Assessment of Air Pollution-Related Health Outcomes and Adaptive Responses in a Rural Municipality of Bangladesh

Pranta Sarker[1], Aritri Bose[2], Angkita Sarker[3], Rima Akter[4], Shanjita Jaman Anny[5], Sonia Akter Aparna[6]

[1]Environmental Science Discipline, Khulna University, Khulna, Bangladesh, Email: sprantas@gmail.com, Orcid Id: https://orcid.org/0009-0005-9364-7886

[2]Department of Economics, Kushtia Government College, Kushtia, Bangladesh

[3]Group of Arts, Kamalkunri Biddyaniketon, Gopalganj, Bangladesh

[4]Biotechnology and Genetic Engineering Discipline, Khulna University, Khulna, Bangladesh

[5]Physics Discipline, Khulna University, Khulna, Bangladesh

[6]Department of CSE, City polytechnic Institute Khulna, Bangladesh

Abstract: **Background:** *Air pollution is a significant environmental health issue, especially in low- and middle-income countries (LMICs), where it is a leading cause of morbidity and mortality. In Bangladesh, air pollution is a critical concern, with rural and semi-urban areas like Kotalipara Municipality facing worsening air quality, largely due to household fuel use, waste burning, and vehicular emissions. Despite efforts to manage air quality, public awareness and governmental measures remain insufficient.*

Aim of the study: *This study aims to assess the health impacts of air pollution in Kotalipara Municipality, examine local perceptions of air quality, and evaluate coping strategies and governmental policy awareness among residents.*

Methods: *A cross-sectional descriptive study was conducted in Kotalipara Municipality using both qualitative and quantitative methods. Data were collected through structured surveys and face-to-face interviews, targeting residents aged 18 years and above who had lived in the municipality for at least one year. The study covered demographic details, health symptoms, air quality perceptions, coping strategies, and governmental awareness. Statistical analysis was performed using SPSS version 26, including descriptive statistics and chi-square tests.*

Result: *The study revealed that a significant proportion of residents perceived air quality as poor or moderate, with vehicle emissions, cooking fuels, and waste burning identified as major pollution sources. Health symptoms such as coughing, wheezing, and shortness of breath were commonly reported. Asthma was the most prevalent diagnosed condition. Many residents adopted protective measures like wearing masks and keeping windows closed, although awareness of government initiatives was low. Households, particularly those in low-income groups, reported a higher burden of health and economic impacts due to air pollution.*

Conclusion: *Air pollution in Kotalipara Municipality has a significant impact on residents' health, particularly respiratory conditions. Despite limited awareness of government initiatives, residents have adopted various coping strategies. There is an urgent need for effective policy implementation, public education campaigns, and cleaner cooking technologies to mitigate the adverse effects of air pollution in the area.*

Keywords: *Air pollution, health impacts, respiratory diseases, public awareness, coping strategies, governmental policy*

Corresponding author: *Pranta Sarker, Environmental Science Discipline, Khulna University, Khulna, Bangladesh, Email: sprantas@gmail.com, Orcid Id: https://orcid.org/0009-0005-9364-7886*

Peer Review Process: The Global Scholars Journal of Multidisciplinary Studies follows a double-blind peer review process, ensuring that the identities of reviewers remain confidential to authors, and likewise, the identities of authors are not disclosed to reviewers.

