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Education as a Determinant of Air Pollution Perception, Adaptation, and Perceived Health Outcomes in a Changing Climate

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Abstract

Introduction/Objectives: Climate change and air quality are interconnected, with the same sources of emissions and processes in the atmosphere leading to air pollutants both contributing to and reacting to changing climatic conditions. Emissions have been exacerbated by rapid urbanization, increased energy demand, and land-use changes, and climate-related factors, including increased temperatures, changes in precipitation, and extreme events, further exacerbate ambient air pollution, especially fine particulate matter (PM) and ozone. Evidence demonstrates that heat stress, extreme events, and high PM levels pose a high risk to population

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health, and thus integrated air quality management is necessary in conjunction with climate mitigation and adaptation. Climate change worsens health outcomes, such as respiratory and ocular morbidity, and places a burden on weak health systems, with low- and middle-income countries disproportionately impacted. Here, knowledge at the community level and locally based adaptation and risk reduction practices are crucial. Sarawal rural municipality is very susceptible to climate change and frequent climate-related disasters. It is thus important to understand how the community perceives the interface between climate change, air pollution, and health impacts. The study seeks to answer: How do communities perceive the interlinkages between climate change, climate-induced disasters, and air pollution? How do educational levels influence the perceptions of risk reduction and adaptation measures of individuals in the face of climate-induced disasters and air pollution? This paper explores perceptions, perceived drivers and community-based adaptation strategies to these risks.

Methodology: The research was carried out in the Sarawal rural municipality, which included three wards (5, 6 and 7). Guided by a post positivist worldview, quantitative research design was used to examine comprehensive understanding of community perceptions and their experiences about climate change, air pollution and their impact on human health. Finite population correction formula was used to calculate the quantitative sample size; a total of 428 households were sampled through systematic random sampling.

Results: A large majority of respondents, 276 (64.48%) out of 428 indicated that climate change causes air pollution whereas 335 (78.27 %) respondents opined that air pollution is a major respiratory health challenge. A total of 330 (77.10%) agreed that sustainable transportation reduces pollution; 383 (89.48%) respondents agreed & strongly agreed that mask use protects health. Respondents with no formal education consistently showed higher proportions of strong agreement e.g., 96 (67.13%) strongly agreed that climate change causes air pollution; 57 (39.86 %) strongly agreed on ventilation; 57 (39.86.0%) strongly agreed on sustainable transport. Respondents with formal education were more represented in neutral and moderate agreement categories e.g.,140 (49.12%) of neutral responses on ventilation and 70 (24.6%) on transport came from literate groups. All associations between education and perception were statistically significant ($p < 0.05$), chi-square tests affirm that there is a significant relationship between education and perceptions.

Conclusion: The research shows that communities in Sarawal rural municipality are highly aware of the connections between climate change, air pollution, and health risks. Protective measures, such as mask use and risk reduction practices, are well-known, and experiential learning reinforces perceptions, proving the importance of community-based risk reduction, adaptation, and health promotion.

Novelty: The paper is the first to combine the climate change-air pollution-health nexus using a community perception framework in rural communities of Nepal, where this type of analysis is scarce. It offers new evidence that experiential knowledge can be more important than formal education in the process of risk perceptions and adaptive responses.

Keywords: Climate change, Air pollution, Risk Reduction, Adaptation

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1. Introduction

Climate change and air pollution have emerged as major concerns for the global community in the last few decades (Hassan, Hassan, & Hashim, 2015) (Kaur & Pandey, 2021). Anthropogenic activities, primarily the burning of fossil fuels and deforestation, have played a critical role in warming our planet. Updated estimates indicate that, for the period spanning 1850 -1900 to 2013–2022, the increase in global mean surface temperature is 1.15°C (range: 1.00 -1.25°C), while land surface temperatures have risen by 1.65°C (range: 1.36–1.90°C) (IPCC, 2023). Air pollution ranks as the fifth leading cause of global morbidity and mortality. Moreover, two of the most critical environmental challenges, air pollution and climate change, are closely interconnected (Singh, Yadav, & E, 2021). Climate change is expected to influence concentrations of ozone and potentially particulate matter, both of which are linked to higher mortality rates and a wide range of respiratory and cardiovascular health outcomes (Spickett, Brown, & Rumchev, 2011). Many developing countries are undergoing a transition from rural to urban economies, which are increasingly confronted with significant challenges arising from climate change and air pollution (Singh, Madhavan, Arvand, & Bazaz, 2021). Land use patterns significantly influence the climate, mainly through anthropogenic emissions, thereby contributing to extreme weather events, including variations in temperature and precipitation (Shastri, Paul, Ghosh, & Karmakar, 2015). Nepal is highly vulnerable to climate change–related risks and ranks 4th, 11th, and 14th globally in terms of overall climate change, flood, and earthquake risk, respectively (Pandey & Niraula, 2023). Climate change has severe impacts on agriculture, food security, biodiversity, and air quality (Pandey, 2025). The ward no 5, 6 & 7 of Sarawal rural municipality are vulnerable to climate-induced disasters, and many health-related impacts were experienced in those areas, and little has been done to overcome climate change impacts and apply risk reduction and adaptation measures (Aryal, 2023). Education plays an important role in addressing climate change-related health challenges in communities (Aryal, Gangal, & Karki, 2025).

Extreme weather conditions have adverse health impacts that can cause mortality and morbidity (Kaur & Pandey, 2021). Climate change triggers extreme events such as floods, droughts, heatwaves, and cold waves, which impact human health both directly and indirectly. On the one hand, droughts reduce food production; on the other hand, floods destroy cultivable land and contaminate water sources, thereby increasing the risk of waterborne diseases. Women, children, and older adults are particularly vulnerable to the impacts of climate change. It is noted that respiratory infections, chronic obstructive pulmonary disease, asthma, allergies, hypothermia, and dehydration are among the health conditions associated with climate change and air pollution. (Filippelli, Freeman, Gibson, Jay, & Moreno-Madriñán, 2020).

