

RESEARCH ARTICLE

Youth perceptions about climate change mitigation in Bangladesh: A mixed-method study

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Abstract

Academics and policymakers have recognized climate change mitigation as a rapidly growing research field, underscoring the urgent need to understand youth perceptions of this critical issue, particularly in vulnerable countries like Bangladesh. This study aims to contribute by exploring how university students perceive climate change mitigation through a mixed-method analysis. Primary data were collected via social surveys (N=438) covering students from the 1st year to master's programs, and semi-structured interviews with a subset of students (N=20). Quantitative data were analyzed using chi-square testing, poisson regression and factor analysis, while qualitative data underwent thematic analysis to provide an in-depth understanding of students' views. The findings reveal that perceptions of climate change mitigation vary significantly according to socio-demographic factors, such as gender, academic year, and academic discipline, illustrating the nuanced ways these variables influence awareness and attitudes. The mixed-method approach highlights a diverse range of strategies, from advanced technological solutions to grassroots community actions, that students identify as essential to addressing climate change. These are not just insights that deepen our understanding of youth perspectives but also provide recommendations for policymakers and educators. By integrating student views into policy frameworks, the present study provides valuable directions for enhancing climate resilience and promoting environmental sustainability in developing countries like Bangladesh, where climate change risks are remarkably high.

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1. Introduction

South Asia is one of the regions most impacted by climate change, facing a wide range of environmental challenges, including rising temperatures, erratic weather patterns, sea-level rise and increased frequency of extreme weather events [1]. The region has experienced sudden and dramatic shifts in climatic events. In addition, rapid urbanization, industrialization, overcrowding, and increased car usage have

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exacerbated the effects of climate change [2]. Despite this growing crisis, there is a significant lack of baseline research to understand how young people perceive climate change and contribute to mitigation efforts. Developing effective strategies to reduce exposure and vulnerability is critical for climate resilience in South-Asian countries [3].

Among South-Asian countries, Bangladesh is one of the most vulnerable to climate change impacts [4]. It is a densely populated country with a population of 173.6 million, facing major economic, political, and environmental challenges [5]. Due to its geographical location, Bangladesh is surrounded by rivers. As a result, the country is faced with climate hazards that put human lives at risk. The country experiences floods, storms, heat waves, landslides, and river erosion. The list is extensive, encompassing phenomena such as changing weather patterns, elevated temperatures, increased frequency and intensity of storms and floods, intensified rainfall, and elevated sea levels [6]. In addition, droughts, river erosion, increased extreme cyclonic activity, storm floods, hotter and drier summers, heavy rainfall, and growing challenges to agricultural production cycles and water security have plagued the country for two decades [7]. Bangladeshis' lives have been affected by these events in every way. A recent cross-sectional study examined people's perceptions of human health risks in two Bangladeshi villages [8], indicating the need for larger studies to generalize. Some study participants understood climate change moderately but were highly aware of its effects on their lives [8]. This suggests a pressing need for broader research to assess climate awareness to engage in mitigation, especially among youth who are key drivers of social change.

As the global conversation increasingly emphasizes the role of developing nations in climate change mitigation, there is increasing focus on how individuals in these regions perceive and respond to the climate crisis. Developing countries, including Bangladesh, bear the brunt of climate-related socio-economic losses, yet they often lack the resources to respond effectively [9]. Therefore, developing countries need to develop evidence-based mitigation strategies and policies to minimize the effects of climate change through increased awareness [1]. Many initiatives are taken by international bodies like the United Nations Framework Convention on Climate Change (UNFCCC), Intergovernmental Panel on Climate Change (IPCC), and United Nations Environment Programme (UNEP) in mitigating global climate change. Key mitigation measures include rational use of energy, promotion of renewable energy, carbon storage and sustainable urban planning.

There is a growing interest in examining how young people in developing countries, including Bangladesh, perceive climate change and respond to the interest in mitigation. Understanding their knowledge, attitudes and willingness to adopt sustainable practices is essential for designing inclusive climate policies. The rising threat of global climate change can be mitigated by increasing awareness and encouraging behavioural shifts at the individual and community levels [10].

It is important to explore how the younger generation, particularly university students understand the effects of climate change and how their perceptions, awareness, knowledge, attitudes, and willingness toward climate change mitigation.

Understanding the perceptions of university students is crucial, as they represent an important and educated segment of Bangladeshi youth who are likely to play key roles in future environmental and policy decision-making. Therefore, this study aimed to analyze the perception of climate change mitigation at Shahjalal University of Science and Technology (SUST), Bangladesh. As a recognized public institution, SUST provides a valuable context for exploring broader youth engagement with climate change mitigation. Particularly, it examined how the students' socio-demographic factors such as gender, academic year, academic discipline, area of residence, ideal place to live, and vulnerability of hometowns to extreme weather events and climate change influence their understanding, knowledge, attitudes, and perception towards climate change mitigation strategies. By employing quantitative and qualitative methods, this study sought to uncover patterns of students' awareness and perception of adopting sustainable practices, thereby leading to a comprehensive picture of youth perspectives on climate action.

2. Literature review

A review of existing literature reveals that several policies aimed at mitigating climate change have been implemented globally. This section explores the fundamental aspects of these measures, with a focus on the behavioural changes that efforts to address climate change.

2.1. Determinants of climate change mitigation

Socio-demographic variables have a considerable impact on perceptions and conversations surrounding climate change. Weber [11] references multiple studies that illustrate the impact of different structural, psychological, social, and cultural factors on individuals' viewpoints regarding climate change. The primary determinants influencing individuals' perspectives on the effects of climate change are gender and levels of education [1]. Individuals with higher levels of education exhibit greater concern regarding the climate change mitigation measures in Bangladesh and Pakistan. In addition, males were more likely to take mitigation measures regarding climate change than females [1]. Semenza et al. [12] revealed that the residents of Houston and Portland in the USA urban centers were aware of climate change and were ready to take necessary actions to alleviate its impacts. Additionally, individuals from lower socioeconomic backgrounds demonstrated a slightly lower level of knowledge about climate change. A study conducted in Germany and the UK revealed that women exhibit more significant levels of worry regarding climate change [13]. The study of Tvinnereim et al. [14] revealed that men tend to externalize solutions, focusing on systemic issues like energy policy and international cooperation, while women emphasize individual behavior and practical changes such as improved public transportation and lifestyle adjustments.