17

INTRODUCTION

Air pollution remains one of the most pressing environmental health challenges worldwide, particularly in low- and middle-income countries (LMICs). According to the statistics, ambient air pollution is responsible for approximately 3 million deaths annually, with over 90% of this burden occurring in LMICs [1]. In South Asia, recent reports have positioned Bangladesh as one of the countries with the highest concentrations of particulate matter (PM2.5), consistently exceeding the WHO air quality guidelines by more than five times [2]. These pollutants, primarily originating from vehicular emissions, industrial activities, and biomass burning, have significant implications for public health, particularly in rural regions where air quality management is less prioritized [3]. Kotalipara Municipality, located in the southwestern region of Bangladesh, this semi-urban area has seen a rise in respiratory diseases and other air pollution-related health concerns, a trend mirrored in similar rural and semi-urban settings across the country [4]. In Kotalipara, the predominant use of firewood and crop residues for cooking contributes significantly to indoor air pollution, which disproportionately affects women and children. According to another statistics, approximately 77% of households in rural Bangladesh still rely on traditional biomass fuels for cooking [5]. This reliance not only exacerbates household air pollution (HAP) but also leads to long-term health issues such as respiratory infections, low birth weight, and cardiovascular diseases [6]. Globally, studies have shown that indoor air pollution from solid fuel use is a leading cause of acute respiratory infections, especially in children under the age of five [7]. A study by Pial et al. (2020) indicated that the use of biomass fuels in households in Bangladesh is associated with a significantly higher risk of chronic obstructive pulmonary disease (COPD) and asthma [8]. The adverse health outcomes in children are particularly alarming, as exposure to fine particulate matter (PM2.5) has been linked to an increased risk of premature births, low birth weight, and developmental impairments [9]. This growing health crisis necessitates urgent public health interventions and comprehensive air quality management programs [10]. Despite efforts to address the issue, such as the adoption of improved cookstoves and the introduction of cleaner cooking technologies, the problem of air pollution remains pervasive in rural areas [11]. Kotalipara's experience with worsening air quality over the past five years underscores the slow progress in mitigating the impacts of pollution. The situation is compounded by a lack of public awareness regarding the dangers of air pollution and the availability of government initiatives [12]. This study aims to explore the current state of air pollution in Kotalipara, assess its health impacts, and identify the gaps in public awareness and governmental policy implementation. By examining local perceptions of air quality, health outcomes, and coping strategies, this research provides valuable insights into the challenges faced by rural communities and the urgent need for integrated air pollution control measures [13]. The aim of this study is to assess the health impacts of air pollution in Kotalipara Municipality, examine local perceptions of air quality, and evaluate coping strategies and governmental policy awareness among residents.

MATERIAL AND METHODS

This study is a cross-sectional descriptive study, designed to assess the health impacts of air pollution in Kotalipara Municipality, Bangladesh. A cross-sectional study design allows for the examination of a particular point in time, providing a snapshot of the prevalence of respiratory health issues, air quality perceptions, and coping strategies among the residents of the area. The study employs both qualitative and quantitative data collection methods to gain a comprehensive understanding of the impact of air pollution. The data type includes primary data obtained directly from respondents through surveys and interviews, and secondary data where available from official sources.

Inclusion Criteria
- Residents of Kotalipara Municipality aged 18 years and above.
- Individuals who have lived in the municipality for at least one year.
- Participants who consent to participate in the study.

Exclusion Criteria
- Individuals with incomplete responses or missing data.
- Individuals who have lived in the municipality for less than one year.
- Pregnant women and children under 18 years of age (to avoid potential health risks and ethical concerns in this vulnerable group).

Ethical Considerations
The study adheres to ethical guidelines as stipulated by the relevant ethical review board. Participants were fully informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any consequences. Informed consent was obtained from all participants. The confidentiality of the participants was ensured, with all data anonymized to maintain privacy. Additionally, ethical considerations regarding vulnerable populations were taken into account, ensuring no harm to participants.

Data Collection Procedure
Data were collected through structured surveys and interviews conducted by trained research assistants. The survey included both closed and open-ended questions to capture demographic details, health symptoms (such as coughing, wheezing, and breathing difficulties), and coping strategies employed to address air pollution exposure. Face-to-face interviews were also conducted to obtain deeper insights into residents' perceptions of air quality and their awareness of governmental initiatives. The data collection period lasted for two months, from January to February 2025.

Statistical Analysis

Data were analyzed using SPSS version 26 (Statistical Package for the Social Sciences). Descriptive statistics, including frequencies and percentages, were used to summarize the demographic characteristics and health-related data. Chi-square tests were employed to explore associations between categorical variables, such as age, gender, and the presence of respiratory symptoms. Additionally, correlation analysis was used to assess the relationship between air quality perception and reported health issues.

