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# Invisible threats in the air: Reviewing the status and impact of particulate matter ($PM_{2.5}$ and $PM_{10}$) in Gazipur City, Bangladesh

**M D Nurul Haque[1*], Tawheda Yasmin Tanina[2]**
[1] Assistant Professor, Department of Chemistry, Ananda Mohan College, Mymensingh, Bangladesh
[2] Department of Chemistry, Ananda Mohan College, Mymensingh, Bangladesh

**Abstract**
Airborne particulate matter (PM) presents a widespread and largely invisible threat to public health in rapidly urbanizing regions. This study critically reviews the status and impact of fine ($PM_{2.5}$) and coarse ($PM_{10}$) particulates in Gazipur City, Bangladesh, a district identified as one of the countries most polluted. Recent monitoring data indicate that ambient $PM_{2.5}$ concentrations in Gazipur city repeatedly exceed both national standards and the World Health Organization guideline, thereby shortening life expectancy by an estimated 8.3 years for its residents according to Bangladesh Fact Sheet, AQLI. A cluster-analysis of $PM_{2.5}$, $PM_{10}$ and gaseous pollutants shows that Gazipur city shares similar pollution-sources with neighboring Dhaka, including industrial emissions, traffic and secondary aerosols, and suffers prolonged exceedance of national standards during dry months. The review synthesizes in PM levels, highlights key contributing sources and meteorological modulations, and discusses health-risk implications, including respiratory and cardiovascular morbidity and shortened life-span. It assesses current regulatory frameworks, monitoring gaps and community-level exposure contexts. The findings underscore not only the magnitude of the particulate-pollution burden in Gazipur city but its unequal impact on vulnerable populations in a low-resource setting. Given these insights, the paper argues for urgent interventions: enhanced ambient air monitoring, cleaner industrial technology adoption, traffic emission controls, and public-health protection strategies personalized to local conditions. By framing Gazipur city as a microcosm of South Asian urban-air-pollution challenges, this review offers actionable perspectives for policymakers, researchers and practitioners working to mitigate invisible threats in the air.

**Keywords:** Airborne particulate matter, ambient air quality, public health, Gazipur City

## Introduction

Airborne particulate matter (PM) notably those fractions with aerodynamic diameters $\leq 10$ µm ($PM_{10}$) and $\leq 2.5$ µm ($PM_{2.5}$) represents a pervasive and often invisible threat to human health and urban environments globally (Uzoho, 2025; Harrison, 2020) [8, 26]. These fine and coarse particles penetrate deep into the respiratory system, provoke oxidative stress, exacerbate cardiovascular and pulmonary diseases, and have been linked to premature mortality. In rapidly urbanizing developing countries, the challenge is particularly acute (Valavanidis, 2019; Mack *et al*. 2020; Sharma *et al*. 2024) [17, 23, 28]. According to a recent assessment, average $PM_{2.5}$ concentration in Bangladesh is five times higher than the national ambient air quality standard and about fifteen times the guideline set by the World Health Organization (WHO) (Ali *et al*. 2025) [2]. The Gazipur City in the Dhaka Division stands out as one of the most impacted urban districts in Bangladesh (Haque, *et al*. 2023) [7]. Situated adjacent to the capital region, Gazipur hosts a dense mix of industrial activity, vehicular traffic, and residential zones all set against a backdrop of meteorological and geographical factors that may exacerbate pollutant accumulation (Arifeen *et al*. 2021) [3]. According to the Air Quality Life Index, residents in Gazipur face a life-expectancy reduction of approximately 8.3 years due to ambient $PM_{2.5}$ exposure. Ground-based studies in the region report alarming concentrations: for example, measured $PM_{2.5}$ levels of ~263 µg $m^{-3}$ and $PM_{10}$ of ~340 µg $m^{-3}$ in a monitoring campaign in Gazipur Sadar. The health risks associated with exposure to high levels of particulate matter ($PM_{2.5}$ and $PM_{10}$) in Gazipur are substantial, affecting both children and adults, with vulnerable populations experiencing the most severe impacts. Children are particularly susceptible to air pollution due to their developing respiratory systems, faster breathing rates, and increased exposure levels (Goldizen *et al*. 2016) [6]. Long-term exposure to high concentrations of PM can lead to chronic respiratory conditions, such as asthma and bronchitis, as well as developmental issues like impaired lung function and reduced growth. Studies have shown that children exposed to elevated $PM_{2.5}$ concentrations have a higher incidence of school absenteeism due to respiratory symptoms. Furthermore, early-life exposure has been linked to cognitive impairments and increased susceptibility to cardiovascular diseases later in life. Adults, especially those with pre-existing health conditions, face heightened risks of cardiovascular and respiratory diseases, such as ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), and lung cancer (Invally *et al*. 2017) [10]. The combination of long-term exposure to fine particulate matter and other environmental stressors significantly increases the risk of premature mortality. Additionally, adults in industrial and construction sectors may be at greater risk due to higher occupational exposures to particulate pollution (Yang *et al*. 2017; Torén *et al*. 2007; Saeedi *et al*. 2021) [22, 25]. Both groups face a significant reduction in life expectancy due to sustained exposure, with children likely to experience lifelong health consequences from the early environmental hazards present in Gazipur.

