

An Assessment of Final-Year Medical Students' Knowledge on Climate Change and Infectious Diseases at a Medical School

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Abstract

Introduction: Although awareness of climate change has increased in recent years, there is still a knowledge gap regarding the impact of climate change on infectious diseases. This study aims to determine the knowledge level of final-year medical students regarding climate change and infectious diseases, to identify related factors, and to contribute to medical education on this topic.

Methods: The population of this cross-sectional study consisted of 279 final-year students at Ankara University Faculty of Medicine. Data analysis was performed using Microsoft Excel and IBM Statistical Package for the Social Sciences 30. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Appropriate analysis methods were used for comparisons between groups, and a $p < 0.05$ was considered statistically significant.

Results: Of the participants, only 17.9% had received education about climate change, and 10.4% had received education about its health effects. 80% expressed concerns about climate change and infectious diseases. The participants' levels of knowledge and perception were moderate overall; however, perception scores were significantly higher among those who had previously received education, thought about, or discussed these topics. In addition, climate-infectious impact scores were significantly higher among those who had previously received education, were willing to receive education, or thought about these topics. While 71.3% of the participants stated that they obtained their information from social media, 59.9% indicated that they would like to receive further education.

Discussion and Conclusion: The current medical school curriculum should be reviewed, and topics related to climate change should be addressed in more detail.

Keywords: Climate change; Infectious diseases; Knowledge level; Medical student

The impact of the climate crisis has been intensifying, especially over the last two centuries, and the effects of it are deepening continuously. The temperature of the Earth's surface has risen to a serious level, with every year since 1992 being recorded as the hottest year in history.^[1,2]

Human activities, mostly based on greenhouse gas emissions, have led to global warming, and between 2011 and 2020, the global surface temperature increased by 1.1°C compared to the average temperature of the 1850–1900 period.^[3]

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The health effects resulting from climate change can occur directly or indirectly. Direct impacts include increased heat stress due to heat waves, disasters, and extreme weather events; changes in the distribution of infectious diseases; and declining air quality.^[4,5]

Health professionals can play important roles in responding to climate change and the growing threat of infectious diseases resulting from this crisis. These roles may include participating in policymaking, leading necessary campaigns or media broadcasts to mobilize the public, producing written materials such as guidelines and educational resources, and making valuable contributions at scientific meetings to shift attention to health effects arising from climate change, both as participants and organizers.^[6]

The studies conducted in Türkiye and abroad show that climate change is generally not included in medical school curricula, and very few faculties use this topic as course content. According to data from a study conducted in Türkiye, only 5% of universities offering medical education in Turkish include "climate change" in their curriculum.^[7,8] When considering the relationship between climate change and infectious diseases, it is evident that current and future societies will continue to be affected by ongoing and future climate changes. Therefore, education on how to cope with climate change should be included in the curriculum of future doctors.^[9,10]

By including climate change in their curricula, medical schools will not only prepare their students for the reality of infectious diseases and living conditions affected by climate change but also develop the important skills modern physicians need to address the increasing health burdens of non-communicable diseases, aging populations, systemic socioeconomic disadvantages, and structural changes in the fundamental determinants of health.^[11,12]

Although recent studies on climate change awareness have increased, there are still gaps in the literature regarding the impact of climate change on infectious diseases. In this study, we aim to assess the level of awareness and the influencing factors regarding the climate crisis and infectious diseases among final-year medical students – who are naturally expected to take on significant roles in the fight against infectious diseases that may emerge with the climate crisis – and to support curriculum development in this field.

Materials and Methods

Study Type, Place, and Design

This cross-sectional study was conducted at Ankara University Faculty of Medicine in July 2023.

Population Research

The study population consisted of 336 final-year students at Ankara University Faculty of Medicine. The goal was to reach all students. Those who declined to participate in the survey and those who did not give consent were excluded from the study, resulting in a total of 279 students being reached.

Data Collection Tools (Questionnaire)

Data were collected through a questionnaire comprising 19 main and subquestions, created on Google Forms. The first seven questions included items on demographic information and educational status. Question 8 measured "perception score of participants regarding climate change and infectious diseases" using a five-point Likert scale consisting of eight questions, and the maximum possible score was 40. Questions 10 and 11 measured "level of knowledge about infectious diseases," and Question 12 measured "level of knowledge about the impact of climate change on infectious diseases." Each correct answer was awarded 1 point in these sections, and the maximum possible score was 17 and 12, respectively. Questions 9 and 13–19 concerned whether respondents had previously thought about or discussed climate change and whether they wished to receive education on the subject in the future.

