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SMOG-RELATED PREVENTIVE BEHAVIOR: INTEGRATING THE HEALTH BELIEF MODEL AND THEORY OF PLANNED BEHAVIOR THROUGH KNOWLEDGE, HEALTH BELIEFS, COMMUNICATION CUES, MODERATED BY ATTITUDES

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Abstract
Human contributions and resulting emissions impact climate and declining air condition, with smog indicating a public health challenge of human-induced environmental challenges in urban Lahore in Pakistan. Repeated events of smog have become a critical respiratory health challenge, signifying the urgency to know how individuals get knowledge, perceive health risks, develop preventive attitudes, and adopt protective behaviors. This research explained the associations among knowledge, health-risk perceptions, attitudes, perceived barriers, demographic characteristics, media exposure, and preventive behavior concerning smog-induced respiratory health risks among media users in Lahore. The study integrated the Knowledge–Attitude–Behavior framework with selected constructs of the Health Belief Model, Theory of Planned Behavior, demographic factors, and cues to action. A quantitative cross-sectional survey was done among 155 media users in Lahore. Data was evaluated using correlation and regression analyses, encompassing hierarchical regression to research the impact of risk perceptions, media and communication cues, and interaction terms. The findings showed that knowledge of smog causes and knowledge of preventive strategies significantly predicted favorable attitudes, whereas knowledge of smog-induced respiratory health effects did not reach statistical significance. Perceived susceptibility, severity, and threat were positively associated with attitudes and preventive behavior, while perceived barriers demonstrated significant negative relationships with both outcomes. Generation and education significantly predicted attitudes and preventive behavior, whereas sex did not demonstrate significant relationships. Media-related cues also showed significant associations with knowledge, attitudes, and preventive

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behavior. Television, social media, academic media, and health communication campaigns showed significant relationships across the proposed pathways, whereas interpersonal communication showed comparatively inconsistent relationships. The results show that preventive responses to smog are shaped by the interplay of knowledge, risk perceptions, attitudes, perceived barriers, demographic characteristics, and communication cues. The research adds to climate and health communication literature.

1. INTRODUCTION

1.1 Global History for the Issue of Smog

The issue of air pollution resulting from smoke and fog dates to Victorian times. In London the air pollution resulting from burning of coal was considered a grave concern that a commission was organized to see into the environmental issue in 1285 (Brimblecombe & Makra, 2005). In the early 1700s Manchester Court Leet through a law in 1592 dealt with public concerns of illicit firing of sooty chimneys and tobacco pipe maker's works in Todd Lane as incidents of public nuisance (Brimblecombe & Makra, 2005). In the 18th century the growth of steam powered factories resulted in the multiplication of chimneys, increased quantity of smoke and soot (Brimblecombe & Makra, 2005). The city of London faced that issue, and it was the first Dr. Henry Antoine des Voeux who in 1905 had introduced the term 'smog' (Brimblecombe & Makra, 2005; Sharma & Masiwal, 2022). In 1909, the term smog was also used to describe the dangerous 5-week long pollution event in Glasgow, Scotland (Sharma & Masiwal, 2022).

People of Los Angeles reported that smog had existed in the County since 1912 (Magill, 1949). The primary cause of the smog in Los Angeles County is the chemical reaction (Tiao, Box & Hamming, 1975). In the 1940s photochemical smog was discovered in Los Angeles, the type of smog composed of carbon dioxides, nitrogen oxides, nitric acids, sulphur dioxides, sulphuric acids, suspended particulate matters, ozones and volatile organic compounds (Rani et.al, 2011). The other cities which had also experienced photochemical smog were Manila, Mexico and other cities in Australia, Greece, Japan, India, Israel and even United Kingdom (Rani et.al, 2011).

Chinese Academy of Social Sciences pointed out that the problem of haze including fog in China during the first months of 2013 was touching a record level and these air pollution problems in China were same to the event of 1952 smog in London in which motionless layer of smoky fumes from the regions coal stoves and factories appeared in the sky (Zang et.al, 2014).

Smog was observed in Delhi, India, in 2012 (Sati & Mohan, 2014). Delhi was the most polluted city in the world according to the World Health Organization's 2014 database for air pollution (Mishra, 2019). The news article, "Poison in the air: Declining air quality in India" discussed air pollution in Indian capital Delhi during the winter of 2017 (Basu, 2019). The major causes of smog in Delhi were reported as rural kitchen, increase in vehicles, burning of residual crops in neighboring states of Delhi such as Punjab, Haryana and Uttar Pradesh (Basu, 2019). Visibility in the parts of Delhi reduced to less than fifty (50) meters (Terry et.al, 2018). Historical data of five years from 2016 to 2020 reflected that visibility had ranged in tropical wet and dry climate within the range of 2.92 to 7.15 kilometers, dry climate in the range of 2.75 to 4.28 kilometers, temperate dry winter warm summer in the range of 5.48 to 5.84 kilometers and 2.72 kilometers in temperate dry winter hot summer (Ulavi & Madanayak, 2024).

1.2 History of Smog in Pakistan

Urbanization relates to industrialization with the use of inanimate sources of energy to increase

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human productivity, agricultural growth and industrial revolution (Rizvi, 2011). Urbanization negatively affects the environmental quality through an increase in energy consumption of the household and transport sector (Khan & Majeed, 2023). Pakistan during the last decade has seen a rapid increase in industrial initiatives, motor vehicle utilization and consumption of various energy sources (Colbeck et.al, 2010). Within this context the government of Pakistan had taken steps towards air quality management with the initiative of Pakistan Clean Air Program (PCAP) which was a five-year plan from 2005 to 2010 (Colbeck et.al, 2010). The purpose of the program was to improve air quality. The PCAP mentioned the smog emitted by private vehicles industry and burning of solid waste as major sources of urban air pollutants (Colbeck et.al, 2010). Colbeck et.al, (2010), found that particulate matter was the most serious air pollutant in Pakistan. In a more comprehensive study Anwar et.al, (2021) researched sources of air pollutant and had found that major cities in India, China and Pakistan had crossed the limits define by World Health Organization for the particulate matter.

1.3 Global Challenges Contextualizing Smog

Zhu and Yao (2019) found that the residents of the city with high smog level present low risk perception of smog, risk perception positively affected behavioral intention. Additionally, resource-related attributes played a moderating role in the relationship between risk perception and behavioral intention (Zhu & Yao, 2019). Furthermore, respondents with low levels of education and income intend to take actions (Zhu & Yao, 2019).

Sharma and Masiwal, (2022) explain that the suspended particles in air scatter the sunlight away from the surface and what might emerge as "winter fog" is impact the lethal smog. Sharma and Masiwal, (2022) continue that such a condition is an extreme hit to a basic right to breathe in fresh air. Sharma and Masiwal, (2022) identify that the critically affected states in north India Haryana, Punjab, Uttar Pradesh and Delhi.

Wei et al. (2017) researched respondents from two Chinese cities in terms of their smog experience, reliance on smog information sources, risk perception, attribution of responsibility and intention for adoption of protective behavior regarding smog. Wei et al. (2017) found that demographics and location affect smog experience and smog information. Additionally, smog information causes risk perception, risk perception affects attribution of responsibility affection to adopt protective behavior (Wei et al., 2017).

