





## Article

# Status and Individual View toward Lightning among University Students of Bangladesh

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**Abstract:** Bangladesh has seen a significant number of fatalities and injuries related to lightning in the past few years, which indicates that lightning has become a deadly hazard. This cross-sectional study aims to determine university students' self-rated status about lightning. Additionally, it evaluates these students' views toward lightning through knowledge, attitude, and practices (KAP). A total of 1274 university students participated in an online KAP survey. Where appropriate, the Kruskal–Wallis or Mann–Whitney U test, Spearman's rank correlation, and logistic regression models were performed. About 90% of university students perceive lightning as a dangerous event, and 38% rated their places unsafe. More than half of the survey population reported frequent lightning; most (84%) did not have lightning safety precautions, and a small portion (26%) received warning messages. Individuals encountering frequent lightning consider lightning-prone areas much more dangerous compared to the individuals encountering occasional lightning. Students living in tin sheds assessed lightning as a dangerous event ( $4.78 \pm 0.53$ ) and having unsafe surroundings ( $2.44 \pm 0.98$ ). Many individuals have enough knowledge (63%), developed positive attitudes (93%), and effective preventative practices (77%). The logistic regression analysis indicated that having adequate information and a good attitude can assist individuals in practicing lightning safety; also, student's Gender, living with family, residential unit, university type, study year, major field, and having lightning-related subjects in university curricula as significant predictors. Females demonstrated better lightning practice than males. Additionally, lightning-related courses in university curricula are critical for educating students about lightning. Behavioral improvements among these students will require substantial lightning campaign actions coupled with effective education.

**Keywords:** lightning safety; lightning prevention; lightning safety education; university students; Bangladesh

## 1. Introduction

The yearly global mortality and injury toll from lightning is unknown. Since many lightning-related deaths occur inside communities and are rarely documented, especially in rural regions with serious lightning risk, the actual figure may be higher [1,2]. Lightning injuries usually result in high mortality and long-term morbidity [3]. It has become a global public health concern. Cardiac and lung injuries, as well as neurologic and neuropsychiatric issues (compartment syndrome, rhabdomyolysis, myoglobinuria, renal failure, sexual dysfunction), are severe effects due to lightning [4]. The economic consequences of lightning damage to property are also enormous, varied, and widespread [5].

Bangladesh has suffered from lightning storms, resulting in many fatalities [2,6,7]. However, as in other developing countries, this country frequently underestimates lightning, with underreported deaths, particularly in rural regions [3,7]. Bangladesh's government declared lightning a disaster in 2016 in response to the high death toll [8]. Lightning-related deaths have not reduced considerably, and the country continues to see an increased number of fatalities [9]. Lightning strikes have killed at least 2400 people in Bangladesh over the last decade, with most casualties being farmers, government data reveals [10]. In May 2021, 66 people were killed, and 8 were injured in Bangladesh [9]. According to Save The Society and Thunderstorm Awareness Forum (SSTF) data, 177 people were killed in lightning strikes until June of 2021 [10]. On 4 August 2021, 17 wedding members were killed by lightning [11].

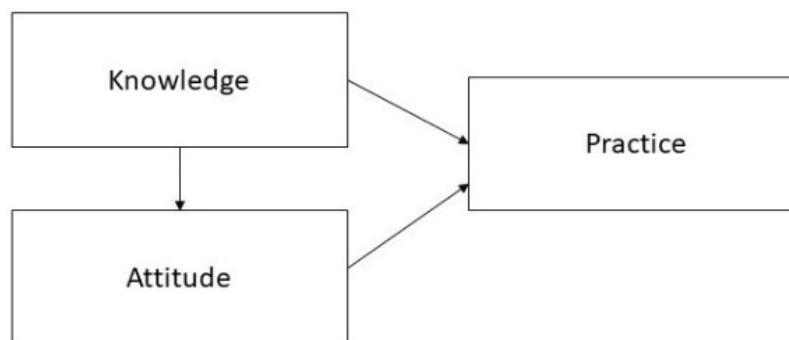
Studies show that developed countries have fewer lightning-related deaths and injuries than developing countries due to better technology, lightning-safety structures, people's socioeconomic status, and public awareness efforts [1,4,12,13]. Many people may have been killed by lightning in Bangladesh since the country has a high density of people working in labor-intensive agriculture, lack of public awareness, and there aren't enough lightning detection systems and lightning-safety structures [2,6,7]. As a result, it necessitates synthesizing climatology, engineering, and social sciences-based study. Some studies have explored the spatiotemporal variability, climatic factors, and the lightning-death link in Bangladesh [4,14–17]. Studies also showed the importance of the public perception of lightning in Bangladesh [2,18]. However, the high risk and frequent fatalities in Bangladesh have prompted more research into public perception and lightning-related actions, which is necessary to reduce the lightning risk [12]. A lack of information about the risk of lightning in Mexico, India, and Bangladesh was determined to contribute to the high number of lightning fatalities [2,19,20]. While farming accounted for around half of all lightning deaths in Bangladesh, other activities (walking home, sports, inside the house, or at educational institutes) are also important to reduce the lightning risk [7]. As a result, the people (farmers and non-farmers) must be aware of the need for lightning risk reduction initiative and education [21]. To that end, a quantitative study was sought to perform an online self-rated and KAP (Knowledge, Attitude, and Practices) survey on lightning activity in Bangladesh among university students. Even though we lack data regarding lightning strikes on university students, there have been cases where university students might be killed by lightning due to risky activities [22]. Additionally, studies indicate that students must be educated about lightning safety [18,23].