The questionnaire used in our study was developed by the authors based on a comprehensive literature review. Subsequently, a pilot test was conducted on 10 participants who were not included in the main study, and necessary adjustments were made based on the feedback received. The detailed questionnaire form is included in Appendix 1.

Statistical Analysis

Data analysis was performed using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) Statistics for Windows, version 30.0 (SPSS Inc., Chicago, Ill., USA) software. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation (SD).

The normality of the data distribution was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests.

The relationship between normally distributed scores and binary variables was analyzed using the t-test, with the test statistic expressed as t. The relationship between normally distributed scores and variables with more than two categories was evaluated using one-way analysis of variance, with post hoc comparisons performed with the Bonferroni test; the test statistic was expressed as F. Normally

distributed group data are presented as mean $\pm$ SD. The relationship between non-normally distributed scores and binary variables was analyzed using the Mann–Whitney U test, with the test statistic expressed as Z, and the data are presented as median (min–max). The relationship between non-normally distributed scores and variables with more than two categories was evaluated using the Kruskal–Wallis test, with the test statistic expressed as X^2 , and post hoc comparisons were performed with Tamhane's T2 test. Effect sizes were calculated to assess the magnitude of the differences examined. Cohen's d was calculated for parametric values, and r values were calculated for non-parametric tests (Mann–Whitney U and Kruskal–Wallis). Effect sizes were interpreted as small (0.1–0.29), medium (0.3–0.49), and large ($\geq$ 0.5).

A value of $p < 0.05$ was considered statistically significant. Statistically significant differences among groups are indicated by different superscript letters.

Ethical Approval

Approval for the study was obtained from the Ethics Committee of Ankara University Faculty of Medicine and the Dean's Office of the Faculty of Medicine. No financial support was received for this research. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Results

Descriptive Properties of Participants

The mean age of the participating students was 23.4 ± 2.7 years. Among the participants, 52.7% ($n=147$) identified as female, 45.9% ($n=128$) were male, 1.1% ($n=3$) preferred not to disclose their gender, and 0.4% ($n=1$) were other. The language of instruction for 94.3% ($n=263$) of the participants was Turkish, whereas 5.7% ($n=16$) received their education in English.

The proportion of participants who stated that they had previously received education, courses, or school lessons related to climate change was 17.9% ($n=50$), whereas the proportion who had received education specifically on the health effects of climate change was 10.4% ($n=29$).

When asked about the factors contributing most to the spread of infectious diseases, 38.4% ($n=107$) of the participants cited social and behavioral factors, followed by pathogen factors at 24.7% ($n=69$), environmental factors at 22.6% ($n=63$), health system factors at 10.0% ($n=28$), and host factors at 4.3% ($n=12$).

When questioned about how often they thought about the impact of climate change on infectious diseases in their daily lives before participating in the survey, 33.3% ($n=93$) responded "never," 41.9% ($n=117$) "rarely," 18.3% ($n=51$) "occasionally," 4.3% ($n=12$) "frequently," and 2.2% ($n=6$) "always."

A total of 52.3% ($n=146$) of the students reported that they had never discussed the impact of climate change on infectious diseases with their peers or instructors. The proportion who stated they rarely discussed it was 33.3% ($n=93$); those who discussed it occasionally were 10.0% ($n=28$), frequently 3.6% ($n=10$), and always 0.7% ($n=2$). After taking the survey, 80.3% ($n=224$) of the participants stated that their views about the impact of climate change on infectious diseases changed toward a more concerned perspective, whereas 19.7% ($n=55$) reported that their opinions did not change.

The most common source of information for participants was social media at 71.3% ($n=199$), followed by official institutional websites at 16.1% ($n=45$), TV programs and documentaries at 9.7% ($n=27$), books and newspapers at 5.4% ($n=15$), radio and podcasts at 3.2% ($n=9$), family and friends at 2.9% ($n=8$), and educational programs and conferences at 2.5% ($n=7$).

A total of 59.9% ($n=167$) of participants stated that they would like to receive education on the impact of climate change on infectious diseases. However, 15.4% ($n=43$) did not wish to receive such education, and 24.7% ($n=69$) had no opinion.

The majority of participants indicated that they would prefer to receive such education online (65.2%, $n=182$). The proportion of those who preferred face-to-face education was 26.9% ($n=75$), those preferring interactive workshops was 21.9% ($n=61$), and those preferring virtual reality simulations was 39.4% ($n=110$).

Analysis of Perception Scores

The mean perception score of participants regarding climate change and infectious diseases was 30.2 ± 4.7 . The knowledge score on infectious diseases ranged from 1 to 17, with a median of 13 (mean $\pm$ SD= 12.6 ± 3.2) (Fig. 1).

