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Public Health Implications and Policy Imperatives of Smog in Sialkot

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Abstract

Smog episodes in Sialkot have emerged as a major public health concern, with significant environmental and social implications. This study surveyed community awareness, health impacts, and protective behaviors across diverse neighborhoods in Sialkot. Findings show high general awareness of smog, mixed adoption of protective behaviors, and varying perceptions of health risks and mitigation strategies. Despite recognition of smog as a health hazard, protective practices remain inconsistent due to barriers such as affordability and skepticism of effectiveness. The results reveal a critical gap between knowledge and action, highlighting the need for targeted public health policies and localized interventions that address behavioral, social, and informational barriers.

Keywords: Smog, Public Health, Community Awareness, Protective Behaviors, Sialkot

1. Introduction

Air pollution and smog have emerged as some of the most pressing environmental and public health challenges in Pakistan over the past few decades. Rapid urbanization, industrial growth, and surging vehicular traffic have combined to produce a hazardous mix of pollutants that not only degrade the atmosphere but also exert serious health impacts. Emissions from vehicles, industries, brick kilns, and the seasonal burning of crop residues contribute heavily to concentrations of fine particulate matter (PM2.5 and PM10) and toxic gases including nitrogen dioxide, sulfur dioxide, and carbon monoxide. Under specific meteorological conditions-particularly during winter, when temperature inversions and low wind speeds are common-these pollutants interact with natural fog to form dense smog episodes. Such episodes have become an almost seasonal phenomenon in many Pakistani cities, presenting both environmental and public health crises (Hussain et al., 2025; Nasar-u-Minallah et al., 2024).

Much of the attention in research and policy has centered on Lahore, which is frequently ranked among the most polluted cities worldwide. However, other industrial cities, such as Sialkot, have not received the same level of scrutiny despite their significant exposure to pollution. Sialkot, a globally recognized manufacturing hub producing surgical instruments, sports equipment, and leather goods, plays a critical role in Pakistan's

economy. Yet this prosperity has come at the cost of deteriorating environmental quality. The combination of clustered industries, a growing population, and rising numbers of vehicles has created conditions conducive to recurring smog events. Despite this, systematic evidence regarding how Sialkot's residents perceive smog, the protective measures they adopt, and their views on governmental responses remains scarce. This lack of data limits both the understanding of local experiences and the capacity of policymakers to craft targeted interventions.

The health risks posed by air pollution are well established. Fine particulates penetrate deep into the lungs and bloodstream, causing or aggravating respiratory diseases, asthma, chronic obstructive pulmonary disease, cardiovascular problems, and premature deaths. Exposure to pollutants is also linked to ocular irritation, skin conditions, and, increasingly, cognitive impairments and neurological disorders (Jabeen et al., 2021). In Pakistan, these risks are particularly acute for low-income populations who have limited access to healthcare. In Sialkot, the convergence of vehicular exhaust and emissions from hundreds of small and medium industries heightens both immediate and long-term health risks for its residents, making the city a critical case for focused investigation.

Regulatory responses have been uneven. Governments at national and provincial levels have introduced measures such as improved fuel standards, cleaner energy initiatives, and bans on crop residue burning, alongside public advisories during high-smog periods (Yousaf et al., 2021; Yang et al., 2021). While these interventions represent important steps, their impact has often been diluted by weak enforcement, fragmented institutional structures, and inadequate community-level engagement. Large-scale policy frameworks may yield modest improvements, but they frequently fail to reflect local realities. Without granular, location-specific assessments, it is difficult to evaluate whether policies are reaching the populations most affected by smog or whether they address the barriers residents face in protecting themselves.

In parallel, research across South Asia has increasingly applied knowledge, attitude, and practice (KAP) frameworks to assess how communities understand and respond to smog. These studies consistently reveal a gap between awareness and protective action. While many individuals are aware of smog's dangers, only a fraction adopt consistent preventive behaviors, such as wearing masks or limiting outdoor activity. This gap is often shaped by financial constraints, limited access to reliable environmental information, and cultural or attitudinal factors (Hussain et al., 2025; Raza et al., 2019). In Pakistan, however, most such research has focused on Lahore, with little systematic evidence from Sialkot or other industrial centers. This represents a serious knowledge gap, given the city's economic and environmental profile.