Despite the severity of the problem, there remains a gap in the literature that specifically reviews the status,

spatial-temporal variability, source contributions, and health-impact implications of particulate pollution in Gazipur city (Jubaer *et al*. 2025) [12]. Much of the national discourse focuses on Dhaka, leaving nearby urban districts such as Gazipur under-represented despite their significance as industrial-residential mixtures and key nodes of pollutant generation and dispersion (Mukta *et al*. 2020) [19]. For researchers and policy-makers alike, an in-depth review of $PM_{2.5}$ and $PM_{10}$ in Gazipur is critical not only for local mitigation but also as a representative case for other industrial peri-urban zones in South Asia.

In this review paper, we therefore aim to (1) synthesize the available evidence on ambient concentrations of $PM_{2.5}$ and $PM_{10}$ in Gazipur, including peak episodes, average levels and exceedances of national and international standards; (2) analyzed contributing emission sources and meteorological/land-use factors that shape particulate patterns; (3) discuss the health risk implications for the local population, drawing on national and regional epidemiological links between particulate exposure and respiratory, cardiovascular and mortality outcomes; and (4) highlight policy, monitoring and mitigation gaps — then propose targeted interventions tailored to the Gazipur context. Through this review, we strive to provide a coherent narrative linking pollutant status to human impacts and governance challenges thereby equipping stakeholders with a consolidated evidence base for action.

## Methodology

This review paper adopts a systematic approach to assess the status and impact of particulate matter ($PM_{2.5}$ and $PM_{10}$) in Gazipur City, Bangladesh. The methodology consists of three key components: (i) Literature review: A comprehensive review of peer-reviewed journal articles, government reports, and grey literature, focusing on air quality monitoring data, pollution sources, health impacts, and policy frameworks relevant to Gazipur. Keywords such as "$PM_{2.5}$," "$PM_{10}$," "Gazipur," "Bangladesh air pollution" and "health effects" were used to gather literature from academic databases like PubMed, ScienceDirect, and Google Scholar. (ii) Data synthesis: The collected data on particulate concentrations, sources, and health outcomes were synthesized to identify trends, temporal patterns, and regional variations. This includes a comparative analysis of PM levels in Gazipur against national and international air quality standards, along with an exploration of meteorological factors influencing particulate dispersion. (iii) Health impact analysis: Epidemiological studies and reports assessing the health risks of PM exposure in similar urban environments were reviewed to establish potential health outcomes for Gazipur's population, including respiratory and cardiovascular diseases.