The perception scores regarding climate change and infectious diseases were profoundly higher among those who had previously received education on climate change (31.6 ± 6.8) compared to those who had not (29.9 ± 4.0) ($t=-2.318$, $p=0.021$). Participants who reported thinking about climate change at any frequency prior to the survey had significantly higher perception scores (31.0 ± 4.2).

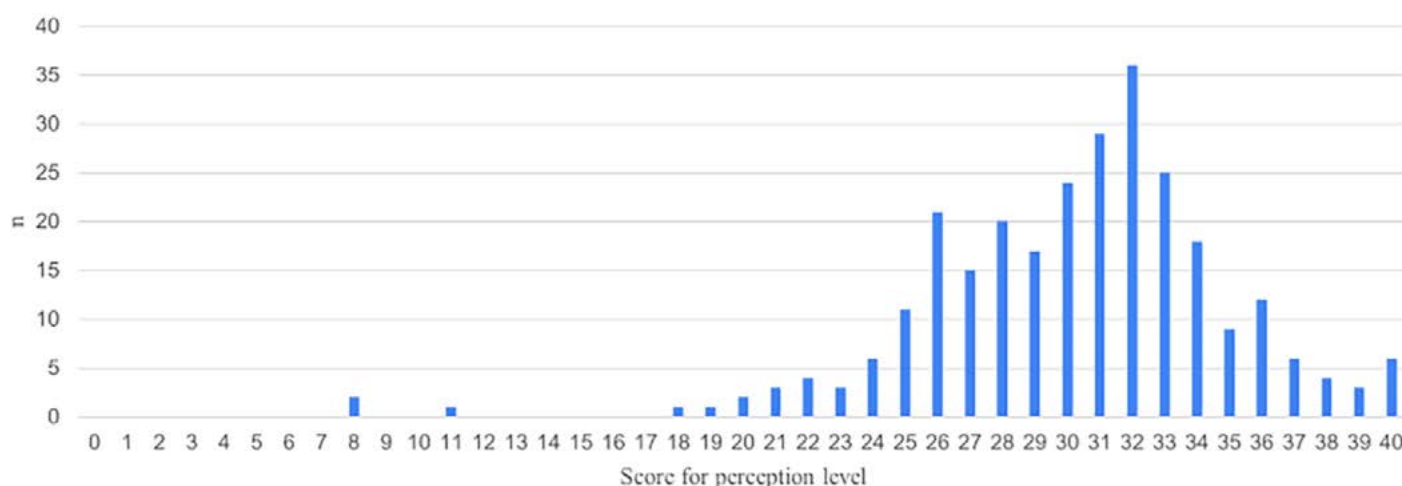


Figure 1. Frequency distribution of participants' perception scores regarding climate change and infectious diseases.

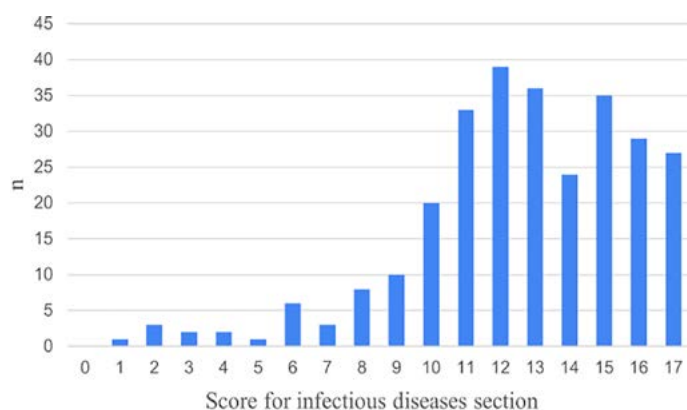


Figure 2. Frequency distribution of participants' knowledge scores on infectious diseases.

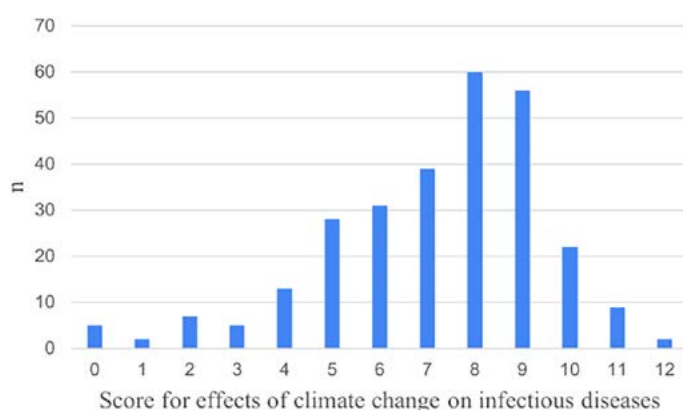


Figure 3. Frequency distribution of participants' scores on the perceived effects of climate change on infectious diseases.

compared to those who reported never thinking about it (28.5 ± 5.1) ($t = -4.186$, $p < 0.001$). Those who had previously discussed or exchanged ideas about climate change with peers or instructors also had significantly higher perception scores (31.4 ± 4.4) than those who had not (29.1 ± 4.7) ($t = -4.098$, $p < 0.001$) (Table 1).