Rapid and unplanned urbanization, coupled with industrialization and population growth, poses a significant threat to human health by exacerbating air pollution and contributing to a range of adverse health outcomes (Dutta, Ghosh, & Dinda, 2021). The deterioration of air quality

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has been further exacerbated by the emission of toxic pollutants, including particulate matter and gaseous pollutants such as SO2, NO_x, and O_3. Further, emissions of aerosols from oceans and forest fires that add air quality depletion (Rumana, Sharma, Beniwal, & Sharma, 2014). Black carbon concentrations in the Indo-Gangetic Plains (IGP) ranged from 8.5 to 19.6 µg m^{-3} during paddy-residue burning in October–November, 2.4 to 18.2 µg m^{-3} during emissions from biofuel and fossil fuel combustion between December and March, and 2.2 to 9.4 µg m^{-3} during wheat-residue burning in April–May (Singh, Rajput, Sharma, Sarin, & Singh, 2014). This is a common practice being used in various parts of Nepal. Air pollution is associated with short-, medium-, and long-term effects on human health (Gumashta & Bijlwa, 2020). Exposure to both short- and long-term air pollutants has been associated with elevated blood pressure and a greater risk of hypertension (Prabhakaran, et al., 2020). Epidemiological evidence suggests that poor air quality poses a substantial risk to human health, leading to outcomes such as reduced lung function, respiratory symptoms, increased incidence of asthma and allergies, and cardiorespiratory diseases (Carosino, et al., 2015).

Weather and climate significantly influence air quality patterns across various temporal and spatial scales, as meteorological variables such as temperature, humidity, wind speed and direction, and mixing height affect the emission, transport, dispersion, chemical transformation, and eventual deposition of air pollutants (Kinney, 2008). Policies and strategies for air pollution risk reduction and adaptation should explicitly incorporate meteorological variables, which are shaped by climate variability and change. Anthropogenic emissions of air pollutants adversely affect human health while simultaneously contributing to climate variability and long-term climate change. Consequently, efforts to mitigate climate impacts through the reduction of fossil fuel combustion are likely to yield co-benefits, including decreased direct health impacts associated with air pollution. Adaptation and mitigation strategies are essential for primary health care providers as well as community at large. Strengthening the monitoring of air pollutants such as particulate matter and ozone alongside tracking related health outcomes, including hospital admissions for cardiovascular and respiratory conditions, constitutes a critical approach to effective risk reduction and adaptation strategies. An advocacy strategy is needed to enhance awareness and understanding of the potential health impacts of rising air pollution linked to climate change, as well as to promote effective adaptation measures aimed at minimizing these adverse effects.

Climate change mitigation and air quality management both emerged as critical environmental challenges in the 21st century. Addressing them in a coordinated manner can gradually slow down climate change and its impact on human health (Nakarmi, et al., 2020). Hindu Kush Himalaya (HKH) region, which includes Nepal, is affected by short-lived climate pollutants (BC, CH4, O3 & CO2) in addition to greenhouse gases. Air pollution, alongside climate change, represents one of the most significant environmental threats to human health (Stanisci, et al., 2024).

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The WHO estimates that climate change will cause about 250,000 more deaths each year between 2030 and 2050, due to malnutrition, malaria, diarrheal diseases, and heat stress. Moreover, the direct health systems costs are projected to be USD 2-4 billion annually in 2030 (WHO, 2023). The Government of Nepal has developed policies that focus on the development of sustainable and low-carbon technologies in major sectors, such as industry, transportation, and physical infrastructure. These policies suggest the implementation of zero-emission technologies by incorporating renewable energy sources, and especially the expansion of such programs in the tourism industry (MOLJPA, 2019). When properly designed and executed, climate change education can be central to the issues of climate change and the process of adopting and implementing suitable adaptation strategies. According to a study carried out in South Asia, there is a lot to be done in the education sector to create awareness on climate change and its effects in different sectors. (Mbah, Shingruf, & Molthan-Hill, 2022).

The above review of the literature shows that climate change and air pollution are two closely related phenomena that can have profound negative impacts on human health. Therefore, it is necessary to investigate how communities perceive climate change and air pollution, especially in terms of its effect on human health. Understanding these perceptions can facilitate the identification of key areas for improvement and inform the development of effective risk reduction and adaptation strategies. The primary aim of this paper is to analyze how education influences the perception of the community towards the interrelationship of climate change and air pollution, and the subsequent effect on human health. This paper will examine questions such as: How do communities see the interconnections between climate change, disasters caused by climate change, air pollution and its effects on human health? To which extent do educational levels influence how people view risk reduction and adaptation measures amid climate-induced disasters and air pollution?

2. Methodology

The Sarawal Rural Municipality ward no 5, 6 & 7 have been selected based on their vulnerability to climate induced disasters and their impact on various sectors. This research assumes that an objective reality exists, but it can only be understood imperfectly due to inherent limitations in human observation and interpretation. It emphasizes empirical inquiry and critical evaluation to refine and approximate truth. This study follows post positivist philosophy. Quantitative approach was used for collecting and analyzing the data. The sample size was calculated using the finite population correction formula, $n = N / [1 + N(e)^2]$ (Yamane, 1973). The total population of the study area (ward no 5, 6 & 7) was 17058; 3,531 households from which 428 households were selected using systematic random sampling with over 19% non-response rate. The total household population of Wards 5, 6, and 7 was divided by the sample size to determine the sampling interval, and households were subsequently selected for interview at every eighth household.

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The study included household heads aged over 30 years (mean = 48.35, SD = 13.59). In cases where the household heads were unavailable, other members of the household were selected as a respondent. The age of respondents ranged from 18 to 80 years. Additionally, participants were required to have resided in the area for more than 10 years, based on the assumption that they would possess sufficient experiential knowledge to provide informed insights into climate variability and change, air pollution, and their impacts on human health. Out of 428 sample population, 311 (72.7%) were male and 117 (27.7%) were female, having different educational background (illiterate/ no formal education 143 (33.4%), literate/informal education 112 (26.2%), primary 115 (26.9%), high school and above 58 (13.6%). Data were collected through a structured household survey questionnaire. There were four categories of respondents in this study; all respondents were clustered into two categories, namely no formal education and formally educated; the literate category includes informal education, primary, high school and above. Responses within the formally educated group did not meet the assumptions of normality; therefore, this group was consolidated into a single category. Furthermore, in certain cases, the five-point Likert scale was reduced to four categories due to the absence of responses in one or more scale points, as presented in Tables 2 and 7.