## Results and discussion

### Ambient concentrations of $PM_{2.5}$ and $PM_{10}$ in Gazipur city

Multiple studies document alarmingly high concentrations of fine ($PM_{2.5}$) and coarse ($PM_{10}$) particulate matter in Gazipur. For example, a monitoring campaign in Gazipur Sadar reported average $PM_{2.5}$ of ~263.53 µg/m³ and $PM_{10}$ of ~340.17 µg/m³. In another broader study, Gazipur registered the highest $PM_{2.5}$ concentration among surveyed Bangladeshi cities at 257.3 µg/m³, with a historical average of $114 \pm 68.6$ µg/m³. Compared with the national context, the country's average ambient $PM_{2.5}$ is ~75 µg/m³ (2020 value) and well above both national and WHO guideline values. According to the Air Quality Life Index (AQLI) fact-sheet, air pollution in Gazipur shortens life expectancy by approximately 8.3 years (the worst among Bangladesh's districts). These data show that Gazipur is a severe hotspot for particulate pollution in Bangladesh. Further evidence suggests persistently high PM loads: cluster-analysis demonstrates that Gazipur (along with neighboring Dhaka and Narayanganj) experiences $PM_{2.5}$ and $PM_{10}$ levels that remain above Bangladesh national ambient air quality standards for much of the year. Real-time monitoring (e.g., via Plum Labs for Gazipur) shows $PM_{2.5}$ of ~50 µg/m³ and $PM_{10}$ ~36 µg/m³ in a given snapshot, though this snapshot is modest relative to peak values. While this suggests some variability, these levels still exceed WHO guidelines and reflect ongoing health risk. Ambient concentrations of $PM_{2.5}$ and $PM_{10}$ in Gazipur City are exceptionally high, far exceeding national and international standards. Industrial and traffic influences, coupled with meteorology and land-use context, drive the elevated levels. Persistent exceedances especially during dry seasons and in industrial zones place large segments of the population at high exposure risk. While data gaps exist, the magnitude of measured concentrations alone underscores the urgency for intensified monitoring, exposure assessment and mitigation in Gazipur.

### Temporal, spatial and seasonal variability

Evidence indicates significant temporal and seasonal variability in particulate concentrations in Gazipur and vicinity. The dry season (November to March) is consistently identified as the period of highest particulate loading due to lower rainfall, stagnant meteorological conditions and enhanced emissions (e.g., from brick kilns, dust re-suspension) (Abuelgasim & Farahat, 2020) [1]. Spatially, industrial zones, heavy traffic corridors and residential/industrial interfaces in Gazipur show elevated PM concentrations compared to cleaner zones. For instance, one local study reported in an industrial area of Gazipur: $PM_{2.5}$ values as high as ~97 µg/m³ and $PM_{10}$ ~190 µg/m³; while in residential zones the corresponding values were lower (~47 µg/m³ for $PM_{2.5}$, ~52 µg/m³ for $PM_{10}$). This underscores that local land-use and industrial/traffic proximity are strong modifiers of PM exposure (West *et al*. 2019) [30]. Spatially, data suggest that concentration levels in industrial zones and traffic-congested corridors (typical of Gazipur's land-use mix) are higher than in more residential or suburban zones. One national clustering study observed that Gazipur, along with Dhaka and Narayanganj, showed almost identical pollutant-source profiles and that particulate concentrations remained above the national standard for about half the year. Temporally, particulate matter levels show significant seasonal variation in the region: the dry/winter season (November–March) tends to have higher loadings owing to reduced wet deposition, boundary-layer stagnation, increased dust re-suspension and emissions from brick kilns and heating. Moreover, meteorological modulators such as low wind speed and temperature inversions strongly influence PM concentrations in Gazipur.

### Sources and contributing factors

The literature identifies a combination of anthropogenic sources contributing to the elevated particulate matter in

Gazipur. Key sources include vehicular emissions (especially heavy traffic and outdated engines), industrial emissions (including factories in and around Gazipur), brick kilns, construction dust, road dust suspension, and trans-boundary pollutants (Islam *et al*. 2024; Khandker *et al*. 2023) [11, 14]. For example, in the Gazipur region biomass and fossil-fuel combustion was found major contributors: biomass burning contributed heavily to $PM_{2.5}$, while fossil-fuel combustion dominated cardiovascular risk impacts. Cluster analysis shows that Gazipur shares similar source-profiles with Dhaka and Narayanganj, implying its particulate pollution is heavily influenced by the same urban/industrial-traffic mix. Meteorological and land-use factors are also key: low wind speed, temperature inversions, topography and land-cover (industrial/residential mix) tend to favor accumulation rather than dispersion. The published "Assessment of temporal shifting" likewise indicates that meteorological parameters significantly modulate $PM_{2.5}$ and $PM_{10}$ concentrations.