### *Conceptual Framework*

Our primary study aim is to evaluate university students' perceptions of lightning. We have also intended to understand the self-rated status of lightning among these students. As mentioned earlier the developing nations such as Bangladesh has higher fatality rates due to lack of information regarding lightning related risk, some studies emphasized on

the public perception of lightning in Bangladesh [2,18–20]. Risk depends on the perception of the victim or affected [24]. Moreover, there are many factors which determine behavioral intentions which includes attitude as one of them [25] and thus the study seeks for answers from such aspects. Lightning safety education and awareness play a key role in minimizing the death tolls around the world. Significant education and awareness programs have reduced the death tolls in the developed countries like the USA [26]. Given the country's high student population, university students may function as a hub and, as a result, transmit proper lightning safety preparation to their close communities. Thus, the outcome from this study may assist the national and international communities in developing effective lightning preparedness and response in terms of educating and creating awareness as well as other structural and nonstructural aspects. Conceptual Framework.

The KAP survey model (Figure 1) was designed in the 1950s to assess respondents' knowledge, attitudes, and practices [27,28]. This questionnaire survey is easy to use, with clear interpretations and concise presentation [17,29]. It also shows the interaction in the KAP domain of the respondents [30]. Calculating the KAP level can help communities' preparedness for a public health issue. This study's findings may be utilized to design behavioral change techniques [31]. Therefore, it may help design effective policies and initiatives to reduce lightning risk across the country.



**Figure 1.** KAP conceptual framework.

## 2. Materials and Methods

### 2.1. Research Design and Ethical Issues

This cross-sectional study used an online self-reported survey in May 2021. The requirements for entry were university students aged 18 or older who resided in Bangladesh and had access to the internet. Regarding the online survey, we followed the guidelines outlined in The Checklist for Reporting Results of Internet Surveys (CHERRIES) [32]. This research was approved by the Department of Disaster and Human Security Management (Ref. BUP DHSM-2021/01), Bangladesh University of Professionals in Dhaka, Bangladesh. In terms of human subjects, this study adhered to all ethical standards outlined in the Declaration of Helsinki and its subsequent amendments [33]. Anonymous respondents' online consent was sought. Additionally, the questionnaire's front page mentioned the survey's duration, the confidentiality of the data, the study's purpose, and any associated ethical concerns. There was no financial inducement to participate. Respondents might exit the online survey at any point during the process.

### 2.2. Survey Instruments

Prior research was reviewed in order to adapt and develop the draft questionnaire from a Bangladeshi perspective [2,3,12,23,34,35]. During the questionnaire preparation, we also considered our target population, university students. Additionally, a pilot survey was conducted to validate the questionnaire. A final structured self-reported online questionnaire was developed in Google Form in English and the native Bengali language.

Bangladesh, entering the second wave of pandemic on March 2021 [36], created a barrier against conducting in-person surveys. There were a lot of change due to pandemic

and to effectively manage the pandemic the role of technology in support of humanity gave a new perspective, technology became a weapon to combat against the pandemic as it provided Seamless communication and connectivity [37]. Due to the limitation due to the pandemic, to conduct this study the researchers decided to move upon available technical approach and thus Google forms were considered as surveying tool to reach the targeted population. The questionnaire contained six sections: socio-demographic and academic information; lightning frequency and safety precautions in their places; self-rated status of lightning as a dangerous event; self-rated status regarding the living place's safety against lightning; media used for lightning-related information; and the KAP sections. They were asked three questions about lightning frequency and safety precautions in their locations: how frequently they experienced lightning in the area, whether they received any warning messages (siren, sign, or announcement) during lightning, and whether they received any lightning safety precautions or training from the authority or any organizations. This part required binary replies such as frequent/infrequent and Yes/No. Even though lightning is generally considered a dangerous event, we have explored its self-rating status. For self-rated sections, two straightforward inquiries, such as 'How dangerous do you think lightning is?', and 'How safe do you think your current place is from lightning?' were about their assessment of the lightning and living place's lightning safety. This self-rated inquiry included a 5-point scale based on the question type (very dangerous/very safe = 5, dangerous/safe = 4, moderately dangerous/moderately safe = 3, least dangerous/unsafe = 2, and not dangerous at all/very unsafe = 1). The KAP section had 22 items (statements/questions). All responses in this section were scored on a 0–1 scale, with 0 being a negative/unknown response, 0.50 representing a neutral response, and 1 representing a correct response. 13 closed-ended items were used to evaluate respondents' knowledge regarding lightning (lightning has become a disaster, the month when lightning is most common, the frequency and number of deaths caused by lightning have increased, all thunderstorms produce lightning, it can strike the same location twice, safety precautions during lightning, and the impact of lightning on human health). Additionally, 04 closed-ended items with a three-point Likert scale (Agree, Neutral, and Disagree) were included to ascertain respondents' attitudes (responsibility for daily weather updates, raising awareness among family and community members, participation in any lightning-related campaigns/trainings, and activities to reduce lightning exposure). The practice section included 05 closed-ended questions with binary replies (avoid open areas, high locations, tin sheds, window and balcony, metal parts, and electrical equipment during lightning). Cronbach's alpha was estimated to be 0.71, 0.66, and 0.67 for the knowledge, attitude, and practice sections, respectively, for internal consistency. Cronbach's alpha >0.60 shows that the questionnaire's internal consistency has been validated [38,39].