RESULTS

The demographic profile of the respondents was represented in Table 1, showing that the majority were aged between 31–45 years, predominantly male, and primarily engaged in agriculture. Most households had 4–6 members, with middle-income earners forming the largest proportion. Educationally, primary and secondary levels were most common. Table 2 demonstrated exposure patterns to air pollution, where firewood was the most commonly used cooking fuel. A notable proportion of households reported frequent waste burning near homes, with many livings close to busy roads. Daily experiences of dust or smoke were frequent, and seasonal worsening of air quality, particularly during winter, was commonly observed. Perceptions of air quality were illustrated in Table 3. Nearly half of the respondents perceived their neighborhood air quality as moderate, while a considerable proportion considered it poor. Over half reported deterioration in air quality over the past five years, with cooking fuel use and waste burning identified as major sources. Table 4 represented the health symptoms and diagnosed conditions among respondents and their families. Coughing, wheezing, and dizziness were frequently reported. Asthma was the most commonly diagnosed health condition, and a majority perceived air pollution as a contributing factor to these health issues. Healthcare utilization and coping strategies were demonstrated in Table 5, where occasional doctor visits for air pollution-related health problems were most common. Protective measures such as wearing masks and keeping windows closed were widely adopted, although awareness about government initiatives remained low. Household vulnerability and children's health issues were outlined in Table 6. Most respondents perceived children as highly vulnerable to air pollution. Frequent coughing, breathing difficulties, and eye or skin irritation were the most commonly reported symptoms among children. Protective practices for children were inconsistent, and a majority emphasized the need for schools to implement special measures. Suggestions for government actions included enhancing public transportation, stricter industrial regulation, more green spaces, and improved waste management. Table 7 demonstrated the impacts of air pollution on daily life, where health concerns, reduced outdoor activities, and economic burdens were predominant. Low-income households reported higher health concerns and economic impacts compared to middle-income households. Table 8 represented the recommended government measures, prioritizing industrial pollution control, transportation improvements, waste management, and green infrastructure development, alongside the promotion of clean cooking alternatives and public education campaigns.

Table 1: Demographic Information

Variable	Frequency (n)	Percentage (%)
Age		
18–30	187	22.60
31–45	412	49.80
46–60	176	0.21
61+	52	6.30
Gender		
Male	456	55.10
Female	371	0.45
Occupation		
Agriculture	389	47.00
Business	316	0.38
Service	73	8.80
Unemployed	34	0.04
Other	15	1.80
Household Size		
1–3 members	187	0.23
4–6 members	521	63.00
7+ members	119	14.40
Income Level		
Low-income (≤10,000 BDT/month)	213	25.80
Middle-income (10,001–30,000 BDT/month)	526	0.64
High-income (30,001+ BDT/month)	88	10.60
Education Level		
No formal education	147	0.18
Primary	261	31.60
Secondary	316	0.38
Higher Education	103	12.40

Table 2: Exposure to Air Pollution

Variable	Frequency (n)	Percentage (%)
Cooking fuel used		
Firewood	467	56.47
Charcoal	7	0.85
Kerosene	16	1.93
LPG	259	31.31
Electricity	78	9.43
Frequently burn waste near home		
Yes	248	30.00
No	579	70.00
Proximity to major pollution sources		
Near a busy road	372	45.00
Near an industrial area	83	10.00
Near open waste burning	124	15.00
None of these	248	30.00
Frequency of dust/smoke experience		
Daily	386	0.47
Weekly	257	31.10
Occasionally	164	19.80
Never	20	2.40
Seasonal differences in air pollution		
Yes, worse in winter	537	64.90
Yes, worse in summer	156	18.90
No change	83	10.00
Don't know	51	6.20

Table 3: Perceived Air Quality

Variable	Frequency (n)	Percentage (%)
Perceived air quality in the neighborhood		
Good	92	11.10
Moderate	362	43.80
Poor	298	36.00
Very Poor	75	9.10
Perceived change in air pollution over the past 5 years		
Yes	485	58.60
No	107	12.90
Not sure	235	28.50
Perceived main source of air pollution in the area		
Vehicle emissions	112	13.50
Industrial pollution	87	10.50
Waste burning	287	34.70
Cooking fuel	311	37.60
Other	30	3.70

Table 4: Reported Health Symptoms, Diagnosed Conditions, and Perceived Impact of Air Pollution among Respondents in Kotalipara Municipality (n = 827)

Variable	Frequency (n)	Percentage (%)
Reported symptoms experienced by respondents or their family members in the past year*		
Coughing	531	64.20
Wheezing	412	49.80
Shortness of breath	276	33.40
Eye irritation	248	30.00
Dizziness	384	46.40
None	102	12.30
Diagnosed health conditions among respondents or their family members		
Asthma	369	44.60
Bronchitis	158	19.10
COPD	83	10.00
Cardiovascular disease	127	15.40
Other	54	6.50
None	243	29.40
Perceived contribution of air pollution to reported health issues		
Yes	513	62.00
No	97	11.70
Not sure	217	26.30