**Source attribution and mitigation insights**

The source-apportionment and cluster-analysis evidence indicate that traffic, industrial emissions, brick kilns, dust re-suspension and meteorological constraints are all important. The fact that Gazipur's source profile clusters with Dhaka suggests shared drivers (urban traffic, industrial emissions). This insight is useful for mitigation strategy: interventions may include cleaner vehicle fleets, stricter industrial emissions controls, dust management (road sweeping, construction site regulation), and grid-based regulation of brick-kiln emissions. The literature also points to a critical observation: while in Bangladesh biomass burning (including cook-stoves) remains a contributor, the highest health-impact burden arises from fossil-fuel combustion. Evidence indicates that the elevated levels of $PM_{2.5}$ and $PM_{10}$ in Gazipur stem from a complex mix of local and regional sources, combined with meteorological/land-use factors that hamper dispersion (Kolawole *et al*. 2025; Chakroborty *et al*. 2025) [4, 15]. Studies in the wider Bangladesh context highlight key contributors: vehicular emissions, industrial operations (including factories and power/heat plants), brick-kiln combustion, road dust and construction activity, and biomass/coal burning. In Gazipur specifically, monitoring campaigns report very high average concentrations (e.g., ~263 µg/m³ for $PM_{2.5}$ and ~340 µg/m³ for $PM_{10}$) with strong correlation between $PM_{2.5}$ and $PM_{10}$ ($R^2$ ~0.98) suggesting shared source streams. Several studies note around 400 plus brick kilns in the Gazipur-Dhaka region, pointing to the significance of kiln emissions for coarse and fine particulate loads. Road transport along busy corridors (e.g., Mymensingh–Gazipur highway) also emerges as high PM contributor via both exhaust and non-exhaust emissions (tyre/road wear, re-suspension). Therefore, prioritizing mitigation of fossil-fuel and industrial emissions in Gazipur may yield greater health benefits.

**Health and life-expectancy impacts**

Particulate matter exposure in Bangladesh imposes a heavy health burden; for the population of Gazipur the burden is especially strong (Hassan *et al*. 2022; Khan *et al*. 2023) [9, 13]. A recent CRA (comparative risk assessment) estimated approximately 102,456 annual premature deaths nationwide could be attributed to $PM_{2.5}$ exposure in Bangladesh, including ~29,920 from ischemic heart disease, ~23,075 from stroke, ~20,976 from COPD, ~9,720 from lower respiratory infections, and ~3,063 from lung cancer. In Gazipur, the AQLI report shows life-expectancy reduction of ~8.3 years the worst in the country. Additional studies in Bangladesh report that urban air pollution may account for up to 10% of respiratory illnesses and disorders. While there is no Gazipur-specific epidemiological cohort publicly available, the inference is strong that Gazipur's extremely high particulate concentrations translate into very substantial local health risk.

**Compliance with standards and regulatory context**

**Against the background of data, Gazipur's particulate concentration far exceeds multiple benchmarks:** The World Health Organization (WHO) guideline for annual mean $PM_{2.5}$ is 5 µg/m³ (2021 update) and for $PM_{10}$ 15 µg/m³ (or prior values). The Bangladesh national ambient air quality standard (NAAQS) for $PM_{2.5}$ is 15 µg/m³ (annual) and for $PM_{10}$ is 50 µg/m³. The measured values in Gazipur (hundreds of µg/m³) thus exceed both WHO and national standards by large factors (orders of magnitude). Despite this, monitoring networks remain limited: while continuous monitoring stations exist across Bangladesh including in Gazipur, the coverage, representativeness and transparency of data remain constrained

