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Brief Report

Investigating the Knowledge and Attitude Gap Regarding Climate Change Between Medical and Non-Medical Students: The Necessity of a Comprehensive Curriculum

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Abstract

Background: Climate change is among the most critical global issues, threatening economies, ecosystems, and human health. It has increased the frequency of heat waves, floods, and droughts, impacting food security, agriculture, and disease patterns. Despite its importance, many medical schools have not sufficiently incorporated climate change into their curricula, leaving future physicians underprepared to address its health impacts.

Objectives: This study assesses medical and non-medical students' awareness, attitudes, and behaviours toward climate change. It emphasizes integrating climate change topics into medical education to prepare students to address health-related challenges and become responsible healthcare professionals.

Methods: In this cross-sectional analytical study, 375 medical and non-medical university students from Kerman province (2023) were enrolled. Data were collected using a validated five-part questionnaire based on Alina Kote's tool, assessing attitudes, awareness, personal concerns, reinforcing, and adaptive behaviours. Convenience sampling was utilized, and ANOVA was conducted to compare the mean scores between the groups. Reliability was confirmed (Cronbach's $\alpha = 0.89$).

Results: The participants included 41.3% males and 58.7% females. Medical students had significantly higher scores in attitudes ($p < 0.001$), personal concerns ($p < 0.001$), and adaptive behaviours ($p = 0.011$), but lower scores in awareness ($p < 0.001$) and reinforcing behaviours ($p = 0.014$) compared to non-medical students. Gender showed no significant influence on the outcomes. Graduate students scored higher in reinforcing and adaptive behaviours than undergraduates ($p = 0.014$ and $p = 0.011$, respectively).

Conclusion: The study found that gender does not affect students' attitudes, knowledge, or adaptive behaviors toward climate change. The results highlight the importance of integrating climate change topics into curricula for all disciplines. Educational interventions tailored to each university are recommended to increase students' awareness and ability to engage in climate adaptation and mitigation. Additionally, students can play a key role in raising public awareness and influencing policy changes at the community level.

Keywords: Climate Change; Global Warming; Awareness; Students

Background

Climate change is one of the most urgent global issues, threatening both the planet and the global economy. It has already caused a temperature increase of approximately 1°C and could rise by up to 6.4 °C (1). The consequences include more frequent heat waves,

floods, and droughts, which impact human health through diseases, injuries, and mental health problems (1-3). Moreover, climate change disrupts food security and agricultural production (4). These effects emphasize the need for preventive measures to mitigate and adapt to climate-related challenges.

Education plays a crucial role in addressing climate change. As UNESCO (2003) states, education must evolve to protect the planet's future (5). Addressing climate change requires a solid foundation of scientific knowledge and a belief in its reality and impacts (6). Schools and universities can promote community participation by raising awareness and helping students engage in democratic decision-making (7). However, many medical schools have yet to integrate climate change into their curricula comprehensively, leaving healthcare professionals unprepared to address its health-related challenges (8, 9). For instance, incorporating climate change into medical and public health curricula at the University of Cape Town and Stanford University has enhanced students' knowledge and attitudes towards this issue (8, 10, 11). By equipping future healthcare professionals with the necessary skills, they can become leaders in promoting public health and sustainability (7).

Tackling climate change requires immediate and collective action. By providing students with accurate information and a sense of responsibility, educators and policymakers can foster a more environmentally conscious society, laying the foundation for a sustainable future (12, 13). Students can also play a crucial role in devising innovative strategies to reduce and adapt to climate change by expanding their knowledge, shaping public opinion, and participating in research (14). Universities are pivotal in raising awareness by integrating climate-related topics into curricula and extracurricular activities, helping develop responsible specialists for the future (15-17).

Environmental literacy is essential for encouraging behaviors that mitigate climate change. Innovative educational initiatives can advance cleaner air, nature restoration, and economic growth, transcending political and religious boundaries (18). Awareness of the risks associated with climate change influences behavioral strategies to reduce its impacts (19). Additionally, individuals with more media exposure are more likely to engage in climate-related discussions, underscoring the importance of access to information (20). Promoting health behaviors that reduce vulnerability to climate change is essential, as traditional responses are often inadequate (21).