Seven statements namely climate change causes air pollution, air pollution is a big challenge for human health, using mask during outdoor air pollution helps protecting health, risk awareness on air pollution helps in reducing vulnerability to human health, using electric vehicles, electric mobility, greater use of public transportation, and riding bicycle help in reducing environmental pollution, having proper ventilation system in house helps in reducing indoor air pollution and development and enforcement of the law are equally important to reduce air pollution were assessed using the five point Likert scale.

Data instruments were pretested, to ensure the validity of the instruments, the questionnaire was initially developed and subsequently refined through technical input from subject experts and colleagues. The revised instruments were then pre-tested among 5% of the sample population in a comparable setting. Feedback obtained from respondents during the pre-testing phase was systematically incorporated to further refine and finalize the data collection instrument. For reliability, Cronbach Alpha test was performed, having Cronbach's Alpha value of 0.779 indicates a good level of internal consistency and reliability. This research was conducted with high ethical standards, voluntary involvement with informed consent, anonymity, data protection, and trained enumerators. No personal identifiers were collected; all data was kept confidential and securely stored. The fieldwork was carried out in three wards of Sarawal rural municipality of Nawalparasi West district. The author was contracted to manage the quality of data, and the enumerators were trained and supervised.

3. Conceptual Framework

The conceptual framework below illustrates the relationships between climate change, air pollution and human health outcomes. Climate change influences the meteorological

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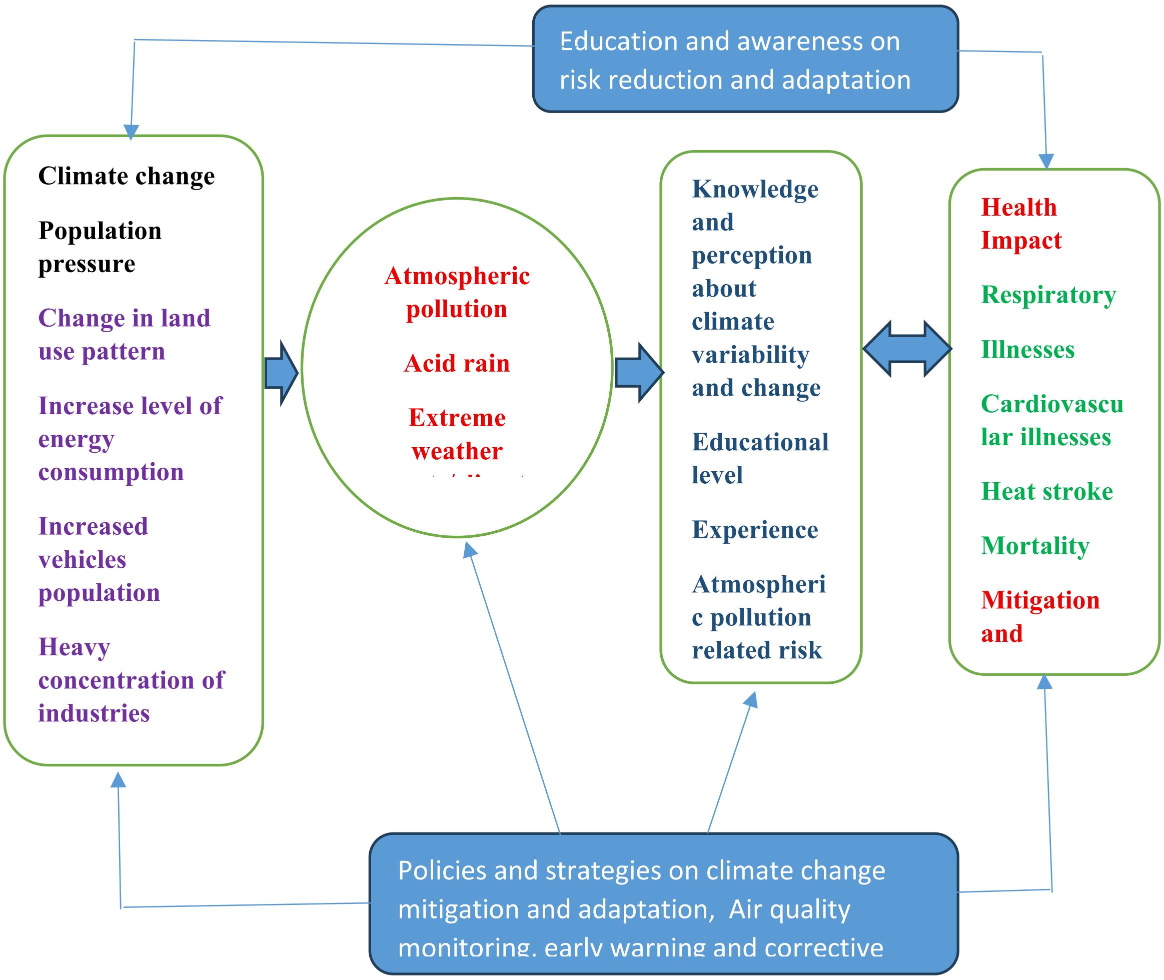
conditions and influences the concentration and distribution of air pollutants, such as particulate matter and ozone. The direct effect of these pollutants is related to the adverse health outcome, particularly respiratory and cardiovascular diseases. Community perception and awareness play the mediating role in the perception and response to these risks. There are also socio-economic factors that play a role in determining the exposure and adaptive ability of the different groups of people. This will lead to increased awareness that will translate into improved practices of prevention and health seeking behavior. The reaction dynamics include mitigation measures and adaptations like pollution control and policy. The aims of these measures are to reduce exposure and health risks. The feedback connection between knowledge, perception and action is also emphasized in the framework. In general, it offers a detailed insight into the interaction of environmental and educational factors to affect human health.