The viewpoints of university students regarding climate change vary based on their academic disciplines. Higher education institutions prioritize the instruction of climate change. Students who were pursuing a degree in environmental sciences had a higher probability of being exposed to information on climate change in their academic setting compared to students in different fields of study [15]. In a recent study of Bangladesh conducted by Saha et al. [16], it was revealed that students' disciplinary backgrounds and vulnerability to extreme weather events or climate events were significant determinants of the environmental concern level. Another study in Bangladesh revealed that student demographics such as gender, religion, affiliation with environmental organizations, discipline backgrounds, and the completion of relevant courses contribute to climate change perception [17]. Based on their research, the viewpoints of university students regarding climate change vary depending on their chosen academic field of study. In Portugal, Ramos et al. [18] discovered that climate education played a fundamental role in the academic training of social educators. A study done in Australia by Akter and Bennett [19] revealed that individuals' level of climate change education directly influences their endorsement of both national and local efforts to address the problem. While individuals with a bachelor's degree or higher were less inclined to reduce their usage of carbon-intensive products, they were more likely to endorse national initiatives aimed at decreasing greenhouse gas emissions. College graduates with more knowledge are more aware that their efforts to minimize greenhouse gas emissions have a minimal impact on the issue of climate change [19].

2.2. Behaviour changes related to climate change

Scientists encounter difficulties in properly communicating weather variability and climate change to the public, politicians, and policymakers, largely due to a lack of trust and public concern [20,21]. The spreading of information is not occurring straightforwardly. Worldview and political ideology are key cultural variables that significantly influence decision-making. These influences revolve around recent events that challenge the existing and alter individuals' aspirations for a more favorable future. As a result, they play a crucial role in shaping how people interpret and understand weather-related phenomena [11].

A study conducted by Semenza et al. [12] revealed that the response to climate change varies significantly between residents of Portland and Houston in the USA. This study also found that Portland's infrastructure has a smaller environmental footprint compared to Houston's. Portland has experienced a decrease in the usage of cars due to the presence of a well-designed and varied public transportation system, including streetcars, light rail, and buses [12]. Due to their increased reliance on external sources for sustenance, such as food, water, and medical assistance, women are more susceptible to becoming victims of such calamities [22]. Alvi et al. [1] found a lack of perceived benefits, motivation, and self-confidence among residents of Dhaka, Bangladesh and Islamabad, Pakistan, regarding climate action. Moreover, most individuals in both cities exhibit unfavourable attitudes toward sustainable practices such as reducing fuel and energy use, recycling, and conserving water.

People's cultural perspectives and understanding of climate conditions appeared to impact their inclination to modify their actions and endorse measures targeted at addressing climate change. Ohwo [23] revealed that 43.33% of respondents describe their knowledge of climate change as either inadequate or very inadequate in Nigeria. Shi et al. [13] discovered that individuals exhibited greater concern and were more inclined to endorse initiatives aimed at protecting the environment once they comprehended the underlying factors contributing to climate change. Understanding both the behaviors and their outcomes appears to impact individuals' readiness to modify their behavior. According to recent research conducted by Lowe et al. [24], it is necessary to use visually appealing and emotionally engaging informative interventions to increase public awareness about the importance of taking action on climate change. Their analysis also revealed a decline in the audience members' perception of climate-related extreme occurrences. The viewers' concern for the environment motivated them to take action.

The concept of climate change is well-established, but understanding how individuals perceive and address its adverse effects presents a critical challenge for our generation. As a globally trending topic, climate change has drawn significant attention in recent years. Most past research highlights individual concerns regarding changing weather patterns, employing either quantitative analyses or qualitative explorations to examine the impacts. In Bangladesh, however, existing studies primarily focus on policy analysis and recommendations, leaving a gap in understanding individual perceptions. So, the present study contributes to addressing this gap by exploring how students perceived climate change mitigation with mixed-method analysis. This research is significant in considering what policy interventions should be taken to mitigate climate change in Bangladesh. Furthermore, students in higher educational institutions face many challenges, such as environmental challenges, including experiences in extreme weather events (floods, extreme heat exposure, irregular rainfall). They may adapt to these challenges with new solutions. So, the perception of university students is very significant in today's world. They often promote new ideas and technological solutions to tackle climate change and their innovation drives a new, sustainable, and green society for our future generations.

3. Methodology

3.1. Methods and study settings

The study's main purpose is to explore how university students perceive climate change mitigation in Bangladesh. Because of this, the study used a mixed method to analyze the relevant data. As the mixed method combines the

advantages of both quantitative and qualitative research, it can help to get a more complete picture of the situation than a single quantitative or qualitative study [25]. To conduct this study, the researcher used a convergent research design, integrating questionnaire surveys and face-to-face interviews. The convergent research design was employed when the researchers collected independent data and followed a distinct analysis procedure [26].

The study was purposefully conducted on students at Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh. SUST is one of the public universities in Bangladesh that comprises 7 schools, 27 departments, 2 institutes, and several centers [27]. As SUST is a public institution, it attracts several out-of-town students. Many students live in university residential halls. Furthermore, the university has a student body with a wide variety of backgrounds. In addition, they are confronted with various environmental issues, such as experiencing extreme weather events in their home areas and the accumulation of plastic waste [Alam et al., 2021]. So, their perception might differ and would not reflect one another. The purpose of selecting SUST students is to explore their perception of climate change mitigation, particularly focusing on students from rural and urban backgrounds. As such, the student body reflects a microcosm of Bangladeshi youth, making it a valuable context for exploring general perceptions toward climate change mitigation.

3.2. Data sources and methods

The researchers focused on the students enrolled at SUST across all academic years, including first year, second year, third year, fourth year, and the Master's degree program. This university is organized into six schools: Agricultural and Mineral Sciences, Applied Sciences and Technology, Life Sciences, Management and Business Administration, Physical Sciences, and Social Sciences, and each of the schools represents different academic disciplines. According to the office of the registrar, 7450 students in 27 departments at SUST comprise the population for this study. For survey research, the sample size was determined (This study utilized an online sample size calculator available on the sample size calculator. The link is <https://www.calculator.net/sample-size-calculator.html>.) based on a 95% confidence level and a 5% margin of error. With a proportion of 50%, the calculated sample size was 366. However, an additional 72 samples were collected to enhance the precise result, resulting in a total of 438 samples. Increasing the sample size helps improve the reliability of the results. Since the student registration numbers were available, simple random sampling was applied to ensure every participant had an equal chance of selection [28]. This method maintains the objectivity of sample composition, as it provides bias in participant selection [28]. To implement this approach, the study used the 'Research Randomizer' software, guaranteeing that every student had an equal probability of being included [29]. This sampling procedure was applied in several studies to conduct statistical analysis [30,31]. The data required for analysis were obtained using a structured questionnaire. A structured questionnaire is a formal instrument employed to gather information from participants. It comprises a set of standardized questions arranged in a preset framework that dictates the specific wording and order of the questions [32].

For semi-structured interviews, the researchers purposefully selected those departments for this study that had taken environmental or climate change-related courses in their academia. Within these departments, participants were chosen using purposive sampling to ensure diversity in academic background, gender and year of study. Students were recruited through classroom announcements and peer referrals. Willingness to participate and the ability to articulate views on climate change mitigation were key criteria in the selection process. The researchers contacted interested students, provided them with detailed information about the study, and obtained their written consent before conducting the interviews. A semi-structured guide question was used for the qualitative interview. The guide questions describe the specific inquiries that the researchers want to address. Proper leading questions encourage researchers to explore deeper meanings and generate unique answers [33].