A study at the University of Heidelberg revealed that while 72.4% of medical students believe physicians should address climate change, only 4.7% felt adequately prepared by their education. This highlights the urgent need to integrate climate-related topics into medical training (22, 23). Higher education institutions must also engage in regional solutions, develop new curricula, and study cultural perceptions of climate change to improve communication and education (24).

Several studies indicate that positive attitudes toward climate change are linked to greater awareness, although these attitudes do not always translate into practical behavior (25). Building capacity through educational programs is crucial, as many students lack the skills to confront climate challenges (26). Greater awareness is associated with more positive environmental attitudes and behaviors (27), and participatory educational activities can foster responsibility in solving environmental problems (28, 29). Media, workshops, and personal experiences are essential for shaping students' views on climate change (30). Furthermore, students' awareness increases with age and education, leading to greater participation in climate reduction efforts (31).

Research has identified a significant gap between the knowledge of medical and non-medical students regarding climate change, underscoring the need for further studies to tailor educational programs across different fields (32). Moreover, many medical students understand the importance of climate change but lack the practical skills to address it, highlighting the need for skill-based education (33). A more systematic integration of climate-related topics in curricula is required to prepare future professionals (34). Understanding non-medical students' knowledge and attitudes toward climate change is equally important for developing comprehensive educational programs (35). Insights from such research can help policymakers enhance curricula and shape effective health policies to address climate change's complex challenges (36).

Objectives

This study assesses medical and non-medical students' awareness, attitudes, and behaviors toward climate change. It emphasizes integrating climate change topics into medical education to prepare students to address health-related challenges and become responsible healthcare professionals.

Methods

The current study is a cross-sectional study to assess the knowledge, attitude, and impact of climate change among medical students in 2023 by descriptive indices and analysis of variance (ANOVA) compared to other universities. The study population consisted of university students in Kerman province in medical and non-medical colleges. Cochran's formula was used to calculate the sample size, where the Z-value was set at 1.96 based on a 5% margin of error and the desired level of sampling error (d) to be 0.05. Since p, which represents the estimated proportion of the population possessing the characteristic under study, is unknown a priori, we assumed it to be 0.5 to maximize variance and determine the largest required sample size. Using a population of 110,683 students in Kerman province, the sample was defined as 383 people.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left[\frac{z^2 pq}{d^2} - 1\right]}$$

A convenience sampling method was employed, and all students were invited to participate; 376 responded by completing the evaluation questionnaire. The inclusion criterion was current enrolment at universities in Kerman province, while the exclusion criterion was a lack of willingness to participate.

The data collection instrument was a five-part questionnaire adapted from Alina Cote's study. Following the translation and localization of specific questions, the Content Validity Index (CVI) and Content Validity Ratio (CVR) were used to assess the tool's content validity. Ten disaster health experts evaluated the questionnaire, and their feedback was incorporated into the final version. The CVI score was 0.85, indicating strong content validity, while the CVR score of 0.70 indicated the essential nature of the questions according to the experts. The questionnaire's reliability was confirmed through an expert panel using Cronbach's alpha ($\alpha = 0.89$).

The questionnaire included a demographic section with five questions on attitudes, three questions on individual concerns, four questions on awareness, four questions on reinforcing behaviors, and eight questions assessing climate change adaptation behaviors. The tool used a 6-point Likert scale ranging from very poor to excellent. The total score of the questionnaire ranged from 24 to 144.

The questionnaire was designed on the Porsline platform and shared through various social media platforms (Telegram, Eitaa, WhatsApp, Baleh) via student groups managed by the universities' cultural units. Data were collected online. A total of 376 questionnaires were received. Data analysis was conducted using SPSS version 23.

This study was registered with ethical approval number IR.KMU.REC.1403.133 at Kerman University of Medical Sciences.

Results

The demographic data of the 375 participants, consisting of associate, bachelor's, master's, and doctoral students from universities affiliated with the Ministry of Health and other institutions, revealed that 155 (41.2%) were men, and 220 (58.5%) were women. Additionally, 276 participants (73.4%) were students at medical universities. Most participants, 272 (72.3%), were undergraduate and graduate students (Table 1).

