Abstract of the Problem:

Respiratory disorders such as asthma, chronic obstructive pulmonary disease (COPD), allergy-related breathing conditions, and pollution-induced lung complications are increasing steadily across India. Rapid urbanization, deteriorating air quality, occupational dust exposure, and post-COVID respiratory vulnerability have significantly contributed to this rise. These conditions require long-term observation and timely intervention; however, current respiratory healthcare practices remain largely reactive and clinic-centered.

Most existing diagnostic tools, including spirometers and peak flow meters, are designed for episodic assessment rather than continuous monitoring. They require trained personnel, controlled clinical environments, and active patient participation, which limits their usability for daily or home-based care. Consequently, early physiological changes such as airway inflammation, mild wheezing, abnormal breathing patterns, or gradual oxygen desaturation often go unnoticed until the condition worsens and requires emergency medical attention.

There is a clear gap in accessible and non-invasive systems capable of monitoring lung health continuously in real-world environments. Respiratory conditions are complex and influenced by multiple factors, yet most available wearable health devices monitor only isolated parameters such as oxygen saturation or heart rate. While useful, these metrics alone do not provide sufficient insight into respiratory health or early disease progression.

Key challenges contributing to this gap include:

- Lack of continuous, real-time respiratory monitoring outside clinical settings
- Dependence on single-parameter or episodic diagnostic tools
- Limited ability to detect early warning signs such as airway inflammation or wheezing
- Absence of correlation between physiological indicators and environmental triggers

Environmental factors play a significant role in respiratory health. Exposure to dust, allergens, and air pollutants can trigger or aggravate respiratory conditions, particularly in children, elderly individuals, and those with pre-existing lung disorders. Workers in sectors such as construction, manufacturing, traffic management, and waste handling face sustained exposure to airborne irritants, increasing long-term health risks. Periodic medical examinations in these settings are insufficient to capture daily exposure patterns or gradual respiratory decline.

From a healthcare delivery standpoint, the lack of continuous respiratory data limits preventive care. Many respiratory emergencies could be avoided if early warning signs were identified in time. Instead, patients often seek medical attention only after symptoms become severe, increasing hospitalization rates, healthcare costs, and system burden.

Additional challenges include:

- Poor user compliance due to complex or intrusive monitoring methods
- Limited suitability of existing tools for elderly patients and children
- High cost and low scalability of advanced respiratory diagnostic equipment

- Inadequate integration of respiratory data into digital health and remote care systems

Healthcare systems are increasingly adopting remote monitoring and home-based care models to improve accessibility and reduce strain on hospitals. However, respiratory health monitoring has not progressed at the same pace as cardiac or metabolic monitoring. The absence of reliable, continuous respiratory data restricts clinicians' ability to make informed decisions and hinders the shift toward preventive and outcome-based healthcare models. Affordability and scalability remain critical concerns. Solutions intended for widespread use must be cost-effective, robust, and easy to deploy across diverse settings, including rural and resource-limited environments. Without such solutions, respiratory healthcare continues to rely heavily on hospital-based diagnosis and treatment.

Addressing this problem requires an integrated approach that considers multiple respiratory indicators alongside environmental exposure. Continuous monitoring of parameters related to airway condition, breathing patterns, oxygen levels, and external triggers would enable earlier detection of risk and more effective disease management. Such an approach would support timely intervention, reduce emergency events, and improve overall quality of life for individuals with respiratory conditions.

The problem lies in the absence of an affordable, non-invasive, and continuously operating respiratory monitoring system that can function effectively outside clinical environments. Bridging this gap would strengthen preventive care, support chronic disease management, reduce healthcare burden, and contribute to more sustainable and accessible respiratory healthcare delivery.