3.3. Ethics statement

The study was reviewed and approved by the School of Ethics Committee (SERC) of the School of Social Science and Research Ethics Board (SREB) of Shahjalal University of Science and Technology, under the reference. no. SSS/

SOC/003/004, dated October 01, 2023. Formal written consent was obtained from all the participants before conducting the survey and interviews. Participants were informed about the objectives of the study, the voluntary nature of their participation, and their right to withdraw at any time without consequences. They were assured that all data would be kept confidential and used only for research purposes and that findings would be published without revealing any personal information.

3.4. Data collection techniques

To test the clarity and relevance of the adapted survey questions, a pilot survey was conducted with a class representative from each of the University's faculties. The pilot survey included 10 participants, and all were master's degree students. Since master's students are generally more familiar with academic research tools, they were considered capable of identifying potential issues with question wording and structure. Feedback and suggestions were used to revise the instrument for use with the full representative sample during the main survey phase. The completed questionnaire was divided into two sections ([S1 Appendix A](#)): the socio-demographic information and the perception of climate change mitigation (with two subparts: awareness and perception-related items). Five data collectors were enlisted to assist with full-scale data collection in this study. Two groups were formed: one focused on Physical Science and Applied Science and Technology, while the other encompassed the remaining areas of study. Students were provided with guidance on how to effectively complete the survey and were given the chance to seek clarification by asking questions. The imperative of maintaining the confidentiality and integrity of all information was also addressed during the briefing. Before the distribution of the surveys, all participants were required to express their intention to take part by signing a consent form. To ensure impartiality, the questions were distributed randomly, considering the participants' registration numbers. It was challenging to monitor the availability of classes during the data collection process. Some students did not attend as anticipated. Several students were inattentive to both the questions and their corresponding answers. The students' timetables posed a challenge in acquiring their schedules. Five months were required for data collection. We started the data collection on October 2, 2023, and ended it on February 20, 2024. The researchers conducted supplementary interviews on January 25, 2024, and continued doing so until February 20, 2024, to guarantee data saturation. The researchers collected 438 samples for quantitative survey data and conducted 20 semi-structured interviews (10 males and 10 females) for qualitative analysis. The interviews used a conversational approach, employing open-ended questions to involve a detailed and thoughtful process. Participants were provided with a pre-made interview guide question that facilitated the collection of data related to their perceptions of addressing climate change ([S2 Appendix B](#)). All interviews were properly recorded with the prior permission of the interviewees and conducted in Bangla, as it aligns with the native language of the study participants.

3.3. Data analysis techniques

The instrument used in this study was developed based on an extensive literature review, particularly related to Ahmed & Haq [34]. In their study of indigenous communities [34], p. 685) developed a 15-item inventory to measure the effects of climate change. We put three items regarding mitigating the impacts of climate change. The items are: "The government bears the responsibility for addressing climate change," "Individuals need to use a variety of strategies to deal with the climate change issue," and "Raising public awareness is essential for addressing climate change". The researchers also developed seven new items based on a literature review ([Table 1](#)).

These items are thoroughly checked for reliability testing and verified through the convergent and discriminant validity tests. According to Cavana et al. [35], an instrument is considered reliable if it can consistently and impartially measure the same thing throughout time and using different parts of the instrument. A threshold greater than 0.6 in Cronbach's alpha analysis is frequently seen to be appropriate for proving internal consistency [36]. All the instrument's items had Cronbach's alpha scores that were within the good range of 0.785, indicating the reliability of the tools used in this study. The researchers conducted a factor analysis on each question to assess the convergent validity of the instrument using a

Table 1. Item regarding the perception of climate change mitigation.

Item one	Individuals need to take steps to lower emissions of greenhouse gases
Item two	Individuals need to use both fossil fuels and renewable energy.
Item three	Individuals need to use a variety of strategies to deal with the climate change issue.
Item four	Climate change can be lessened through environmental education.
Item five	Community-level engagement is needed to address the climate change issue.
Item six	Increase local leader participation in climate change mitigation strategies.
Item seven	The government should regulate emissions and clean technology adoption.
Item eight	The government bears the responsibility for addressing climate change
Item nine	Raising public awareness is essential for addressing climate change
Item ten	Motivating people to live greener lives and create more sustainable communities.

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factor loading pattern matrix and the component analysis extraction method, resulting in the average factor for two components exceeding 0.735 [37]. According to Fornell and Larcker [38], discriminant validity is obtained when the square root of the average variance extracted (AVE) is higher than the correlation between different constructs. Components out of the ten items used to assess individuals' perceptions of efforts to mitigate the impacts of climate change exhibited an Average Variance Extracted (AVE) that surpassed the correlation between the two sets of variables. The result confirms that the instrument used in this study was accepted as valid.

Determinants like gender, academic background (faculty), academic year, residency, ideal place to live, and home area susceptible to climate change or EWEs are independent variables that impact how climate change mitigation is perceived. Perceptions of climate change mitigation serve as the dependent variable. For statistical analysis, this study used a crosstab with Chi-square test, Poisson Regression, and Factor Analysis using SPSS and R software. Cross-tab with Chi-square used to see the association between socio-demographic factors and awareness of climate change mitigation. Poisson regression is used to estimate the value of a dependent variable that is influenced by counting data from one or more independent variables. According to Statistics [39], to predict the value of a dependent variable, it is necessary to use independent variables, which are also known as predictors or informative variables. Factor analysis is commonly employed in the social sciences to decrease the number of variables and reveal patterns in their interconnections [40].

For the qualitative part, the researchers transcribed the audio files. Before analyzing the data, the researcher attentively listened to the interview audio recordings. Systematically, Bangla audio was translated into English writings by a professional data transcriber. Then, this study used thematic analysis [41] to evaluate qualitative data using MAXQDA software. Thematic analysis was conducted to use codes and generate themes. The study's findings were strengthened by incorporating interview quotes with quantitative data.

4. Results

4.1. Socio-demographic information of respondents

Table 2 shows the socio-demographic information of the respondents. The table shows that 50.5% were male students and 49.5% were female students. The academic disciplines of agricultural and mineral science accounted for 6.4% of the student body, life science for 6.6%, applied science and technology for 18.9%, management and business administration for 5.3%, and social science for 45.0%. 31% were 1st year, 24% were 4th year, and the rest were split as follows: 16% were 2nd year, 10% were in the 3rd year, and 17% were in the master's degree program. The student body was divided as follows: 43.4% lived in cities, 38.6% in rural areas, and 18.0% in a combination of the two. Another area that was included in the survey was the students' ideal place to live. Half of the students chose urban areas because of all the opportunities and services, while nearly half chose rural areas because of the fresh air, reduced pollution levels, and delicious food. In

terms of the vulnerability of students' hometowns to EWEs and climate change, the results showed that half of the students (50.5%) think their hometowns are safe from the effects of extreme weather events and climate change, whereas nearly the other half (49.5%) of the students think the opposite.

