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SOCIO-CHEMICAL DETERMINANTS OF PUBLIC PERCEPTION AND BEHAVIOURAL RESPONSE TO ENVIRONMENTAL POLLUTION IN INDUSTRIAL COMMUNITIES

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Abstract

Industrial pollution presents serious health and environmental risks, but public perception and behavioural responses to these hazards are shaped by a complex interplay of chemical realities and social factors. This interdisciplinary mini review explores how sensory experiences, cognitive biases, institutional trust, environmental stigma, and sociodemographic characteristics influence how industrial communities perceive pollution and take action. Sensory cues such as odours and visible emissions often play a dominant role in shaping awareness, sometimes overshadowing scientific measurements. Psychological biases, including feelings of personal invulnerability and the tendency to view one's immediate environment as safer than it objectively is, can distort risk perceptions and hinder protective behaviours. Institutional trust is a critical determinant of public engagement; when trust in authorities and regulators is low, skepticism and social activism increase, while transparent communication fosters cooperation. Environmental stigma can deeply affect community identity and wellbeing, leading to avoidance behaviours and social withdrawal even amid remediation efforts. Sociodemographic factors such as gender, income, education, and proximity to pollution sources—moderate risk perception and responses across diverse populations. Participatory monitoring initiatives that engage residents in data collection have shown promise in bridging the gap between subjective perceptions and objective environmental data, enhancing awareness and empowering communities. By integrating insights from both chemical and social sciences, this review highlights the importance of holistic, cross-disciplinary approaches for managing industrial pollution and supporting resilient, informed communities.

Keywords*: Industrial pollution, Public perception, Behavioural response, Sensory exposure, Risk perception, Institutional trust*

Graphical Abstract

1.0 Introduction

Industrial pollution, from air, water, or soil contamination poses serious health and environmental risks [1-6]. Yet public responses are shaped not just by chemical exposure, but by sensory cues, institutional trust, demographics, and community identity [7-9]. This interdisciplinary mini-review demonstrate empirical research on how chemical realities and social factors combine to influence perception and behaviour in industrial communities.

Despite advancements in environmental monitoring and toxicology, many communities continue to rely on subjective cues, such as odors, visible emissions, and personal health experiences, to assess environmental risks. These perceptions are further shaped by sociological variables, including class, education, local history, and political marginalization (Table 1). For instance, residents living near industrial zones may either normalize pollution due to economic dependency or overestimate risks due to distrust in authorities [11-16].

Understanding the interplay between chemistry and sociology is crucial for effective public health interventions, policy development, and risk communication. Misalignment between perceived and actual risk can lead to either complacency or social unrest, both of which hinder mitigation strategies [17-18]. This review explores key socio-chemical determinants such as risk misperception, environmental stigma, community mobilization, and participatory monitoring that influence how industrial pollution is understood and acted upon by affected populations. By integrating evidence from environmental science, public health, and social `theory, the review highlights the need for cross-disciplinary approaches in managing industrial pollution and its societal consequences.

Table 1: Key Sociological Variables Influencing Risk Perception

Sociological Variable	Influence on Risk Perception	Citations
Cultural Worldviews	Egalitarian values increase risk perception; individualism and hierarchism decrease it	[10]
Education	Higher education is linked to greater risk perception and pro-environmental behavior	[11]
Gender	Women consistently report higher environmental risk perception than men	[12]
Ethnicity	Ethnic background shapes risk perception through shared experiences and cultural attitudes	[13]
Political Ideology	Political beliefs and marginalization affect trust in authorities and risk assessments	[14]
Local History & Experience	Prior exposure to hazards and local narratives shape normalization or heightened concern	[15]
Environmental Knowledge	More knowledge generally increases risk perception and pro-environmental action	[16]

2.0 Sensory Exposure and Perception

In industrial communities, perceptions of environmental pollution are often shaped less by formal measurements than by direct sensory encounters. Residents frequently rely on visible smoke, unpleasant odors, changes in water colour, or respiratory irritation to judge the presence and severity of pollution. These sensory cues, while not always scientifically correlated with specific pollutants or toxicity levels, strongly influence how individuals interpret environmental risk. As a result, subjective experience can become a primary driver of community concern and behavioral response, especially in contexts where access to environmental data is limited or institutional trust is low. This phenomenon reveals a complex interplay between chemical reality and social interpretation, in which the sensory body becomes an informal diagnostic tool for environmental harm [19-23]

The study by Noël *et al.* (2022) offers a clear empirical illustration of this dynamic. Investigating public understanding of air pollution in Brussels, the authors found that residents overwhelmingly based their definitions of pollution on what they could perceive through the senses (particularly smell and visibility), rather than on scientific data or pollutant concentrations [24]. Their work highlights the limitations of top-down, data-driven risk communication strategies that fail to account for how communities physically and emotionally experience their environment. By centering sensory perception as a legitimate and influential mode of environmental awareness, Noël et al. emphasize the need for more participatory and responsive frameworks in pollution monitoring and communication. Their findings underscore how social and chemical realities must be jointly considered to fully understand public responses to industrial pollution.

