratory health. By reducing energy consumption, individuals can decrease air pollution and greenhouse gas emissions. Sustainable waste management prevents the buildup of allergens and irritants in indoor environments. Using eco-friendly household products and promoting sustainable transportation options further improve air quality and reduce exposure to asthma triggers.

7. Call to Action in Asthma Management

Healthcare providers play a crucial role in asthma management and prevention. By staying updated on environmental research, educating patients on proactive management strategies, providing personalized asthma action plans, and advocating for respiratory health policies, healthcare professionals can make a significant impact in improving asthma outcomes.

7.1 Staying Updated on Environmental Research:

Healthcare providers should stay informed about the latest research findings and developments in environmental factors associated with asthma. This includes understanding the effects of air pollution, allergens, climate change, and other environmental triggers on respiratory health. By staying updated, healthcare providers can provide accurate information to their patients, make informed treatment decisions, and offer relevant advice on minimizing exposure to environmental triggers.

7.2 Educating Patients on Proactive Management Strategies:

Healthcare providers should educate patients on managing asthma effectively. This includes teaching them to recognize and avoid triggers like air pollution and allergens. They should emphasize medication adherence, proper inhaler technique, and regular monitoring. Providing information on lifestyle modifications, such as maintaining a clean indoor environment and practicing good hygiene, helps minimize asthma symptoms and improve respiratory health.

7.3 Providing Personalized Asthma Action Plans:

Each individual's asthma management needs are unique, and healthcare providers should develop personalized asthma action plans for their patients. These plans should outline specific steps to be taken during

different asthma scenarios, such as identifying symptoms, adjusting medication use, and seeking medical assistance when necessary. Personalized action plans empower individuals to take control of their asthma and provide clear guidance on managing their condition effectively. Healthcare providers should ensure that patients understand their action plans and have the necessary resources to implement them.

7.4 Advocating for Respiratory Health Policies[16]:

Healthcare providers can advocate for respiratory health by collaborating with organizations and policymakers to raise awareness about the impact of environmental factors on asthma. They can stay updated on research, educate patients, provide personalized action plans, and support policies that aim to prevent and manage asthma. Community engagement is crucial in fostering support networks and implementing strategies to address local environmental challenges. By involving community members and organizations, we can create a supportive environment that empowers individuals to manage asthma effectively and reduce exposure to triggers.

7.5 Support Networks and Behavioral Changes:

Community support networks play a vital role in asthma management, providing a platform for individuals to connect, share experiences, and gain practical advice. These networks offer emotional support, knowledge sharing, and a sense of belonging, empowering individuals to make positive changes. Promoting behavioral changes through community engagement is essential, raising awareness about lifestyle modifications and providing practical guidance on maintaining a clean indoor environment, practicing good hygiene, and avoiding triggers. By encouraging these changes, we can create a supportive environment that promotes respiratory health and effective asthma management.

8. Conclusion: Proactive Asthma Management in a Changing Environment

Asthma management must adapt to changing environmental conditions. Factors like air pollution, allergens, climate change, and indoor air quality significantly impact respiratory health. To address these challenges, environmental policies should focus on reducing air pollution and promoting clean energy alternatives. Public awareness and education are key to empowering individuals to adopt preventive measures and sustainable practices. Healthcare providers play a crucial role in educating patients and advocating for respiratory health policies. Tailoring strategies to local environmental challenges and engaging communities can foster support networks and promote behavioral changes. Together, we can reduce asthma triggers, improve control, and enhance the quality of life for individuals with asthma.

REFERENCES:

1. Jain, Vibhor Kumar. "Mast cell stabilizing effect of hydroalcoholic extract of Jasminum sambac leaves against compound 48/80-induced degranulation." *International Journal of Green Pharmacy (IJGP)* 12, no. 02 (2018).
2. Jain, V.K., Ahirwar, D., Jain, B. and Ahirwar, B., 2018. Evaluation of Acute Oral Toxicity and Mast Cell Degranulation of an aqueous ethanolic extract of Tritium aestivum Linn. *Research Journal of Pharmacy and Technology*, *11*(2), pp.643-648.
3. Jain, B., Ahirwar, D., Jain, V.K. and Ahirwar, B., 2018. Comparison of Phenolic Content and Antioxidant Properties of Aqueous Ethanolic Extracts of Leaves of Mangifera indica L. and Nicotiana tabacum L. *Research Journal of Pharmacy and Technology*, *11*(2), pp.717-722.