4.2. Perception of climate change mitigation

This study aimed to explore students' perceptions of climate change mitigation in relation to their socio-demographic factors. Firstly, this study examined the link between socio-demographic factors and awareness of climate change mitigation. Secondly, Poisson regression was used to examine the perception of climate change mitigation based on some predictors. Finally, Factor analysis was used to test the sampling adequacy for the items about the perception of climate change mitigation.

4.2.1. Link between socio-demographic factors and awareness of climate change mitigation. A Chi-square test was performed to assess the link between socio-demographic variables and students' perception of climate change mitigation. The dependent variable in this study pertains to awareness of climate change mitigation, including knowing about the causes of climate change, changing human behavior, planting trees and restoring forests.

4.2.1.1. Understand the factors causing climate change: Fig 1 illustrates the link between socio-demographic factors and understanding the factors causing climate change. Based on the data presented in the table, it can be said that there is a statistically significant relationship between the understanding of the factors causing climate change and two variables: gender and academic discipline. There is a high statistical significance between gender and understanding of the factors causing climate change ($p = .026$). The test shows that female respondents mostly know the reason behind climate change (82.9%) compared to male students (74.2%). The results of our study indicate that all (100.0%) of students in the field of agriculture and mineral sciences know the reason behind climate change, in comparison to 82.8% of students

Table 2. Categorical variable information.

Variables	Categories	Percentage (%)
Gender	Female	49.5
	Male	50.5
Academic year	First-year	31.3
	Second year	16.9
	Third year	10.3
	Fourth year	24.0
	Master's	17.6
Academic disciplines	Life science	6.6
	Agriculture & Mineral Science	6.4
	Applied Science & Technology	18.9
	Management & Business Administration	5.3
	Physical science	17.8
	Social Science	45.0
Area of residence	Countryside	38.6
	City	43.4
	Both	18.0
Ideal area to live	Countryside	49.8
	City	50.2
Vulnerability of hometowns to extreme weather events and climate change	Yes	49.5
	No	50.5

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in the field of life sciences who held the same belief. The observed association between academic disciplines and the understanding of the factors causing climate change holds statistical significance at a 5% level ($p = .028$). However, the statistical analysis using the Chi-Square test revealed that characteristics such as academic year, area of residence, ideal place to live, and vulnerability of hometowns to extreme weather events and climate change did not demonstrate statistical significance. Based on the findings of the study, it indicated that understanding the factors causing climate change is neither influenced nor dependent upon these elements. However, the results should be regarded as preliminary indicators that require validation in broader contexts.

4.2.1.2. Changing human behaviour helps to mitigate climate change: Fig 2 presents the interrelationship between socio-demographic factors and changing human behaviour that can help to mitigate climate change. Based on the data presented in the table, it can be inferred that there is a highly statistically significant relationship between changing human behavior to help mitigate climate change and two variables: gender and academic year. There is a high statistical significance between gender and changing human behaviour that can help to mitigate climate change ($p = .000$). The test shows female respondents mostly believe that changing human behaviour can help to mitigate climate change (84.8%) compared to male students (70.1%). Among students, those who studied in a master's program mostly believe that changing human behaviour can help to mitigate climate change (90.9%), while those who studied in 2nd year rarely believe that changing human behaviour can help to mitigate climate change (62.2%). The observed association between academic years and changing human behaviour can help to mitigate climate change holds statistical significance at a 1% level ($p = .001$).

4.2.1.3. Planting trees and restoring forests: Fig 3 presents the interrelationship between socio-demographic determinants and planting trees and restoring forests to help mitigate climate change. Based on the data presented in the table, it can be inferred that there is a statistically significant relationship between planting trees and restoring forests to mitigate

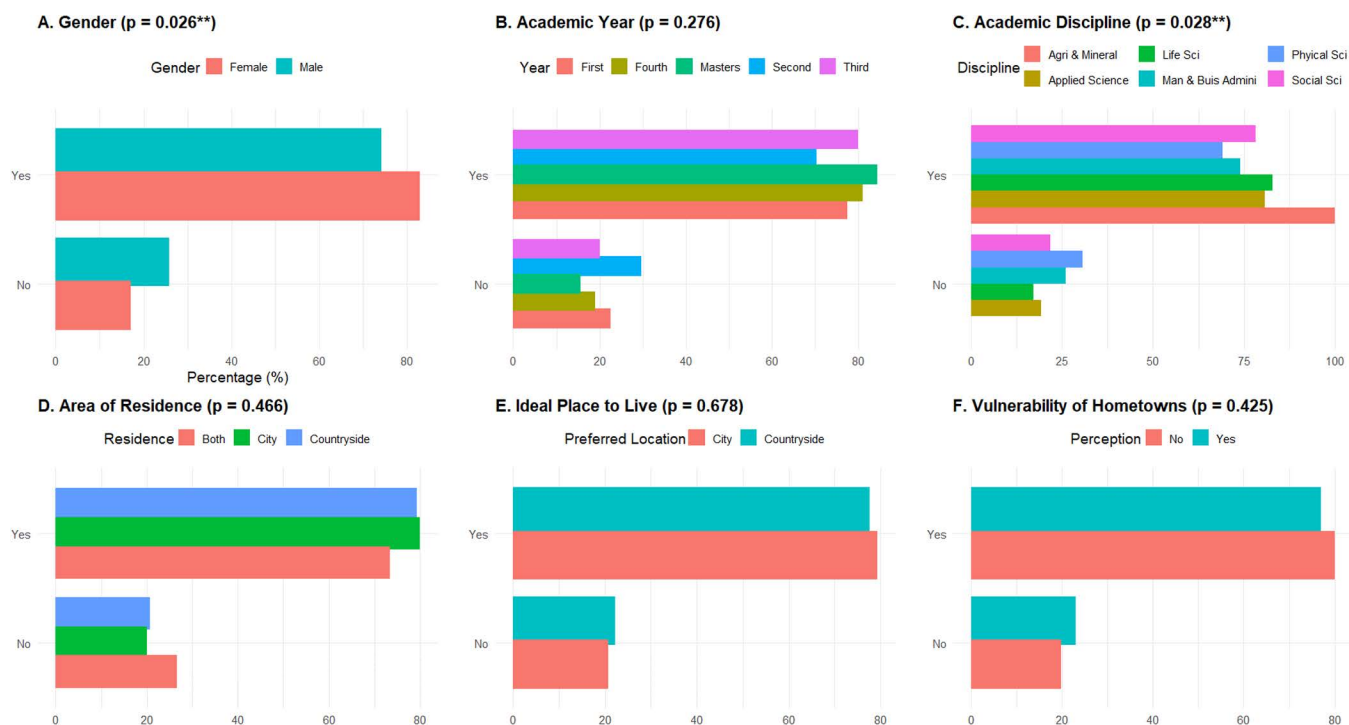


Fig 1. Understand the causing factors of climate change according to socio-demographic determinants.