Independent variables:

Level of Education: Level of education is the highest level of formal education of the respondents during the survey. It is operationalized as a categorical variable, which is divided into specific groups, including illiterate (no-formal education), literate, primary education, secondary education, and higher education. During analysis phase, the subgroups of formally educated are clustered into one category.

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Dependent variables:

Perception of climate change: Perception of climate change is the degree of awareness, knowledge and subjective interpretation of climate change, its causes, trends and observable effects by the respondents. It is operationalized with a series of Likert-scale statements (e.g., strongly disagree to strongly agree) that measure knowledge, beliefs, and perceived severity of climate change.

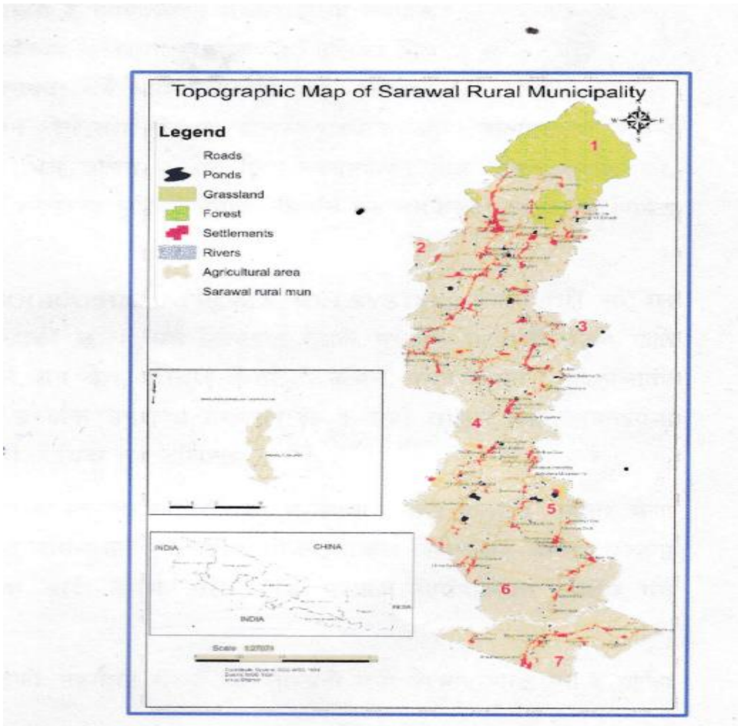
Perception of air pollution: Perception of air pollution is the awareness and knowledge of the respondents about the sources of air pollution, the severity, and the effects on the environment. This variable is quantified by Likert-scale questions that reflect perceived causes, visibility, and seriousness of air pollution in their locality.

Perceived impact on human health: Perceived impact on human health refers to respondents' beliefs regarding the extent to which climate change and air pollution affect human health, including respiratory, cardiovascular, ocular, and other health outcomes. It is operationalized through Likert-scale responses assessing the perceived link between environmental changes and health risks.

Perceived linkages among climate change, air pollution, and health: This variable refers to respondents' understanding of the interconnections between climate change, air pollution, and their combined effects on human health. It is measured using composite Likert-scale items that capture the perceived causal and reinforcing relationships among these factors.

Perception of risk reduction, mitigation, and adaptation measures: This variable refers to respondents' awareness, attitudes, and perceived effectiveness of strategies aimed at reducing risks and impacts associated with climate change and air pollution. It is operationalized using Likert-scale items assessing knowledge and acceptance of preventive actions (e.g., mask use, policy measures, emission reduction, behavioral changes, and community-level adaptation practices).

Map of study area:



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4. Results

The findings are provided below each statement, including knowledge and perception of the issue, risk reduction and adaptation practices.

a. Frequency Distribution

Table 1 data shows that overall, the respondents understand climate change causes air pollution, although there is some difference among the educational groups.

Table 1: Climate change causes air pollution

Educational qualification of the respondent		Climate change causes air pollution: Strongly disagree (Count/ %)	Disagree (Count/ %)	Neutral Count/ %	Agree Count/%	Strongly agree Count/ %	Total Count/ %	Chi-Square Tests
Educational qualification of the respondent	No formal education	1 (0.7)	0 (0.0)	10 (7)	36 (25.2)	96 (67.1)	143 (100)	Value=98.506 Df=4 p=.000
	Formally educated	0 (0.0)	5 (1.8)	136 (47.7)	77 (27.0)	67 (23.5)	285 (100)	
Total		1 (0.2)	5 (1.2)	146 (34.1)	113 (26.4)	163 (38.1)	428 (100)	

Data Source: Field Survey 2025

The data presented in Table 1 reveals an apparent contrast in perceptions between education groups about the assertion that climate change causes air pollution. Among respondents with no formal education/illiterate, there is a tremendously strong level of agreement, with 67.1% strongly agreeing and 25.2% agreeing, while only an insignificant proportion express neutrality (7.0%) or disagreement (0.7%). In contrast, literate respondents reveal a more moderate and dispersed response pattern: nearly half (47.7%) remain neutral, while 27.0% agree and 23.5% strongly agree, and a small proportion express disagreement (1.8%). Overall, the combined sample indicates a tendency toward agreement (64.5% agree or strongly agree), but with a widespread neutral segment (34.1%), largely driven by the literate group.

The statistical analysis further confirms that this observed variation is highly significant. The Pearson Chi-square test ($\chi^2 = 98.506$, df = 4, $p < 0.001$) indicates a strong association between education level and perception of the relationship between climate change and air pollution. Similarly, the likelihood ratio and linear-by-linear association tests also show statistically significant results ($p < 0.001$), reinforcing the robustness of this relationship.