Smog pollution is a serious problem in China, in response to this, the Chinese officials take the initiative to improve smog pollution as priority of its environmental protection work in 2016 and starts the "Blue Sky Protection Campaign" (Zhu et al, 2019). In addition to this, in the year 2018, the Chinese State Council's institutional modification plan contributed to the establishment of the "Ministry of Ecology and Environment in China" (Zhu et al., 2019).

Zhu and Lu (2021) found that individuals' knowledge about smog positively affected perceived risk, information need, and smog reduction intention. Moreover, perceived risk significantly affected information need, information seeking, and smog reduction intention (Zhu & Lu, 2021). Additionally, seeking information positively determines smog reduction intention. In addition to this, it is also found that financial incentive policy positively impacts smog reduction intention (Zhu & Lu, 2021).

Yang and Wu (2021) analyzed Chinese people's exposure to health information on social media and how they had affected their health protective behaviors in response to haze, particularly wearing a PM2.5 anti-haze mask. Yang and Wu (2021) found that attitude and descriptive norm positively mediated the relationships between using Weibo for health information and behavioral intention while descriptive norm negatively mediated the relationship between

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using WeChat for health information and intention. Furthermore, Yang and Wu (2021) reported that attitude, descriptive norm and injunctive norm significantly had predicted behavioral intention and wearing mask.

Lim and Zhang (2023) explain how risk appraisals of PM2.5 influence Chinese people's behavioral intentions to adopt government-recommended protective behaviors through negative affect and explains institutional trust media. It is found that negative effect mediates the effects of perceived susceptibility perceived severity on individuals' intentions to take preventive measures against the PM2.5 risk (Lim & Zhang, 2023). In addition to this, institutional trust appears to increase people's behavioral intentions, but the media sensationalism decreases people's behavioral intentions (Lim & Zhang, 2023).

The surging industrial development in China has put substantive environmental pressure. In addition to this, the long-term adoption of extensive economic development modes. China's ecological environment has been seriously damaged and problems such as smog pollution (Huang, Qi & Chen, 2024). As the main constituent of smog pollution, the average dilution of PM2.5 in China in 2006 and the end of 2015, the area polluted by smog in China reached 530,000 square kilometers (Huang, Qi & Chen, 2024).

The seasons in which the extreme smog affects air quality in India are late autumn and winter months (Gautam et al., 2023). Gautam et al. (2023) uses the satellite data and find that there is an increase in aerosol exceedances over northern India, resulting in atmospheric warming and surface cooling. It is also found that there is a lower tropospheric stability and increase in relative humidity, leading to an increase in poor visibility during daytime.

The natural elements of sunrays varying temperatures and speed of the wind affect the expansion and attributes of smog (Kumar et al., 2024). The primary sources to produce smog are coal burning, traffic emissions and stubble burning and erupting volcanoes. These activities contribute to production of PM2.5 and PM10, the major particles of smog (Kumar et al., 2024). These extremely small particles are serious environmental problems and reach deep epithelia, causing coughing, sneezing and shortness of breath (Kumar et al., 2024).

Al-Ghamdi (2024) researched the knowledge, attitudes, and practices and related health impact of environmental pollutants and climate change in Saudi Arabia. It was found that participants had fair knowledge on immunological and health effects of environmental pollution and climate change. Moreover, they were aware of the influence of environmental pollutants and climate change on the spread of infectious diseases (Al-Ghamdi, 2024).

1.4Smog and Challenges in Pakistan

Malik et al. (2024) in their empirical research explains the relationship between smog and the respiratory, hypertensive and cardiovascular health of adults with the help of surveys in the polluted urban areas of Lahore, Multan and Faisalabad. It is found that smog exposure affects morbidity among people in terms of respiratory diseases, hypertension and cardiovascular diseases in the vulnerable low socio-economic strata (Malik et al., 2024).

1.5Media and Smog

Al-Shidi et al. (2021) found that social media was a primary source of access to information regarding air pollution in Muscat. In addition to this, Al-Shidi et al. (2021) found that majority of the respondents were aware of the meaning of air pollution and interested in the issue of air quality, while females have a higher level of air pollution awareness than males.

Ahmad et al. (2025) explores the public perception and willingness to pay for smog reduction and find that almost half of respondents perceive smog pollution "strongly severe", attributing it primarily to industrial and vehicular emissions. Further, Ahmad et al (2025) find that after receiving the

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information, the respondents' willingness to pay for smog increased, but they were more willing to pay for self-protection than to support the control and preventive measures. In addition to this, education and income reduction (Ahmad et al, 2024).

1.6 Research Problem Statement

Mushtaq et al. (2024) describe the impact of smog on public health and the role of media coverage in shaping public perception in the context of Pakistan's smog crisis by using agenda-setting theory, and content analyze sixty-nine (69) news clips from City 42, SAMAA TV, and ARY News. It is found that media coverage often has less depth and correctness, possibly biasing public understanding of smog-related risks (Mushtaq et al. 2024). The findings underscore the urgent need for comprehensive and accurate media coverage to address the smog crisis effectively (Mushtaq et al., 2024). Mushtaq et al. (2024) recommend promoting enhancing media literacy initiatives, promoting connections between media organizations and healthcare professionals, and encouraging evidence-based reporting to increase public consciousness and nurture informed decision-making. In this context it is important to research knowledge, attitudes and practices contextualizing smog.

Huang et al. (2024) researched proactive measures aimed at improving indoor air quality in Kaohsiung and Tainan cities in Taiwan because of air pollution. Research by Huang et al. (2024) fills the valuable academic gap by focusing on the proactive measures. These proactive measures have not been extensively researched contextualizing Pakistan, especially in Lahore where there is a severe issue of acute respiratory infection.

1.7Objectives of the Study

The objectives of the study are to research the five pathways.

In the first pathway, Knowledge, Attitude, Behaviour (KAB), this study research knowledge about causes of smog, the smog-induced respiratory infection, and preventive measures indirectly affecting behavior of adopting preventive strategies through shaping attitudes or feelings towards the preventive measures.

In the second pathway, Risk-perception-Attitude-Behaviour, extending from Health Belief Model and the Theory of Planned Behaviour, the current study explains individuals perceived susceptibility, perceived severity, and perceived threat for smog-induced respiratory infection and how these affect their attitude, which then encourage the adoption of behavior of adopting preventive strategies.

In the third pathway, extending from Heath Belief Model (HBM), this study contributes by analyzing the effects of perceived barriers such as costs, lack of time, and limited house-hold space on attitudes and behavior.

In the fourth pathway, extending from Health Belief Model, the current study explains the influence of the demographics of generation, education, and sex, on knowledge concerning causes of smog, smog-induced respiratory infection, preventive strategies, attitudes towards preventive strategies, and behavior or the adoption for the preventive strategies.

The previous research (Hung et al., 2024) does not include the mediated and communication related cues to action, therefore extended from the "cues to action" aspect of Health Belief Model (HBM), this study in the fifth pathway also contributes by analyzing the use of television news, social media use, academic media, awareness about health communication campaigns, and the use of interpersonal communication as cues to knowledge, attitudes and the behavior.

