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PSYCHOSOCIAL DETERMINANTS OF PUBLIC ENGAGEMENT IN URBAN WASTEWATER MANAGEMENT: A STUDY OF WATER QUALITY AWARENESS IN KANPUR, INDIA

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Abstract
Kanpur faces severe water contamination due to unchecked industrial effluent discharge from tanneries, textile, and chemical factories, which has critically degraded water quality and posed significant public-health risks. This study examines the psychosocial determinants of public engagement in urban wastewater management, focusing on household awareness, behaviour, and responses to industrial pollution. Evidence from demographic surveys shows that middle-aged males with moderate education and stable occupations dominate participation, reflecting firsthand experiences with contaminated water. Spatial assessments reveal that households relying on shallow wells or hand-pumps near industrial zones face higher exposure to heavy metals and microbial pollutants compared with deeper tube-wells or treated municipal water, highlighting the role of location-specific environmental risk perception. Socioeconomic status strongly influences risk awareness, water-source choices, and adoption of purification methods, indicating that disadvantaged households bear a double burden of higher exposure and limited mitigation capacity. Observed community behaviour demonstrates that fear, stress, and limited knowledge—key psychosocial factors—shape household coping strategies, while participation in local monitoring and reporting remains low. The findings underscore gaps in urban wastewater management and the urgent need for sustainable urban water governance, integrating technical interventions with social measures, education, and community empowerment. This study highlights that effective water-quality management in Kanpur is not merely a technical issue but also a psychological and social challenge. Understanding how psychosocial determinants influence awareness and engagement can guide policymakers and stakeholders to design targeted interventions, enhance public participation, and reduce health risks in industrially polluted urban settings.
Keywords: Urban wastewater management, water quality, environmental risk perception, psychosocial determinants, community behaviour, Psychosocial factors, Sustainable urban water governance

INTRODUCTION

Kanpur City faces severe urban wastewater management challenges due to unchecked industrial effluent discharge. Numerous tanneries, textile, and chemical factories release toxic waste into rivers, which degrade water quality and threaten public health. The Ganga River receives untreated sewage and hazardous industrial chemicals daily, exposing nearby communities to serious health risks. People living close to industrial zones suffer frequent waterborne diseases, while contaminants such as chromium and lead cause long-term illnesses. Weak disposal systems and poor waste governance worsen the crisis, leaving many households without access to safe water. This study also explores how psychosocial determinants influence community response and risk awareness as industrial pollution continues to trigger widespread waterborne infections in Kanpur.

LITERATURE REVIEW

Industrial effluent discharge has critically degraded Kanpur's water quality, threatening both ecosystem stability and public health while exposing major weaknesses in urban wastewater management. Renu et al. (2023) reported that industrial zones release heavy metals and toxic compounds, reflecting gaps in sustainable urban water governance and weak regulatory enforcement. Savita and Dwivedi (2024) found alarming pollution in the Ganga River, which influences environmental risk perception among residents and shapes community behaviour toward local water use. These conditions reveal key psychosocial determinants, as fear, awareness, and trust affect public responses to contamination. Such conditions also amplify harmful psychosocial factors, especially stress and anxiety linked to unsafe resources and rising waterborne diseases.

Gupta et al. (2023) showed that toxic industrial discharge severely harms water quality, with heavy metals entering soil, sediments, and human blood. Saxena et al. (2024) highlighted failures in urban wastewater management, noting strong pollutant interactions that increase toxicity and elevate health risks. Pal et al. (2025) further stressed weaknesses in sustainable urban water governance, as industrial expansion continues without effective regulation. These conditions shape environmental risk perception and influence community behaviour, especially in areas facing unsafe supplies. The resulting stress and fear reflect key psychosocial determinants; while recurring anxiety and health concerns represent harmful psychosocial factors across exposed populations.

METHOD

Data Collection Process

Primary data was gathered through field surveys and household interviews. A semi-structured questionnaire collected information on family background and water use patterns. Respondents shared their water sources, purification habits, and sanitation practices. Questions also covered awareness of waterborne diseases and government health schemes. The survey design ensured complete demographic and socioeconomic coverage. Secondary data were collected from official reports of CPCB, CGWB, and JalJeevan Mission (Raghav et al. 2024). Research articles and government records supported validation of local field findings.

