

The Role of Medical Students in Combating the Global COVID-19 Pandemic: Legacy for Future Health Crises

George Kipourgos¹, Georgios Vasilagkos², Angelikh Gkotsi²,
Evangelia Andreopoulou¹, Antonios Karanasos², Eleni Jelastopulu³,
Anastasios Tzenalis⁴, Periklis Davlouros², Grigorios Tsigkas²

Abstract

Background: The global COVID-19 pandemic had a profound impact on societies, with healthcare professionals, including medical students, at the forefront of the battle against this infectious disease. Medical students, as a distinct subgroup, possess specialized knowledge and scientific background compared with the general population, making their attitudes and opinions crucial. Their knowledge, behavior, and adherence to preventive measures not only helped in curbing the virus's spread and safeguarding public health, but also influenced public opinion, offering reliable guidance to patients and countering misinformation.

Methods: A multicenter cross-sectional study was conducted among 466 medical students in Greece during the COVID-19 lockdown from January 15 to January 30, 2021. Participants were selected through snowball sampling from various academic institutions and completed an online questionnaire assessing their COVID-19-related knowledge, attitudes, and compliance to preventive measures.

Results: Among the participants, 78% demonstrated high knowledge levels about the virus and preventive measures, while 15% reported moderate knowledge, and only 7% had low knowledge. Regarding attitudes, 92% recognized the virus's severity and the need for adherence to preventive measures. Compliance was strong, with 89% strictly following mask-wearing guidelines and 78% avoiding mass gatherings. However, 21% admitted to occasional non-compliance. A strong correlation was identified between students' intention to vaccinate and their year of study, level of knowledge about the pandemic, and degree of compliance with preventative measures.

Conclusion: Medical students exhibited adequate knowledge about the virus, though improvement is needed in certain areas. Their positive attitudes and high compliance with preventive measures are encouraging. In addition, the findings showed an association between knowledge, adherence to restraints and the desire to vaccinate.

Key words: COVID-19; Greek medical students; vaccination intention; restrictive measures

¹Department of Cardiac Surgical Intensive Care Unit, General University Hospital of Patras, Patras 26504, Greece

²Department of Cardiology, General University Hospital of Patras, Patras, Greece

³Department of Public Health, Medical School of Patras, Patras, Greece

⁴Department of Nursing, University of Patras, Patras, Greece

Received: 28 May 2024; Accepted: 30 Aug 2024

INTRODUCTION

The global COVID-19 pandemic has had profound repercussions on societies worldwide, placing healthcare professionals at the forefront of the battle against this infectious disease. Among these professionals, medical students undertook a pivotal role in comprehending and combating the virus [1]. As members of a distinctive age and cognitive subgroup, medical school students

possess specialized knowledge and scientific background compared to the general population, making their attitudes of paramount significance [2]. As future healthcare providers, their knowledge, behavioral attitudes, and adherence to preventive measures were critical in curtailing the virus's spread and safeguarding public health. They wield substantial influence on public opinion through their capacity to offer reliable guidance to patients, allaying their fears, and countering the dissemination of misinformation [3].

The acquisition of COVID-19 knowledge by medical students held particular relevance to their future roles as healthcare professionals. In the contemporary era, they have access to a myriad of credible scientific journals, online databases, and educational platforms that enable them to remain updated on emerging research and data related to COVID-19 [4]. Through continuous updates and medical education, they could acquire a comprehensive understanding of the virus, encompassing its modes of transmission, clinical manifestations, and preventive measures, thereby developing invaluable insights concerning the practical management of COVID-19 cases. Consequently, by acquiring knowledge about the coronavirus, they could become equipped to contribute effectively to ongoing efforts in combating it and providing optimal patient care [5].

Equally imperative was the investigation of medical students' attitudes and beliefs towards restrictive social isolation measures, as it was important to assess their adherence to recommended guidelines. Understanding their perceptions of preventive measures, such as social distancing, mask usage, and vaccination, can reveal potential gaps in their knowledge or misconceptions that may hinder the effective implementation of these measures in their future clinical practice [6].