1.8 Significance of Research

The current study is significant because it contributes to the framework of knowledge, attitude and behavior or known as KAB to know individual's psychological make up when thinking about smog. Secondly, the current study contributes to theory of planned behavior by analyzing the associations among risk perceptions,

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attitudes and behavior when it comes to discussion about smog. Third, the study is significant because it also contributes to the health belief model by analyzing the perceptions of personal risk or susceptibility, and the seriousness of health impacts or the severity as central drivers for proactive actions against smog and smog induced respiratory infection. Four, the study extends the media and communication aspects as cues to actions for proactive behavior against smog and the smog-induced respiratory infection. Fifth, the current study would be valuable for making effective health communication campaigns against smog and the smog-induced respiratory infection in Lahore city and across Pakistan where the smog is affecting people.

2. LITERATURE REVIEW

2.1 Framework of Knowledge-Attitude-Behaviour/Practice

According to Wang et al. (2015), respondents demonstrated a high level of awareness regarding air pollution sources, health effects, and its connection to children's respiratory health, with over 80% classified as having substantial knowledge. Additionally, nearly 90% of participants acknowledged that improving air quality is a collective responsibility, reflecting positive environmental attitudes and support for relevant policies and behavioral changes (Wang et al., 2015). Despite these findings, self-reported protective practices, including mask-wearing and limiting outdoor exposure on polluted days, remained low, suggesting a gap between knowledge, attitudes, and actual behaviors (Wang et al., 2015).

Unni et al. (2022) found that knowledge levels were generally low, especially among older individuals and those with lower education and income. Knowledge was positively associated with behaviors aimed at improving Index Air Quality (IAQ), suggesting that increased awareness can promote proactive actions. Unni et al. (2022) the attitudinal scores were moderate and could be influenced through knowledge sharing interventions. Unni et al. (2022) observed that knowledge sharing improved attitude scores significantly, implying that enhancing knowledge can foster more positive perceptions toward IAQ. Unni et al. (2022) despite positive attitudes, actual behaviors related to IAQ were relatively lower. Unni et al. (2022) discovered a significant positive association between knowledge and behavior, indicating that increasing knowledge could lead to better IAQ-related practices.

Huang et al. (2024), reveal that having more knowledge, especially about air purifiers and anti-haze window screens, strongly shapes people's views on protective measures. Knowledge affects behavior indirectly through attitudes, with the biggest impact seen in understanding certain protective tools (Huang et al., 2024). Huang et al. (2024), attitudes act as a link between knowledge and actions, influencing how knowledge turns into real protective steps. People who understand better tend to have more positive views about using harm reduction methods.

Huang et al. (2024), explain how more knowledge improves attitudes, which then lead to protective actions. This highlights the need to increase public awareness to encourage behavior change. Huang et al. (2024), using structural equation modeling, find that knowledge has the strongest impact on attitudes, which in turn shape behaviors aimed at reducing air pollution.

2.2 Theory of Planned Behaviour

The theory of reasoned action and the theory of planned behavior are developed on the basic principles of knowledge-attitude-behavior framework or which is known as KAB. The Theory of Reasoned Action (Fishbein & Ajzen, 1975) was extended to theory of planned behavior incorporating perceived behavioral control and creating the theory of planned behavior or TPB as a more comprehensive model for understanding deliberate behaviors (Ajzen, 1985). The theory of planned behavior explains all sequence of steps that lead from beliefs to behavior (Ajzen, 1985). These steps are behavior; beliefs and outcome

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evaluations, normative beliefs and motivation to comply, attitude toward the behavior and subjective norm, behavioral intention, perceived behavioral control and behavior or action (Ajzen, 1985). The theory of planned behavior is extended by Huang et al. (2024) to explore how knowledge and attitudes impact behaviors related to adopting protective measures against air pollution. Huang et al. (2024) uses attitudes and perceived barriers from TPB, and researchers' attitudes as mediators influenced by knowledge and risk perception, and perceived barriers as a measure of behavioral control that directly affect behavior for buying air purifiers to deal with air pollution

2.3 Health Belief Model and Smog

The Health Belief Model developed out of a set of independent, applied research problems with which a group of investigations in the Public Health Service were confronted between 1950 and 1960 (Rosenstock, 1974).

The components of health belief model introduced by Rosenstock (1974), include perceived susceptibility to disease and perceived seriousness or severity of disease, modifying factors perceived threat of disease, cues to action, perceived benefits of preventive actions, perceived barriers to preventive actions and likelihood of taking recommended preventive health action. The modifying introduced by Becker et al. (1974) are demographics variables, socio-psychological variables and structural variables. The dimensions of demographic variables may include age, sex, race, ethnicity, level of education and the level of employment. The socio-psychological variables may include personality, social class, peer, reference group pressure, family system and institutional affiliation. The dimensions of structural variables include knowledge about their disease, prior contact with the disease and medical history. The component of cues to action in the health belief model may include elements like mass media campaigns, advice from others, reminder Postcard/SMS/Email from physicians, illness of family member or friend newspaper or magazine article.

Becker et.al. (1974) reformulated the Health Belief Model as predictor of compliance in pediatric situations. The attributes of the model included mother's psychological level of readiness to take recommended health actions. The motivations or predispositions are physical threat, control over health matters, attitude toward medical authority and general health concern (Becker et.al. 1974). The values of threat reduction are child vulnerability, degree of bodily harm and interference with social roles (Becker et.al. 1974). The probabilities of action reducing the threat are belief in diagnosis, perceived efficacy of the medicine and belief in modern medicine (Becker et.al. 1974). The general variables include demographic, family issues, continuity of medical care, satisfaction level with clinic, learning new behavior, communication between the physician and the patient (Becker et.al. 1974). The variables specific to present in illness include family experience and child previous experience with illness and the medicine history (Becker et.al. 1974). The readiness to take recommended health actions is also included (Becker et.al. 1974). The cues to action encompass child's symptomatology, advice from others, current medicine and follow-up appointment (Becker et.al. 1974). The behavioral variables cover the likelihood of compliance with learning about medication and appointments, giving medication and keeping appointments (Becker et.al. 1974).

Farrah et al. (2023) surveys the role of social media campaigns in creating awareness about smog and encouraging sustainable behaviors and finds that social media can be best harnessed to cope with smog or other climate-related issues through a well-structured and target-oriented strategy of climate communication.

Chen and Liu (2023) explain exposure to news, discussion, worry and the protective behavioral intentions to wear facemask and to use air purifier. The positive effects of perceived threat, perceived benefit and perceived self-efficacy are found on

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intention to wear facemask or intention to use air purifier. Surprisingly, neither exposure nor discussion is related to perceived threat (Chen & Liu, 2023). The effect of worry on intention to wear facemasks or intention to use air purifier is mediated by perceived threat (Chen & Liu, 2023). Iftikhar et.al (2024) direct effects of media coverage and perceived barriers on adherent behavior toward smog by using survey and only small effect is found of perceived threats. Iftikhar et.al (2024) explains mediating effects of perceived threat, benefits and self-efficacy and the large effects are found of perceived benefits between the associations of media coverage and adherent behaviors. The medium effect is also found of self-efficacy between the variables of media coverage and adherent behaviors (Iftikhar et.al, 2024). Iftikhar et.al (2024) reports the moderating effects of personality between the variables of perceived threats and adherent behaviors, and there are found moderating effects of the personality traits of neuroticism agreeableness and the openness to experience. Iftikhar et.al (2024) extend health belief model and theory of planned behavior to explain the association among variables. Iftikhar et.al (2024) also discuss gaps in research and recommend adding more communication channels other than conventional media and emphasizes to use online media for future research.