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Table 2: Air pollution is a big challenge for human respiratory health

Educational qualification of the respondent		Air pollution is a big challenge for human respiratory health				Total Count/%	Chi-Square Tests
		Disagree Count/%	Neutral Count/%	Agree Count/%	Strongly agree Count/%		
Educational qualification of the respondent	No formal education	2 (1.4)	19 (13.3)	94 (65.7)	28 (19.6)	143 (100)	Value=15.002 Df=3 p=.002
	Formally educated	4 (1.4)	68 (23.9)	189 (66.3)	24 (8.4)	245 (100)	
Total		6 (1.4)	87 (20.3)	283 (66.1)	52 (12.1)	428 (100)	

Data Source: Field Survey 2025

From the cross-tabulation analysis, it indicates that a strong consensus among respondents that air pollution constitutes a significant challenge for human respiratory health. An extensive majority in both education groups conveyed agreement, with 65.7% of respondents with no formal education/illiterate and 66.3% of respondents with formal education selecting “Agree.” On the contrary, notable differences emerge in the intensity and distribution of responses. Respondents with no formal education demonstrate a higher proportion of strong agreement (19.6%) compared to their literate counterparts (8.4%), suggesting a more definitive perception of the severity of the issue. Conversely, literate respondents show a greater tendency toward neutrality (23.9%) than illiterate respondents (13.3%), indicating a relatively more cautious or nuanced stance. The proportion of disagreement remains minimal and identical (1.4%) across both groups, reinforcing the overall recognition of air pollution as a critical health concern.

The results of the Chi-square test indicate that the relationship between the level of education and perception is statistically significant. The Pearson Chi-square value ($\chi^2 = 15.002$, df = 3, p = 0.002) shows that there is a significant relationship between educational background and respondents views. This is also supported by the likelihood ratio test (p = 0.002) and the linear-by-linear association ($p < 0.001$) indicates a steady trend in ordered categories. Overall, the results propose that education plays an important role in determining perceptions, with literate individuals showing more nuanced views, while illiterate respondents tend to show sounder agreement concerning the severity of air pollution as a public health concern.

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Table 3: Using masks during outdoor air pollution helps protect your health

		Using masks during outdoor air pollution helps protect the health					Total Count/ %	Chi-Square Tests
		Strongly disagree Count/ %	Disagree Count/ %	Neutral Count/ %	Agree Count/%	Strongly agree Count/%		
Education qualification of the respondent	No formal schooling	1 (0.7)	5 (3.5)	15 (10.5)	73 (51.0)	49 (34.3)	143 (100)	Value:15.891 Df=4 p=.003
	Formally educated	0 (0.0)	6 (2.1)	18 (6.3)	199 (69.8)	62 (21.8)	285 (100)	
Total		1 (0.2)	11 (2.6)	33 (7.7)	272 (63.6)	111 (25.9)	428 (100)	

Data Source: Field Survey 2025

The analysis shows that there is a generally good awareness that risk awareness of air pollution helps in minimizing human health vulnerability with significant differences among educational groups.

From the cross-tabulation analysis, it shows a high level of agreement among respondents that using masks during outdoor air pollution helps protect health, although distinctions exist across education groups. Amongst respondents with no formal education, 51.0% agreed and 34.3% strongly agreed, directing a strong endorsement (85.3% combined agreement). Likewise, respondents with formal education also exhibited considerable agreement, with 69.8% agreeing and 21.8% strongly agreeing (91.6% combined agreement). Nevertheless, differences are evident in the intensity of responses: illiterate respondents are more leaning toward strong agreement, whereas literate respondents are inclined to select medium level of agreement more repeatedly. Furthermore, a slightly higher proportion of illiterate respondents (10.5%) reported neutrality compared to literate respondents (6.3%), while disagreement remains marginal in both groups.

The results of the Chi-square test show that the relationship between the level of education and perception is statistically significant. The Pearson Chi-square ($\chi^2 = 15.891$, df = 4, p = 0.003) and the likelihood ratio (p = 0.003) indicate that the differences between the educational groups are not likely to be by chance. The linear-by-linear association is, however, not statistically significant (p = 0.1613) indicating that the relationship is not in a linear pattern across the response categories.

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Table 4: Risk awareness of air pollution helps in reducing vulnerability to human health

		Risk awareness of air pollution helps in reducing vulnerability to human health					Total Count /%	Chi-Square Tests
		Strongly disagree Count/ %	Disagree Count/ %	Neutral Count/ %	Agree Count/ %	Strongly agree Count/ %		
Education qualification of the respondent	No formal education	1 (0.7)	4 (2.8)	22 (15.4)	68 (47.6)	48 (36.6)	143 (100)	Value=12.157 Df=4 p=.016
	Formally educated	0 (0.0)	5 (1.8)	52 (18.2)	170 (59.6)	58 (20.4)	285 (100)	
Total		1 (0.2)	9 (2.1)	74 (17.3)	238 (55.6)	106 (24.8)	428 (100)	

Data Source: Field Survey 2025

From the analysis of table 4 denotes a strong overall agreement among respondents that risk awareness of air pollution promotes reducing vulnerability to human health, though differences are evident across education levels. Among respondents with no formal education, 47.6% agreed and 33.6% strongly agreed, resulting in a high combined agreement of 81.2%. In comparison, respondents with formation education/literate exhibited an even higher tendency toward agreement (59.6%), but a lower proportion of strong agreement (20.4%), producing a combined agreement of 80.0%. This suggests that while both groups widely admit the importance of risk awareness, respondents with no formal education/illiterate are more likely to express stronger assurance, whereas literate respondents tend to adopt a more moderate position. Additionally, neutrality is slightly higher among literate respondents (18.2%) compared to illiterate respondents (15.4%), indicating relatively more cautious or differentiated perspectives among the educated group.

The results of the Chi-square test show that the relationship between the level of education and perception is statistically significant. The Pearson Chi-square ($\chi^2 = 12.157$, df = 4, p = 0.016) and the likelihood ratio (p = 0.017) indicate that the differences between the educational groups are not likely to be by chance. The linear-by-linear association is, however, not statistically significant (p = 0.110) indicating that the relationship is not in a linear pattern across the response categories.

Despite this limitation, the findings underscore a broadly shared recognition of risk awareness as an important adaptive measure, with variation primarily in the intensity of agreement rather than overall perception.