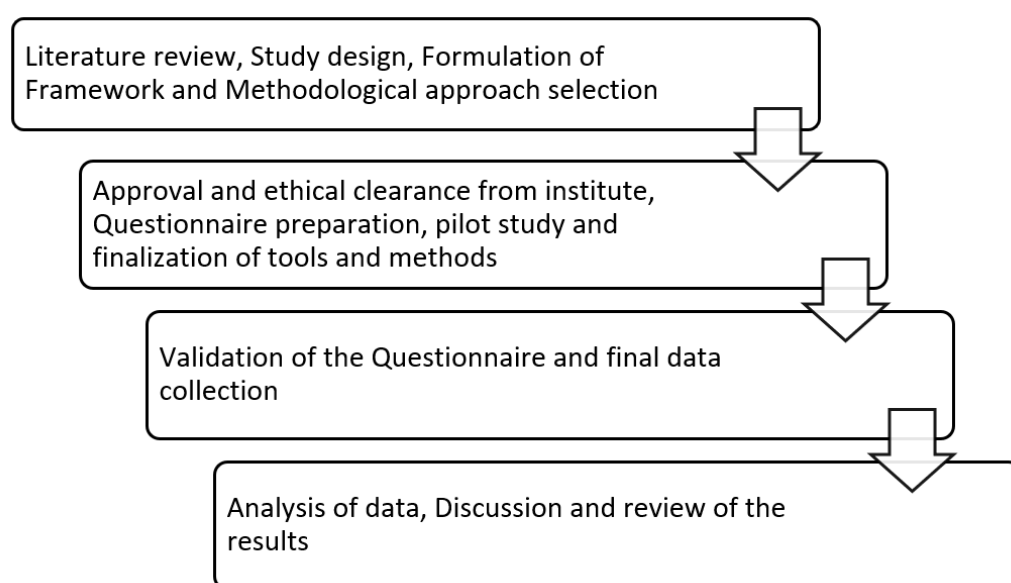
### 2.3. Data Collection

This study used non-probability sampling techniques. We recruited a group of university students (depending on their previous research experience). We instructed them to conduct the questionnaire survey through Facebook, WhatsApp, Google Classroom, Microsoft Teams, or email, whichever was most convenient. The study team undertook routine data checks. 384 respondents (95% Confidence Interval (CI)) were required for this perception-based study based on Morgan's Table [40]. To comply with the ethical principle of participant anonymity, we did not use cookies or the IP addresses of the participants' devices. Nonetheless, the study team frequently examined and double-checked the data to ensure no biases.

### 2.4. Data Analysis

Figure 2 shows the steps taken to conduct the study. Python (2.7; Beaverton, OR 97008, USA) and the 'R' program, version 3.6.3, were used to handle data and conduct statistical analyses [41,42]. Where appropriate, descriptive statistics (frequency, percentage, mean, and standard deviation) were calculated. Shapiro-Wilk and Kolmogorov-Smirnov tests

were performed to determine the normality of data. Due to the non-normal distribution of the data, non-parametric tests such as the Kruskal-Wallis or Mann-Whitney U tests were performed to determine the association between socio-demographic and academic characteristics with self-rated sections. A post hoc test (Dunn's test) was also considered. Here, the Bonferroni correction was used to adjust the  $p$ -value. Spearman's rank correlation and logistic regression analysis were used to determine the association in the KAP domain. By summing the scores for each item, the total score for knowledge, attitude, and practice was determined. Then, replies were graded as 'good' or 'poor', and we used an 80% cut-off point. For instance, 10.4 was estimated to constitute 80% of the overall knowledge score (13). A score of 10 or above was deemed to have a good level of knowledge. The good and poor levels were denoted by numbers 1 and 0. A logistic regression analysis was conducted to determine the KAP level. After screening, multiple logistic regression analysis was performed with only significant univariate factors. All statistical studies considered the 95% Confidence Interval (CI).



**Figure 2.** Steps followed to conduct the study.

### 3. Results

#### 3.1. Socio-Demographic and Academic Characteristics

Out of approximately 1400 questionnaires distributed among university students of Bangladesh, 1274 responded, giving a participation rate of 91%. Table 1 shows the demographic and academic status of university students. Briefly, the study population is predominantly males (55%) with 18–25 age group. Almost all respondents were living with their families (90%). More than half of the university students (51%) resided in high-rise units. The majority of them were from government-funded public universities (76%). Of the total respondents, 43% were studying in 3rd year and majoring in Arts and Social Sciences (41%). About half of these students (48%) did not have any lightning-related subject in their university curriculum.



**Table 1.** Association of socio-demographic and academic information with the self-rated status regarding lightning and living place's safety against lightning.

Features	N (%)	Self-Rating of Lightning as Dangerous Event (Mean $\pm$ SD)	Self-Rating of Living Place's Safety against Lightning (Mean $\pm$ SD)
1. Gender		$p = 0.509$	$p = 0.534$
– Male	703 (55.18)	4.61 $\pm$ 0.73	2.88 $\pm$ 1.05
– Female	571 (44.82)	4.63 $\pm$ 0.74	2.82 $\pm$ 1.04
2. Living with Family		$p = 0.089$	$p = 0.382$
– Yes	1146 (89.95)	4.64 $\pm$ 0.70	2.86 $\pm$ 1.04
– No	128 (10.05)	4.46 $\pm$ 0.95	2.72 $\pm$ 1.08
3. Residential Unit		$p < 0.001$	$p < 0.001$
– High-Rise <sup>#</sup>	653 (51.26)	4.69 $\pm$ 0.70	2.75 $\pm$ 1.05
– Low-Rise <sup>##</sup>	379 (29.75)	4.50 $\pm$ 0.76	3.15 $\pm$ 1.00
– Tin Shed	134 (10.52)	4.78 $\pm$ 0.53	2.44 $\pm$ 0.98
– Others	108 (8.48)	4.50 $\pm$ 0.76	2.95 $\pm$ 0.97
4. University		$p = 0.146$	$p = 0.054$
– Public	963 (75.59)	4.61 $\pm$ 0.72	2.89 $\pm$ 1.06
– Private	311 (24.41)	4.64 $\pm$ 0.77	2.75 $\pm$ 1.00
5. Year		$p = 0.031$	$p < 0.001$
– 1st	191 (14.99)	4.70 $\pm$ 0.62	2.51 $\pm$ 1.01
– 2nd	306 (24.02)	4.72 $\pm$ 0.58	3.07 $\pm$ 1.02
– 3rd	553 (43.41)	4.58 $\pm$ 0.77	2.74 $\pm$ 1.01
– 4th and above	224 (17.58)	4.50 $\pm$ 0.88	3.12 $\pm$ 1.07
6. Major		$p = 0.632$	$p < 0.001$
– Arts and Social Sciences	521 (40.89)	4.65 $\pm$ 0.70	2.69 $\pm$ 1.04
– Business and Economics	265 (20.80)	4.55 $\pm$ 0.87	3.06 $\pm$ 1.07
– Medical Studies	115 (9.03)	4.63 $\pm$ 0.63	2.65 $\pm$ 1.05
– Science and Engineering	231 (18.13)	4.63 $\pm$ 0.66	3.25 $\pm$ 0.91
– Security and Strategic	142 (11.15)	4.62 $\pm$ 0.77	2.61 $\pm$ 0.99
7. Lightning-related Subject in Curriculum		$p = 0.027$	$p < 0.001$
– Yes	429 (33.67)	4.66 $\pm$ 0.69	2.46 $\pm$ 0.96
– No	614 (48.19)	4.56 $\pm$ 0.79	3.05 $\pm$ 1.09
– Maybe	231 (18.13)	4.71 $\pm$ 0.65	3.05 $\pm$ 0.88