Hussain et al. (2024) researched how the public feels about smog among Lahore residents who drive vehicles, and it is found that during smog people shifted from bike to public transport and rate of car users were also increased from 13% to 25%, half of the people came to know about smog through TV channels. Hussain et al. (2024) reported that people had symptoms like chest tightness, eye irritation and breathing difficulties. Vehicle users took preventive measures such as keeping themselves hydrated, worn masks and driven less (Hussain et al., 2024). Motor vehicle users were found to be more knowledgeable about the causes of smog, but the cycle users were the least knowledgeable (Hussain et al., 2024).

2.4 Protective Action Decision Model and Smog

The Protective Action Decision Model (PADM) is applied in crisis communication perspective and this model states that respondents who are exposed to certain risk, they get warning information from external sources and such information contributes to their risk perceptions, resulting in protective behavior intentions (Lindell et al., 2005).

Cheng et al. (2017) explain protective behaviors of the citizens in response to city smog using protective action decisions to understand their actions. It was found that hazard-related attributes were the strongest predictors for willingness to adopt protective behaviors (Cheng et al, 2017) and public risk perception only positively affected self-protective actions. Moreover, Cheng et al (2017) also report that information sources affected risk perception and context of demographics of respondents' self-protective intentions. In the context of demographics of respondents, older adults and respondents with lower educational levels were more likely to adopt environmentally friendly actions (Cheng et al., 2017).

Extending PADM, Wu et al. (2018) explain the relationship among the risk knowledge, risk perception and brand benefits and the consumers' purchase intentions of a specific air purifier against city smog in China and find that consumers' risk knowledge and knowledge about product affect their purchase of an air purifier brand.

Liu et al. (2019) extended PADM to research adaptive risk behaviors, with predictors of protective action perception, risk perception, and stakeholder perception from electric vehicle customers in Beijing. Liu et al. (2019) found that hazard-related attributes have positive effects on the societal acceptability of electric vehicles in the long run. In addition to this, Liu et al. (2019) reported that resource-related attributes had negative effects on their long-run acceptability and purchase intention. Moreover, Liu et al. (2019)

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reported that attribute importance moderates the effect of hazard and resource-related attributes on adoption indicators, and risk perception has positive effects on consumers' adoption indicators, and trustworthiness and the government's responsibility to protect the environment also influence consumer behavior intention.

Kumar et al. (2025) research the households' attitudes and intentions to adopt an indoor air purifier against the smog crisis in India. Kumar et al. (2025) finds that mental health risk perception was the most important factor of households' attitudes toward adopting air purifiers, followed by smog knowledge, physical health risk perception, and information seeking and product knowledge. In addition to this, it is also found that households' attitude is a leading determinant of their adoption intention toward the air purifier compared to subjective norms and perceived behavioral control.

2.5 Media's Role during Public Health Crisis

Li and Tilt (2019) research public knowledge and perceptions of smog, public trust in various sources of information about smog and various actions, both individual and institutional that people believe can be effective in managing and mitigating smog. It is found that smog, with its effects on human health and quality of life is perceived as a serious concern (Li & Tilt, 2019). Moreover, it is explored that trust in these information sources is shaped by educational attainment (Li & Tilt, 2019).

Mheidly and Fares (2020) report on the implications of the COVID-19 infodemic and explore practical ways to use health communication strategies to manage it. They also discuss the infodemic response checklist as a comprehensive tool for addressing the challenges posed by current and future infodemics.

Media is an important channel for disseminating wellness education. It plays a crucial role in the public's response to a pandemic, acting as a communication portal between governments, health institutions, and the public. Due to the 'invisible' nature of pandemics, the media serves as an essential source of information for the public. Media channels provide accurate information, scientific facts, government decisions, and public reactions. The information that people receive influences their actions and responses to the pandemic (Mheidly and Fares, 2020).

Ahsan et al. (2020) explore the level of knowledge and the preventive practices regarding smog and find that the majority were dissatisfied with the air quality and were taking preventive measures inhouse. Half of respondents felt that the citizens were primarily responsible for the current situation, but they did not use face masks when they were away from home.

Anwar et al. (2022) explain the switching intentions of people from conventional vehicles toward green vehicles in the context of smog and it is found that smog knowledge, perceived environment health risk, decision self-efficacy, willingness to pay and alternative attractiveness positively impact the switching intentions toward green vehicles.

Siddiqui et al. (2023) explore the role of social media campaigns in creating awareness about smog and it is revealed that social media can be an instrumental tool to provide awareness about smog and for better action.

2.6 Academic Research Gap

Huang et al. (2024) fills the gap by focusing on proactive personal exposure prevention strategies and examining the underlying factors that affect their adoption for air pollution protective behaviors by combining Knowledge-Attitude-Behaviour (KAB) model, Health Belief Model, and Theory of Planned Behavior. The current study extends the study by Huang et al. (2024) and fills the gap by adding the knowledge about causes of smog, and the preventive strategies for the smog-induced respiratory infection in Lahore city of Pakistan.

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2.7 First Path: Research Questions (RQs) Extended from KAB

RQ1. To what degree, the knowledge about causes of smog affect behavior of adopting preventive strategies through shaping attitudes?

RQ2. To what degree, the knowledge about the smog-induced respiratory infection affect behavior of adopting preventive strategies through shaping attitudes?

RQ3. To what degree, the knowledge about the preventive measures affect behavior of adopting preventive strategies through shaping attitudes?

2.8 Second Path: RQs Extended from HBM and TPB

RQ4. To what extent the perceived susceptibility for smog induced respiratory infection, affect behavior of adopting preventive strategies through shaping attitudes?

RQ5. To what extent the perceived severity for smog-induced respiratory infection, affect behavior of adopting preventive strategies through shaping attitudes?

RQ6. To what extent the perceived threat for smog-induced respiratory infection, affect behavior of adopting preventive strategies through shaping attitudes?

2.9 Third Path: RQs Extended from HBM Contextualizing Perceived Barriers

RQ7. To what extent the perceived barriers like lack of costs, lack of time, and limited household space affect attitudes of adopting preventive strategies?

RQ8. To what extent the perceived barriers like lack of cost, lack of time, and limited household space affect behavior of adopting preventive strategies?

2.10 Fourth Path: RQs by Extending the Demographic Aspect of HBM

RQ9. To what degree, the demographics of generation, education, and sex affect the attitude towards preventive strategies?

RQ10. To what degree, the demographics of generation, education, and sex affect the behavior towards preventive strategies?

2.11 Fifth Path: RQs by Extending the Cues to Action Aspect of HBM

RQ11. To what extent the use of television news, social media use, academic media, awareness about the health communication campaigns, and uses of interpersonal communication contribute as cues for enhancing the knowledge about causes of smog?