Sampling Technique

A random sampling approach selected 400 households across 19 wards in Zone-5. The sample was calculated using a statistical formula ensuring 95% confidence level. The parameters included access to potable water, error precision, and population proportion. The computed value of 393 households was rounded to 400 for balance. This ensured equal representation of various income and demographic groups. The process minimized bias and improved statistical reliability of responses. Each household was contacted personally for detailed interviews.

Laboratory Water Testing

Water samples were collected from taps, hand pumps, and open wells. These samples underwent laboratory tests following BIS and WHO guidelines. Physical indicators such as pH, turbidity, and TDS were first recorded. Chemical parameters like chromium, lead, and arsenic were measured carefully. Microbial analysis checked for coliform bacteria and harmful pathogens. The procedure ensured high precision in evaluating contamination levels. All tests followed standardized laboratory protocols to maintain result accuracy. Findings were compared with safe water standards.

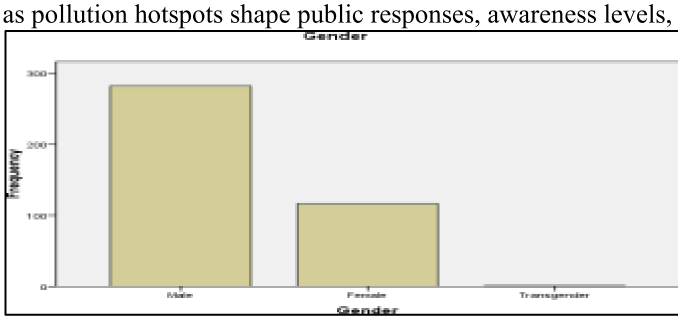
Data Analysis Procedure

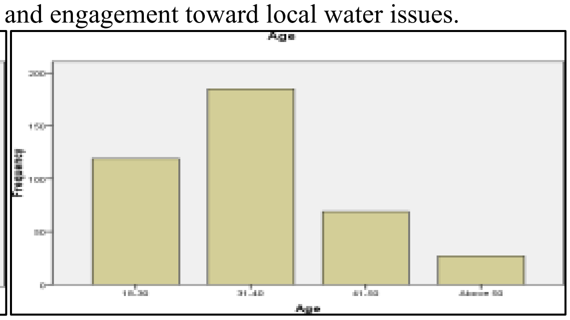
Collected data were processed using SPSS version 20 for analysis. Descriptive statistics such as frequencies and averages summarized household and water variables. Chi-square tests measured relationships between awareness and socio-economic factors. Correlation analysis identified links between water quality and disease occurrence. Regression models predicted waterborne illness likelihood from pollution exposure levels. Microsoft Excel graphs visualized patterns and supported clear interpretation. Statistical validation strengthened the connection between industrial pollution and health risks.

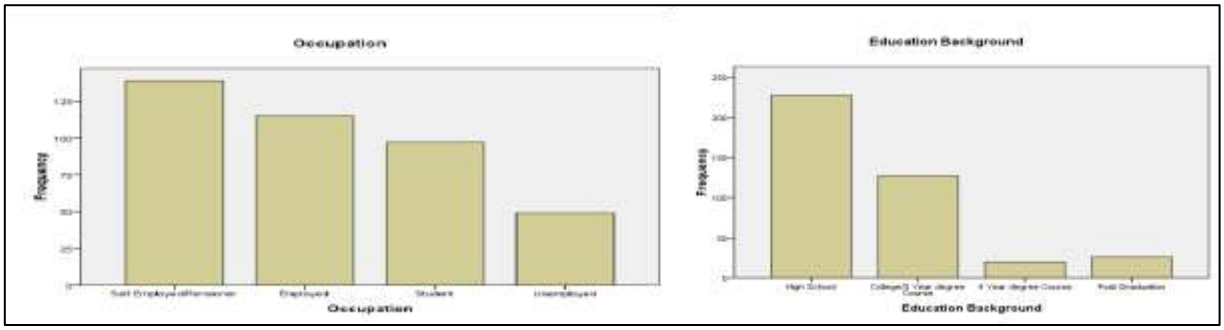
Result and Discussion

Variation in Water Quality Across Different Sampling Locations

In Kanpur, water quality assessments reveal sharp spatial differences across industrial clusters, river stretches, and groundwater zones. Areas with weak urban wastewater management show higher suspended solids, low dissolved oxygen, and elevated total dissolved solids near discharge points. These conditions influence community behaviour, as pollution hotspots shape public responses, awareness levels, and engagement toward local water issues.