**Interpretation of results in context**

The results illustrate that Gazipur stands out not only nationally, but regionally, as an extreme case of particulate pollution. While Bangladesh as a whole see elevated $PM_{2.5}$ concentrations (e.g., ~75 µg/m³ on average) and life-expectancy losses of ~4.8–6.8 years, the situation in Gazipur is significantly worse (life-expectancy loss ~8.3 years). The extraordinarily high measured concentrations of $PM_{2.5}$ and $PM_{10}$ in Gazipur mean that the local population is exposed to very hazardous levels of air pollution on a regular basis. The spatial heterogeneity (industrial vs residential zones) and seasonal variability (dry vs rainy season) point to the complex interplay of emissions, meteorology, land-use, and local geography. That industrial and traffic adjacent zones exhibit much higher concentrations underscores the contribution of local anthropogenic emissions. The dry season elevation of particulate levels reflects reduced wet-deposition, lower mixing heights, and increased emissions (for example brick-kiln activity, dust re-suspension) (Oldani *et al*. 2017; Wu *et al*. 2018) [21, 31]. This pattern is consistent with broader research in South Asian cities where winter/early-spring months show peak particulate burdens. Comparing the measured values against national and international standards emphasizes the scale of non-compliance. The values of ~250-300 µg/m³ for $PM_{2.5}$ and ~340 µg/m³ for $PM_{10}$ are roughly an order of magnitude or more above the WHO guideline (5 µg/m³ for $PM_{2.5}$) and far above the Bangladesh standard (15 µg/m³ for $PM_{2.5}$). This gap highlights both the severity of the problem and the challenge of mitigation.

**Health implications and risk magnitude**

Given the well-documented associations between fine particulates and mortality/morbidity (respiratory diseases, cardiovascular disease, stroke, lung cancer) the situation in Gazipur appears very serious (Luo *et al*. 2023; Valavanidis,

2023) [16, 29]. Studies indicate that across Bangladesh, $PM_{2.5}$ exposure is responsible for tens of thousands of deaths annually (~102,456 per recent estimate). Even though Gazipur-specific epidemiological cohort data are limited, the extraordinarily high exposure suggests that the local attributable burden is disproportionately large. For example, if the national mortality burden is largely driven by exposures at ~75 μg/m³, then exposures at ~250 μg/m³ (as in Gazipur) might lead to substantially greater relative risk, though non-linear exposure-response relationships must be considered. The life-expectancy reduction of ~8.3 years in Gazipur (AQLI) is a sobering statistic and helps translate exposure into tangible human cost. Vulnerable group's children, the elderly, individuals with pre-existing conditions are likely at especially high risk. The World Bank emphasizes that in Bangladesh high air pollution "raises the risks of breathing difficulties, cough, lower respiratory tract infections, as well as depression and other health conditions." For the building engineering/construction context (your interest), the high particulate exposures may also bear implications for occupational health (construction workers, brick kiln workers) in the Gazipur industrial-residential mix (Vaidya *et al*. 2015) [27].

Exposure to elevated ambient concentrations of $PM_{2.5}$ and $PM_{10}$ in Bangladesh and by extension in Gazipur city poses profound health risks for both children and adults (Ali *et al*. 2025) [2]. Children, owing to their developing respiratory systems, higher ventilation rates per body weight, more time spent outdoors and still-developing immune systems, are especially vulnerable. According to a report by UNICEF, children under five years old in Bangladesh suffer health impacts including premature birth, low birth weight, asthma, and other lung diseases, with more than 40% of lower respiratory tract infection deaths in this age-group attributed to air pollution. For instance, elevated ambient $PM_{2.5}$ has been statistically linked with increased incidence of child pneumonia in urban Bangladesh (Tabassom *et al*. 2025; Majumder *et al*. 2023) [18, 24].

For adults, long-term inhalation of fine and coarse particulate matter contributes to a range of outcomes: chronic obstructive pulmonary disease (COPD), ischemic heart disease, stroke, lung cancer, and shortened life expectancy (Ni *et al*. 2015; Fatkhutdinova *et al*. 2021) [5, 20]. Recent analyses for Bangladesh estimate that ambient $PM_{2.5}$ exposure causes thousands of premature deaths, hundreds of thousands of emergency visits for asthma, and millions of lost workdays annually. A health-risk assessment study in the nearby mega-city context found hazard quotient (HQ) values for infants >1 (indicating significant risk) and between 0.32-0.78 for adults; non-cancer risk is already present even at these massive exposures. In the high-pollution environment of Gazipur, where, $PM_{2.5}$ and $PM_{10}$ levels far exceed national and international standards the risk magnitudes for both children and adults are accordingly elevated. Children may face higher lifetime burden: impaired lung development, heightened asthma incidence, and potential cognitive or growth delays. Adults including those in occupationally exposed groups (industrial or construction workers) may incur increased morbidity and mortality, contributing to a measurable loss of life years in the local population. The combined evidence underscores that the particulate matter burden in Gazipur city is not simply an environmental challenge, but a major public-health crisis requiring urgent, age-sensitive mitigation.