RQ12. To what extent the use of television news, the social media use, academic media, awareness about health communication campaigns, and uses of interpersonal communication contribute as cues for enhancing knowledge about smog-induced respiratory infection?

RQ13. To what extent the use of television news, the social media use, awareness about health communication campaigns, academic media, and uses of interpersonal communication contribute as cues for knowledge about preventive strategies?

RQ14. To what extent the television news, social media use, awareness about health communication campaigns, academic media, and uses of interpersonal communication contribute as the cues for shaping attitudes for preventive strategies for mitigating smog-induced respiratory infection?

RQ15. To what extent the television news, social media use, academic media, awareness about health communication campaigns, and the uses of interpersonal communication contribute as cues for shaping behavior of adopting preventive strategies for mitigating smog-induced respiratory infection?

3.THEORETICAL FRAMEWORK

The present study advances existing literature on the Knowledge-Attitude-Practice (KAP) model, the Health Belief Model (Becker et al., 1974; Rosenstock, 1974; Iftikhar et al., 2024; Huang et al., 2024), and the Theory of Planned Behavior by proposing an integrated framework. This

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framework systematically assesses individuals' knowledge, attitudes, and behaviors concerning smog, while also contextualizing media and communication channels as critical cues that influence both attitudinal and behavioral outcomes.

First Path: Hypotheses Extended from KAB

H1. The knowledge about causes of smog is likely to indirectly affect the behavior for adopting preventive strategies through shaping attitudes.

H2. The knowledge about smog-induced respiratory infection is likely to indirectly affect the behavior for adopting preventive strategies through shaping attitudes.

H3. The knowledge about the preventive strategies is likely to indirectly affect the behavior for adopting preventive strategies through shaping attitudes.

Second Pathway: Hypotheses Extended from HBM and TPB

H4. The perceived susceptibility for smog induced respiratory infection affect behavior of adopting preventive strategies through shaping attitudes.

H5. The perceived severity for smog-induced respiratory infection, affect behavior of adopting preventive strategies through shaping attitudes.

H6. The perceived threat for smog-induced respiratory infection affect behavior of adopting preventive strategies through shaping attitudes.

Third Pathway: Hypotheses Extended from HBM Contextualizing Perceived Barriers

H7. The perceived barriers are likely to affect the attitudes of adopting preventive strategies.

H8. The perceived barriers are likely to affect the behavior of adopting preventive strategies.

Fourth Path: Hypotheses by Extending the Demographic Aspect of HBM

H9. Demographics are likely to affect attitudes towards preventive strategies.

H9 (a). The variable of generation is likely to affect the attitude towards prevention strategies.

H9 (b). The variable of education is likely to affect the attitude towards prevention strategies.

H9 (c). The variable of sex is likely to affect the attitude towards prevention strategies.

H10. The demographics are likely to affect the behavior for adopting preventive strategies.

H10(a). The demographic of generation is likely to affect the behavior for adopting preventive strategies.

H10(b). The demographic of education is likely to affect the behavior for adopting preventive strategies.

H10(c). The demographic of sex is likely to affect the behavior for adopting preventive strategies.

Fifth Path: Hypotheses Extended From the Cues to Action Aspect of HBM

H11. Media users in Lahore are likely to be knowledgeable about the causes of smog.

H11(a). The users of television news in Lahore are likely to be knowledgeable about the causes of smog.

H11(b). The users of social media in Lahore are likely to be knowledgeable about the causes of smog.

H11(c). The users of academic media in Lahore are likely to be knowledgeable about the causes of smog.

H11(d). The users of information about the health communication campaigns for smog are likely to knowledgeable about the causes of smog.

H11(e). The users of interpersonal communication about smog are likely to be knowledgeable about the causes of smog.

H12. Media users in Lahore are likely to be knowledgeable about smog-induced respiratory infection.

H12(a). The users of television news in Lahore are likely to be knowledgeable about smog-induced respiratory infection.

H12(b). The users of social media in Lahore are likely to be knowledgeable about smog-induced respiratory infection.

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H12(c). The users of academic media in Lahore are likely to be knowledgeable about smog-induced respiratory infection.
H12(d). The users of information about the health communication campaigns about smog are likely to be knowledgeable about the causes of smog.
H12(e). The users of interpersonal communication about smog are likely to be knowledgeable about the causes of smog.
H13. Media users in Lahore are likely to be knowledge about the preventive strategies to protect themselves from smog-induced respiratory infection.
H13(a). The users of television news in Lahore are likely to be knowledgeable about the preventive strategies to protect themselves from smog-induced respiratory infection.
H13(b). The users of social media in Lahore are likely to be knowledgeable about the preventive strategies to protect themselves from smog-induced respiratory infection.
H13(c). The users in academic media in Lahore are likely to be knowledgeable about the preventive strategies to protect themselves from smog-induced respiratory infection.
H13(d). The users of the information about the health communication campaigns about smog are likely to be knowledgeable about the preventive strategies to protect themselves from smog-induced respiratory infection.
H13(e). The users of the interpersonal communication about smog are likely to be knowledgeable about the preventive strategies to protect themselves from smog-induced respiratory infection.
H14. Media users in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced respiratory infection.
H14(a). The users of television news in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced respiratory infection.
H14(b). The users of social media in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced respiratory infection.
H14(c). The users of academic media in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced respiratory infection.
H14(d). The users of information about the health communication campaigns about smog in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced respiratory infection.
H14(e). The users of interpersonal communication about smog in Lahore are likely to hold encouraging attitudes towards preventive strategies against smog-induced infection.
H15. Media users in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.
H15(a). The users of television news in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.
H15(b). The users of social media in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.
H15(c). The users of academic media in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.
H15(d). The users of information about health communication campaigns in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.
H15(e). The users of interpersonal communication about smog in Lahore are likely to adopt behavior of preventive strategies to protect themselves from smog-induced respiratory infection.

4. METHODS

This chapter outlines the methodological framework employed in this study to investigate

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the hypotheses derived from Knowledge-Attitude-Behavior (KAB), Health Belief Model (HBM), and Theory of Planned Behavior (TPB) frameworks in the context of smog awareness and prevention behaviors among university students in Lahore, Pakistan. The study is guided by the post-positivist research paradigm, which accepts that reality can be studied and approximated using empirical methods, but with the acknowledgment that findings may be influenced by contextual and human factors. The post-positivist approach is particularly appropriate here as it allows the investigation of complex behavioral constructs such as knowledge, risk perception, attitudes, and behavioral intentions through measurable variables and inferential statistics (Creswell, 2014). The universe of the study includes the public in the Punjab province of Pakistan. However, the target population is more specific and includes university students residing in Lahore. This population is selected based on their presumed active media use and education levels, making them suitable respondents for investigating smog-related knowledge and behavior (Bryman, 2016). The sampling method used is purposive sampling, focusing on university students who are regular users of media platforms such as television news, social media, academic media, and health communication campaigns. These students were selected from several public and private universities in Lahore. The data for this study was collected in June 2025 using a cross-sectional survey design. A structured online questionnaire was distributed via email and university forums to maximize reach and encourage participation while maintaining ethical research standards. The questionnaire comprised multiple sections: Demographic details, media usage patterns, knowledge about smog, perceived risk and severity, attitudes toward preventive actions, preventive behaviors, perceived barriers. Responses were captured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The following analytical strategy was employed to evaluate the hypotheses: Data cleaning involved removing incomplete responses, normality testing was done using skewness, kurtosis, and the Kolmogorov–Smirnov test (Ghasemi & Zahediasl, 2012), Cronbach's Alpha was computed for each scale to assess internal consistency. A threshold of $\alpha \geq 0.70$ was used for reliability. Descriptive statistics for sample were computed to understand sample characteristics. Pearson correlation was used to examine bivariate relationships among key constructs (Field, 2018). Multiple linear regression was used to test the impact of independent variables on dependent variables. Hierarchical regression models were used to test moderating effects of media use types by entering blocks of variables sequentially. Participation was voluntary, and informed consent was obtained digitally. Data confidentiality and anonymity were strictly maintained.