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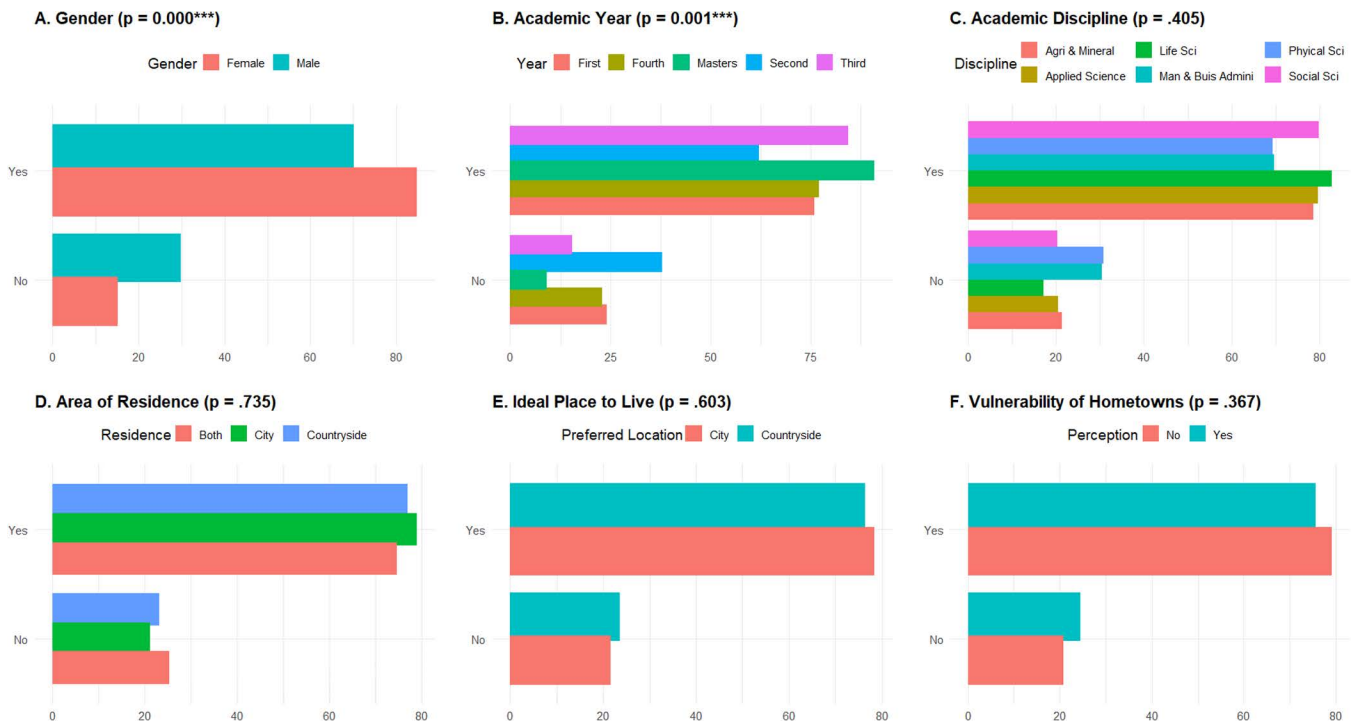


Fig 2. Changing human behaviour helps mitigate climate change according to socio-demographic determinants.

<https://doi.org/10.1371/journal.pclm.0000719.g002>

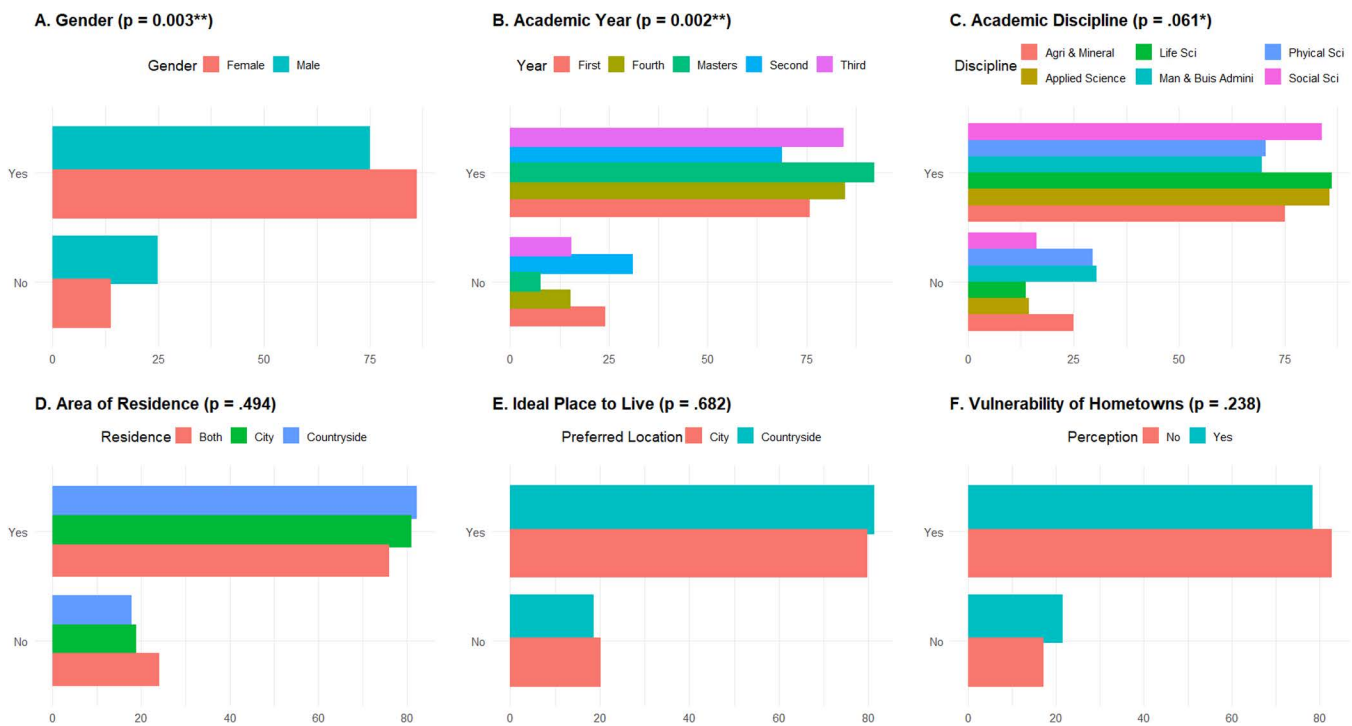


Fig 3. Planting trees and restoring forests help to mitigate climate change according to socio-demographic determinants.