3.0 Risk Misperception and Cognitive Bias

Public perceptions of environmental pollution often diverge sharply from scientifically measured pollution levels, a discrepancy that is frequently driven by cognitive heuristics [25]. These mental shortcuts used to simplify complex information—can bias how individuals interpret environmental risks, sometimes leading to underestimation or overreaction**.** Table 2 shows the factors influencing perception vs. scientific measurement of pollution. Such heuristics are especially influential in familiar or socially cohesive environments, where people tend to assess safety based on subjective impressions rather than empirical evidence [26-31]

Table 2: Factors Influencing Perception vs. Scientific Measurement of Pollution

Factor	Effect on Perception-Measurement Gap	Citations
Socioeconomic status	Alters accuracy of perception	[26]
Mental health	Can increase perception accuracy	[27]
Age and occupation	Older adults/students may underestimate	[28]
Urban environment features	Green space, transport density affect perception	[29]
Media and sensory cues	Visibility, news, and social media shape perception	[30]
Lack of standardized measures	Limits comparability and alignment	[31]

Boso *et al.* (2025), in a recent scoping review, identified a range of psychological biases that contribute to this perceptual gap. Notably, they describe the "neighbourhood halo effect," wherein individuals view their immediate environment as inherently safer or cleaner due to social familiarity or aesthetic cues [32]. This can result in a misplaced sense of security even in the face of measurable pollution. Another key finding from the review is the prevalence of personal invulnerability bias—the tendency for individuals to believe they are less susceptible to environmental harm than others. These distortions in risk perception undermine the effectiveness of public health messaging and reduce the likelihood of adaptive behaviours such as participation in pollution mitigation efforts or health-protective practices. Boso et al.'s findings underscore the importance of incorporating psychological insights into environmental policy and communication strategies to more effectively align public behaviour with actual risk.

4.0. Institutional Trust and Media Framing

Institutional trust, particularly in regulatory agencies, scientific experts, and industrial actors are foundational determinant of how communities interpret and respond to environmental contamination. When trust is compromised, public engagement, risk communication, and remediation efforts are often met with skepticism or outright resistance [33-36]. This dynamic is especially pronounced in communities affected by prolonged or high-profile pollution events, where the credibility of institutions is continuously evaluated by the public in light of historical actions, transparency, and responsiveness [37-39].

One of the most compelling illustrations of this relationship comes from the work of Zhuang *et al.* (2019), who conducted a longitudinal content analysis of media coverage surrounding dioxin contamination in Midland, Michigan—a region heavily impacted by industrial pollution over several decades [40]. Their study systematically examined

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how the framing of contamination events in local and national media evolved over time, and how such framing influenced public discourse around risk, responsibility, and institutional credibility.

Zhuang and colleagues identified four dominant and interrelated themes: risk communication, social stigma, trustworthiness of institutions, and citizen participation [40]. In the early stages of coverage, news narratives largely emphasized scientific uncertainty and industrial accountability, reflecting broader societal tensions between economic interests and environmental protection. Over time, however, the framing shifted to include more nuanced portrayals of community impact, particularly the psychological and social burdens of living in a contaminated environment [41-44].

The study highlighted how media representations of institutional trustworthiness significantly shaped public perceptions. For instance, portrayals of regulatory agencies as inconsistent or opaque in their communication undermined public confidence, whereas reports that emphasized community engagement, transparent risk assessments, and corporate responsibility fostered greater trust [45-46]. This evolution in media framing not only influenced how residents perceived the severity and legitimacy of the environmental threat but also played a critical role in mobilizing (or discouraging) citizen action, including participation in public hearings, community advocacy, and grassroots monitoring [47-50].

By tracing how narratives of trust and risk were constructed and contested in the media, Zhuang *et al.* (2019) underscore the power of media as both a mirror and shaper of public sentiment [40]. Their work reinforces the idea that media is not merely a passive channel of information but an active arena where meanings are negotiated, institutional credibility is tested, and public behaviors are catalyzed. As such, any strategy aimed at effective environmental risk communication must carefully consider the role of media framing and prioritize building trust with affected populations through consistent, transparent, and participatory engagement [51-53].