5. RESULTS

A total of 155 university students from Lahore participated in the study. The demographic profile includes gender, generation, and education level. The breakdown is provided in Table 1.

Table 1: ***Demographic Characteristics of the Respondents (N = 155)***

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	82	52.9
	Female	73	47.1
Generation	Gen Z (18–26)	122	78.7
	Millennials (27–35)	33	21.3
Education Level	Undergraduate	108	69.7

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Graduate	47	30.3

These results reflect a relatively balanced gender representation and a predominantly younger demographic in higher education.

Table 2: Consolidated Hypothesis Testing Results Across the Proposed Theoretical Pathways

Theoretical pathway	Hypothesis	Proposed relationship	β	*t* / *r*	*p*	Status
KAB pathway	H1	Knowledge of smog causes → Attitude → Preventive behavior	.23	3.00 / .56	.003 / <.001	Supported
KAB pathway	H2	Knowledge of smog-induced respiratory infection → Attitude → Preventive behavior	.16	1.89 / .56	.061 / <.001	Not supported
KAB pathway	H3	Knowledge of preventive strategies → Attitude → Preventive behavior	.25	2.90 / .56	.005 / <.001	Supported
HBM–TPB pathway	H4	Perceived susceptibility → Attitude → Preventive behavior	.18	2.22 / .47	.028 / <.001	Supported
HBM–TPB pathway	H5	Perceived severity → Attitude → Preventive behavior	.22	2.88 / .48	.005 / <.001	Supported
HBM–TPB pathway	H6	Perceived threat → Attitude → Preventive behavior	–	.52 / .50	<.001 / <.001	Supported
HBM: Perceived barriers	H7	Perceived barriers → Attitude	−.21	−2.71	.008	Supported
HBM: Perceived barriers	H8	Perceived barriers → Preventive behavior	−.28	−3.58	<.001	Supported
HBM: Demographic factors	H9(a)	Generation → Attitude	.14	2.12	.036	Supported
HBM: Demographic factors	H9(b)	Education → Attitude	.19	2.74	.007	Supported
HBM: Demographic factors	H9(c)	Sex → Attitude	.11	1.78	.077	Not supported
HBM: Demographic factors	H10(a)	Generation → Preventive behavior	.16	2.39	.018	Supported
HBM: Demographic factors	H10(b)	Education → Preventive behavior	.21	3.01	.003	Supported
HBM: Demographic factors	H10(c)	Sex → Preventive behavior	.09	1.52	.130	Not supported
Cues to action: Causes knowledge	H11(a)	TV news → Knowledge of smog causes	.18	2.31	.022	Supported
	H11(b)	Social media → Knowledge of smog causes	.24	3.18	.002	Supported
	H11(c)	Academic media → Knowledge of smog causes	.15	2.05	.042	Supported

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Theoretical pathway	Hypothesis	Proposed relationship	β	*t* / *r*	*p*	Status
	H11(d)	Health communication campaigns → Knowledge of smog causes	.21	2.81	.006	Supported
	H11(e)	Interpersonal communication → Knowledge of smog causes	.13	1.96	.052	Not supported
Cues to action: Health-effects knowledge	H12(a)	TV news → Knowledge of respiratory health effects	.16	2.08	.039	Supported
	H12(b)	Social media → Knowledge of respiratory health effects	.22	2.91	.004	Supported
	H12(c)	Academic media → Knowledge of respiratory health effects	.17	2.27	.025	Supported
	H12(d)	Health communication campaigns → Knowledge of respiratory health effects	.23	3.04	.003	Supported
	H12(e)	Interpersonal communication → Knowledge of respiratory health effects	.14	2.01	.046	Supported
Cues to action: Prevention knowledge	H13(a)	TV news → Knowledge of preventive strategies	.19	2.52	.013	Supported
	H13(b)	Social media → Knowledge of preventive strategies	.26	3.47	.001	Supported
	H13(c)	Academic media → Knowledge of preventive strategies	.18	2.36	.020	Supported
	H13(d)	Health communication campaigns → Knowledge of preventive strategies	.25	3.29	.001	Supported
	H13(e)	Interpersonal communication → Knowledge of preventive strategies	.16	2.18	.031	Supported
Cues to action: Attitude	H14(a)	TV news → Favorable preventive attitudes	.17	2.24	.027	Supported
	H14(b)	Social media → Favorable preventive attitudes	.23	3.06	.003	Supported
	H14(c)	Academic media → Favorable preventive attitudes	.14	1.98	.049	Supported
	H14(d)	Health communication campaigns → Favorable preventive attitudes	.22	2.94	.004	Supported
	H14(e)	Interpersonal communication → Favorable preventive attitudes	.12	1.82	.071	Not supported
Cues to action: Preventive behavior	H15(a)	TV news → Preventive behavior	.15	2.04	.043	Supported

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Theoretical pathway	Hypothesis	Proposed relationship	β	*t* / *r*	*p*	Status
	H15(b)	Social media → Preventive behavior	.25	3.38	.001	Supported
	H15(c)	Academic media → Preventive behavior	.16	2.16	.032	Supported
	H15(d)	Health communication campaigns → Preventive behavior	.24	3.12	.002	Supported
	H15(e)	Interpersonal communication → Preventive behavior	.13	1.87	.063	Not supported

Note. N = 155. β = standardized regression coefficient; t = regression test statistic; r = Pearson correlation coefficient. For H1–H6, the two reported statistics represent the relevant constituent relationships in the proposed pathway: predictor → attitude and attitude → preventive behavior (with the second value reported as r where that is the available statistic). The overall attitude model was significant, R^2 = .56, $F(6, 148) = 31.45$, $p < .001$. The hierarchical model predicting preventive behavior explained 49% of variance at Step 1, 54% at Step 2 (ΔR^2 = .05, p = .001), and 58% at Step 3 (ΔR^2 = .04, p = .004).