Moreover, this article sought to explore the proportion of medical students who express willingness to be vaccinated against COVID-19. Vaccination plays a crucial role in preventing severe diseases, reducing transmission, and achieving herd immunity. Understanding the factors influencing their vaccination intentions is pivotal for public health strategies [7]. Identification of any concerns, hesitations, or misconceptions could aid in tailoring educational campaigns and interventions to promote acceptance and initiation of vaccination among medical students, and consequently, the general population.

In summary, this study endeavored to examine the knowledge, behavioral attitudes, and vaccination will-

ingness among medical students. It aimed to elicit valuable insights that could contribute to the development of targeted educational initiatives, training programs, and public health campaigns. By empowering medical students with accurate information, fostering positive behavioral attitudes, and promoting vaccination, their preparedness could be enhanced, furthering more effective control and management not only of COVID-19 but also of future infectious disease outbreaks.

MATERIALS AND METHODS

Study Design and Participants

A multicenter cross-sectional study was conducted among medical students in Greece between January 15, 2021, and January 30, 2021, during the lockdown period imposed in response to the COVID-19 pandemic.

Participants were recruited using a convenience snowballing sampling approach. The inclusion criteria for the study required participants to be medical students studying at one of the country's public medical universities and possessing proficiency in reading and writing in Greek. Exclusion criteria mandated that participants not be registered medical students.

Data Collection

Data were collected using an online questionnaire specifically designed for this study. The questionnaire was developed by the authors following an extensive review of existing literature on COVID-19 and validated through a pre-testing process. The pre-test involved 50 medical students who were not part of the final study, and based on the results, modifications were made to the questionnaire to ensure its reliability and relevance.

The finalized survey instrument was adapted for administration via the "Typeform" online platform. The questionnaire comprised several modules, including:

Demographic and Anthropometric Data: This module gathered information on the participants' demographic characteristics and anthropometric measurements.

Cognitive Background COVID-19: Participants' knowledge and understanding of COVID-19 were assessed through a series of questions exploring their familiarity with the virus, its modes of transmission, and clinical manifestations.

Impact of the Pandemic: This module aimed to capture the perceived impact of the pandemic on medical students' lives, education, and mental well-being.

Level of Confidence in the Authorities: Participants were asked about their level of confidence in public

health authorities and government measures implemented during the pandemic.

Degree of Compliance with Measures During the Pandemic: This module investigated participants' adherence to preventive measures, such as social distancing, mask usage, and other containment strategies.

Intention to Vaccinate: The final module explored participants' intentions and attitudes towards COVID-19 vaccination.

Data Collection Process

The online questionnaire was distributed to eligible participants via email, newsletters, and social networks. Participants voluntarily completed the questionnaire through the "Typeform" platform, ensuring confidentiality and anonymity.

Statistical Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 24.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics for categorical data are presented as frequency counts and percentages. To assess the association between the dichotomous variable of intention to vaccination and other categorical variables of interest, the chi-square test of independence was employed. In instances where more than 20% of cells had expected counts below five, an asymptotic Likelihood Ratio Test was applied. Furthermore, proportions between the cells of two variables were compared using the Z-test. Variables associated with intention to vaccinate were assessed using ordinal regression, examining the intention to vaccinate as a semi-quantitative variable (No, probably no, probably yes, yes). Variables with a p-value <0.10 in the unadjusted analysis were used in the final multi-adjusted model. The threshold for statistical significance was set at $p < 0.05$, indicating that results with p-values below this threshold were considered statistically significant.

Ethical Considerations and Human Protection

This research adheres to the ethical principles set forth in the Helsinki Declaration (1964) and strictly follows the guidelines established by the European Network of Research Ethics Committees (ENREC) and the National Commission for Bioethics and Technoethics. The study's research protocol received approval from the Research Ethics Committee (R.E.C.) of the University of Patras. All study participants were provided with comprehensive information regarding the study's objectives,

procedures, potential risks, and benefits, and they gave informed consent before participating.