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Table 5: Using electric vehicles, greater use of public transportation, less car driving, and more riding bicycles helps in reducing environmental pollution

		Using electric vehicles, greater use of public transportation, less car driving, and more riding bicycles help in reducing environmental pollution					Total Count/ %	Chi-Square Tests
		Strongly disagree Count/%	Disagree Count/ %	Neutral Count/ %	Agree Count/ %	Strongly agree Count/ %		
Education qualification of the respondent	No formal education	1 (0.7)	4 (2.8)	16 (11.2)	65 (45.5)	57 (39.9)	143 (100)	Value=36.669[a] df=4 p=.000
	Formally educated	1 (0.4)	6 (2.1)	70 (24.6)	165 (57.9)	43 (15.1)	285 (100)	
Total		2 (0.5)	10 (2.3)	86 (20.1)	230 (53.7)	100 (23.4)	428 (100)	

Data Source: Field Survey 2025

The results in Table 5 show that there is a high overall awareness that sustainable transportation practices, including the use of electric vehicles, public transportation, less use of personal cars, and more cycling, help to decrease environmental pollution, and that there are significant variations between educational groups.

The analysis presented in Table 5 discloses a strong overall agreement among respondents that adopting sustainable transportation practices—such as using electric vehicles, increasing public transportation, reducing car use, and promoting cycling—helps reduce environmental pollution. Among respondents with no formal education, 45.5% agreed and a notably high 39.9% strongly agreed, resulting in a combined agreement of 85.4%, reflecting a high level of conviction. In contrast, respondents with formal education/literate also exhibited substantial agreement, with 57.9% agreeing; however, only 15.1% strongly agreed, while a larger proportion (24.6%) remained neutral. This indicates that although both groups recognize the environmental benefits of such practices, illiterate respondents express stronger certainty, whereas literate respondents tend to adopt a more moderate or cautious stance. Disagreement remains minimal across both groups, suggesting broad consensus on the issue.

The results of the Chi-square test prove that the correlation between the level of education and perception is statistically significant. Pearson Chi-square ($\chi^2 = 36.669$, df = 4, $p < 0.001$) and likelihood ratio ($p < 0.001$) show that there is a strong correlation between the educational background and the opinion of the respondents. Moreover, the linear-by-linear correlation is also statistically significant ($p < 0.001$), which indicates a similar tendency in the ordered response categories. Explicitly, lower educational attainment is associated with stronger agreement, while higher educational attainment agrees with more neutral and moderate responses. This pattern suggests that education influences not only awareness but also the

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degree of certainty in environmental perceptions. Given the absence of major violations in expected cell counts, the results can be considered robust. Overall, the findings highlight widespread recognition of sustainable mobility as a key strategy for pollution reduction, with education shaping the intensity and distribution of perceptions.

Table 6: Having a proper ventilation system in-house helps in reducing indoor air pollution

		Having a proper ventilation system in-house helps in reducing indoor air pollution					Total Count/%	Chi-Square Tests
		Strongly disagree Count/%	Disagree Count/%	Neutral Count/%	Agree Count/%	Strongly agree Count/%		
Education qualification of the respondent	No formal education	0 (0.0)	1 (0.7)	24 (16.8)	53 (37.1)	65 (45.5)	143 (100)	Value=62.119ª df=4 p=.000
	Formally educated	2 (0.7)	14 (4.9)	140 (49.1)	79 (27.7)	50 (17.5)	285 (100)	
Total		2 (0.5)	15 (3.5)	164 (38.3)	132 (30.8)	115 (26.9)	428 (100)	

Data Source: Field Survey 2025

The analysis shows that the overall awareness of the significance of proper household ventilation in the reduction of indoor air pollution is high, with significant variations among educational groups.

The analysis in table 6 shows a largely high level of agreement among respondents that having a proper in-house ventilation system helps reduce indoor air pollution, though clear contrasts emerge across education groups. Among respondents with no formal education/illiterate, a substantial proportion expressed strong agreement (45.5%) and agreement (37.1%), generating a collective agreement of 82.6%, with relatively few neutral responses (16.8%) and almost no disagreement. In contrast, respondents with formal education/literate display a more dispersed pattern: while 27.7% agreed and 17.5% strongly agreed (45.2% combined agreement), nearly half (49.1%) remained neutral, and a slightly higher proportion expressed disagreement (5.6%). This suggests that illiterate respondents tend to express stronger conviction regarding the effectiveness of ventilation, whereas literate respondents adopt a more cautious or less definitive stance.

The results of the Chi-square test indicate that the relationship between the level of education and perception is very statistically significant. The Pearson Chi-square ($\chi^2 = 62.119$, df = 4, $p < 0.001$) and the likelihood ratio ($p < 0.001$) show that there is a strong correlation between the educational background and the views of the respondents. Moreover, the linear-by-linear correlation is also statistically significant ($p < 0.001$), indicating a definite trend between ordered response categories.

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Table 7: The development and enforcement of the law are equally important to reduce air pollution

		The development and enforcement of the law is equally important to reduce air pollution				Total Count/ %	Chi-Square Tests
		Disagree	Neutral	Agree	Strongly agree		
Education qualification of the respondent	No formal education	4 (2.8)	13 (9.1)	55 (38.5)	71 (49.7)	143 (100)	Value=31.110 [a] df=3 p=.000
	Formally educated	10 (3.5)	60 (21.1)	147 (51.6)	68 (23.9)	285 (100)	
Total		14 (3.3)	73 (17.1)	202 (47.2)	139 (32.5)	248 (100)	

Data Source: Field Survey 2025

The information in table 7 shows that there is a high general awareness of the significance of legal frameworks in particular the formulation and implementation of laws in curbing air pollution with evident differences among the educational groups.

The data in Table 7 indicates a strong overall agreement among respondents that the development and enforcement of laws are evenly important for reducing air pollution, with 79.7% of the total sample either agreeing (47.2%) or strongly agreeing (32.5%). Nonetheless, significant variances emerge across education groups in the intensity and distribution of responses. Respondents with no formal education/Illiterate exhibit a higher level of strong agreement (49.7%) compared to literate respondents (23.9%), suggesting a more definitive perception of the role of legal frameworks. In contrast, literate respondents are more likely to select moderate agreement (51.6%) and neutrality (21.1%) than illiterate respondents (38.5% and 9.1%, respectively), indicating a relatively more nuanced or cautious stance. Disagreement remains low in both groups, reinforcing a broad consensus on the importance of legal measures in air pollution control.