<sup>#</sup> High Rise = More than 5-story residential unit, <sup>##</sup> Low Rise = 5-story or less than 5-story residential unit. SD = Standard Deviation. Bold shows significant results.

### 3.2. Self-Rated Status towards Lightning

We began our analysis by assessing the self-rating status regarding lightning and the current place's safety against lightning (Table 1). Our results suggest that as of our period of analysis, the majority of the study population rated lightning as a very dangerous (74%) and dangerous (17%) event. Of course, it is critical to ask how they rate their place's safety against lightning. We have assessed that many of the study population rated their places unsafe (38%), followed by moderately safe (26%) and safe (23%) against lightning. Our results in Table 1 demonstrate that the self-rating status of lightning as a dangerous event is significantly higher for the university students living in the tin shed unit, 1st and 2nd-year students, and students who had the lightning-related subject in their curriculum. The largest rating we find is for students living in the tin shed unit, which indicates that efforts to improve living conditions in this group should be a top priority. This group also rated their living places as significantly unsafe against lightning. The lightning-related subject also appears to be playing an important role in self-rating status.

Our results also identify that the majority of the university students experienced frequent lightning (62%), whereas they did not have enough warning messages (74%) and lightning safety precaution/training (84%) (Table 2). Frequent lightning-experienced

individuals, warning message receiver, and individuals without any lightning-related training rated their places significantly unsafe.

**Table 2.** Association of lightning frequency and safety precautions with the self-rated status regarding lightning and living place's safety against lightning.

Features	N (%)	Self-Rating of Lightning as Dangerous Event (Mean $\pm$ SD)	Self-Rating of Living Place's Safety against Lightning (Mean $\pm$ SD)
1. Lightning Experience in the locality during the season		$p = 0.435$	$p < 0.001$
– Frequent	794 (62.32)	4.64 $\pm$ 0.70	2.74 $\pm$ 0.99
– Infrequent	480 (37.68)	4.59 $\pm$ 0.78	3.05 $\pm$ 1.10
2. Any warning message (siren, sign, or announcement) during lightning in the locality		$p = 0.470$	$p < 0.001$
– Yes	336 (26.37)	4.59 $\pm$ 0.77	2.31 $\pm$ 0.92
– No	938 (73.63)	4.63 $\pm$ 0.72	3.05 $\pm$ 1.02
3. Lightning Safety Precaution/Training		$p < 0.001$	$p < 0.001$
– Yes	198 (15.54)	4.38 $\pm$ 0.94	3.47 $\pm$ 0.93
– No	1076 (84.46)	4.66 $\pm$ 0.68	2.74 $\pm$ 1.03

SD = Standard Deviation. Bold shows significant results.

### 3.3. Knowledge about Lightning

While understanding general predispositions toward lightning is valuable, it is just as important to evaluate individuals' knowledge regarding lightning. We explore it in Table 3, which presents correct responses toward lightning. Almost all the questions in the 'knowledge' category were answered correctly by more than half of the study population. Most students knew lightning had become a disaster in Bangladesh (83%), and the frequency of lightning and deaths due to it has been increased (83%). Furthermore, most participants responded correctly to questions on the month of more thunderstorms in the country regarding the safety of using electronic devices and bathing during lightning. However, the knowledge that all thunderstorms can produce lightning and lightning can strike the same place twice was lacking among the study participants. More than half of the study population were not aware of these. Regarding activity in the car during lightning, 81% of university students correctly responded. 80% of them knew the adverse effects of lightning on human health. Most of them also knew the objects (tall trees, electric poles, metal poles, and mobile towers) needed to stay away from the lightning. Overall, based on an 80% cut-off value, 63% of university students were identified to have substantial knowledge of lightning.

Factors associated with good knowledge (Table 4) were gender, living with family, university type, study year, major field, lightning-related subject in the curriculum, and lightning experience in living place ( $p < 0.05$ ). In contrast, residential unit type has no association with students' knowledge. Our findings revealed that male university students and students living with their families have better knowledge than females (OR = 0.66) without their families (OR = 0.55). Moreover, public university and 3rd-year students, majoring in Arts and Social Sciences and with lightning-related subjects have better knowledge about lightning. Students experiencing infrequent lightning in their living places are less likely to have good knowledge (OR = 0.49) than students with frequent lightning experiences. After all significant factors ( $p < 0.05$ ) were included in the analysis, the multiple analysis models (Table 5) revealed all factors, except university type, as the independent predictors of good knowledge.