<https://doi.org/10.1371/journal.pclm.0000719.g003>

climate change and three variables: gender, academic year, and academic discipline. There is a statistical significance between gender and planting trees and restoring forests to help mitigate climate change ($p = .003$). The test shows that female respondents mostly believe that planting trees and restoring forests help to mitigate climate change (86.2%) compared to male students (75.1%). Among students, those who studied in master's degree programs mostly believe that planting trees and restoring forests help to mitigate climate change (92.2%), while those who studied in 2nd year rarely believe that planting trees and restoring forests help to mitigate climate change (68.9%). The observed association between academic years and planting trees and restoring forests helps to mitigate climate change holds statistical significance at a 5% level ($p = .002$). The results of our study indicate that all (100.0%) of students in the field of Agriculture and Mineral Sciences believe that planting trees and restoring forests help to mitigate climate change, in comparison to 82.8% of students in the field of Life Science who held the same belief. The observed association between academic disciplines and planting trees and restoring forests helps to mitigate climate change holds statistical significance at a 10% level ($p = .061$).

4.2.2. Significant variables affecting the perception of climate change mitigation: Poisson regression. For Poisson regression, the variables coded under consideration in this study include gender, academic year, academic disciplines, area of residence, ideal area to live and vulnerability of hometowns to EWEs or climate change. The dependent variable is an item regarding the perception of climate change mitigation. The dependent variable descriptors are "Strongly agree=5 to Strongly disagree=1." Poisson regression is commonly used for modeling count data [42]. To make count data, the researchers added the values of all items related to how people perceive climate change mitigation.

Table 3 displays the Poisson regression model for the perception of climate change mitigation and other independent variables. Pearson Chi square = 1.628; Deviance = 1.830 indicates over-dispersion. For overdispersion, the researchers analyzed negative binomial regression. The Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) of Poisson regression are 3157.018 and 3218.251, respectively, lower than negative binomial regression, indicating the Poisson regression model is suitable for this analysis. Omnibus Test $p = .006$ represents statistical significance. So, this model fulfilled the assumptions for conducting Poisson regression. The table also shows Poisson regression coefficient estimates and odds ratios. This Table shows that only one independent variable (academic year) contributed to the model at 5% significance. The odds ratio for a master's program is 1.115. This indicated 11.5% increase in the perception of climate change mitigation among those who studied in the Master's degree program compared to those who studied in 1st year. The odds ratio for 4th year is 1.086. This indicates that 8.6% increase in the perception of climate change mitigation among those who were studied in 4th year compared to those who studied in 1st year.

4.2.3. Factor analysis for the perception of climate change mitigation. The factor analysis indicates the sampling adequacy for the items regarding the perception of climate change. The factorability of 10 items was determined based on a KMO score (0.902). The study revealed two components that had Eigen values of more than 1.0, as shown in **Table 4**. The Varimax rotation method was employed in the analysis, with a correlation coefficient threshold of 0.50 being utilized.

It was observed on the table that a total of eight items displayed significant loadings on factor one. These items are as follows: individuals need to take steps to lower emissions of greenhouse gases; individuals need to use a variety of strategies to deal with the climate change issue; climate change can be lessened through environmental education; community-level engagement is need to address the climate change issue; increase local leader participation in climate change mitigation strategies; the government should regulate emissions and clean technology adoption; raising public awareness is essential for addressing climate change; motivating people to live greener lives and create more sustainable communities. Factor two included two items. The items are: individuals need to use both fossil fuels and renewable energy; the government bears the responsibility for addressing climate change.

4.2.4. Mitigation strategies regarding climate change: innovations and Communities United. The findings gathered from the interviews show that there are some parallels and some distinctions in perceived mitigation strategies regarding climate change. The quantitative analysis revealed that there is a relationship between academic disciplines

Table 3. Results of the multivariable generalized Poisson regression analysis to study the perception of climate change mitigation.

Explanatory Variables	Coefficient	Sig.	Odds Ratio	95% Wald Confidence Interval for Exp(B)	
				Lower	Upper
Gender					
Female 1	.004	.822	1.004	.969	1.04
Ref (Male 0)					
Academic year					
Masters (5)	.109	.000***	1.115	1.061	1.171
Fourth year (4)	.083	.000***	1.086	1.039	1.136
Third year (3)	.043	.147	1.044	.985	1.106
Second year (2)	.022	.397	1.022	.972	1.075
Ref (First year 1)					
Academic disciplines					
Social science (6)	-.001	.983	.999	.935	1.067
Physical science (5)	-.024	.524	.977	.908	1.05
Management and business administration (4)	.004	.93	1.004	.915	1.101
Applied Science and Technology (3)	-.007	.84	.993	.924	1.067
Agriculture and Mineral Science (2)	.001	.983	1.001	.916	1.093
Ref (Life Science 1)					
Area of residence					
Both (3)	.005	.826	1.005	.96	1.052
City (2)	.017	.407	1.018	.976	1.061
Ref (Countryside 1)					
Ideal place to live					
Countryside (1)	.015	.431	1.015	.978	1.054
Ref (City 0)					
Vulnerability of hometowns to EWEs and climate change					
Yes (1)					
Ref (No 0)	.001	.931	1.001	.969	1.035

Dependent Variable: Perception of climate change mitigation

Omnibus Test: Sig.=.006 (N=438)

Deviance: Value/df= 1.830

Pearson Chi-Square: Value/df=1.628

AIC=3157.018

BIC=3218.251

***p<0.01

<https://doi.org/10.1371/journal.pclm.0000719.t003>

and perceived climate change mitigation. The qualitative data also produced similar results. Those who belong to STEM-based (STEM-based subjects refer to academic disciplines relation to science, technology, engineering and mathematics. In this study, Physical science, Applied Science and Technology and Agriculture and Mineral Science are academic disciplines that fall under STEM fields.) subjects said that technological innovation can mitigate the impact of climate change. On the other hand, those who belong to non-stem-based (Non-STEM-based subjects refer to academic disciplines that are not part of science, technology, engineering and mathematics. In this study, social science and management and business administration disciplines fall under non-STEM fields) subjects expressed that community development can mitigate climate change effects. In addition, master’s degree students and fourth-year undergraduate

Table 4. Factor analysis for the perception of climate change mitigation.