This case from Midland, Michigan demonstrates that trust is not static; it is dynamic and responsive to how institutions perform, how they are represented, and how openly they involve the public [54]. Addressing environmental crises therefore requires not only technical solutions but also deliberate efforts to cultivate institutional legitimacy and public confidence through ethical communication and inclusive governance [55-57].

5.0 Environmental Stigma and Community Identity

The concept of environmental stigma has gained increasing attention as a critical dimension in understanding the socio-psychological impacts of living in polluted environments [58]. This form of stigma arises when communities become associated with environmental contamination, leading to both internal and external judgments that shape identity, behaviour, and well-being [59-60]. In a seminal qualitative study, Zhuang et al. (2016) investigated the experiences of residents living in the dioxin-contaminated region of Midland–Saginaw–Bay City, Michigan—an area long affected by industrial pollution [61]. Their research revealed that stigma was deeply internalized by residents, manifesting across affective, cognitive, and behavioural domains. Emotionally, individuals expressed feelings of embarrassment and discomfort about living in a place perceived by outsiders as "contaminated." Cognitively, many residents developed a persistent awareness of their environmental risk status, accompanied by uncertainty about the safety of daily practices. This was often reinforced by conflicting information from media and authorities. Behaviourally, residents reported avoiding locally caught fish—a traditional and economic resource in the area—out of fear of exposure to toxins. In some cases, this led to social withdrawal and decreased participation in community life, indicating a deterioration of collective identity and cohesion [62-64].

Crucially, Zhuang and colleagues found that these patterns of stigma persisted even in the face of active remediation efforts. This suggests that psychological and social dimensions of environmental exposure can outlast the physical presence of contaminants, underscoring the resilience of stigma and its capacity to influence long-term community dynamics. These interwoven experiences are encapsulated in Figure 1, which visually represents the multidimensional nature of environmental stigma. The figure illustrates how industrial pollution shapes emotional responses (such as shame), avoidance behaviours (like steering clear of local fish), and broader effects on social identity and participation, even amid efforts to restore environmental safety.

This case study serves as a powerful reminder that environmental justice efforts must go beyond technical remediation. To foster true recovery in contaminated communities, interventions must also address the psychological and social scars left by environmental stigma, rebuilding not just physical environments but also public trust, community agency, and identity.

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Figure 1. Environmental stigma and community identity in industrial areas.

6.0 Sociodemographic Moderators

Public perception of environmental pollution is not uniform; rather, it is significantly shaped by socio-demographic variables such as gender, education level, income, and residential context [65-67]. These factors act as key moderators that influence how individuals interpret environmental risks, assign responsibility, and decide whether to take protective actions. In a comprehensive cross-national study spanning several European countries, Maione *et al.* (2021) found that perceptions of air pollution risks are unevenly distributed across social groups [68]. Women were consistently more likely than men to express concern about air quality, a trend that may reflect broader gendered differences in environmental health awareness and caregiving responsibilities. Similarly, residents of urban areas, where exposure to traffic emissions and industrial pollutants is typically higher—demonstrated greater sensitivity to air pollution risks than their rural counterparts. Lower-income populations also reported heightened risk perception, which may be related to their limited capacity to mitigate exposure or relocate away from polluted zones. Figure 2 shows the socio-demographic moderators of pollution perception in Europe and Zimbabwe.

These sociodemographic patterns are not confined to high-income regions. In Zimbabwe, for instance, Ngwenya *et al.* (2024) conducted in-depth qualitative interviews with residents of Kwekwe City, a mining-intensive area characterized by chronic exposure to toxic chemical pollutants such as heavy metals and cyanide [69]. Their findings reveal that proximity to mining operations significantly amplifies perceived health risks, particularly in communities where environmental governance and enforcement mechanisms are weak. Residents expressed acute concerns about water contamination, respiratory problems, and long-term effects on children's health—concerns that were often compounded by limited access to accurate information and medical services. The study highlights how localized experiences of pollution interact with broader structural inequities, including socioeconomic status and political marginalization, to shape environmental perception and community response.

Together, these findings illustrate that sociodemographic characteristics play a critical role in mediating how pollution is perceived and responded to. Understanding these moderators is essential for designing equitable environmental health interventions and ensuring that communication strategies are effectively tailored to diverse populations. Such insights also call attention to the need for inclusive policymaking that accounts for the lived realities of vulnerable and marginalized groups disproportionately affected by environmental degradation.