**Relation to policy and governance**

The divergence between measured pollution levels and policy targets/standards underscores significant governance and implementation gaps. Although Bangladesh has established national ambient air quality standards and more recently a National Air Quality Management Plan 2024-2030, the enormity of the challenge, especially in places like Gazipur, means policy implementation must be accelerated. The monitoring network (CAMS/C-CAMS) exists but coverage, spatial density, public transparency and real-time data dissemination remains limiting robust trend tracking and accountability. The fact that Gazipur is the most affected district indicates a need for place-based interventions tailored to the local industrial, traffic and meteorological context.

**Research gaps and limitations**

Despite the rich evidence, key gaps remain. First, the number of peers-reviewed studies specifically centered on Gazipur (rather than more broadly Dhaka region) remains small; many data are one-off campaigns rather than long-term continuous monitoring. Second, health-outcome studies (epidemiological cohorts, exposure–response for local population) are nearly absent for Gazipur specifically, meaning attributed health burdens are inferred rather than directly measured. Third, emission inventories, source-apportionment studies specific to Gazipur's unique industrial/traffic mix are limited. Fourth, high-resolution spatial modelling (e.g., mapping exposure across micro-zones within Gazipur) remains rare. Fifth, indoor and occupational exposures (especially in industrial or construction settings) in Gazipur receive little attention, despite their relevance given the local economy. Last, most studies focus on $PM_{2.5}$; $PM_{10}$ (and ultra-coarse particles) and their specific contributions and health impacts receive less focus.

**Implications for Gazipur and similar settings**

For Gazipur, the extreme levels of exposure call for urgent action. The high-exposure context suggests that even incremental reductions in PM concentrations may yield substantial public-health benefits. The results also reinforce that industrial-adjacent urban districts in South Asia are not simply "suburbs" but major pollution hotspots in their own right, sometimes more severe than central cities. Thus, while much attention in Bangladesh has historically focused on Dhaka, Gazipur deserves targeted attention.

**Interventions should be multi-pronged:**

- Strengthening ambient monitoring with high spatial and temporal resolution in Gazipur to better characterize exposure gradients and trends.
- Deploying source-apportionment studies in Gazipur to identify the dominant local emission sectors (e.g., traffic, industrial, brick kilns, and dust re-suspension).
- Expanding health-impact assessments locally (cohort, case–control, panel studies) to quantify exposure–response relationships for Gazipur's population.
- Implementing regulatory and infrastructural interventions: e.g., retrofitting or relocating high-emission industries, enforcing vehicle emissions

standards, controlling dust (roads, construction), regulating brick kiln emissions, and improving urban planning (zoning, green buffers).
- Engaging community-level mitigation and awareness: promotion of indoor air filtration, public health messaging, occupational safety for workers.
- Monitoring progress: setting Gazipur-specific targets (e.g., reduce annual average $PM_{2.5}$) and publicly reporting.

**Broader relevance beyond Gazipur city**

The situation in Gazipur exemplifies the broader challenge in South Asia of urban-industrial peri-urban zones becoming extreme particulate-pollution hotspots. While capital cities (e.g., Dhaka) receive most attention, adjacent industrial/residential districts like Gazipur can be even more polluted, due to the confluence of industrial parks, heavy traffic, construction, and weak regulatory oversight. The findings thus have relevance for policymakers and researchers in Bangladesh, as well as other developing countries with similar urbanization/ industrialization patterns.