	Component	
	1	2
Factor One		
Individuals need to take steps to lower emissions of greenhouse gases	.748	
Individuals need to use a variety of strategies to deal with the climate change issue	.490	
Climate change can be lessened through environmental education	.704	
Community-level engagement is needed to address the climate change issue	.773	
Increase local leaders participation in climate change mitigation strategies	.646	
The government should regulate emissions and clean technology adoption	.787	
Raising public awareness is essential for addressing climate change	.776	
Motivating people to live greener lives and create more sustainable communities.	.726	
Factor 2		
Individuals need to use both fossil fuels and renewable energy		.545
The government bears the responsibility for addressing climate change		.891
Eigen values	4.317	1.026
Percentage (%) of variance	43.173	10.258
KMO (Kasier-Meyer-Olkin)	.902	
Bartlett's test of sphericity: Approx. Chi square (df)	1433.855 (45)***	

***p < 0.01

<https://doi.org/10.1371/journal.pclm.0000719.t004>

students emphasized the importance of conducting a detailed analysis of climate change mitigation strategies. They even explained how technology and social action can mitigate climate change. Since they have often been involved in academic courses and specialized in environmental-related fields. Their academic backgrounds equip them with an in-depth understanding of climate change mitigation.

4.2.4.1 Technical Solution: Most participants from STEM-based subjects acknowledged that climate change should be addressed through technical solutions. For instance, they proposed strategies such as polymer synthesis techniques, black smoke filtration, waste oil management, biogas production, reforestation, sustainable urban planning, plastic recycling, anaerobic digestion, catalytic converters, renewable energy adoption, and the use of organic fertilizers.

One participant added

I suggest polymer synthesis, which involves creating new polymers from plastic waste. Different types of new polymers are created by doping. It reduces plastic waste. In addition, waste oil can be regenerated, and tannery wastewater is treated using specialized systems to remove contaminants, ensuring safe discharge into natural water bodies. Biodiesel can be produced from waste oil. However, all these are very costly processes. Likewise, I can propose numerous ideas to mitigate climate change; however, the irony lies in the lack of funding to continue this crucial work (Male, Master's degree program, Applied Science and Technology).

Another participant suggested

Catalytic converters can be used in cars where the amount of Sulfur dioxide (SO2) can be reduced. When the use of private transportation can be reduced, the amount of public transportation will be sufficient. Public transport is packed with people. So, the management system of public transportation should be better. The use of bicycles as

transportation should be increased. It is eco-friendly on the one hand and good for health on the other hand (Female, 4th year, Life Science).

Another participant stated

Planting trees absorbs carbon dioxide, reducing greenhouse gases. Anaerobic digestion, a process using anaerobic bacteria, reduces methane release from fuel. Anaerobic bacteria digest agro-waste, producing biogas for cooking and electricity. Methanogen bacteria, which produce methane, can be used as an alternative fuel and reduce the pressure on fossil fuels. Although it may contain hydrogen sulfide, its potential is high. The remaining part can be used as a bio-fertilizer that reducing the use of chemical fertilizers (Female, 4th year, Agriculture and Mineral Science).

Another participant recommended

The factory is using updated technology to emit white smoke instead of black smoke, aimed at filtering out black wash in the industry in developed countries. Despite temporary costs, the government and TV advertisements are promoting its use. However, the owners do not want to use it in the industries of our country (Male, 3rd year, Physical Science).

Other elaborated

“Microorganisms are crucial there. Deforestation reduces land fertility, but artificial management can reforest. Various fungi and plant-symbiotic bacteria can restore the soil. One is repairing climate-damaged areas, and the other is reducing what is possible.” (Male, 3rd year, Life Science)

Another said

Scientific measures are essential. I heard some time ago that a liquid-like substance has been discovered which can act as an alternative to oxygen. Liquid Plants will be set up in various parts of the city, and they will function like trees, releasing oxygen and absorbing carbon dioxide. This application has started in developed countries. Other steps have been taken in developed countries. For example, converters can be added to car engines. These converters can purify smoke that contains sulfur dioxide (Male, 3rd year, Physical Science).

4.2.4.2. Community-based Approaches: Most participants from non-STEM disciplines emphasized that addressing climate change requires community-based approaches. They suggested strategies to raise social awareness of climate change through campaigns, organizing boot camps and seminars, utilizing advertisements, posters, and signboards, and increasing government-owned transportation systems (only bus or train).

One of the participants said,

Everyone in society needs to be aware of environmental pollution. Additionally, industrialists and policymakers also need to be conscious. For example, if policymakers set regulations for environmental conservation, the public will follow them (Male, Master’s degree program, Social Science).

Another added

Lack of awareness among people leads to the destruction of trees and increased carbon dioxide. To address these issues, pollution-causing activities should be stopped, such as CFC gas use and black smoke-emitting vehicles. The government and policymakers should collaborate, enact laws to discourage plastic usage, and impose penalties or

finer for pollution. Government officials involved in pollution should also face salary cuts (Female, 4th year, Social Science).

Another explained

We need to plant a lot more trees. The use of transport that emits a lot of carbon dioxide should be reduced. The use of renewable energy, such as solar energy, should be increased. Additionally, everyone needs to become more aware (Male, 3rd year, Social Science).

One of the students suggested,

The city's drainage system needs to be repaired. Waste from factories needs to be treated before disposal. Garbage should not be piled up everywhere on the streets. These things can cause people to fall ill. These are mainly responsible for environmental pollution. (Female, Master's degree program, Management and Business Administration)

Another explained

Bangladesh's private-owned vehicles, including buses, cars, bikes, and rickshaws, contribute to air, noise, and fuel consumption issues in Dhaka. This contrasts with other countries, where they only use trains or buses to travel, which are government-owned. This vehicle of our country consumes many times more resources than that one train spends on resources. Bangladesh's construction is not properly structured, unlike Canada's rule for green spaces in houses. This is due to the country's climate being unsuitable for biodiversity, and the government is addressing this concern to increase settlements (Female, Master's degree program, Social Science).

4.2.5. The role of individual and national participation. The researchers asked participants, "Do you believe that individual and national-level participation can help mitigate climate change? If so, how?" Most participants expressed that individuals alone cannot address climate change in Bangladesh; efforts must originate from authorities. They emphasized the importance of government-led initiatives, such as preserving roadside trees by replanting them elsewhere and ensuring proper care. Additionally, localized efforts, like seminars, campaigns, and promoting green spaces, should inspire small communities. For instance, Rajshahi, one of Bangladesh's temperature-sensitive cities, could serve as a focal point for such initiatives.

Another added

Initiatives need to be taken at the national level. Everyone needs to be made aware by hanging various advertisements, posters, and signboards. Garbage must be disposed of in designated areas. Jute bags and paper can be used instead of plastic. (Female, Master's degree program, Social Science).