The results of the Chi-square test demonstrate that the relationship between the level of education and perception is significant. The Pearson Chi-square value ($\chi^2 = 31.110$, df = 3, $p < 0.001$) and the likelihood ratio ($p < 0.001$) indicates that the correlation between the educational background and respondents' opinions is very strong. In addition, the linear by linear correlation is statistically significant ($p < 0.001$), which shows continuous pattern of correlation among the ordered response categories. Overall, the analysis indorses that education influences not only the level of agreement but also the degree of certainty in perceptions, with literate individuals showing more nuanced attitudes toward the effectiveness of legal and regulatory approaches to air pollution control.

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Furthermore, the descriptive statistics show that this variable has a high mean score (M = 4.0888), indicating a strong overall endorsement relative to other statements. Collectively, these findings underscore the widespread recognition of regulatory and enforcement mechanisms as critical strategies for mitigating air pollution, with education influencing the degree of certainty in these perceptions.

3.2 **Descriptive and Inferential Statistics**

The descriptive (Table 8) and inferential statistics (Table 9) provide a clear understanding of the perception of air pollution, its health impacts, and mitigation measures by the respondents, and the educational background differences.

3.2.1 Descriptive Analysis

The descriptive statistics indicate that the overall level of agreement with all statements is high with the mean of 3.80 to 4.12 on a Likert scale (presumably 1-5). It means that there is a positive attitude, in general, and a high level of awareness regarding the nexus of air pollution, climate change, and human health.

Table 8: Descriptive Statistics

Descriptive Statistics		
Risk reduction measures against air pollution	**N**	**Mean**
Climate change causes air pollution	428	4.0093
Air pollution is a big challenge to human respiratory health	428	3.8902
Using masks during outdoor air pollution helps protect the health	428	4.1238
Risk awareness of air pollution helps in reducing vulnerability to human health	428	4.0257
Using electric vehicles, greater use of public transportation, less car driving, and more riding bicycles help in reducing environmental pollution	428	3.9720
Having a proper ventilation system in-house helps in reducing indoor air pollution	428	3.8014
The development and enforcement of the law is equally important to reduce air pollution	428	4.0888

Data Source: Field Survey 2025

Of the statements, the highest mean (M = 4.1238) is recorded in the statement, which is, using masks during outdoor air pollution helps protect health, which means that the statement is the most agreed and recognized in terms of personal protection measures. Likewise, the development and enforcement of the law is equally important to reducing air pollution (M = 4.0888) and risk awareness of air pollution helps in reducing vulnerability to human health (M = 4.0257) also have high levels of agreement, which demonstrates trust in both institutional mechanisms and awareness-based interventions.

That climate change causes air pollution (M = 4.0093) and that sustainable transportation practices can contribute to reducing environmental pollution (M = 3.9720) also demonstrates

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that they possess a very good understanding of the bigger environmental relationships. In the meantime, Air pollution is a big challenge to human respiratory health (M = 3.8902) indicates a high degree of agreement, albeit a bit less than other items. The mean of having a proper ventilation system in-house helps in reducing indoor air pollution is the lowest (M = 3.8014), which implies a relatively low level of awareness or confidence in the strategies of mitigating indoor air pollution.

On the whole, these results indicate that the respondents are highly aware of the causes and effects of air pollution, and possible mitigation measures, albeit with a minor focus on indoor environmental control.

3.2.2 Inferential Analysis: Educational Differences

The t-test comparing the differences by the educational background also indicates a statistically significant difference (t = 5.399, df = 300, p < 0.001). The mean scores of respondents who have no formal education (M = 3.7418) are higher than the literate respondents (M = 3.4727) with a mean difference of 0.269.

Table 9: T-Test

Group Statistics					
	Education qualification of respondent	N	Mean	Std. Deviation	Std. Error Mean
Risk Reduction Measures	Illiterate	143	29.6993	3.55844	.29757
	Literate	285	27.0211	3.14658	.18639

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Risk Reduction Measures	Equal variances assumed	5.064	.025	7.945	426	.000	2.67825	.33711	2.01564	3.34086
	Equal variances not assumed			7.628	255.607	.000	2.67825	.35113	1.98678	3.36971

Data Source: Field Survey 2025

The seven statements used for assessing the perception were considered as the risk reduction measures. The Cronbach's Alpha test was performed, the value of 0.779 indicates a good level of internal consistency and reliability. The independent samples t-test reveals a statistically significant difference in the mean score of risk reduction measures between illiterate and literate respondents. Specifically, respondents with no formal education/illiterate reported a higher mean score (M = 29.70, SD = 3.56) compared to literate respondents (M = 27.02, SD =

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3.15), indicating comparatively greater agreement or engagement with risk reduction practices among the illiterate group.

Levene's Test was significant (F = 5.064, p = 0.025), showing unequal variances; thus, the "equal variances not assumed" results are appropriate. The difference persists highly significant (t = 7.628, df = 255.607, p < 0.001), with a mean difference of 2.68 and a 95% confidence interval (1.99–3.37) excluding zero. This confirms that educational status significantly influences risk reduction measures in the study population. This finding is consistent with previous cross-tabulations, in which no formal education respondents always indicated stronger agreement in a series of statements.