The present study addresses this gap by conducting a comprehensive multi-area survey of smog awareness, protective behaviors, and community perceptions among Sialkot residents. By including both urban core and peri-urban neighborhoods, the research captures a spectrum of experiences across socioeconomic groups and levels of pollution exposure. The survey, designed on established KAP models, examines awareness of smog and its sources, self-reported health impacts, protective behaviors, reliance on information sources, and perceptions of government policies. Importantly, the study also documents mental health impacts of smog an underexplored aspect in the Pakistani context while analyzing how factors such as age, gender, education, and occupation shape responses.

The findings contribute to a more nuanced understanding of the challenges Sialkot's residents face in confronting smog. By documenting both the widespread recognition of smog as a hazard and the persistent gaps in protective behaviors, this research underscores the need for interventions that address not only knowledge but also affordability, accessibility, and trust. Moreover, by situating local perceptions within the broader narrative of Pakistan's smog crisis, the study provides evidence that can support more responsive, neighborhood-specific policies. Beyond academic value, the results are intended to inform municipal authorities, public health practitioners, and civil society organizations seeking to strengthen community resilience against air pollution.

In doing so, this study positions Sialkot within the broader discourse on environmental health in Pakistan. It highlights the city's distinct vulnerabilities, emphasizes the inadequacy of generic policy responses, and calls for a shift toward targeted, participatory strategies. By bridging the gap between large-scale environmental assessments and community-level perspectives, this research contributes both to the scientific literature on smog and to the practical design of interventions aimed at protecting health and improving urban living conditions in one of Pakistan's most important industrial centers.

2. Methods

2.1 Survey Instrument and Sample

A structured survey was deployed across multiple neighborhoods in Sialkot from October–December 2024, with sections covering: demographics, awareness, perceived causes, protective behaviors, health impacts, information sources, and attitudes toward governmental policy. Reliability testing during pilot administration yielded Cronbach's α values >0.78 for awareness and perception scales, indicating internal consistency.

Sampling targeted Aziz Bhatti Town, Sialkot Cantt, Sambrial, and surrounding peri-urban areas to capture diversity in socioeconomic profiles and pollution exposure.

2.2 Data Collection and Processing

Data collection combined door-to-door paper surveys (70%) with digital Google Forms (30%) for accessibility. After cleaning (removing incomplete and duplicate responses), a total of **n = 722** valid responses were retained. Data were aggregated at neighborhood level to protect anonymity.

2.3 Statistical Analysis

Frequencies and percentages were calculated for categorical variables. Chi-square contingency tests were attempted to explore neighborhood differences in awareness, protective behaviors, and perceptions; however, sparse cells in smaller neighborhoods limited robust statistical power. Analyses are therefore descriptive but highlight meaningful community-level differences, consistent with prior health and community-survey studies in Pakistan (Zakar et al., 2025).

3. Results

3.1 Demographics

The survey population was relatively youth-skewed (majority aged 18–30), with balanced male–female representation. Education levels were high in urban centers but more variable in peri-urban neighborhoods. Occupations ranged from students and private employees to factory workers and small business owners, reflecting socioeconomic diversity (Table 1).

Table 1. Demographic characteristics of survey participants (n = 722).

Characteristic	Category	Frequency (n)	Percentage (%)
Age Group	18–30 years	375	51.9
	31–45 years	227	31.4
	46–60 years	100	13.8
	> 60 years	20	2.9
Gender	Male	368	51.0
	Female	354	49.0
Education	No formal education	55	7.6
	Primary/Middle	134	18.6
	Matric/F.A./F.Sc.	249	34.5
	Bachelor's or above	284	39.3
Occupation	Student	208	28.8
	Private Employee	168	23.3
	Factory Worker	112	15.5
	Business Owner	100	13.8
	Homemaker	82	11.4
	Other	52	7.1
Neighborhood	Urban Core	433	60.0
	Peri-urban	289	40.0

3.2 Awareness and Perceptions

Most respondents (over 80%) recognized smog as a recurring seasonal problem. Awareness was highest in central Sialkot neighborhoods, while peri-urban respondents showed slightly lower recognition (Figure 1A). The most cited causes were vehicular exhaust (75%), industrial emissions (63%), and agricultural residue burning (58%). Secondary causes included open trash burning (33%) and climate change effects (27%) (Figure 1B).