Table 5: Healthcare & Coping Strategies

Variable	Frequency (n)	Percentage (%)
Frequency of doctor visits for respiratory or air pollution-related health issues		
Frequently (> 5 year)	192	23.20
Occasionally (1-4 year)	472	57.10
Never	163	19.70
Protective measures taken to reduce exposure to air pollution		
Wearing masks	486	58.80
Using air purifiers	107	12.90
Keeping windows closed	529	64.00
Planting trees	241	29.10
No measures taken	138	16.70
Awareness of government initiatives to reduce air pollution in the area		
Yes	176	21.30
No	651	78.70

Table 6: Household Vulnerability, Children's Health Issues, Protective Practices, and Suggestions for Government Actions to Address Air Pollution in Kotalipara Municipality (n = 827)

Variable	Frequency (n)	Percentage (%)
Perceived vulnerability of children to air pollution-related illnesses		
Yes	497	60.10
No	87	10.50
Not sure	243	29.40
Reported symptoms experienced by children in the past year		
Frequent coughing	376	45.50
Breathing difficulties or asthma	156	18.90
Eye or skin irritation	312	37.70
Cold and flu symptoms	201	24.30
Other	43	5.20
None	168	20.30
Perceived contribution of air pollution to children's health issues		
Yes	431	52.10
No	96	11.60
Not sure	300	36.30
Protective measures taken for children against air pollution		
Limiting outdoor playtime	189	22.90
Wearing masks	297	35.90
Using air purifiers at home	36	4.40
Planting more trees	97	11.70
Other	52	6.30
No measures taken	289	35.00
Perceived need for special measures by schools to protect children from air pollution		
Yes, special measures are needed	576	69.60
No, not necessary	78	9.40
Not sure	173	21.00
Suggested government actions to protect children's health from air pollution		
Improve public transportation and reduce vehicle emissions	392	47.40
Enforce stricter regulations on industrial pollution	365	44.10
Create more green spaces and implement tree planting programs	329	39.80
Ban/regulate open waste burning	301	36.40
Provide subsidies for clean cooking fuels	278	33.60
Install air quality monitoring systems in schools and public areas	243	29.40
Develop air pollution awareness programs in schools	231	27.90
Distribute free masks to school children	205	24.80
Implement air filtration systems in schools	193	23.30
Relocate schools away from high pollution areas	167	20.20
Provide regular health check- ups for children	152	18.40
Create "clean air zones" around schools	141	17.00
Subsidize home air purifiers for families with children	98	11.90
Adjust school schedules during high pollution days	87	10.50
Restrict industrial activities near residential areas	76	9.20

Other suggestions	64	7.70
No response/Don't know	45	5.40

Table 7: Impacts of Air Pollution on Daily Life

Impact Category	Frequency (n)	Percentage (%)
Health Concerns	512	61.90%
Reduced Outdoor Activities	389	47.00%
Economic Burden	356	43.00%
Household Challenges	301	36.40%
Mental Health Impact	243	29.40%
Sleep Disturbances	187	22.60%
Daily Routine Adjustments	176	21.30%
Diminished Quality of Life	143	17.30%
Agricultural Impacts	98	11.80%
No Significant Impact	67	8.10%
Other Impacts	43	5.20%

Table 7: Income-Level Analysis of Air Pollution Impacts

Impact Category	Low-Income (n=213)	Middle-Income (n=526)
Health Concerns	76%	58%
Economic Burden	67%	39%
Household Challenges	41%	35%
Mental Health Impact	21%	31%
Daily Routine Adjustments	12%	22%

Table 8: Recommended Government Measures to Improve Air Quality

Government Measure	Frequency (n)	Percentage (%)
Industrial Pollution Control	487	58.90%
Transportation Improvements	456	55.10%
Waste Management Solutions	412	49.80%
Green Infrastructure	367	44.40%
Clean Cooking Alternatives	342	41.40%
Public Awareness and Education	289	35.00%
Air Quality Monitoring	267	32.30%
Healthcare Support	231	27.90%
Agricultural Practices	178	21.50%
Construction Regulations	156	18.90%
Financial Incentives	134	16.20%
Emergency Measures	102	12.30%
Other Measures	56	6.80%