4. Jain, B., Jain, V.K., Farooqui, M.A., Mourya, R., Patel, B. and Bhattacharya, A., From bench to bedside: Targeting receptors in asthma treatment. *Eur. Chem. Bull. 2023,* 12(Special Issue 4), 10185-10197
5. Jain, B., 2018. Acute oral toxicity and in vitro leukotriene inhibitory property of hydroalcoholic extract of Nicotiana tabacum in guinea pig lung strips. *International Journal of Green Pharmacy (IJGP)*, *12*(02).
6. Dwivedi, N. and Dubey, A.D., Therapeutic Potential of Polyphenols and Flavonoids for Asthma: A Structural Activity and Mechanistic Perspective., *Eur. Chem. Bull. 2023,* 12(Special Issue 4), 5588–5606
7. Qutubuddin, M., Singh, S.M., Nayak, C., Koley, M. and Saha, S., 2019. A systematic review of controlled trials of homeopathy in bronchial asthma. *Complementary medicine research*, *26*(2), pp.111-117.
8. Jain, V.K., 2018. Mast cell stabilizing effect of hydroalcoholic extract of Jasminum sambac leaves against compound 48/80-induced degranulation. *International Journal of Green Pharmacy (IJGP)*, *12*(02).
9. Azalim, S.P., Camargos, P., Alves, A.L., Senna, M.I.B., Sakurai, E. and Schwabe Keller, W., 2014. Exposure to environmental factors and relationship to allergic rhinitis and/or asthma. *Annals of Agricultural and Environmental Medicine*, *21*(1).
10. Diette, G.B., McCormack, M.C., Hansel, N.N., Breysse, P.N. and Matsui, E.C., 2008. Environmental issues in managing asthma. *Respiratory care*, *53*(5), pp.602-617.
11. Qiang, W., Lee, H.F., Lin, Z. and Wong, D.W., 2020. Revisiting the impact of vehicle emissions and other contributors to air pollution in urban built-up areas: A dynamic spatial econometric analysis. *Science of The Total Environment*, *740*, p.140098.
12. Eguiluz-Gracia, I., Mathioudakis, A.G., Bartel, S., Vijverberg, S.J., Fuertes, E., Comberiati, P., Cai, Y.S., Tomazic, P.V., Diamant, Z., Vestbo, J. and Galan, C., 2020. The need for clean air: the way air pollution and climate change affect allergic rhinitis and asthma. *Allergy*, *75*(9), pp.2170-2184.
13. Baur, X., Aasen, T.B., Burge, P.S., Heederik, D., Henneberger, P.K., Maestrelli, P., Schlünssen, V., Vandenplas, O. and Wilken, D., 2012. The management of work-related asthma guidelines: a broader perspective. *European Respiratory Review*, *21*(124), pp.125-139.
14. Lemanske Jr, R.F., Kakumanu, S., Shanovich, K., Antos, N., Cloutier, M.M., Mazyck, D., Phipatanakul, W., Schantz, S., Szefler, S., Vandlik, R. and Williams, P., 2016. Creation and implementation of SAMPRO™: A school-based asthma management program. *Journal of Allergy and Clinical Immunology*, *138*(3), pp.711-723.
15. Papi, A., Haughney, J., Virchow, J.C., Roche, N., Palkonen, S. and Price, D., 2011. Inhaler devices for asthma: a call for action in a neglected field. *European Respiratory Journal*, *37*(5), pp.982-985.
16. Celedón, J.C., Roman, J., Schraufnagel, D.E., Thomas, A., Samet, J. and a working group of the Health Equality Subcommittee of the American Thoracic Society, 2014. Respiratory health equality in the United States. The American thoracic society perspective. *Annals of the American Thoracic Society*, *11*(4), pp.473-479.
17. Athari, S.S., 2019. Targeting cell signaling in allergic asthma. *Signal Transduction and Targeted Therapy*, *4*(1), p.45.