The demographic charts reveal patterns that shape environmental risk perception and influence public responses to water quality threats in Kanpur. The gender chart shows about 290 males and 120 females, with negligible transgender participants, suggesting that males are more active in community behaviour related to civic issues. The age distribution indicates 190 respondents in the 31–40 group, 120 in the 18–30 group, 80 in the 41–50 group, and about 30 above 50, reflecting how age-linked psychosocial determinants affect awareness and engagement. The occupation chart shows self-employed or pensioners at around 140, employed individuals at about 110, students at nearly 95, and unemployed participants at about 50, indicating how economic roles shape attitudes toward urban wastewater management. The education chart shows around 230 respondents with high school education, about 120 with three-year degrees, and only 30–40 with four-year degrees or postgraduate qualifications, revealing how psychosocial factors like stress and insecurity drive concern over polluted resources. These patterns highlight gaps in sustainable urban water governance, where stronger psychological engagement is needed to support wastewater reforms in Kanpur.

		Frequency	Percentage
Opinion about solid waste management	Poor	25	4.91
	Fair	170	46.80
	Good	164	31.90
	Excellent	20	4.40
	Don't Know	6	1.48
Opinion about water pollution	Least	20	4.93
	Small	127	25.36
	Moderate	185	47.35
	High	23	6.25
	Don't Know	16	3.20

Table 1: Opinions of Respondents on Certain Issues of the Localities

Most people rated solid waste management as fair (46.80%) or good (39.90%). Only 6.40% said it was excellent, while 3.94% said poor. A small group (1.48%) did not know about waste management. On water pollution, 48.03% felt it was moderate, and 35.04% said small. Only 7.14% believed pollution was high, and 4.93% said least. Around 3.20% were unsure about water pollution levels. These numbers show mixed public views on Kanpur's water issues. Many thinks pollution is moderate, not extreme. Waste management is seen as average, needing improvement. Few people rate the system as excellent, showing scope for better planning.

A 2024 household survey in Zone-5 of Kanpur showed sharp spatial inequalities in water quality, especially among families using hand-pumps and shallow wells near industrial clusters (Yadav et al. 2025). Communities in these polluted localities displayed heightened environmental risk perception, since untreated tannery and textile effluents leach into shallow aquifers and drains feeding the Ganga. Seasonal changes intensify contamination, shaping community behaviour as households shift sources during dry and monsoon months. These spatial disparities also expose critical failures in urban wastewater management, where unchecked discharge creates hotspots of exposure only a few kilometres apart. Such uneven risk zones highlight key psychosocial determinants, as fear, awareness, and lived experience influence public reactions to contamination. Rising anxiety and health concerns represent harmful psychosocial factors, especially in neighbourhoods facing long-term exposure. Addressing these issues requires sustainable urban water governance with spatially targeted monitoring and interventions, rather than uniform city-wide assumptions (Agrawal, 2022).

Detection of Heavy Metals in Household and Groundwater Samples

Studies in Kanpur consistently document the presence of heavy metals — especially chromium, lead, cadmium and nickel — in river water, sediments and groundwater near industrial zones. A one-year monitoring programme of five stations on the Ganga at Kanpur found elevated hexavalent chromium (Cr^{6+}), lead (Pb) and cadmium (Cd) in river water attributed to tannery effluents (Sharma et al. 2022). More recently, a news-analysis described the situation in

Kanpur and surrounding districts as an "emergency", revealing that chromium and mercury had entered residents' bodies due to soil, ground water and surface water contamination well above permissible limits.

		Frequency	Percentage
Exact Location	Next to Agricultural Land	47	12.85
	Next to River Bank/Urbanisation	215	58.32
	Next to an Industrial Land	61	13.25
	Next to waste water disposing area	37	9.11
Water quality (Zone-5)?	Poor	18	4.43
	Fair	198	30.15
	Good	220	44.51
	Excellent	36	8.87
	Don't Know	12	2.96
Satisfied with the water quality	Yes	214	52.75
	No	135	32.15
	Don't know	43	9.36
Ground water (Zone 5)?	Poor	33	8.13
	Fair	161	39.66
	Good	174	42.86
	Excellent	23	5.67
	Don't Know	9	2.22