DISCUSSION

The findings from Kotalipara Municipality align with broader national and international research on the health impacts of air pollution, particularly in low- and middle-income countries. The heavy reliance on firewood for cooking mirrors national energy consumption trends in Bangladesh, where over 80% of rural households depend on solid fuels like wood, crop residues, and cow dung [14]. A national survey by Islam et al. (2022) reported that cooking with solid fuels nearly doubles the risk of acute respiratory infections (ARIs) in children under five [15]. In Kotalipara, similar health issues such as coughing, wheezing, and breathing difficulties were prevalent, particularly among vulnerable groups like children and the elderly. Globally, numerous studies have established a consistent relationship between exposure to household air pollution and adverse respiratory and cardiovascular outcomes [16]. Research indicates that exposure to fine particulate matter (PM2.5) during critical periods such as pregnancy and early childhood is associated with increased risks of low birth weight, stillbirth, preterm births, and long-term developmental impairments [17]. In fact, a 2022 meta-analysis estimated that up to 39.7% of stillbirths in low- and middle-income countries could be directly attributed to exposure to air pollution [18]. These international findings significantly reinforce the concerns observed in Kotalipara, where a number of respondents reported worsening health conditions in newborns and infants, including breathing problems shortly after birth, frequent hospital visits, and failure to thrive. The evidence underscores the urgent need for addressing indoor air quality as a means of improving maternal and child health outcomes in vulnerable communities [19]. Bangladesh remains one of the countries with the highest annual average PM2.5 concentrations globally, consistently exceeding WHO-recommended limits by more than five times [20]. This chronic and widespread exposure to hazardous levels of air pollution exacerbates the risk of major non-communicable diseases such as ischemic heart disease, chronic obstructive pulmonary disease (COPD), lung cancer, and stroke [21]. Alarmingly, these diseases are increasingly reported in semi-urban and rural communities such as Kotalipara, indicating that air pollution is no longer just an urban health crisis but a pervasive rural health issue as well. In terms of coping mechanisms, Kotalipara residents reported adopting various self-protective strategies such as wearing masks, keeping windows and doors shut during periods of heavy pollution, restricting outdoor activities, and, in some cases, moving cooking activities outdoors to minimize indoor smoke accumulation. These behaviors are remarkably similar to those observed in urban areas like Dhaka during periods of severe smog events [22], suggesting that public awareness of pollution risks is gradually improving even in rural settings [23]. However, while these measures may offer short-term or marginal protection, they fail to address the fundamental sources of pollution exposure [24]. Wearing a mask may reduce inhalation of particulates outdoors, but cannot significantly protect against persistent indoor air pollution generated by the use of traditional cookstoves without proper ventilation [25]. The limited adoption of improved cookstoves, enhanced ventilation systems, or cleaner fuels points to a substantial technological and policy gap that remains unaddressed [26]. Despite national projects and awareness campaigns, access to clean cooking technologies in rural Bangladesh remains low, primarily due to financial constraints, lack of infrastructure, and insufficient government support mechanisms [27]. Another notable finding was the generally low awareness of government pollution control initiatives among the Kotalipara population. This observation mirrors trends reported from other regions of Bangladesh, where despite the establishment of important national projects are actual community engagement remains insufficient [28]. Many residents remain unaware of their rights to clean air, the existence of government programs promoting cleaner technologies, or available financial incentives for adopting clean energy solutions [29]. The policy suggestions from Kotalipara residents including stricter industrial emissions control, improved public transportation, and vehicle emission regulations align with successful interventions in places like Delhi, where measures like compressed natural gas (CNG) buses and industrial shutdowns improved air [30]. While Bangladesh faces different socio-economic and infrastructural challenges, integrated and multi-sectoral interventions tailored to the local context could achieve similar outcomes [31]. Strategies such as the promotion of electric vehicles, strengthening vehicle emission testing programs, regulating brick kilns, and establishing low-emission zones could be feasibly adapted to both urban and rural areas [32]. Expanding household air pollution reduction programs, such as the "Bondhu Chula" (improved cookstove) initiative, alongside better access to LPG or electric cooking options [33], could significantly reduce the health burden in Kotalipara.

Limitations of the study:

- The study's focus on a single municipality.
- Potential reporting bias from self-reported data on health symptoms and coping strategies.
- Lack of data on long-term health outcomes related to air pollution exposure.
- Insufficient representation of different socioeconomic groups within the study population.
- Limited assessment of outdoor air pollution sources beyond household activities.
- Reliance on cross-sectional data, preventing conclusions about causality.