**Table 3.** Knowledge regarding lightning with sources.

Items	Responses	Correct Response (n (%))	95% CI
Lightning has become a disaster in Bangladesh [2,3]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	1056 (82.89)	80.82 to 84.96
Which month usually has more thunderstorms in Bangladesh? [34]	<ul style="list-style-type: none"> <li>– December-February</li> <li>– August-December</li> <li>– <b>April-June</b></li> <li>– All of above</li> <li>– I don't know</li> </ul>	1002 (78.65)	76.40 to 80.90
The frequency of lightning has been increased over time in Bangladesh [2,43]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	1060 (83.20)	81.15 to 85.26
Deaths related to lightning accidents have been increased over time in Bangladesh [2,43]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	1059 (83.12)	81.06 to 85.18
Can all thunderstorms produce lightning? [23]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	623 (48.90)	46.15 to 51.65
Can lightning strike the same place twice? [23]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	634 (49.76)	47.01 to 52.51
It's safe to use electronic devices when lightning is present [2,23,34]	<ul style="list-style-type: none"> <li>– Yes</li> <li>– <b>No</b></li> <li>– I don't know</li> </ul>	1086 (85.24)	83.30 to 87.19
It's safe to bath when lightning is present [23,44]	<ul style="list-style-type: none"> <li>– Yes</li> <li>– <b>No</b></li> <li>– I don't know</li> </ul>	901 (70.72)	68.22 to 73.22
What should you do if you are in the car during lightning? [23,34,44]	<ul style="list-style-type: none"> <li>– Avoid touching the metal part of the car only</li> <li>– Continue driving</li> <li>– <b>Avoid touching the metal part of the car and take shelter under a concrete shed</b></li> <li>– I don't know</li> </ul>	1027 (80.61)	78.44 to 82.79
Which one should you stay away from during lightning? [23,34,44]	<ul style="list-style-type: none"> <li>– Tall Trees</li> <li>– Electric Poles</li> <li>– Metal Poles</li> <li>– Mobile Tower</li> <li>– <b>All of above</b></li> <li>– I don't know</li> </ul>	1043 (81.87)	79.75 to 83.99
Is it comparatively safe to seek shelter in a building or under a concrete shed during lightning? [23,34,44]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	1055 (82.81)	80.73 to 84.88
Is it safe to give first aid to a lightning victim if lightning danger is no longer present? [2,34]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	948 (74.41)	72.01 to 76.81
Does lightning has adverse effects on human health? [1,3,35]	<ul style="list-style-type: none"> <li>– <b>Yes</b></li> <li>– No</li> <li>– I don't know</li> </ul>	1021 (80.14)	77.95 to 82.33

CI = Confidence Interval. Bold shows correct answer.



**Table 4.** Univariate predictors of KAP level toward lightning.

Features	Knowledge		Attitude		Practice	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
1. Gender						
– Male	1		1		1	
– Female	0.66 (0.53–0.84)	<b>&lt;0.001</b>	1.37 (0.88–2.14)	0.165	1.46 (1.12–1.92)	<b>0.005</b>
2. Living with Family						
– Yes	1		1		1	
– No	0.55 (0.38–0.80)	<b>0.001</b>	0.41 (0.24–0.73)	<b>0.001</b>	0.51 (0.35–0.76)	<b>&lt;0.001</b>
3. Residential Unit						
– High-Rise <sup>#</sup>	1		1		1	
– Low-Rise <sup>##</sup>	0.81 (0.63–1.06)	0.122	0.78 (0.49–1.24)	0.288	0.98 (0.72–1.34)	0.908
– Tin Shed	0.89 (0.61–1.32)	0.573	4.88 (1.48–30.16)	<b>0.029</b>	0.91 (0.59–1.44)	0.694
– Others	0.72 (0.47–1.09)	0.117	0.72 (0.37–1.57)	0.380	0.65 (0.42–1.04)	0.066
4. University						
– Public	1		1		1	
– Private	0.69 (0.53–0.90)	<b>0.005</b>	0.69 (0.44–1.12)	0.127	0.91 (0.67–1.23)	0.539
5. Year						
– 1st	1		1		1	
– 2nd	1.03 (0.71–1.50)	0.852	0.47 (0.18–1.06)	0.086	0.28 (0.15–0.48)	<b>&lt;0.001</b>
– 3rd	1.47 (1.04–2.07)	<b>0.026</b>	0.58 (0.23–1.26)	0.209	0.33 (0.18–0.55)	<b>&lt;0.001</b>
– 4th and above	0.58 (0.39–0.85)	<b>0.006</b>	0.29 (0.11–0.65)	<b>0.005</b>	0.18 (0.10–0.32)	<b>&lt;0.001</b>
6. Major						
– Arts and Social Sciences	1		1		1	
– Business and Economics	0.29 (0.21–0.39)	<b>&lt;0.001</b>	0.50 (0.29–0.87)	<b>0.014</b>	0.60 (0.42–0.87)	<b>0.006</b>
– Medical Studies	0.41 (0.27–0.62)	<b>&lt;0.001</b>	3.21 (0.94–20.05)	0.115	2.19 (1.15–4.62)	<b>0.025</b>
– Science and Engineering	0.32 (0.23–0.44)	<b>&lt;0.001</b>	0.51 (0.29–0.92)	<b>0.023</b>	0.32 (0.23–0.45)	<b>&lt;0.001</b>
– Security and Strategic	0.48 (0.32–0.71)	<b>&lt;0.001</b>	0.75 (0.37–1.66)	0.449	0.85 (0.54–1.38)	0.500
7. Lightning-related Subject in Curriculum						
– Yes	1		1		1	
– No	0.23 (0.17–0.31)	<b>&lt;0.001</b>	0.23 (0.11–0.42)	<b>&lt;0.001</b>	0.40 (0.29–0.56)	<b>&lt;0.001</b>
– Maybe	0.60 (0.41–0.87)	<b>0.007</b>	0.35 (0.16–0.77)	<b>0.009</b>	0.38 (0.26–0.57)	<b>&lt;0.001</b>
8. Lightning Experience						
– Frequent	1		1		1	
– Infrequent	0.49 (0.39–0.62)	<b>&lt;0.001</b>	0.81 (0.53–1.26)	0.357	0.96 (0.74–1.27)	0.796

OR = Odds Ratio; CI= Confidence Interval. <sup>#</sup> High Rise = More than 5-story residential unit, <sup>##</sup> Low Rise = 5-story or less than 5-story residential unit. Bold shows significant results.