5. Discussion

The results of this research are valuable in terms of understanding the perceptions of the community regarding the interconnections between climate change, air pollution, and human health, especially in the framework of Nepal, where the environmental vulnerability is still high. (Pandey & Niraula, 2023). The general high consistency rate of all the statements of perception indicates that the respondents have a lot of awareness regarding the connection between environmental change and perceived health outcomes. This aligns with the past literature that recognizes climate change and air pollution as interrelated international issues that significantly lead to morbidity and mortality (Hassan et al., 2015; Singh et al., 2021). The perceived knowledge of the respondents is also indicative of the wider evidence in the world that the increase in temperatures and the alteration of climatic conditions contribute to the increase in air pollution levels, especially ozone and particulate matter, which in turn increases the risks of respiratory and cardiovascular diseases (Spickett et al., 2011; IPCC, 2023). The descriptive findings, in which the mean scores range between 3.80 and 4.12 indicate that the general agreement on the key issues, such as the protective effect of masks, the importance of legal enforcement and the importance of risk awareness is high. The largest mean score of mask use (M = 4.1238) indicates that there is a high level of awareness of personal protective measures, which is consistent with the literature on the topic of personal health that highlights the importance of behavioral interventions in minimizing exposure to air pollutants (Gumashta & Bijlwa, 2020). Likewise, a high consensus on the role of legal frameworks (M = 4.0888) indicates the realization of institutional responsibility in environmental governance, which has been emphasized as critical in dealing with air pollution and climate change issues (Nakarmi et al., 2020). The perception of risk awareness as a protective factor is high (M = 4.0257) which also confirms the results of the earlier researches that knowledge and awareness have a significant impact on adaptive capacity and health outcomes (Aryal et al., 2025).

One of the significant contributions of this study is that statistically significant differences in perception were identified depending on educational background. However, contrary to the traditional expectations, the respondents who had no formal education showed a higher agreement with several variables than the formally educated respondents. The t-test results (p < 0.001) support this finding and are consistent with the cross-tabulation patterns of all seven statements. This tendency can be attributed to the importance of experience and first-hand

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experience of environmental hazards, especially in rural and disaster-affected regions. Moreover, the majority of the participants in this research were household heads, with extensive experience and previous exposure to training and workshops, which could have led to their acquaintance with the problem being studied. Also, the area of the study is extremely vulnerable to the disasters caused by climate, which has probably increased their awareness and sensitivity to these problems. Past studies in related settings have indicated that communities that are regularly exposed to environmental risks tend to develop powerful intuitive knowledge and risk perceptions, despite lack of formal education (Filippelli et al., 2020). Conversely, respondents with formal education were more neutral, possibly because of a more conservative or critical approach to the issues (Niraula, Pandey, & Pariyar, 2026).
The research also points out the differences in awareness among various adaptation and mitigation measures. Although outdoor preventive strategies, including mask use and sustainable transportation, were highly supported, the mean score of indoor ventilation (M = 3.8014) is relatively low, which means that people are not very aware of indoor air pollution. This observation is in line with the available literature, which indicates that indoor air pollution is an under-appreciated health hazard despite its considerable role in respiratory diseases, especially in developing nations (Carosino et al., 2015). Since the indoor air quality depends on the household fuel consumption and ventilation systems, this gap highlights the importance of specific interventions aimed at reducing the risk at the household level.

The statistically significant relationships found in chi-square tests in all variables further support the significance of socio-demographic factors in the formation of environmental perceptions. These results are consistent with the larger body of evidence that socio-economic status, education, and information access affect exposure to environmental risks and the ability to respond effectively (Dutta et al., 2021). These perceptions are probably influenced by the experience and the local environmental factors in the context of Sarawal rural municipality where communities experience frequent disasters caused by climate, including floods and landslides. (Aryal, 2023).

Moreover, the high level of agreement on sustainable transportation practices 330 (77.10%) indicates an increased awareness of mitigation measures that can decrease air pollution and greenhouse gas emissions. This is especially applicable in fast-growing urban areas, where the growth of vehicular emissions is a major contributor to air pollution (Singh et al., 2021). The findings also support the argument that integrated approaches to climate change mitigation and air quality management can generate co-benefits for human health (Nakarmi et al., 2020).
Policy and governance are also critical as highlighted in the results. A significant proportion of the respondents with no formal education 126 (88.11%) and 215 (75.43%) respondents with formal education recognized the need to create and implement laws to curb air pollution. This is in line with the national policy trends that encourage the use of low-carbon technologies and integration of renewable energy sources as sustainable development strategies (MOLJPA, 2019). Nevertheless, as pointed out in the literature, the success of such policies lies in their

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implementation and enforcement at the local level, and the involvement and awareness of the people. The research indicates a considerable degree of community awareness of the nexus between climate change, air pollution, and human health, as well as shows significant differences between educational groups and the types of mitigation strategies. The results highlight the importance of context-sensitive and inclusive climate change, education and risk communication. Enhancing institutional structures, encouraging community-based adaptation strategies, and increasing awareness of indoor air pollution are crucial in minimizing health vulnerabilities. Climate change is projected to cause a substantial rise in health burden in the next few decades as evidenced by the global projections, and it is therefore urgent to consider community perception in policy formulation and execution (WHO, 2023).
The selection criteria for respondents (over 30 years, resided more than 10 years in that area) might have introduced potential confounding effects, as they could be associated with higher representation thereby influencing the observed outcomes. This can imply that respondents with no formal education are more dependent on experience and first-hand experience of environmental and health hazards, which results in more conclusive perceptions. Conversely, more moderate or critical positions can be taken by respondents who have formal education, which leads to relatively low mean scores.

6. Conclusion

The analysis shows that the overall level of awareness of the respondents on interconnection between climate change, air pollution and its health effects and mitigation strategies is high. Especially popular strategies of prevention, such as mask-wearing, and policy-based interventions, such as legal action, are well-known, and the awareness of reducing indoor air pollution appears to be comparatively low.

The analysis of data using the inferential analysis demonstrates that there are significant differences based on the educational background. No formally educated respondents have higher chances of reporting higher levels of agreement as compared to formally educated respondents respectively. These differences suggest that knowledge is not the sole determinant of perception, but socio-demographic factors, including lived experience, information access, and possibly cultures.

Moreover, incorporating air pollution education, and indoor pollution into the current local-level public health and disaster risk reduction programs can improve the effectiveness of implementation. Enhancing institutional coordination, encouraging behavior change communication, and ensuring that environmental regulations are enforced to increase public awareness and encourage effective air pollution reduction measures and reducing the health burden of air pollution will be essential in converting awareness into lasting action and quantifiable health outcomes.

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