CONCLUSION AND RECOMMENDATIONS

The findings from Kotalipara Municipality highlight the significant health risks posed by indoor air pollution, primarily due to the widespread use of firewood for cooking. While temporary coping strategies offer short-term relief, they do not address the underlying causes of pollution. Increased public awareness, coupled with effective government interventions, is crucial for mitigating these risks. Policy recommendations such as stricter industrial regulations, improved transportation systems, and expanded access to clean cooking technologies could significantly improve air quality and reduce the health burden in Kotalipara, aligning with successful global examples. Sustainable solutions are essential for long-term health improvements.

REFERENCES

1. World Health Organization. Ambient air pollution: A global assessment of exposure and burden of disease. Clean Air Journal. 2016 Dec 3;26(2):6-.
2. Kumar S, Saha N, Mohana AA, Hasan MS, Rahman MS, Elmes M, MacFarlane GR. Atmospheric particulate matter and associated trace elements pollution in Bangladesh: a comparative study with global megacities. Water, Air, & Soil Pollution. 2024 Apr;235(4):222.
3. Chen J, Li C, Ristovski Z, Milic A, Gu Y, Islam MS, Wang S, Hao J, Zhang H, He C, Guo H. A review of biomass burning: Emissions and impacts on air quality, health and climate in China. Science of the Total Environment. 2017 Feb 1;579:1000-34.
4. Perera GB, Emmanuel R, Nandasena YL, Premasiri HD. Exposure to aerosol pollution and reported respiratory symptoms among segments of urban and rural populations in Sri Lanka. Built-Environment Sri Lanka. 2010 May 31;7(2).
5. Hassan MK, Halder P, Pelkonen P, Pappinen A. Rural households' preferences and attitudes towards biomass fuels-results from a comprehensive field survey in Bangladesh. Energy, sustainability and Society. 2013 Dec;3:1-4.
6. Simkovich SM, Goodman D, Roa C, Crocker ME, Gianella GE, Kirenga BJ, Wise RA, Checkley W. The health and social implications of household air pollution and respiratory diseases. NPJ primary care respiratory medicine. 2019 Apr 26;29(1):12.
7. Ali MU, Yu Y, Yousaf B, Munir MA, Ullah S, Zheng C, Kuang X, Wong MH. Health impacts of indoor air pollution from household solid fuel on children and women. Journal of hazardous materials. 2021 Aug 15;416:126127.
8. Pial RH, Hashan MR, Ghozy S, Dibas M, El-Qushayri AE, Abdel-Daim MM. Comparative study on respiratory function among rural women using biomass fuel and non-biomass fuel: evidence of a cross-sectional survey in Bangladesh. Environmental Science and Pollution Research. 2020 Jul;27(19):24039-47.
9. Liu J, Chen Y, Liu D, Ye F, Sun Q, Huang Q, Dong J, Pei T, He Y, Zhang Q. Prenatal exposure to particulate matter and term low birth weight: systematic review and meta-analysis. Environmental Science and Pollution Research. 2023 May;30(23):63335-46.
10. Craig L, Brook JR, Chiotti Q, Croes B, Gower S, Hedley A, Krewski D, Krupnick A, Krzyzanowski M, Moran MD, Pennell W. Air pollution and public health: a guidance document for risk managers. Journal of Toxicology and Environmental Health, Part A. 2008 May 29;71(9-10):588-698.
11. Arora P, Rehman IH, Suresh R, Sharma A, Sharma D, Sharma A. Assessing the role of advanced cooking technologies to mitigate household air pollution in rural areas of Solan, Himachal Pradesh, India. Environmental Technology & Innovation. 2020 Nov 1;20:101084.
12. Ramírez AS, Ramondt S, Van Bogart K, Perez-Zuniga R. Public awareness of air pollution and health threats: challenges and opportunities for communication strategies to improve environmental health literacy. Journal of Health Communication. 2019 Jan 2;24(1):75-83.
13. Anwar MN, Shabbir M, Tahir E, Iftikhar M, Saif H, Tahir A, Murtaza MA, Khokhar MF, Rehan M, Aghbashlo M, Tabatabaei M. Emerging challenges of air pollution and particulate matter in China, India, and Pakistan and mitigating solutions. Journal of Hazardous Materials. 2021 Aug 15;416:125851.
14. Asaduzzaman M, Barnes DF, Khandker SR. Restoring balance: Bangladesh's rural energy realities. World Bank Publications; 2010 Mar 29.
15. Islam MA, Hasan MN, Ahammed T, Anjum A, Majumder A, Siddiqui MN, Mukharjee SK, Sultana KF, Sultana S, Jakariya M, Bhattacharya P. Association of household fuel with acute respiratory infection (ARI) under-five years children in Bangladesh. Frontiers in Public Health. 2022 Dec 1;10:985445.
16. Kurmi OP, Lam KB, Ayres JG. Indoor air pollution and the lung in low-and medium-income countries.
17. Yuan L, Zhang Y, Gao Y, Tian Y. Maternal fine particulate matter (PM 2.5) exposure and adverse birth outcomes: an updated systematic review based on cohort studies. Environmental Science and Pollution Research. 2019 May 1;26:13963-83.