**Table 5.** Multiple logistic analysis to identify the predictors of KAP level toward lightning.

Features	Knowledge		Attitude		Practice	
	aOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>	aOR (95% CI)	<i>p</i>
1. Gender						
– Male						
– Female	0.63 (0.49–0.82)	<b>&lt;0.001</b>			1.26 (0.94–1.69)	0.121
2. Living with Family						
– Yes						
– No	0.64 (0.43–0.95)	<b>0.026</b>	0.43 (0.24–0.79)	<b>0.005</b>	0.53 (0.35–0.81)	<b>0.003</b>
3. Residential Unit						
– High-Rise <sup>#</sup>						
– Low-Rise <sup>##</sup>			0.69 (0.42–1.14)	0.142		
– Tin Shed			4.27 (1.28–26.49)	<b>0.048</b>		
– Others			0.72 (0.36–1.58)	0.384		
4. University						
– Public						
– Private	0.99 (0.73–1.32)	0.926				
5. Year						
– 1st						
– 2nd	0.97 (0.63–1.49)	0.893	0.73 (0.27–1.73)	0.493	0.37 (0.19–0.66)	<b>0.001</b>
– 3rd	1.00 (0.67–1.49)	0.991	0.70 (0.27–1.58)	0.418	0.35 (0.19–0.62)	<b>&lt;0.001</b>
– 4th and above	0.52 (0.33–0.82)	<b>0.005</b>	0.47 (0.18–1.12)	0.106	0.27 (0.14–0.50)	<b>&lt;0.001</b>
6. Major						
– Arts and Social Sciences						
– Business and Economics	0.47 (0.33–0.68)	<b>&lt;0.001</b>	0.85 (0.46–1.58)	0.626	0.86 (0.57–1.28)	0.451
– Medical Studies	0.73 (0.44–1.22)	0.235	4.06 (1.10–26.44)	0.069	1.76 (0.87–3.90)	0.136
– Science and Engineering	0.47 (0.33–0.69)	<b>&lt;0.001</b>	0.86 (0.46–1.62)	0.642	0.45 (0.31–0.66)	<b>&lt;0.001</b>
– Security and Strategic	0.91 (0.59–1.41)	0.674	1.15 (0.54–2.66)	0.713	1.08 (0.66–1.82)	0.757
7. Lightning-related Subject in Curriculum						
– Yes						
– No	0.33 (0.24–0.47)	<b>&lt;0.001</b>	0.24 (0.11–0.48)	<b>&lt;0.001</b>	0.45 (0.31–0.66)	<b>&lt;0.001</b>
– Maybe	0.90 (0.60–1.36)	0.621	0.38 (0.16–0.87)	<b>0.023</b>	0.45 (0.29–0.70)	<b>&lt;0.001</b>
8. Lightning Experience						
– Frequent						
– Infrequent	0.60 (0.46–0.77)	<b>&lt;0.001</b>				

aOR = Adjusted Odds Ratio; CI= Confidence Interval. <sup>#</sup> High Rise = More than 5-story residential unit, <sup>##</sup> Low Rise = 5-story or less than 5-story residential unit. Bold shows significant results.

### 3.4. Attitude toward Lightning

Table 6 shows the participated university students' attitudes toward lightning risk reduction. Around 84% of them would like to participate in lightning-related training activities. More than 25% of them were unaware of the '30 min waiting rule' after hearing the last thunder. The majority of them agreed to follow daily weather forecasts before outdoor activities, and they are agreed to raise lightning prevention awareness among their community. Based on 80% cut-off value, around 93% of the study population possess an appropriate and acceptable attitude toward lightning risk reduction, and this is associated with living with family, residential unit type, study year, major field, and lightning-related subject in the curriculum (Table 4). In multiple analysis models, living with family, residential unit type, and lightning-related subjects in the curriculum were independent factors significantly associated with a good attitude (Table 5).

**Table 6.** Attitude toward lightning with sources.

Items	Positive Response (n (%))	95% CI
Listen and follow daily weather forecasts before planning outdoor activities. [2]	1136 (89.17)	87.46 to 90.88
Raise lightning prevention awareness to my family and community. [2]	1169 (91.76)	90.25 to 93.27
Participate in any lightning-relevant campaign/training activities. [2]	1070 (83.99)	81.97 to 86.00
Wait at least 30 min after I hear the last thunder before resuming outdoor activities. [2,34,44]	919 (72.14)	69.67 to 74.60

CI = Confidence Interval.

### 3.5. Practices toward Lightning

Table 7 shows participants' practices toward reducing lightning risk. In general, around 33% of participants have unsatisfactory practice toward lightning risk reduction based on 80% cut-off. The response 'avoid open or high place' (90%), 'stay away from the window and balcony' (88%), and 'avoid metal faucet, metal railings of stairs, pipe, etc.' were much-preferred actions of reducing lightning risk by participants. About 77% of them avoided tin shed for sheltering during lightning. They were also aware of using electronic devices during lightning. Gender, living with family, study year, major field, and lightning-related subject in the curriculum are factors correlated with good practices for lightning (Table 4). Female students were 1.46 times more likely to have good lightning risk reduction practices than male students. Students having lightning-related subjects have better practices regarding lightning. The multiple analysis models (Table 5) determine all significant factors in univariate analysis, except gender, as predictors of good practices toward lightning.

**Table 7.** Practices of lightning risk reduction (with sources).

Items	Correct Response (n (%))	95% CI
Avoid open or high places during lightning. [34,44]	1148 (90.11)	88.47 to 91.75
Avoid tin shed for sheltering during lightning. [34]	982 (77.08)	74.77 to 79.39
Stay away from the window and balcony during lightning. [23,34,44]	1117 (87.68)	85.87 to 89.48
Avoid touching the metal faucet, metal railings of stairs, pipe, etc., during lightning. [34,44]	1078 (84.62)	82.63 to 86.60
Avoid using all electronic devices such as mobile, laptop, computer, telephone, TV, refrigerator, etc., during lightning. [23,34,44]	1015 (79.67)	77.46 to 81.88

CI = Confidence Interval.