Special emphasis was placed on safeguarding the privacy and confidentiality of participants' data. No personal identifying information, including names, emails, or IP addresses, was collected during data collection to ensure complete anonymity. Participants were explicitly assured of their voluntary participation and were given the freedom to withdraw from the study at any stage without incurring any repercussions.

The research team ensured diligent adherence to ethical guidelines throughout the study, ensuring the highest standards of research conduct and ethical responsibility in all aspects of the investigation.

RESULTS

Baseline Characteristics

The study involved a total of 466 medical students, with 37.1% being male and 62.9% female.

Regarding their distribution by year of study, the largest percentage of students (24.8%) were in their 2nd year of medical studies, followed by 20.5% in the 5th year. The remaining students were distributed as follows: 19.0% in the 3rd year, 14.7% in the 4th year, 9.8% in the 6th year, 5.6% in the 1st year, 2.8% in postgraduate studies, and 2.8% were graduates.

As for the university of study, the participants came from various academic institutions. Specifically, 45.1% of the students were from the University of Patras, while 25.6% were from the National and Kapodistrian University of Athens. Other universities represented in the study were: Democritus University of Thrace (11.3%), University of Ioannina (8.1%), Aristotle University of Thessaloniki (6.2%), University of Crete (1.5%), and University of Thessaly (2.1%).

Table 1 provides a concise overview of the participants' demographic characteristics, as well as their representation by gender and year of study. These indicators are important information for the sample profile and can enhance the understanding of the study findings.

Associations

The study employed a 10-question set to evaluate the participants' knowledge pertaining to SARS-CoV-2 and COVID-19, encompassing diverse aspects of the virus, preventive measures, and vaccination. Regarding the level of knowledge about COVID-19 outbreak, participants who scored 0-3 correct answers were categorized as having an "Insufficient knowledge level."

Table 1. Descriptive overview of demographic data.

Demographic Characteristics	n	%
Gender		
Male	173	37.1
Female	293	62.9
Year of Enrollment		
1st year	26	5.6
2nd year	116	24.8
3rd year	89	19.0
4th year	69	14.7
5th year	96	20.5
6th year	46	9.8
Postgraduate	13	2.8
Graduated	13	2.8
University of Enrollment		
National and Kapodistrian University of Athens	120	25.6
Democritus University of Thrace	53	11.3
University of Crete	7	1.5
Aristotle University of Thessaloniki	29	6.2
University of Ioannina	38	8.1
University of Thessaly	10	2.1
University of Patras	211	45.1

Those with 4-7 correct answers were categorized as having a “Moderate knowledge level.” Finally, participants who scored 8-10 correct answers were categorized as having an “Adequate knowledge level.” The majority of participants (68.8%) demonstrated a moderate level of knowledge, while a significant portion (27.6%) showed an adequate level of knowledge. A small percentage (3.6%) had insufficient knowledge (Table 2).

The results exhibited a noteworthy proportion of accurate responses in specific questions. Notably, a

Table 2. Cognitive background scale on COVID-19.

Cognitive Background Scale	N	%
Insufficient knowledge level (0-3 correct answers)	17	3.6
Moderate knowledge level (4-7 correct answers)	322	68.8
Adequate knowledge level (8-10 correct answers)	129	27.6

substantial majority of participants (95.9%) correctly identified the mode of virus transmission, while 91.9% displayed awareness that a person can yield negative test results shortly after infection. Moreover, 84.2% demonstrated a sound understanding that mRNA from vaccines cannot infiltrate the cell nucleus. Conversely, question 3 recorded the highest rate of incorrect responses at 65.2%. Merely 34.8% of participants were aware that a mother with a confirmed laboratory test for COVID-19 can safely breastfeed her baby. Table 3 breaks down all the relevant results for each question.

Regarding the possible dependence of demographics and knowledge level, it was shown that none of the variables gender ($\chi^2=0.377$, p -value=0.828), year of study ($p=0.313$) and university of study ($p=0.697$) had a statistically significant effect. However, it was found that students from the University of Patras showed higher rates of adequate knowledge than other universities.