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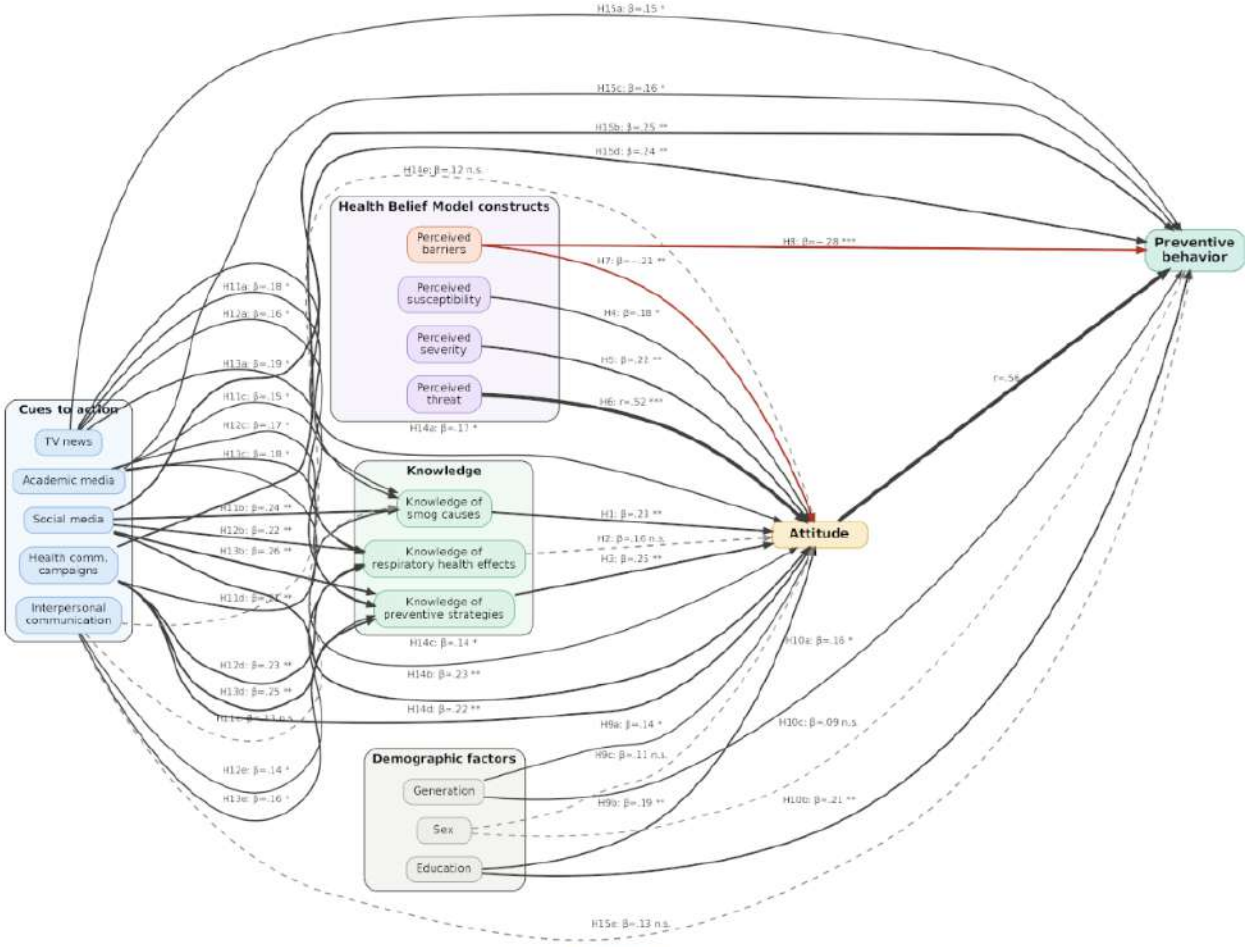
Figure 1: ***Structural Model for Consolidated Hypothesis Testing Results Across the Proposed Theoretical Pathways***



The hypothesis-testing findings are figured out in line with the hypothesized indirect and direct routes. Knowledge of smog causes was hypothesized to have an indirect positive effect on preventive behavior through attitudes (H1). Knowledge of smog causes significantly predicted attitudes (β = .23, t = 3.00, p = .003), while attitudes were positively associated with preventive behavior (r = .56, p < .001). An indirect effect of knowledge about smog-induced respiratory infections on preventive behavior through attitudes was proposed (H2). But its influence on attitudes was not significant (β = .16, t = 1.89, p = .061). An indirect effect of preventive-strategy knowledge through attitudes and was supported (H3) because knowledge significantly predicted attitudes (β = .25, t = 2.90, p = .005), followed by a significant attitude–behavior relationship. In the same way, there were hypothesized (H4 & H5) indirect effects of perceived susceptibility and perceived severity, respectively, on preventive behavior through attitudes. Both predictor-to-attitude paths were significant (β = .18, p = .028; β = .22, p = .005), and attitudes were significantly related to preventive behavior; therefore, the proposed pathways were maintained. H6 proposed an indirect effect of perceived threat through attitudes. Perceived threat was significantly related to attitudes (r = .52, p < .001) and preventive behavior (r = .50, p < .001), providing support for the proposed pathway.

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The hypotheses (H7–H15) also researched direct effects. H7 and H8 proposed direct negative effects of perceived barriers on attitudes and preventive behavior, respectively. Both were supported (β = −.21, p = .008; β = −.28, p < .001). For demographics, H9a–H9c examined direct effects on attitudes. Generation (H9a) and education (H9b) were significant, whereas sex (H9c) was not. Likewise, H10a–H10c examined direct effects on preventive behavior; generation (H10a) and education (H10b) were significant, while sex (H10c) was not. The hypotheses (H11–H15) tested direct effects of cues to action. The results reinforced the proposed direct associations of television, social media, academic media, and health communication campaigns with knowledge, attitudes, and preventive behavior. However, interpersonal communication did not predict knowledge of smog causes (H11e), favorable attitudes (H14e), or preventive behavior (H15e). The results support for most of the proposed indirect and direct pathways, with exclusions for health-effects knowledge, sex, and selected interpersonal-communication associations.

6. DISCUSSION

The current study researched the associations among knowledge, health-risk views, attitudes, preventive behavior, perceived hurdles, demographics, and media-related signs related to smog-induced respiratory health risks among those who used media and communication forms in Lahore city. The study combines the Knowledge–Attitude–Behavior/Practice (KAB) framework with selected dimensions of the Health Belief Model (HBM), Theory of Planned Behavior (TPB), and cues to action. The results give ample evidence for the proposed conceptual framework, while few associations were not statistically sound. Generally, the findings show that preventive responses to smog are not determined by knowledge alone but emerge through the interaction of cognitive understanding, perceived health risks, attitudes, perceived barriers, demographic characteristics, and exposure to different communication sources.

The findings provide partial support for the KAB framework and are broadly consistent with previous research suggesting that knowledge can contribute to favorable attitudes and preventive practices. The results revealed that knowledge of smog causes significantly predicted attitudes (β = .23, t = 3.00, p = .003), while attitudes were positively related with preventive behavior (r = .56, p < .001). This finding is consistent with Wang et al. (2015), who reported high levels of knowledge concerning air pollution sources and health effects, although protective practices remained comparatively low. Their findings demonstrate that knowledge and attitudes do not automatically translate into corresponding protective practices. The present study extends this observation by demonstrating a significant association between knowledge of smog causes and attitudes and a subsequent association between attitudes and preventive behavior.

The result is also consistent with Unni et al. (2022), who reported a positive association between knowledge and indoor air-quality-related behavior. Their study indicated that knowledge-sharing interventions could improve attitudes. Results inform that knowledge can establish a vital mental base for preventive health responses.