### 3.6. Association in KAP Domain

The correlation test (Table 8) found a significant positive correlation between knowledge-attitude ( $r = 0.357, p < 0.001$ ), knowledge-practice ( $r = 0.306, p < 0.001$ ) and attitude-practice ( $r_s = 0.405, p < 0.001$ ). With further analysis, it was found that university students who had good knowledge were 9.87 times more likely to have good attitudes (OR: 9.87; 95% CI: 5.76–18.07), and 3.22 times more likely to have good practices (OR: 3.22; 95% CI: 2.46–4.23). Nonetheless, participants with good attitudes are 5.53 times more likely to have good practice regarding lightning risk reduction.

**Table 8.** Association in KAP domain.

Association	r-Value	p-Value	OR (95% CI)	p-Value
Knowledge and Attitude	0.357	<0.001	9.87 (5.76–18.07)	<0.001
Knowledge and Practice	0.306	<0.001	3.22 (2.46–4.23)	<0.001
Attitude and Practice	0.405	<0.001	5.53 (3.56–8.64)	<0.001

r = correlation coefficient; OR = Odds Ratio; CI = Confidence Interval.

### 3.7. Sources of Lightning Information

As shown in Table 9, individuals obtained lightning-related information mostly through social media (39%), electronic media such as television and radio (23%), and the internet (23%). Additionally, around 6% recognized universities as the most often cited sources.

**Table 9.** Most used sources for lightning-related information.

Sources	n (%)
Social media	493 (38.70)
Electronic media (TV, Radio)	299 (23.47)
Internet	299 (23.47)
People (Community, Family Members)	80 (6.28)
University	71 (5.57)
Print media	49 (3.85)
Others	53 (4.16)

## 4. Discussion

This study is the first to describe the self-rated status and KAP toward lightning among university students in Bangladesh, which has recently seen an increase in lightning-related fatalities. Like many other countries in the region, Bangladesh has been struck by lightning frequently in recent years [7,18,45]. While lightning-resistant structures are necessary to prevent fatalities, developing nations such as Bangladesh must implement an effective public awareness campaign to reduce the lightning risk [18]. More effort is needed to educate university students about lightning risk reduction and encourage them to take action. Human behavior plays a critical part in disaster management since the intensity of many disasters is determined by human activity. The most recent KAP study in Bangladesh found that participants from lightning-prone regions have superior knowledge than those from lightning-infrequent areas, which corroborates the current study's findings [18]. The present study is particularly concerned with the KAP level of university students from lightning-prone areas and the factors that influence these variables. The study's findings may aid in the implementation of a proactive program to safeguard university students in the community.

### 4.1. Lightning Safety Perception

It is noteworthy that interpretation and comparison of data from this and other studies must be performed with caution. It is due to methodological discrepancies between research, such as various modalities of data analysis, the varied focus of questionnaire items, respondents with varying demographic backgrounds, and different scoring methods or cut-off points for 'poor' and 'good' KAP, among others. In light of the foregoing, the current study's findings were compared to those of earlier research involving students and adults in comparable contexts. Previous Bangladeshi studies revealed that the general population lacks sufficient information than their positive attitude [2,18].

We observed that university students assessed lightning as a dangerous event, believing their homes to be insecure against lightning. It corroborates the country's regular

lightning strikes and associated deaths [8,11,18,35]. However, the majority of these students lacked any lightning-related training that may have helped them mitigate their risk of being struck by lightning. Education and training on lightning safety are necessary to safeguard the community [12].

#### 4.2. Knowledge, Attitudes, and Practices

This KAP research reveals that, despite the fact that the study population is the most educated in the country, more than 30% of the study population lacked appropriate lightning information. Nonetheless, it should be mentioned that university students as a whole have exceptional awareness of lightning as a disaster and its recent frequency of occurrence. It is similar to findings from previous cross-sectional research conducted in the country [2,18]. It might be as a result of the government's recent lightning awareness campaigns [46]. However, certain misconceptions about lightning persist among the study population, consistent with prior research performed in Bangladesh and in the US [2,18,23]. A prior lightning strike in the same field or house raises suspicions, as a second lightning strike in the same spot is rather common [31,47,48]. Moreover, all thunderstorms have the potential to produce lightning [35]. Additionally, nearly 30% of university students were unaware that bathing during lightning is dangerous. Residents should avoid water activities in the house while lightning is present, as lightning can travel through plumbing [49]. One study also found lightning-related deaths in Bangladesh's water-related activities [7]. Thus, it is vital to raise students understanding of the risks of lightning. Likewise, students are informed of the harmful impacts of lightning on human health. They are aware that they may seek refuge beneath concrete structures. However, the study concluded that the structure should be adequately protected [50,51]. In addition, the study suggests a fully enclosed metal-topped vehicle as a lightning-safe shelter [44].

In both univariate and multiple analyses, lightning-related subjects in the university curriculum were associated with good knowledge of lightning. Many studies suggest lightning safety education to reduce the risk [12,18,23,52]. In the current study, lightning events also influenced students' adoption of lightning safety information.

Students at the university demonstrated an exemplary positive attitude and good practice. However, many university students disagreed with the recommendation to wait at least 30 min after the last sound of thunder before going outdoor, which is critical for reducing the risk of lightning [53]. Similar results were found in Bangladesh and other countries [2,23]. Most of these students agreed to participate in training activities connected to lightning. Given that lightning has become a significant disaster in the country, authorities should perform multiple training exercises similar to those they have already conducted for cyclones, floods, and earthquakes [18]. Good knowledge and attitudes about lightning risk reduction must be translated into good practices.