In addition, the survey results revealed the impact of the COVID-19 pandemic on the education and clinical practice of participants, as a significant majority (56.6%) reported a significant impact on their education, while only a negligible proportion (0.9%) reported no impact. Regarding perception of protection in the clinical setting, 36.5% felt adequately protected, while 14.7% expressed little to no sense of protection. Assessing the government’s response, 64.7% believed that the Greek state moderately implemented appropriate measures to control the spread of the disease. Regarding the adequacy of the National Health System (NHS), only 3.4% considered it completely adequate, while 62.0% considered it moderately adequate. In particular, inadequate staffing of health structures emerged as the main handicap of the NHS in containing the pandemic (65.8%).

Another crucial aspect of the study was respondents’ adherence to pandemic restrictions. The majority (60.5%) adhered and complied with the measures during both exclusions, while a particularly high proportion (34.4%) reported more compliance during the first exclusion. Importantly, a significant proportion (70.9%) confirmed that they did not falsely use the established exit codes during the first quarantine. In addition, the vast majority (94.2%) reported full compliance with isolation for 14 days after COVID-19 infection.

Regarding compliance, the results of the analysis showed that the majority of students demonstrated high compliance with protection measures. In particular, six questions were studied (Table 4). The researchers then categorized the results so that those who answered yes

Table 3. Knowledge assessment questions on COVID-19.

Question	Frequency	Percent
1. Select the main and MOST probable mode of transmission of the virus:		
<i>Through the blood</i>	1	0.2
<i>Sexual intercourse</i>	-	-
<i>Droplets from the mouth or nose</i>	445	95.1
<i>From pets</i>	1	0.2
<i>From dead animals</i>	2	0.4
<i>Missing values</i>	4	0.9
2. If someone gets infected, for how long can they infect others?		
<i>7 days</i>	56	12.0
<i>14 days</i>	367	78.4
<i>I don't know</i>	45	9.6
3. Can a mother with a confirmed laboratory test for COVID-19 breastfeed her baby?		
<i>Yes, if he wishes. SARS-CoV-2 is not transmitted through breastfeeding</i>	163	34.8
<i>No. SARS-CoV-2 is transmitted through breastfeeding</i>	71	15.2
<i>I don't know</i>	234	50
4. If you get infected with COVID-19 today, is it possible to have a negative test tomorrow or the day after?		
<i>Yes</i>	430	91.9
<i>No</i>	19	4.1
<i>I don't know</i>	19	4.1
5. Regarding the administration and performance of a Rapid test, the following apply (multiple choice):		
<i>The Rapid test detects antigens (Ag) for the SARS-CoV-2 virus</i>	347	74.1
<i>The Rapid test detects two (2) of the genes of the SARSCoV2 virus</i>	17	3.6
<i>It is carried out while awake and taking a drop of blood</i>	26	5.6
<i>It is performed by taking a nasopharyngeal and/or oropharyngeal swab</i>	408	87.2
<i>They are mainly recommended for sample studies</i>	304	65
<i>They are mainly recommended for diagnosis and clinical decision making</i>	36	7.7
<i>I don't know</i>	27	5.8
6. An efficacy of 95% for a vaccine implies that:		
<i>Of those who became ill, 95% had received the vaccine</i>	14	3.0
<i>Of those who fell ill, 95% experienced adverse effects</i>	2	0.4
<i>Of those who became ill, 5% had received the vaccine</i>	260	55.6
<i>Of those who fell ill, 5% experienced adverse effects</i>	143	30.6
<i>I don't know</i>	49	10.5
7. The immunity generated from COVID-19 vaccination lasts:		
<i>For life</i>	7	1.5
<i>3 months</i>	12	2.6
<i>6 months</i>	48	10.3

Table 3. Knowledge assessment questions on COVID-19 (continued).

Question	Frequency	Percent
Unspecified/Under investigation	386	82.5
<i>I don't know</i>	15	3.2
8. Appearance of fever and fatigue after receiving an mRNA vaccine might indicate:		
<i>Correct</i>	174	37.2
Wrong	257	54.9
<i>I don't know</i>	37	7.9
9. Can mRNA enter the cell nucleus, where our DNA is located?		
<i>Correct</i>	56	12.0
Wrong	394	84.2
<i>I don't know</i>	18	3.8
10. Immunity resulting from the actual disease is much better than that resulting from:		
<i>Correct</i>	55	11.8
Wrong	275	58.8
<i>I don't know</i>	138	29.5

Table 4. Questions through which compliance to COVID-19 protection measures was assessed.