Table 1. Demographic status

Variable		Frequency	Percent
Sex	Men	155	41.2
	Women	220	58.5
Education level	PhD-Associate	103	27.5
	Master	73	19.5
	Bachelor	199	53
University	Medical Sciences	276	73.4
	Sciences	99	26.6

In the analysis of variance (ANOVA), no significant differences were observed in students' responses to questions about climate change across five domains based on gender. However, medical students scored higher in attitude, personal concern, and adaptive behaviors, while scoring lower in awareness and reinforcing behaviors compared to non-medical universities (Table 2).

Table 2. Comparison of Mean Scores between Medical and Non-Medical Students

University	Attitude	Concern Persona	Awareness	Reinforcing Behaviors	Adaptive Behaviors
	Mean (SD)				
Medical Sciences	4.56 (0.72)	4.26 (0.95)	3.77 (0.72)	3.14 (1.07)	4.60 (0.79)
Other Universities	4.39 (0.77)	3.54 (0.94)	4.22 (0.79)	3.36 (1.09)	4.58 (1.05)
Total	4.51 (0.74)	4.07 (0.99)	3.88 (0.76)	3.20 (1.08)	4.60 (0.87)

SD: Standard deviation

The differences in awareness and personal concern were statistically significant (P < 0.001), whereas other domains showed no significant variation (Table 3). Medical students obtained significantly better scores than the Ministry of Science students on questions about Attitude, Concern Persona, and Adaptive Behaviors. However, they were weaker in Awareness and Reinforcing Behaviors. Differences in responses are statistically significant for the Concern Persona and Awareness domains (P < 0.001) (Tables 3, 4).

Table 3. Analysis of Variance of Different Domains by University Type

Variable	F	P-value
Attitude	3.843	0.051
Personal Concern	40.933	0.000
Awareness	26.981	0.000
Reinforcing Behaviors	2.974	0.085
Adaptive Behaviors	0.057	0.811

Medical students obtained significantly better scores than the Ministry of Science students on questions about Attitude, Concern Persona, and Adaptive Behaviours. However, they were weaker in Awareness and Reinforcing Behaviours (Table 2). Differences in responses are statistically significant for the Concern Persona and Awareness domains (P < 0.001) (Table 3).

Masters and PhD students scored higher across all domains, with statistically significant differences in reinforcing and climate change adaptation behaviours. (Reinforcing Behaviours: P = 0.014, Adaptive Behaviours: P = 0.011) (Table 4).

Table 4. Analysis of variance of Different Domains by Educational Level

Variable	F	P-value
Attitude	2.430	0.120
Personal Concern	0.044	0.833
Awareness	0.034	0.854
Reinforcing Behaviors	6.155	0.014
Adaptive Behaviors	6.475	0.011

Discussion

This study is the first to collect data on students from medical and non-medical universities regarding attitudes, personal concerns, awareness, reinforcing behaviours, and adaptive behaviours related to climate change.

The findings indicate that gender does not affect students' attitudes, knowledge, and adaptive behavior regarding climate change. This shows the role of higher education and postgraduate education in this group's knowledge, attitudes, and behaviour.

Graduate students scored higher across all examined areas than undergraduate and diploma students. Medical Sciences University students scored higher in areas related to attitudes, personal concerns, and adaptive behaviors toward climate change. Still, they scored lower in awareness and enhancing behaviors than students from other universities. This difference was significant in areas of awareness and personal concerns. (P < 0.001)

The study's findings by Zolfaghari et al. indicate that students' knowledge level about global warming and climate change is average. Still, there is no difference in students' level of awareness based on gender (29), which is consistent with the results of this study. However, there was no difference between students' awareness level and the faculty in which they were studying.

In the present study, medical university students in Kerman expressed higher levels of concern than students in other universities, but their level of awareness was lower.

The presence of various disciplines and specializations in climatology, geography, and geology at universities in Kerman under the supervision of the Ministry of Science has led to increased awareness among students regarding climate change. This highlights that climate change-related courses and their impact on health are less emphasized in the curricula of medical universities, except for fields such as health in disasters and emergencies. As a result, there is lower awareness and, consequently, higher levels of concern among medical students. In the study by Zolfaghari et al. (29), there was a statistically significant difference between males and females in the level of awareness and attitude, which was not consistent with the results of the present study. Therefore, by emphasizing the influence sphere of students and raising their awareness about concrete actions related to daily life, especially in individual activities, their self-efficacy can be strengthened to perform climate-adaptive behaviors. Thus, in this study, we examined the attitudes, knowledge, personal concerns, and adaptive behaviors of students in Kerman province toward climate change. The results of this research indicate that there is no significant difference between men and women in terms of awareness regarding the variables measured, which aligns with the studies by Zolfaghari et al. (29) and Yasen

et al. (31) but contradicts those by Lill Filho et al. (35) and Harrod et al. (37).