Table 2: Opinions regarding the surrounding of the Respondents

Also, comparative studies of river sediment between Kanpur and Prayagraj found heavy metal concentrations in deposited sediments far above baseline background values, underscoring the accumulation of industrial pollution over time (Aggarwal et al. 2022). The pathways to household exposure include use of groundwater drawn from shallow aquifers contaminated by industrial leachate, use of surface-water sources for irrigation and domestic purposes, and consumption of crops irrigated with polluted water or grown on contaminated soil. These multiple exposure routes mean that despite municipal treatment, many households in industrial-zone proximity remain at risk of chronic heavy-metal exposure. The effective removal of these metals often demands advanced filtration or ion-exchange systems which are beyond the affordability of many users. On a policy level, the documented detection of heavy metals in both water and human biomonitoring samples highlights the urgency of enforcing industrial pretreatment regulations (Gupta et al. 2023). It is upgrading sewage and effluent treatment plants in Kanpur and monitoring groundwater quality continuously in vulnerable neighbourhoods.

Correlation Between Water Contamination and Reported Health Problems

Empirical evidence from Kanpur links degraded water-quality parameters with higher incidences of waterborne illnesses among local populations. Historical data show that in 1991, Kanpur experienced a large waterborne hepatitis E epidemic (Sinha, 2021). Here, wards supplied by mixed river and tubewell water recorded attack rates around 5.6 % compared with 1.2 % in wards supplied only by tubewell water. More recently, a survey of 400 families in Zone-5 found that many respondents reported suffering from typhoid, cholera and hepatitis along with skin infections; statistical analysis revealed significant correlations between heavy-metal contamination, microbiological contamination and health outcomes. Another broader study of Uttarakhand and Uttar Pradesh regions (including Kanpur) found that access to safe drinking-water, sanitation, income, education and household size are all critical determinants of waterborne diseases (Sinha et al. 2022).

	Frequency	Percentage
Dug Well/Tube Well	40	12.58
Tap from Water Board	245	56.4
Tap from community Water scheme	115	26.51
Surface Water (River, stream, spring)	13	3.2
by look, taste, smell	49	11.82
Water quality reports	122	25.12
Environment around the water	189	48.25

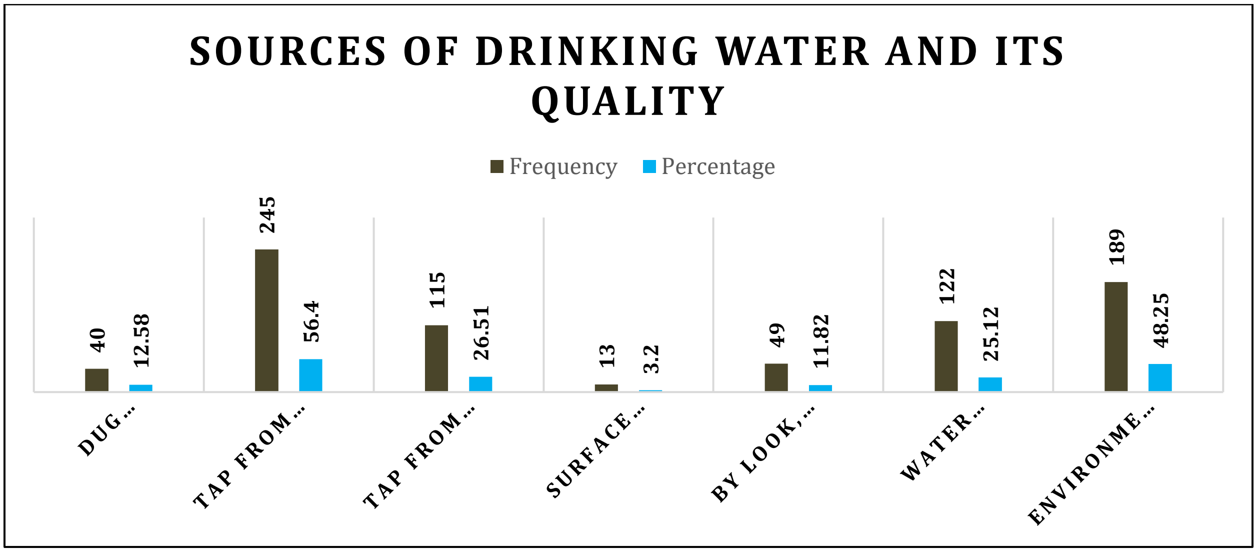


Table 3: Sources of Drinking Water and its Quality

Most people (56.40%) get drinking water from the Water Board tap. Around 27.59% use community water schemes, and 11.33% use wells. Only 3.49% depend on surface water like rivers. About 57.21% trust water quality reports for safety. Nearly 12.82% judge water by taste, smell, or look. For treatment, 69.55% use filters or RO systems. Around 21.57% add chlorine, and 11.33% boil water. Only 6.73% do no treatment at all. Drinking water is rated good by 57.90% people. About 23.66% said fair, and 14.44% said poor. These numbers show strong use of tap water and filtering methods.