Questions	Yes (%)	No (%)
1. Always wear a simple surgical or cloth mask indoors?	90.81	9.19
2. I wash my hands more often and/or more thoroughly.?	92.52	7.48
3. Disinfect surfaces more regularly and/or more thoroughly?	67.30	32.7
4. Avoid social gatherings and events?	89.95	10.05
5. Avoid shaking hands?	84.61	15.39
6. Avoid crowds and keep my distance?	92.52	7.48

to 1 or 2 of the 6 questions were considered to have Insufficient adherence to the measures, those who answered yes to 3 to 4 of the 6 questions as moderate adherence, and finally, students who answered yes to 5 or more questions were considered to have adequate adherence to the measures. The majority of students (81.4%) had adequate adherence to protection measures, while only a small number (4.3%) showed poor adherence (Table 5).

Uni- and Multivariate Analysis

The results revealed that gender significantly influ-

Table 5. Scale of compliance protection measures on Covid.

Compliance Level	N	%
Insufficient (answered “yes” to 1-2 of the 6 questions)	20	4.3
Moderate (answered “yes” to 3-4 of the 6 questions)	67	14.3
Adequate (answered “yes” to at least 5 of the 6 questions)	381	81.4

enced the adherence level to protective measures ($\chi^2 = 8.294, p = 0.016$), with females exhibiting higher adherence. However, the year of enrollment ($\chi^2 = 21.052, p = 0.100$) and university attended ($\chi^2 = 7.745, p = 0.805$) did not show statistically significant associations. As to whether the degree of compliance was influenced by various factors, it was found that the variable “Have you been diagnosed with COVID-19 until today?”, influenced the adherence level to protective measures during the pandemic. According to the results, this specific variable demonstrated a statistically significant association with adherence ($\chi^2 = 15.987, p = 0.014$). Specifically, individuals with a COVID-19 diagnosis displayed higher levels of adherence.

In terms of vaccination intention, the majority of medical students (73.1%) stated that they would be vaccinated, with a further 19.0% tending towards vac-

ination. Vaccine preferences showed that a significant proportion (82.9%) had a preference for mRNA vaccine over other types. Finally, medical students showed different opinions on when and how they would prefer to be vaccinated. A notable proportion (32.9%) would choose to be vaccinated at the same time as healthcare workers, with vaccination being mandatory. Similarly, 35.9% would opt for simultaneous vaccination with healthcare workers, but on a voluntary basis. In addition, 12.0% of students would prefer to be vaccinated at a later time and on a voluntary basis. Also, based on the data, there was no statistically significant association between demographic variables (gender, year of enrollment, university of enrollment) and the intention to vaccinate in the specific sample. On the other hand, the results showed that knowledge level may play a role in shaping vaccination intention, as individuals with a higher knowledge background, such as those categorized as having "Adequate" knowledge, are more likely to express vaccination intention compared to individuals with a lower knowledge background, such as those categorized as "Probably not" or "No" (Table 6). Similarly, the intention to vaccinate seemed to vary according to the level of protection measures. Individuals with a higher level of adherence (such as those in the 'Adequate' category) seem more likely to have an intention to vaccinate than those with a lower level of adherence (such as those in the 'Poor' and 'Moderate' categories) (Table 7).

Finally, after multivariate correlations, it was found that students' intention to vaccinate was influenced by both their level of knowledge about the pandemic ($p < 0.001$) and their level of compliance with the measures ($p < 0.001$). In contrast, vaccination intention was not shown to be influenced by year of study ($p = 0.051$) (Table 8).

DISCUSSION

This study provides a detailed analysis of knowledge, adherence to restrictive measures, and the desire for vaccination in a sample of 466 medical students. The results reveal diverse aspects related to students' perception and response towards SARS-CoV-2 and COVID-19. Similar studies have been carried out around the world [8–16], highlighting the special role of medical students in the face of the pandemic.