#### 4.3. Socio-Demographic Determinants of KAP Level

Our study demonstrates that living with family is critical for KAP level improvement in the presence of lightning. Students may benefit from positive knowledge sharing from family members, as well as positive attitudes and lightning risk reduction activities. Students living in tin sheds had a highly positive attitude, despite the fact that they evaluated their dwelling as risky against lightning. Surprisingly, 1st students reported better lightning practices than other year students. We discovered that female students exhibited positive behaviors. Another recent KAP study found that females in Bangladesh had a more favorable opinion toward lightning than their male counterparts [18]. As with the knowledge section, including lightning-related courses in university curricula is critical for developing positive attitudes and practices regarding lightning. It demonstrates the crucial necessity for university students to receive a lightning safety education. However, the curriculum must be structured carefully to ensure that the intended audience receives authentic information. Additionally, the authority can organize demonstrations for students to obtain practical knowledge about lightning risk reduction. According to the study,

developing countries may face major challenges and barriers to acquiring knowledge and training on lightning protection measures [12].

#### 4.4. *Lightning Risk Mitigation Strategies*

Following the discussion above, there can be some mitigation strategies suggested for the university student community to make them more resilient:

The authority should develop an integrated lightning management system that allows for collaboration between the university, the society, and the authority. Lightning detection systems, as well as the identification of lightning safety places with protective structures, must be installed by the country's disaster management sectors [7].

Bangladesh National Building Code (BNBC) has regulations on installing on lightning arresters in the buildings as a standard of building construction procedure as a measure to protect properties from lightning related losses [54], which is policy provided by the Government of Bangladesh. Bangladesh's government declared lightning a disaster in 2016 in response to the high death toll [8]. After the declaration, many projects have been undertaken among them a lightning warning system and the establishment of shelters in 723 lightning-prone areas [10,54] are few. Awareness campaign such as advertisement was also telecasted on the national television. Ministry of disaster and relief issued instruction during lightning [34]. But there are no specific regulations or policy regarding lightning education and awareness. Where multi-sectoral actions are necessary, the authority should include them. Government agencies, local governments, educational institutions, government and private offices, health professionals, disaster management practitioners, lightning experts, and community leaders can all contribute to a sufficient distribution of knowledge about lightning, as well as positive attitudes and preventive practices [18].

Given the country's large student population, university students might serve as a hub, transmitting accurate lightning safety preparedness to their surrounding communities. Along with the university's lightning curriculum, the university's administration may organize a short-term training session to gain practical experience with lightning risk reduction measures.

The central government might engage with universities. They could establish a separate fund to perform university-level research and training on lightning. Students at universities have increased access to the internet. Additionally, they are habituated to mobile applications. Authorities may use this as an opportunity to reach out to this generation. Furthermore, we found that among our research population, social media, internet website, and electronic media such as television and radio are the most frequently used sources of information on lightning. Indeed, a study suggests that media can serve as an effective warning system for lightning [55]. These platforms might be utilized by the university and central authorities to communicate with university students about lightning-related issues. The university administration must equip and teach their personnel and students to properly confront this disaster.

#### 4.5. *Limitations and Future Scope of the Study*

Some limitations of this study include the fact that individuals were recruited by non-probabilistic online sampling. Additionally, their self-rated status and KAP levels are assessed at a single point, implying that the entire dynamic may vary over time. Moreover, because a self-reporting questionnaire was utilized, respondents may have offered responses that were not indicative of their true attitudes and behaviors in order to seem socially acceptable. Due to ongoing COVID-19 pandemic and online pattern, this study has certain limitations that should be considered when interpreting the findings. the findings are based entirely on self-reported information. For instance, participants perceived an unsafe location in the presence of lightning, but this was not confirmed by actual observation of a single response.

Despite its limitations, this study could potentially have a wide impact and pave the way for future research. It can be expanded to the general people, or the vulnerable groups



can be taken as study sample. The study can be further done with more specific study area where lightning strikes are high but due to the lack of lightning density data and infrastructure it was not possible. If such data is available, then area specific study can be conducted. Qualitative research can be conducted which would give better insights.

## 5. Conclusions

Globally, lightning has killed and injured people. Despite this, many communities seem unconcerned. Due to better technology, lightning-safety structures, people's socio-economic status, and public awareness efforts developed countries have less fatality and injuries compared to developing countries [1,4,12,13]. Developing country like Bangladesh has seen increasing lightning related fatality and injury over the time [2,3,6–8], and the higher fatality rates are due to lack of information regarding lightning related risk, some studies emphasized on the public perception of lightning in Bangladesh [2,18–20]. Thus, figuring out the KAP level for lightning is vital. Given the country's large student population, university students may function a hub, transmission of proper lightning safety preparation to their close communities. According to the study's findings, over 90% of university students believed lightning was a dangerous event. Over 35% of them rated their places were unsafe against lightning. More than half of the study's participants experienced frequent lightning. People who had frequent lightning strikes reported much more risky areas than those who had only a few. Over 70% of people received no warnings, and only a few received lightning safety instructions. These youngsters exhibited strong knowledge, attitudes, and prevention practices. But these learners should be more knowledgeable. They still have certain misunderstandings that need to be addressed during the campaign. The data also show that having a good understanding and a positive outlook might help one practice lightning safety. Female students had better lightning practices than male students. The university curriculum's lightning-related subjects help prepare students for lightning. Overall, significant lightning campaign actions and comprehensive instruction are necessary to modify these students' behavior. Both university and central disaster management authorities must improve lightning risk monitoring. The findings stress the need to spread accurate knowledge (and dispel myths) and constantly evaluate lightning risk mitigation strategies. The data also suggest that improving people's quality of life through well-built houses, lightning protection shelters, and reliable information updates may reduce lightning risk.

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**Informed Consent Statement:** Informed online consent was obtained from all subjects involved in the study.

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