These studies show that short-term microbiological exposure leads to immediate infections, whereas chronic physicochemical contamination causes long-term liver, kidney, and cardiovascular risks, shaping environmental risk perception in polluted neighbourhoods. The strong links between industrial discharge, illness patterns, and source choice reveal how psychosocial determinants drive household decisions on water quality protection. Such inequalities also influence community behaviour, as fear, awareness, and trust shape responses to contamination. The findings expose failures in urban wastewater management, where weak monitoring increases anxiety and other harmful psychosocial factors tied to unsafe supplies. Addressing these health burdens demands sustainable urban water governance through integrated sanitation, health education, and socioeconomic interventions in Kanpur (Chhaparia & Jha, 2023).

Community Awareness and Perception of Water Pollution in Kanpur

The depth of community awareness regarding water-quality risks in Kanpur varies widely and this variability influences household behaviours and exposure levels. A study using data from Lucknow and Kanpur found that sources of drinking water, income, household size, education level and caste were strong determinants of both purification behaviour and incidence of waterborne diseases (Terefe et al. 2024). In Kanpur's Zone-5 survey, although many households recognised occasions of foul-smelling or discolored water and reported skin or gastrointestinal ailments, fewer households associated longer-term risks (like heavy-metal contamination) or believed industry-linked pollution was the root cause. Even where households expressed concern, their capacity to upgrade to advanced treatment (e.g., reverse osmosis) was often constrained by cost.

		Frequency	Percentage
Severity of threat posed to water [Industrial or factory waste]	No threat	9	2.22
	Not much of a threat	30	7.39
	Somewhat Threat	109	26.85
	Moderate Threat	229	56.40
	Serious threat	22	5.42
Severity of threat posed to water [Runoff from cities and towns]	No threat	33	8.13
	Not much of a threat	59	14.53
	Somewhat Threat	181	44.58
	Moderate Threat	117	28.82

	Serious threat	10	2.46
Severity of threat posed to water [Loss of natural areas]	No threat	7	1.72
	Not much of a threat	53	13.05
	Somewhat Threat	196	48.28
	Moderate Threat	121	29.80
	Serious threat	23	5.67
Severity of threat posed to water [Community sewage treatment plants & septic tanks]	No threat	8	1.97
	Not much of a threat	26	6.40
	Somewhat Threat	130	32.02
	Moderate Threat	214	52.71
	Serious threat	22	5.42