Analysis of Level of Knowledge about Infectious Diseases

The median score for risk factors for contracting infectious diseases was 7, ranging from 1 to 8 ($\text{mean} \pm \text{SD} = 6.4 \pm 1.6$). The median score for awareness of disease vectors was 6, with scores ranging from 0 to 9 ($\text{mean} \pm \text{SD} = 6.1 \pm 2.0$). Total score for knowledge about infectious diseases ranged from 1 to 17, with a median of 13 ($\text{mean} \pm \text{SD} = 12.6 \pm 3.2$) (Fig. 2). No significant association was found between participants' various characteristics and their knowledge scores regarding infectious diseases (Table 1).

Analysis of the Impact of Climate Change on Infectious Diseases' Scores

The score for the impact of climate change on infectious diseases ranged from 0 to 12, with a median of 8 ($\text{mean} \pm \text{SD} = 7.2 \pm 2.3$) (Fig. 3).

The scores for the impact of climate change on infectious diseases were significantly higher among those who had received education on climate change (9 [4–11]) compared to those who had not ($Z = -3.315$, $p = 0.001$). Participants who had received education on the health effects of climate change also had significantly higher scores for the impact of climate change on infectious diseases (9 [4–12]) than those who had not ($Z = -3.377$, $p = 0.001$). Those who expressed a desire to receive education on the impact of climate change on infectious diseases had significantly higher scores in this area (8 [0–12]) compared to those who did not (7 [0–10]), whereas there was no significant difference between those who had no opinion and the other groups ($\chi^2 = 9.623$,

Table 1. Comparison of participants' perception and knowledge levels according to sociodemographic characteristics

Variable	n	Score 1 perception level	Test p	Score 2 knowledge level	Test p	Score 3 climate-infectious impact	Test p
Previous climate change education							
Yes	50	31.6±6.8	t=-2.318	13 (2-17)	Z=-0.988	9 (4-11)	Z=3.315
No	229	29.9±4.0	0.021*	13 (1-17)	0.323***	7 (0-12)	0.001***
Previous climate and health education							
Yes	29	31.2±8.5	t=-1.264	14 (2-17)	Z=-1.421	9 (4-12)	Z=-3.377
No	250	30.1±4.0	0.207*	13 (1-17)	0.155***	8 (0-12)	0.001***
Did the survey change your opinion?							
Yes, more concerned	224	30.3±4.3	t=0.522	13 (2-17)	Z=-0.988	8 (0-12)	Z=-1.485
No, not changed	55	29.9±5.9	0.602*	13 (1-17)	0.323***	8 (0-12)	0.138***
Willingness to receive education							
Yes	167	30.4±4.8	F=0.675	13 (2-17)	X ² =1.567	8 (0-12) ^a	X²=9.623
No	43	29.5±4.9	0.510**	13 (1-17)	0.457****	7 (0-10) ^b	0.008****
No opinion	69	30.1±4.3		13 (2-17)		7 (0-12)	
Thinking before survey							
Never	93	28.5±5.1	t=-4.186	12 (2-17)	Z=-1.380	7 (0-11)	Z=-2.688
Yes	186	31.0±4.2	p<0.001*	13 (1-17)	0.168***	8 (0-12)	0.007***
Discussion with peers							
No	146	29.1±4.7	t=-4.098	12 (2-17)	Z=-1.155	7 (0-11)	Z=-1.946
Yes	133	31.4±4.4	p<0.001*	13 (1-17)	0.248***	8 (0-12)	0.052***

*: T-test; **: One-way analysis of variance; ***: Mann-Whitney U; ****: Chi-square test. a, b: Values with different superscript letters within the same column are statistically significantly different based on post-hoc pairwise comparison (p<0.05).

p=0.008). Participants who reported thinking about climate change at any frequency prior to the survey had significantly higher scores for the impact of climate change on infectious diseases (7 [0-11]) compared to those who reported never thinking about it (8 [0-12]) (Z=-2.688, p=0.007) (Table 1).