18. Xue T, Tong M, Li J, Wang R, Guan T, Li J, Li P, Liu H, Lu H, Li Y, Zhu T. Estimation of stillbirths attributable to ambient fine particles in 137 countries. Nature communications. 2022 Nov 29;13(1):6950.

19. Ok E, Enoch O, Barnabas B, Eniola J. Exploring the Links Between Urban Climate Change and Maternal Health Outcomes.

20. Islam MS, Roy S, Tusher TR, Rahman M, Harris RC. Assessment of Spatio-temporal variations in PM2. 5 and associated long-range air mass transport and mortality in South Asia. Remote Sensing. 2023 Oct 16;15(20):4975.

21. Kim JB, Prunicki M, Haddad F, Dant C, Sampath V, Patel R, Smith E, Akdis C, Balmes J, Snyder MP, Wu JC. Cumulative lifetime burden of cardiovascular disease from early exposure to air pollution. Journal of the American Heart Association. 2020 Mar 17;9(6):e014944.

22. Kelly FJ, Fussell JC. Air pollution and public health: emerging hazards and improved understanding of risk. Environmental geochemistry and health. 2015 Aug;37:631-49.

23. Mendelsohn RO, Muller NZ. Using marginal damages in environmental policy: A study of air pollution in the United States. AEI Press; 2013 Jan 19.

24. Carlsten C, Salvi S, Wong GW, Chung KF. Personal strategies to minimise effects of air pollution on respiratory health: advice for providers, patients and the public. European Respiratory Journal. 2020 Jun 4;55(6).

25. Rahaman MA, Kalam A, Al-Mamun M. Unplanned urbanization and health risks of Dhaka City in Bangladesh: uncovering the associations between urban environment and public health. Frontiers in public health. 2023 Oct 19;11:1269362.

26. Mondal MA, Kamp LM, Pachova NI. Drivers, barriers, and strategies for implementation of renewable energy technologies in rural areas in Bangladesh—An innovation system analysis. Energy policy. 2010 Aug 1;38(8):4626-34.

27. Elsaid AM, Ahmed MS. Indoor air quality strategies for air-conditioning and ventilation systems with the spread of the global coronavirus (COVID-19) epidemic: Improvements and recommendations. Environmental Research. 2021 Aug 1;199:111314.

28. Wang Q, Chen Y. Barriers and opportunities of using the clean development mechanism to advance renewable energy development in China. Renewable and Sustainable Energy Reviews. 2010 Sep 1;14(7):1989-98.

29. Saha M, Varghese D, Bartindale T, Thilsted SH, Ahmed SI, Olivier P. Towards Sustainable ICTD in Bangladesh: Understanding the Program and Policy Landscape and Its Implications for CSCW and HCI. Proceedings of the ACM on Human-Computer Interaction. 2022 Apr 7;6(CSCW1):1-31.

30. Imarhiagbe O, Nwodo MU, Ogwu MC. Innovations for Cleaner Futures: Emerging Technologies in Air Pollution Mitigation. Sustainable Strategies for Air Pollution Mitigation: Development, Economics, and Technologies. 2024 Sep 21:377-407.

31. Islam S. Community-based strategies for localising SDG in Bangladesh.

32. Krelling C, Badami MG. Cost-effectiveness analysis of compressed natural gas implementation in the public bus transit fleet in Delhi, India. Transport Policy. 2022 Jan 1;115:49-61.

33. Ahmad R, Ilyas HN, Li B, Sultan M, Amjad M, Aleem M, Abbas A, Imran MA, Riaz F. Current challenges and future prospect of biomass cooking and heating stoves in Asian Countries. Frontiers in Energy Research. 2022 Sep 28;10:880064.