One student added

I think both individual-level and national-level participation can mitigate climate change. The initiative taken by the Swapnothan organization (Swapnothan is a voluntary organization that was established in 2007 at Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh. <https://www.sust.edu/181/student-organizations/109>) in our campus is to replace plastic with trees. Many trees are brought, but the trees do not remain. We have new trees every day. Also, Kin organization (KIN is also voluntary organization that was founded in the year 2003 at Shahjalal University of Science and Technology, Sylhet, Bangladesh. <https://kinsust.org/>) gave the tree very little money since the program was there. I think this is a very good initiative. These programs can be done every year. It will increase people's interest

in plantations. We have given the plastic bottles to the city corporation. Bottles are mainly recycled, and polyethylene is destroyed (Male, 3rd year, Applied Science and Technology)

Another added

“We need to reduce the use of plastics on a personal level. To reduce their use, we need alternative resources. The government should work with these alternative resources, the scientists, the chemical scientists who are working on natural polymer-based solutions, to invest in or fund this research. First, find alternatives, then reduce, and then reuse or recycle. Do not do direct dumping. Increasing the use of trees that survive a long time or trees that retain soil fertility.” (Female, 4th year, Life Science)

Other explained

I don't think it will be possible to do this individually. There are various environmental organizations, but I am doubtful about their success rates. They sometimes conduct tree plantation programs, but it is mainly for showing off. Without continuity, these initiatives do not yield results. Therefore, I think government participation on a larger scale is necessary (Male, 4th year, Master's degree program, Social Science).

5. Discussion

Climate adaptation is highly context-dependent, requiring tailored approaches for implementation. Successful implementation is needed for understanding the unique ecological, social, economic, and institutional factors influencing people's responses to climate change [43]. Using mixed method analysis, the present study examines how university students perceive climate change mitigation. The quantitative analysis found that gender, academic year, academic disciplines were identified as factors that influenced students' views on how to lessen the impact of climate change. Students who belong to the master's degree program and 4th year are more likely to have a strong commitment to finding solutions, according to the present study. Students from life science also tend to have a more positive outlook on climate change initiatives compared to students from other academic backgrounds, according to this study. A crosstab analysis with a chi-square test and Poisson regression was utilized to evaluate individuals' understanding of the impacts of climate change and their perspectives on potential mitigation strategies. Haq and Ahmed [17] studied the viewpoints of Bangladeshi students on the origins of climate change by analyzing a range of demographic factors, such as gender, and participation in environmental organizations, previous environmental education, and academic background. When it comes to mitigating climate change, 82.9% of women in this research showed more understanding, which is significantly higher than the men (74.2%). This finding is consistent with other research. Recent research out of Germany and the United Kingdom found that women are more concerned about global warming than men [13]. The same was discovered by Saha et al. [16] about environmental concerns in Bangladesh. Our result indicate that senior students demonstrated a better understanding of climate change mitigation. According to Alvi et al. [1], those with higher levels of education were more likely to take mitigation measures regarding climate change.

This present study found no correlation between students' previous residency and their understanding of climate change mitigation. Despite the conclusions drawn from previous research, Semenza et al. [12] found that people living in urban areas had both awareness of and readiness to act in response to climate change. Students' views on how to mitigate climate change are statistically related to their majors, according to the research. The viewpoints of college students on climate change differed according to major, according to Ayanlade and Jegede [15]. A correlation between climate change awareness and gender, academic year, and major was found in this study. Poisson regression analysis revealed that the current school year was the single most important factor. Those enrolled in the Master's degree program

and 4th-year students had a higher perception of climate change mitigation compared to first-year students ($.000 < p$). It indicates that students in their undergraduate level academic courses related to the environment or climate change help to make strong viewpoints regarding climate change mitigation. The study's findings corroborate this. Thorough interviews were conducted to gather qualitative data that could be used to support the quantitative findings. The purpose of collecting qualitative data was to explore people's responses to the concept of climate change mitigation. Their perspectives on how to mitigate the effects of climate change were illuminated by semi-structured interviews that were conducted. The qualitative findings highlight the diverse and innovative strategies that can be employed to mitigate climate change, ranging from advanced technologies to community-driven actions, as noticed by Haque et al [8]. However, these efforts face significant challenges, including high costs, lack of funding, and resistance to adopting sustainable practices, particularly in developing countries like Bangladesh [44]. The disparity between developed and developing nations in addressing climate change is evident, with the latter often lacking the resources to implement and sustain critical initiatives. The present study underscores the urgent need for systemic changes, increased funding for research, and widespread public awareness. Collaborative efforts between governments, industries, and communities are crucial to overcoming these barriers and creating a sustainable future for all.

6. Limitations and future directions of the study

This analysis has several important limitations. For instance, a key limitation of this study is that data were collected solely from students at one public university (SUST). Therefore, the findings may not fully represent the views of students from other public or private universities across Bangladesh. However, given SUST's national reach and the geographic diversity of its student population, the results offer a meaningful representation of Bangladeshi youth perspectives. While the findings are not statistically generalizable to all youth or students in other institutions in Bangladesh, they can offer insightful trends for future large-scale studies. Future research could broaden the scope by including participants from multiple institutions across different universities. Another limitation is that the study employed a simple random sampling to gather survey data. While this approach ensured that every student had an equal opportunity of selection, we acknowledge that a stratified sampling technique based on departments/disciplines could have enhanced the representativeness of the sample. Students from STEM or environment-related departments may possess different levels of awareness and perception regarding climate change compared to those from non-STEM departments. Executing a stratified sampling in this study was difficult due to instability in politics, winter vacation, academic semester tests, class scheduling conflicts, and time constraints. However, we attempted to address this gap by conducting semi-structured interviews with students who had taken environment-related courses across various departments (both STEM and non-STEM). This qualitative data provided nuanced insights into the perceptions of students who had direct academic knowledge of climate change mitigation strategies, thus complementing and enriching the survey results. The study's findings help to make new policies through collaboration with policymakers, young researchers, and national and international organizations. Future research suggests that considering a larger sample size from different universities in Bangladesh could test the causal mechanisms developed in this study.

7. Concluding remarks

Addressing climate change requires shared responsibility among governments, national and international organizations, and individuals. Collaboration between developed and developing nations is essential to achieve meaningful progress. While developed countries contribute significantly to the problem, the disproportionate effect on vulnerable nations like Bangladesh underscores the urgent need for global collaboration and awareness. In Bangladesh, government incentives, such as subsidies for solar panel installations, demonstrate how policy can drive sustainable practices. However, the success of such measures relies heavily on individual awareness and active participation. Every individual's effort, no matter how small—like creating a rooftop garden—contributes to the larger goal of combating climate change. This study

highlights that climate and environmental education could be particularly valuable, as it provides the knowledge base necessary for informed decision-making. Embedding these themes into curricula and community-based initiatives could help translate knowledge into meaningful behavioural change. Public awareness, particularly in rural areas where populations are often less informed, is critical. Urban planning, public transportation improvements, and the promotion of eco-friendly behaviors like cycling and tree planting are essential steps forward. Building communities dedicated to spreading knowledge and fostering sustainable habits can create a ripple effect, ensuring that climate action becomes a collective movement. By bridging the gap between policy and individual action, society can move toward a more sustainable future, addressing the inequities of climate change impacts and safeguarding the planet for future generations [27].

Supporting information

S1 Appendix. A. Questionnaire 1. Questionnaire used for survey research.

(DOC)

S2 Appendix. B. Questionnaire 2. Guide Question for In-depth Interview.

(DOC)

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