3.3 Self-Reported Health Impacts

Respondents frequently linked smog exposure to respiratory infections (72%), eye irritation (68%), and headaches (55%). Notably, about 21% reported mental health symptoms (stress, anxiety, mood changes) during smog episodes, an often-overlooked dimension in smog studies (Figure 1C).

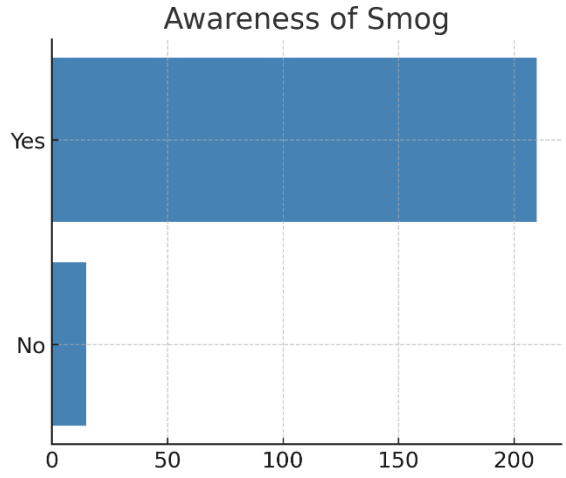

Figure 1A. Awareness of smog among respondents.

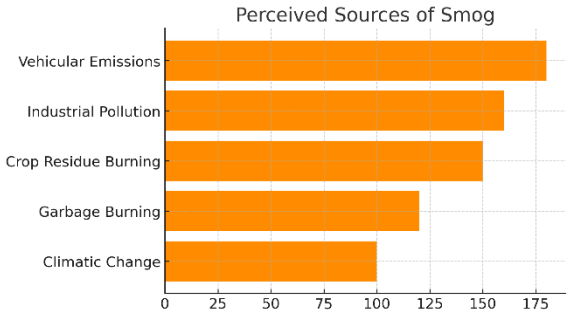

Figure 1B. Perceived sources of smog.

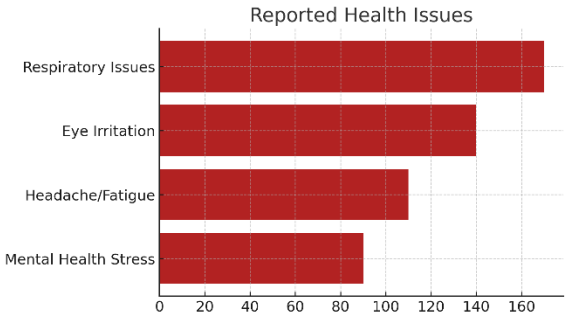

Figure 1C. Reported health issues linked to smog exposure.

3.4 Protective Behaviors

Protective behaviors varied: mask-wearing (54%) was the most common, while staying indoors during peak smog (41%) and air purifier use (11%) were less frequent (Figure 1D). Respondents cited barriers such as cost, lack of access, and perceptions of limited efficacy as key reasons for inconsistent adoption.

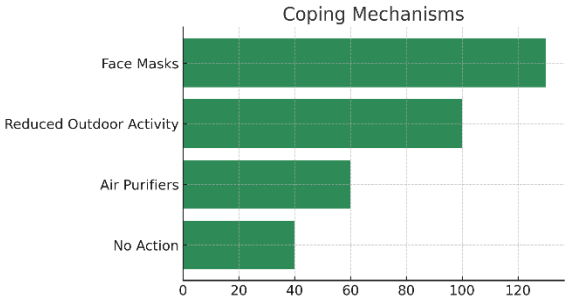

Figure 1D. Protective behaviors adopted by respondents

3.5 Information Sources and Policy Awareness

Social media (65%), TV news (52%), and peer networks (36%) were the leading sources of smog-related information. Awareness of government-led initiatives was inconsistent, with only ~40% recalling official smog control campaigns (Table 2).

Table 2. Community suggestions for smog mitigation policies (n = 722).