Regarding students' attitudes toward climate change, our findings are consistent with the studies by Ramezani and colleagues (38), Emma C. Ryan et al. (39), Asmaa Ebrahim et al. (40), Harrod et al. (37). The results show an adequate level of knowledge and awareness among students about climate change, which agrees with the research by Lill Filho et al. (35), Yasen et al. (31), Harrod et al. (37) and Kumar et al. (32).

This study indicates that graduate students scored higher on all questions across all domains, consistent with the investigations by Zolfaghari et al. (29) and Filho et al. (35). Given that reinforcing behaviors had higher scores among graduate students, it can be concluded that proper education for this group can effectively influence society in changing behaviors related to climate change. Additionally, medical science students scored higher on attitude, personal concern, and adaptive behavior domains associated with climate change but lower on knowledge and reinforcing behavior questions than the Ministry of Science students. Panahi et al.'s study showed that individuals express more concern when information regarding harm is presented. This difference in response to questions about knowledge and personal concerns was significant and aligned with positive student attitudes toward climate change in the present study (34).

Limitations: This study was only conducted among students from southeastern countries. A convenience sampling method was used, which may limit the generalizability of the study's results. This study did not examine other factors that might influence students' attitudes, knowledge, and behaviors regarding climate change. Given these limitations, further research is proposed using more diverse sampling methods and in various geographical areas to obtain more generalizable results.

Conclusion

Numerous studies have emphasized the significant carbon emissions from high resource consumption, including energy and waste generation, by laboratories and healthcare sectors, especially medical universities. Therefore, it is imperative to revise medical curricula to integrate climate change topics, empowering medical students to play an active role in safeguarding public health and the environment. Moreover, given the nature of their mission in public health and the availability of suitable infrastructure for enhancing community preparedness regarding the effects of climate change, increasing the awareness of graduates from these universities should be a goal for planners and policymakers in the Ministry of Health. On the other hand, the consequences of low awareness levels among students and the general public will affect the healthcare system. Given the findings of this study, it is suggested that medical universities and other institutions develop educational programs and interventions appropriate for enhancing awareness and supportive behaviors regarding climate change among students. This includes fostering attitudes, personal concerns, and adaptive behaviors towards climate change. Additionally, specialized training courses on climate change and coping strategies should be considered for postgraduate students. A comprehensive educational program and curriculum planning across all disciplines and academic levels, or a general course incorporating climate change topics into similar subjects, is also recommended. It is important to consider gender and educational differences in designing educational programs related to climate change. Organizing workshops and seminars on climate change, including practical information relevant to life, can enhance students' knowledge and self-efficacy in performing adaptive actions and mitigating the effects of climate change. Furthermore, interdisciplinary collaborations between medical students and those from other fields for knowledge and experience exchange on climate change should be encouraged. Increasing awareness and adaptive behavior towards climate change through creating an environment in universities that encourages green culture and environmental responsibility is crucial. Encouraging students to conduct research projects and collaborate with scientific institutions on climate changes and coping strategies, utilizing students as a significant societal group for public education and policy change at the community level, conducting further research in other universities to understand the level of knowledge, attitudes, and individual concerns of students about climate issues, and organizing continuous international conferences on climate changes at university level are among the other suggestions of this study.

One strength of this study is its performance on a relatively large sample of students, providing access to extensive and reliable data. Moreover, a reputable measurement tool has been used for data collection, ensuring accuracy and high validity. The results of this study can be beneficial for educational planning and

interventions in the field of climate change as they provide valuable information about students' attitudes, knowledge, and behaviors related to this issue.

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Conflict of interests: There is no conflict of interest.

Ethical approval: This study was conducted with the approval of the Ethics Committee of Kerman Medical University with the ethics code IR.KMU.REC.1403.133 The questionnaire was completed voluntarily by the participants.

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