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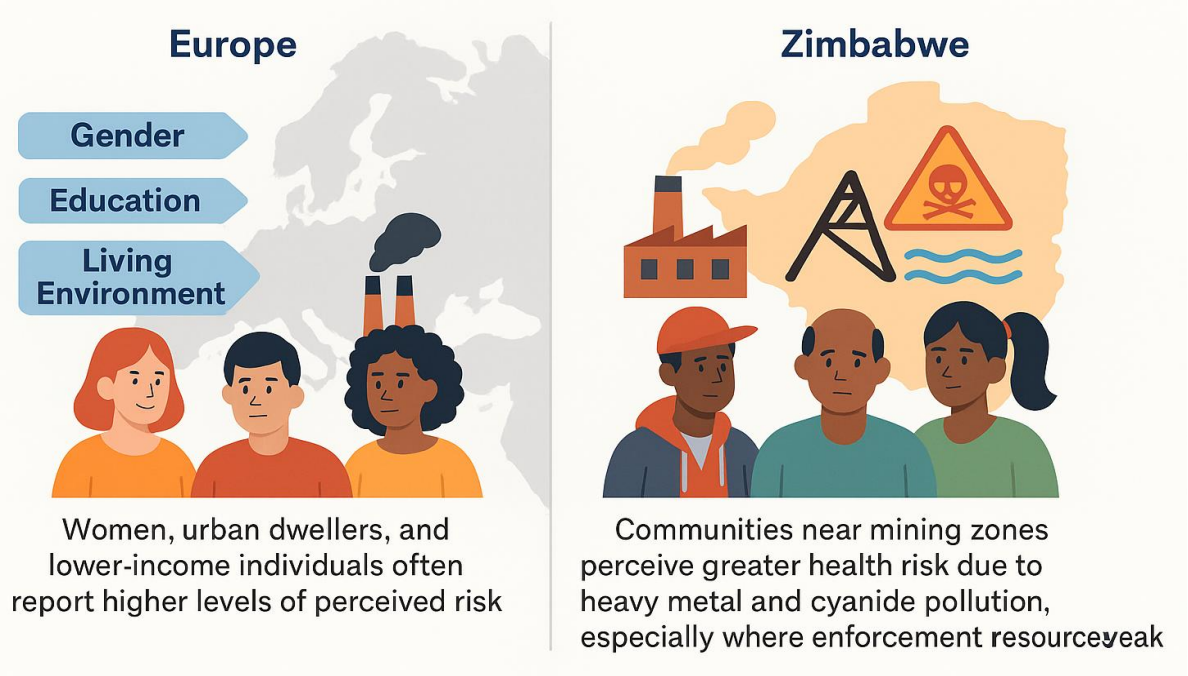

Figure 2. Sociodemographic moderators of pollution perception in Europe and Zimbabwe.

7.0 Behavioural Responses to Environmental Risks

Understanding community behavioural responses to environmental hazards is essential for designing effective risk communication and public health interventions. Numerous studies have shown that people's reactions to contamination events or perceived risks are influenced by a complex interplay of trust in authorities, access to information, and the alignment between perceived and actual risks.

For instance, Zhuang *et al.* (2016) conducted a detailed analysis of public reactions to dioxin contamination in Midland, Michigan [61]. Their research highlighted how community members often respond with avoidance behaviors, such as reducing or completely avoiding the consumption of locally sourced fish, which they perceive as a direct route of exposure to the contaminant. This avoidance is not merely an individual choice but is frequently embedded within wider social movements and forms of community activism, particularly when institutional trust is low. Zhuang and colleagues emphasized that when residents distrust regulatory agencies or perceive corporate actors as unreliable or deceptive, they are more likely to engage collectively in activism and demand greater transparency and remediation efforts. Moreover, the availability and accessibility of credible information play a pivotal role in shaping these responses. Communities with better access to accurate risk information are more empowered to make informed decisions and mobilize effectively.

Complementing these findings, Ngwenya *et al.* (2024) examined behavioral patterns in a different socio-cultural context and found that the adoption of personal protective measures—such as wearing masks or limiting outdoor activities—remains relatively low when individuals' perceptions of risk do not correspond with the actual levels of hazard exposure [69]. This misalignment can stem from cognitive biases, misinformation, or a lack of clear communication from authorities. Ngwenya and colleagues pointed out that without an accurate understanding of the severity and nature of risks, people may underestimate the need for protective behaviours, thereby potentially increasing their vulnerability. They further noted that enhancing risk perception accuracy through targeted education and community engagement is critical for fostering the uptake of protective practices. Table 3 shows the Key Drivers of Behavioral Responses to environmental risks.