Suggested Policy Intervention	Frequency (n)	Percentage (%)
More greenery / urban plantation	410	56.8
Subsidized masks and air filters	375	51.9
Early-warning air quality alerts	290	40.2
Stricter control on industrial emissions	265	36.7
Ban on crop residue burning	240	33.2
Better traffic management	225	31.2
Public awareness campaigns	198	27.4

3.6 Neighborhood Differences

Urban respondents reported higher awareness and protective behavior adoption compared to peri-urban groups. For instance, mask-wearing was ~20% higher in urban core neighborhoods. However, peri-urban residents expressed greater concern about affordability and demanded stronger policy support.

4. Discussion

This study highlights a central paradox in environmental health behavior: while awareness of smog in Sialkot is high, protective action remains inconsistent and fragmented. Over four-fifths of respondents recognized smog as a recurring seasonal problem and were able to identify its major sources, yet fewer than two-thirds reported adopting consistent preventive measures such as mask-wearing or limiting outdoor exposure. This

gap between knowledge and behavior reflects a broader phenomenon seen in South Asian cities, where public awareness campaigns raise recognition but do not always translate into sustained protective practices (Ali & Khan, 2021; Raza et al., 2019).

Several explanations may account for this disconnect. Financial barriers were reported frequently, particularly in peri-urban neighborhoods, where the cost of air filters and high-quality protective masks remains prohibitive. Access-related barriers were also salient, as many respondents expressed limited availability of affordable protective equipment in local markets. Equally important were perceptual barriers: a sizeable proportion of respondents expressed doubts about the efficacy of interventions such as cloth masks or home-based purifiers, which has also been documented in studies of public adoption of pollution-related health interventions in India and Bangladesh. These findings suggest that interventions need not only to improve access but also to address perceptions of effectiveness through public trust-building and transparent communication.

A novel contribution of this study is the documentation of mental health impacts of smog exposure in Pakistan. Approximately one in five respondents reported stress, anxiety, or mood disturbances during smog episodes. While physical health consequences such as respiratory irritation and headaches are well-documented in the literature, the psychological dimensions of smog have received far less attention in local public health discourse. Evidence from international studies suggests that prolonged exposure to polluted air is associated with heightened anxiety, depressive symptoms, and even cognitive decline. The identification of mental health impacts in Sialkot underscores the need to broaden the scope of smog mitigation strategies beyond physical health to encompass psychological well-being, which is often marginalized in environmental health policies.

Neighborhood-level analysis further strengthens the case for localized interventions. Urban core respondents demonstrated higher awareness and adoption of protective behaviors, but peri-urban residents expressed greater economic vulnerability and stronger demands for governmental action. This suggests that one-size-fits-all messaging may be insufficient. Instead, tailored strategies that reflect neighborhood-specific needs—such as subsidized protective gear in peri-urban communities or stricter enforcement of emission controls near industrial hubs are likely to be more effective.

The findings also have important policy implications. First, subsidized or freely distributed protective equipment, such as certified masks and basic indoor air filtration units, could significantly reduce barriers for low-income households. Second, the reliance on social media and peer networks for information indicates that government communication strategies should leverage these platforms more effectively, while also addressing misinformation. Localized and multilingual smog alerts could help bridge informational divides across literacy and socioeconomic lines. Third, the integration of mental health services into environmental health campaigns could provide a dual benefit: addressing immediate psychological impacts while fostering trust in public health institutions. Finally, structural measures such as reforestation, urban green corridors, and stricter regulation of industrial and vehicular emissions remain essential to tackling the root causes of smog, rather than only managing its effects.

Taken together, the results suggest that Sialkot's smog problem cannot be addressed solely through

top-down regulation or community-level behavioral changes. Instead, a multi-layered approach that combines accessible protective equipment, targeted community interventions, mental health integration, and structural environmental reforms will be necessary to mitigate the health burden of smog.

5. Conclusion

Smog remains a critical environmental and public health issue in Sialkot, with widespread awareness not consistently translating into protective actions. The gap between knowledge and behavior is driven by significant financial, social, and informational barriers, including the high cost of protective gear, public skepticism about the effectiveness of mitigation strategies, and a lack of consistent, clear public health messaging. To effectively combat this hazard, a comprehensive strategy is needed. This strategy must prioritize the development and distribution of affordable, accessible interventions. Furthermore, it should include robust, consistent public health campaigns and local initiatives that address community-specific barriers and integrate mental health support to help individuals cope with the psychological stress of prolonged exposure to poor air quality.

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