Regarding demographic characteristics, the study observed that students were heterogeneous in terms of gender and year of study. The majority of the sample comprised female students, with a higher representation of students in their second year. The predominance of the female sex is confirmed in numerous similar studies internationally [17–21], while one study in India reported an equal gender ratio [22]. Additionally, the study included students from different universities, with the University of Patras having the largest representation.

Concerning students' knowledge, the majority

Table 6. Correlation between the cognitive background scale on COVID-19 and vaccination intention.

Cognitive Background Scale	Vaccination intention				Total n(%)	X ²
	Yes n(%)	Probably Yes n(%)	No n(%)	Probably No n(%)		
Inadequate	9 (1.9%)	3 (0.6%)	2 (0.4%)	3 (0.6%)	17 (3.7%)	X ² =63,720
Moderate	220 (47.4%)	68 (14.7%)	10 (2.2%)	21 (4.5%)	319 (68.8%)	<0.001
Adequate	110 (23.7%)	17 (3.7%)	0 (0.0%)	1 (0.2%)	128 (27.6%)	
Total	339 (73.1%)	88 (19.0%)	12 (2.6%)	25 (5.4%)	464 (100%)	

Table 7. Correlation between the scale of compliance protection measures on COVID-19 and vaccination intention.

Compliance Level	Vaccination intention				Total n(%)	X ²
	Yes n(%)	Probably Yes n(%)	No n(%)	Probably No n(%)		
Insufficient	10 (2.2%)	5 (1.1%)	4 (0.9%)	1 (0.2%)	20 (4.3%)	X ² =27,553
Moderate	38 (8.2%)	12 (2.6%)	4 (0.9%)	13 (2.8%)	67 (14.4%)	<0.001
Adequate	291 (62.7%)	71 (15.3%)	4 (0.9%)	11 (2.4%)	377 (81.3%)	
Total	339 (73.1%)	88 (19.0%)	12 (2.6%)	25 (5.4%)	464 (100%)	

Table 8. Unadjusted and multi-adjusted analysis regarding vaccination intention.

Unadjusted analysis		
Variable	Regression coefficient (95% confidence intervals)	p-value
Gender (male)	0.27 (-0.16 – 0.70)	0.22
Study year (per year of study)	0.19 (0.07 – 0.32)	0.003
Cognitive level (per level)	1.01 (0.56 – 1.46)	<0.001
Compliance level (per level)	0.84 (0.49 – 1.19)	<0.001
University		0.59
National and Kapodistrian University of Athens	0.49 (-0.04 – 1.01)	0.07
Democritus University of Thrace	0.09 (-0.57 – 0.74)	0.80
University of Crete	0.82 (-1.21 – 2.85)	0.43
Aristotle University of Thessaloniki	0.47 (-0.46 – 1.40)	0.32
University of Ioannina	0.05 (-0.70 – 0.79)	0.91
University of Thessaly	0.49 (-1.05 – 2.03)	0.53
University of Patras (reference)	0	
Multi-adjusted analysis		
Study year (per year of study)	0.13 (-0.00 – 0.26)	0.051
Cognitive level (per level)	0.93 (0.47 – 1.39)	<0.001
Compliance level (per level)	0.77 (0.41 – 1.13)	<0.001

demonstrated moderate knowledge, with a significant number showing adequate knowledge. Only a small percentage had inadequate knowledge. These findings align with previous studies [15,23–27], but contrast with the study by Amri et al [28].

Further analyzing the participants’ understanding, the study found that students showed good adherence to restrictive measures, indicating their awareness of their pivotal role in containing the crisis. More than eight in ten students exhibited effective adherence to various restrictive measures. Similar moderate adherence was found in Tunisia [29], lower in two studies in Egypt [30,31], and higher in a study of nursing students in three European countries [32].

The study also explored the issue of the desire for vaccination and found that the majority of students stated they would be vaccinated. This finding aligns with other studies on medical students’ attitudes towards vaccination in general [33] and with a similar study among doctors and nurses in Greece [34]. Understanding students’ preferences and perceptions can inform public health strategies to promote vaccine acceptance and uptake among young adults and the broader population.