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Factor	Influence on Behavior	Citations
Risk Perception	Higher perceived risk increases willingness to act, especially for immediate, personal threats	[70]
Trust in Authorities	Greater trust promotes collaborative behaviors; low trust can lead to confrontational or radical actions	[71]
Information & Communication	Effective risk messages and information channels (media, interpersonal) amplify risk perception and action	[72]
Constructive Hope	Positive outlook enhances the link between willingness and actual pro-environmental behavior	[73]
Cultural & Social Factors	Cultural worldviews and social norms mediate risk perception and pro-environmental actions	[74]
Type of Impact	Immediate, individual-level impacts drive action more than distant, community-level risks	[70]

Together, these studies underscore the importance of building and maintaining institutional trust and ensuring the availability of transparent, accessible information. When these conditions are met, communities are more likely to respond adaptively, adopting behaviours that effectively mitigate health risks. Conversely, low trust and poor information flow often lead to avoidance and activism as communities seek alternative means of protecting themselves.

8.0 Participatory Monitoring and Knowledge Integration

In recent years, participatory monitoring through citizen science initiatives has emerged as a powerful strategy to bridge the often-significant divide between community perceptions of environmental risks and scientifically measured realities [75-76]. These initiatives actively involve residents in the data collection process, thereby fostering a sense of ownership and enhancing the credibility of the gathered information within the community [77].

Sîrbu *et al.* (2015) provide a compelling example through their study of community-based air quality monitoring projects [78]. In these projects, local residents were trained and equipped to collect real-time data on ambient pollution levels in their neighborhoods. This hands-on engagement not only demystified the scientific process but also played a crucial role in raising environmental awareness among participants. Sîrbu and colleagues found that when individuals actively participate in monitoring efforts, their subjective perceptions of pollution—often influenced by anecdotal experiences or misinformation—become more closely aligned with objective measurements. This alignment is essential because it reduces the gap between perceived and actual risk, which is frequently a barrier to effective risk management and behavior change.

Furthermore, the study by Sîrbu *et al.* (2015) highlights that participatory monitoring facilitates the integration of local experiential knowledge with scientific data, enriching both the interpretation and communication of environmental risks. By valuing community observations alongside technical measurements, these initiatives help cultivate a more inclusive approach to environmental governance. This, in turn, can strengthen trust between communities and authorities, improve the responsiveness of regulatory bodies, and ultimately support more informed decision-making at both local and policy levels.

Thus, citizen science not only empowers communities by giving them tools to assess their environment but also fosters a collaborative knowledge exchange that enhances risk perception accuracy and promotes proactive environmental stewardship [79].

9.0 Conclusion

The perception and behavioural response to industrial pollution in affected communities cannot be fully understood without considering the intricate relationship between chemical realities and social dynamics. Sensory experiences, cognitive biases, and sociodemographic factors shape how individuals and communities interpret environmental risks, often leading to gaps between perceived and actual hazards. Institutional trust and media framing critically influence public engagement, either fostering cooperation or fuelling skepticism and activism. Additionally, environmental stigma profoundly impacts community identity and social cohesion, with consequences that extend beyond physical contamination. Importantly, participatory monitoring and citizen science initiatives offer promising pathways to empower communities by aligning subjective perceptions with scientific data, thereby enhancing risk awareness and fostering proactive environmental stewardship. To effectively address the complex challenges of industrial pollution, policy and intervention strategies must adopt a cross-disciplinary approach that integrates chemical, psychological, social, and cultural dimensions. Only by embracing this holistic perspective can sustainable solutions be developed that protect both environmental and community health while promoting trust, equity, and resilience in industrial regions.

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Conflict of Interest
The authors declare that they have no conflict of interest.

Data Availability Statement:
All data supporting this study are available upon request from the corresponding author.

Authors' Declaration
Samuel A. Ogunkoya, Idris Oladimeji Junaid, and Uanzekin-Ohis Faith Scholastica contributed to the literature search, data curation, and initial drafting of the manuscript. Gregory E. Onaiwu, Sunday Oghenetega, Aireguamen I. Aigbodion provided critical insights, reviewed and edited the manuscript for intellectual content, and contributed to the conceptual framework. Ikhazuagbe Hilary Ifijen supervised the study, conceptualized the review, coordinated the writing process, and finalized the manuscript. All authors read and approved the final version of the manuscript.

Ethical Declarations Human/Animal Studies
Not Applicable.

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