Discussion

Our study is one of the first conducted in Türkiye to assess medical students' knowledge regarding climate change and infectious diseases. While existing studies in the literature focus on the relationship between climate change and infectious diseases, our study differs from previous work in that it demonstrates medical students' knowledge levels. In all these respects, our study contributes to the literature and lays the foundation for future studies.

This study evaluated the knowledge and perception levels of final-year medical students at a medical school regarding climate change and infectious diseases. The fact that only 17.9% of participants reported having received education about climate change, and only 10.4% about the health effects of climate change, confirms the point emphasized in

the literature regarding the integration of climate change into medical education. Two separate studies conducted at different medical faculties in the Indian cities of Karimnagar and Bangalore have shown that both healthcare workers and medical students, who are future healthcare professionals, need more knowledge about the impact of climate change on health.^[13,14] With the increase in global temperatures and the frequency of extreme weather events, climate-related illnesses such as heat-related diseases, vector-borne diseases, and infectious diseases have become a significant public health problem.^[15]

In our study, the perception scores regarding climate change and infectious diseases were found to be significantly higher among those who had previously received education on climate change compared to those who had not. This shows that education-based approaches are highly effective in increasing individuals' awareness. Indeed, as stated in a study conducted at Stanford University in California, USA, involving faculty members, clinicians, and medical students, with the aim of creating a comprehensive model for climate and medical education,

as climate change is forcing the world to rethink the concept of a “new normal,” it is of great importance for clinicians to be prepared for the new health effects that climate change may bring to the communities they serve. Another study conducted at Erasmus MC in Rotterdam, the Netherlands, among medical students emphasized that climate change should be better integrated into the medical curriculum from the 1st year onward.^[16,17]

The majority of participants stated that they were open to receiving education about climate change and infectious diseases and that they preferred simulation-based or online approaches. Most participants also indicated their willingness to receive education on the impact of climate change on infectious diseases. If such training were offered, they would prefer to receive it online. This finding is consistent with several studies in the literature. For example, in a study conducted in China, role-play and simulations that mimic reality were used to help students understand different perspectives, predict events that could occur in the future, and increase their interest and enjoyment in learning. It was shown that these simulations increased students' willingness to contribute to the real world in the same way.^[18]

Regarding the impact of climate change on infectious diseases, the most frequently cited source of information by participants was social media. This shows that digital platforms have become the primary source of information for young healthcare professionals. A scoping review conducted by performing systematic searches in PubMed, Scopus, Web of Science, ProQuest, and EBSCO databases on climate change with medical and nursing students also identified the internet as the most popular source.^[19]

The health effects of climate change are not limited to heat waves and extreme events; they also affect the geographic distribution of infectious diseases by changing the habitats of vectors. In this context, the low frequency of participants discussing the impact of climate change on infectious diseases with their peers or instructors suggests that this topic does not receive sufficient attention in academic settings. Indeed, a study conducted with medical and nursing students at Yale University revealed that medical curricula lack sufficient education on climate change.^[20]

After the survey, 80% of participants reported that their views shifted in a more “concerned” direction, indicating that informative and awareness-raising initiatives can be effective. This also suggests that even a survey can raise awareness in the short term. Similarly, a study published in 2021 described the design and implementation of a

new elective course titled “The Impact of Climate Change on Human Health” for Stanford medical students, and the findings revealed that courses on climate science and health in medical schools led to changes in students' opinions and behaviors.^[21]

Our study had certain limitations. First, as the present study was cross-sectional, it was not suitable for establishing causal relationships. Second, as the data were collected through self-reporting, recall bias or social desirability bias may have occurred. Third, as the participants were selected from a single medical school, the results may not be generalizable to all medical students. Furthermore, as the study was conducted during a specific period, it may not reflect awareness levels that may change over time. However, one of the strengths of the study was the examination of many independent variables from different perspectives.

Conclusion

This study has demonstrated that awareness among medical students regarding the impact of climate change on infectious diseases needs to be increased. Including this topic in educational curricula will not only raise students' individual knowledge levels but also enable a more robust response to these issues within the health system in the future.

Although the majority of medical students recognize the importance of issues caused by climate change, most have not received any education on this topic and experience a lack of knowledge. The small group who had taken a course or class on the subject had a significantly higher level of knowledge. The current medical school curriculum should be reviewed, and topics related to climate change should be addressed in more detail.

Ethics Committee Approval: The Ankara University Faculty of Medicine and the Dean's Office of the Faculty of Medicine Ethics Committee granted approval for this study (date: 17.05.2023, number: İOS-312-23).

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