Knowledge of respiratory health effects did not significantly predict attitudes (β = .16, t = 1.89, p = .061). This finding is important because it indicates that awareness of health consequences alone may not be sufficient to generate favorable attitudes toward prevention. The finding can be compared with Wang et al. (2015), who found that respondents had substantial knowledge concerning air pollution and children's respiratory health but nevertheless demonstrated relatively low protective practices. Thus, both studies point toward a possible knowledge–action gap, although the present study specifically indicates that knowledge of health effects did not significantly predict attitudes.

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Knowledge of preventive strategies significantly predicted attitudes (β = .25, t = 2.90, p = .005), and attitudes were positively associated with preventive behavior. This result is particularly consistent with Huang et al. (2024), who found that knowledge about protective measures, including air purifiers and anti-haze window screens, influenced attitudes toward protective actions and that attitudes formed an important pathway through which knowledge was related to protective behavior. The present findings similarly suggest that actionable knowledge may be more closely connected to preventive orientations than knowledge that simply describes the health consequences of smog. This informs that health communication interventions should not only communicate the seriousness of smog but should also provide clear, practical, and actionable information concerning what people can do to reduce exposure and protect their health.

The results for perceived susceptibility, severity, and threat provide support for the incorporation of HBM and TPB-related constructs into the proposed framework. It was proposed that perceived susceptibility would indirectly affect preventive behavior through attitudes. Perceived susceptibility significantly predicted attitudes (β = .18, t = 2.22, p = .028), while attitudes were positively related to preventive behavior. This result informs that people who think themselves as personally weak to smog-related respiratory issues are more likely to nurture attitudes toward preventive actions. Perceived severity significantly predicted attitudes (β = .22, t = 2.88, p = .005), and attitudes were positively related with preventive behavior. This result is in line with the HBM that perceptions concerning susceptibility and seriousness can contribute to readiness for preventive action. Chen and Liu (2023) found positive effects of perceived threat on intentions to undertake protective behaviors such as wearing facemasks and using air purifiers. Their findings further showed that worry influenced behavioral intentions through perceived threat. The present study similarly demonstrates a significant role for perceived threat, although the present framework places attitudes as an important component of the proposed pathway.

Perceived threat was positively associated with attitudes (r = .52, p < .001) and preventive behavior (r = .50, p < .001). These results indicate that individuals who perceive smog as a meaningful health threat also tend to report more favorable attitudes toward preventive strategies and greater preventive behavior. The findings differ somewhat from Iftikhar et al. (2024), who reported only a small direct effect of perceived threat on adherent behavior and identified larger effects for perceived benefits and a medium effect for self-efficacy.

It was proposed a direct negative effect of perceived barriers on attitudes, and the hypothesis was supported (β = −.21, t = −2.71, p = .008). It was proposed that a direct negative effect of perceived barriers on preventive behavior, which was also supported (β = −.28, t = −3.58, p < .001). These findings indicate that individuals may recognize the risks associated with smog and hold favorable attitudes toward prevention while still experiencing difficulties in adopting preventive strategies. The negative relationship with behavior is particularly important because it suggests that behavioral change requires more than increasing awareness. This result is compatible with Iftikhar et al. (2024), who explicitly examined perceived barriers in relation to adherence to smog-related protective behavior. Their findings similarly demonstrate the importance of barriers within an extended HBM–TPB framework. The present study adds to this evidence by demonstrating significant negative relationships of perceived barriers with both attitudes and preventive behavior. It is inferred that health communication campaigns should not merely tell individuals what they should do. They should also address whether and how people can realistically perform the recommended behavior.

The demographic findings provide partial support for the proposed hypotheses. There were significant direct relationships of generation and education with attitudes, whereas sex, was not

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supported. Similarly, generation and education affected preventive behavior, whereas sex did not. The current findings therefore inform that demographic characteristics can affect health communication. Education may facilitate the interpretation and application of environmental-health information, while generational differences may reflect differences in media exposure, communication preferences, health experiences, or patterns of engagement with information. However, the nonsignificant findings for sex indicate that such demographic effects should not be assumed without empirical evidence. In the present sample, sex did not significantly predict either attitudes or preventive behavior.

Television news, social media, academic media, and health communication campaigns significantly predicted knowledge of smog causes, whereas interpersonal communication did not. This finding demonstrates the relevance of mediated information environments for developing public understanding of the causes of smog. The result is compatible with Hussain et al. (2024), who reported that approximately half of the vehicle users in their Lahore-based study obtained information about smog through television channels. The present findings extend this evidence by showing that several media sources, rather than television alone, can be associated with knowledge of smog causes. This suggests that knowledge concerning health consequences may be acquired through a broader communication environment involving both mediated and interpersonal sources. All five sources significantly predicted knowledge of preventive strategies. This finding is particularly relevant because preventive knowledge represents actionable information that can potentially facilitate protective responses. The result is consistent with the broader argument of Siddiqui et al. (2023), who identified social media campaigns as an instrumental mechanism for increasing awareness about smog and encouraging better action. Television, social media, academic media, and health communication campaigns were significantly associated with favorable attitudes toward preventive strategies, whereas interpersonal communication was not. This pattern indicates that mediated and organized communication may be more consistently associated with attitudinal outcomes than interpersonal communication within the present sample. Television, social media, academic media, and health communication campaigns were significantly related to preventive behavior, whereas interpersonal communication was not. This finding is important because it demonstrates that communication sources were associated not only with knowledge but also with the behavioral outcome examined in the study. Social media significantly predicted knowledge of smog causes, health effects, and preventive strategies, as well as favorable attitudes and preventive behavior. Health communication campaigns demonstrated a similarly consistent pattern. These findings correspond with Farrah et al. (2023) and Siddiqui et al. (2023), who emphasized the potential of social media campaigns for creating awareness about smog and encouraging sustainable or protective behavior. The present findings provide empirical support for the relevance of social media within an extended HBM-based health communication framework. Individuals who are already concerned about smog may also be more likely to seek information through social media.

The results inform that smog-related health communication in Lahore should combine risk information with actionable preventive guidance and strategies for overcoming perceived barriers.

6. CONCLUSION

The findings suggest that effective smog-related health communication should move beyond simply disseminating information. Communication strategies should provide actionable preventive knowledge, strengthen appropriate perceptions of susceptibility and severity, encourage favorable attitudes, and address practical barriers to preventive action. Social and mediated communication channels can

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serve as important mechanisms for delivering such messages to media users.

7. CONTRIBUTIONS

The research integrates KAB, HBM, and TPB to contextualize smog-related health behavior in a developing country setting. It extends the understanding of media as a cue to action for protective behavior in public health communication and presents new empirical insights on urban youth behavior in Pakistan regarding environmental hazards.

8. RECOMMENDATIONS

Government and NGOs should design targeted awareness campaigns that use social and academic media platforms. Universities should incorporate environmental education in curricula to enhance proactive health behaviors. Policies should aim to reduce perceived barriers by subsidizing preventive tools like masks and air purifiers.

9. LIMITATIONS

The sample was limited to university students in Lahore and may not reflect broader population behaviors. Cross-sectional data limits causal interpretations. Self-reported data may be subject to social desirability bias.

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