**Critical reflections**

While the data paints a stark picture, there is also the reality of data limitations, measurement uncertainties (duration, instrumentation, representativeness), and potential bias (campaign vs long-term monitoring). The highest reported values (e.g., ~263 µg/m³) may reflect peak hotspots rather than typical average exposure; thus, care is needed in interpretation. Yet even "lower" values (e.g., ~114 µg/m³ historical average) remain extremely high. The life-expectancy reduction figure (~8.3 years) while compelling should be interpreted as an estimate based on modeling, not direct cohort follow-up. It is also important to recognize that exposure–response relationships at very high concentrations may deviate from linear extrapolations used in many health models derived from lower exposures; this could influence estimates of attributable burden. Moreover, mitigation in such high-exposure contexts may face diminishing returns if certain sources persist unabated or if meteorology constrains dispersion.

**Link to Building Engineering & Construction Management interest**

Weak soils and construction in southern Bangladesh align with the need to consider air-pollution burdens in infrastructure planning and occupational health. In Gazipur, construction and industrial activity contributes to dust and particulate emissions; thus, building foundation works, dam/road construction in weak-soil zones must consider ambient air quality as an additional risk dimension (for workers, for materials exposed during construction, for nearby communities). Awareness of local weak-foundation challenges might extend into integrated planning that includes air-quality mitigation (e.g., dust control, work-site filtration, scheduling work for lower-pollution times) in highly polluted districts like Gazipur.

**Recommendations**

To address the extreme particulate-matter burden in Gazipur City, a multi-pronged strategy is needed. First, strengthen the ambient monitoring network: deploy additional continuous sensors and co-locate them in industrial, traffic-heavy and residential zones. These data will improve spatial and temporal characterization of $PM_{2.5}$ and $PM_{10}$ exposures. Building on the national plan National Air Quality Management Plan 2024-2030 this should include publicly accessible real-time dashboards and community-level alerts.
Second, target major emission sectors: accelerate adoption of cleaner technologies in brick kilns, enforce modern vehicle emission standards and upgrade industrial process controls. For the traffic domain, promote electric or low-emission vehicles and priorities clean-fuel transition.
Third, integrate land-use and dust-control measures: regularly pave or water unpaved roads, regulate construction-site dust, and establish green buffer zones around industrial clusters to reduce re-suspension.
Fourth, expand health-impact and exposure studies locally in Gazipur, especially occupational and vulnerable-group exposures, to link high concentrations with morbidity/ mortality directly.
Finally, engage the public and private stakeholders: raise awareness of indoor-outdoor exposure, promote low-cost filters or clean-air spaces for high-risk groups (children, elderly, construction workers), and incentivize industries to adopt best practices through financing schemes and zoning regulations. Together these recommendations can help move Gazipur toward compliance with both national and WHO guidelines, and reduce the excessive health burden associated with particulate pollution.

**Conclusion**

This review highlights the severe particulate pollution crisis in Gazipur City, Bangladesh, with both $PM_{2.5}$ and $PM_{10}$ levels consistently exceeding national and international air quality standards. The city's high levels of particulate matter are primarily attributed to a combination of industrial emissions, vehicular traffic, brick kilns, and dust re-suspension, compounded by geographical and meteorological factors that limit pollutant dispersion. The health implications are profound, with significant risks of respiratory and cardiovascular diseases, premature mortality, and a life expectancy reduction of approximately 8.3 years for Gazipur's residents. Despite the ongoing efforts to manage air quality, the existing regulatory framework and monitoring infrastructure remain insufficient to address the scale of the problem. The results underscore the urgent need for a more robust and integrated approach to pollution control, involving enhanced air quality monitoring, stricter emissions regulations, and targeted health interventions. Additionally, public awareness campaigns and community-level pollution mitigation strategies are essential to reduce exposure, particularly for vulnerable populations such as children, the elderly, and workers in high-risk industries. In conclusion, addressing the invisible threat of particulate pollution in Gazipur is critical not only for improving public health but also for ensuring sustainable urban growth. By prioritizing comprehensive pollution control measures and expanding research on the health impacts of air pollution, policymakers can make meaningful strides toward mitigating the effects of air pollution, ultimately improving the quality of life for Gazipur's residents and setting a precedent for other cities facing similar challenges in South Asia.

**Disclosure statement**

Conflict of Interest: The author declares that there are no conflicts of interest.
Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

**Declaration of Competing Interest**

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Data availability**

All data generated or analyzed during this study are included in this published article and its supplementary information files.

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