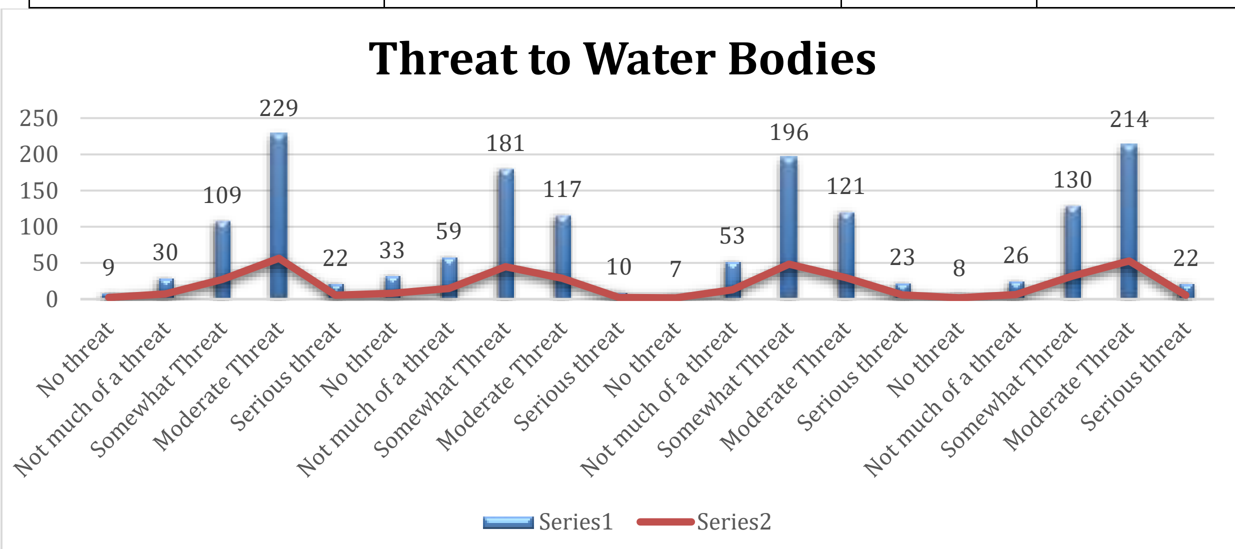


Table 4: Threat to Water Bodies

Industrial waste is a moderate threat for 29.97% of respondents. About 26.05% see it as somewhat threatening, and 21.63% call it serious. Only 2.22% think it poses no threat. City runoff is a moderate threat for 28.89%, and serious for 25.71%. Around 28.65% say it’s somewhat threatening. Loss of natural areas is a moderate threat for 49.38%. About 27.42% see it as somewhat threatening. Sewage and septic tanks are a moderate threat for 52.54%. Only 5.42% call them a serious threat. These numbers show people worry most about sewage and land loss. Industrial and city runoff also concern many.

As a result, many households rely on boiling or basic filtration, which reduces microbial risks but fails to improve water quality in areas contaminated by dissolved heavy metals. This mismatch between awareness and action reflects weak urban wastewater management, where hidden exposure continues to shape environmental risk perception among conscious families (Choudhury et al. 2024). Such conditions reveal key psychosocial determinants, as limited resources and partial knowledge influence community behaviour and weaken long-term protection. Anxiety and confusion about invisible contaminants also create harmful psychosocial factors, especially in high-exposure neighbourhoods. Strengthening sustainable urban water governance through awareness programmes, community monitoring, and collaborative reporting platforms is essential for industrial hotspots like Kanpur.

Statistical Relationship Between Socioeconomic Factors and Waterborne Diseases

Analyses from Kanpur and comparable urban regions demonstrate that socioeconomic status strongly shapes environmental risk perception and susceptibility to waterborne diseases. In the 2017 “Drinking Water, Sanitation and Water-borne Diseases” study, households with higher income, better education, and improved sanitation access were significantly less likely to rely on unsafe water sources and reported lower disease incidence (Shukla, 2017). The 2024 Kanpur household survey further showed that household income and educational attainment were statistically significant predictors of knowledge about water quality and adoption of purification methods; families with lower income and limited schooling often relied on shallow wells or open hand-pumps near industrial zones. Regression analyses, controlling for age and household size, found that water-source type (industrial-zone shallow well vs. deep tube-well) and income explained substantial variation in reported illnesses. These findings highlight how weak urban wastewater management in industrial areas disproportionately affects disadvantaged groups, reinforcing structural inequities. The interaction of socioeconomic disadvantage with proximity to industrial effluents also underscores critical psychosocial determinants, as stress, fear, and uncertainty shape community behaviour and influence water-use practices. Limited coping strategies and chronic exposure generate harmful psychosocial factors, including anxiety about invisible pollutants and long-term health risks. Addressing these disparities requires stronger sustainable urban water governance, combining technical interventions with social measures such as subsidies for safe water systems, inclusive sanitation programs, and community education. Integrating awareness, empowerment, and monitoring ensures that water-safety interventions in Kanpur are both effective and equitable, emphasizing that public health challenges arising from industrial pollution are as much social-policy issues as they are technical problems (Ghosh et al., 2023).

CONCLUSION

This study reveals industrial effluent critically degrades water quality in Kanpur. Heavy metals like chromium, lead, and cadmium contaminate groundwater, rivers, and soils. Residents near industrial zones report more waterborne illnesses and chronic health issues. Socioeconomic factors influence exposure and ability to treat contaminated water. Community awareness exists but lacks capacity for advanced filtration. Seasonal and spatial variations create uneven exposure across the city. Tannery and textile industries are the main contributors to pollution. Regulatory gaps and ineffective wastewater treatment exacerbate risks. Targeted monitoring and remediation in high-risk zones are urgently needed. Integrated strategies combining pollution control, public awareness, and equitable water access can reduce health risks. Immediate intervention is essential to safeguard both human and environmental health in Kanpur.

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