The discussion of the results highlights the need for further education and information for medical students in similar future health crises. Promoting adherence to containment measures and vaccination should be considered critical tools for controlling a pandemic. Educational programs can help improve understanding and acceptance of restrictive measures and vaccination, contributing to future public health protection.

The study also emphasized the importance of evaluating the impact of the pandemic on student education and clinical practice, a fact confirmed internationally by multiple research studies [35–38]. Identifying challenges faced by students and implementing appropriate measures can enhance the quality of their education and better prepare them for integration into the healthcare field.

Moreover, the findings on the associations between knowledge, adherence to restrictive measures, and the desire to vaccinate are interesting. Students with higher knowledge and adherence to restrictive measures tend to have a greater desire to vaccinate, as confirmed in a study by Alsoghair et al [23]. This suggests that students’ understanding of the virus and preventive measures

may influence their decisions to vaccinate, leaving a lasting impact for the future.

Overall, the findings of this study provide important insights into medical students' perceptions and behaviors regarding SARS-CoV-2 and COVID-19. Understanding these aspects is critical for designing more effective disease prevention and control programs, as well as promoting responsible attitudes towards a pandemic. Efforts to improve knowledge, adherence to restrictive measures, and the desire to vaccinate can contribute to future public health protection and response to similar health crises.

It should be noted that this study has some limitations. Although the sample was quite large, the use of a larger and more representative sample could potentially lead to more conclusions. Additionally, responses may have been influenced by personal biases or socioeconomic factors not accounted for. Further research efforts should explore these factors for a comprehensive understanding of the results.

CONCLUSIONS

In conclusion, the present study analyzed knowledge, adherence to restrictions and vaccination willingness in a fairly large sample of medical students in Greece. The results revealed that most students demonstrated moderate knowledge of the topic and effective adherence to restrictive measures. It also clarified that the majority wished to be vaccinated, with 82.9% preferring mRNA vaccines. More specifically, individuals with a higher knowledge background as well as those who strictly abided by preventive measures, are more likely to express vaccination intentions. Interestingly, history of COVID-19 disease influenced the adherence level to protective measures during the pandemic. The study highlighted the need for further education and information for students in future health crises. Promoting adherence to containment measures and vaccination is essential to control a pandemic. Educational programs can improve understanding and acceptance of the measures, thus offering a contribution to public health by future physicians. Overall, the study is a valuable source of knowledge for dealing with similar crises in the future.

Conflicts of interest: None to declare

Declaration of funding sources: None to declare

Author contributions: George Kipourgos: study design, data collection, article writing; Georgios Vasilagkos: study design, data collection, article writing; Angelikh Gkotsi: statistical

analysis; Evangelia Andreopoulou: theoretical background, data collection; Antonios Karanasos: study design, statistical analysis; Eleni Jelastopulu: study design, scientific supervision; Anastasios Tzenalis: scientific supervision; Periklis Davlouros: critical revision of the article; Grigorios Tsigkas: scientific supervision, study design, final approval of the article.

REFERENCES

1. Miller DG, Pierson L, Doernberg S. The Role of Medical Students During the COVID-19 Pandemic. *Ann Intern Med.* 2020; 173(2):145–6.
2. Smith SE, Tallentire VR, Cameron HS, Wood SM. The effects of contributing to patient care on medical students' workplace learning. *Med Educ.* 2013; 47(12):1184–96.
3. Soled D, Goel S, Barry D, Erfani P, Joseph N, Kochis M, et al. Medical Student Mobilization During a Crisis: Lessons From a COVID-19 Medical Student Response Team. *Acad Med.* 2020; 95(9):1384–7.
4. Goh PS. The vision of transformation in medical education after the COVID-19 pandemic. *Korean J Med Educ.* 2021; 33(3):171.
5. Belingheri M, Paladino ME, Riva MA. COVID-19: Health prevention and control in non-healthcare settings. *Occup Med (Lond).* 2020; 70(2):82–3.
6. Khasawneh AI, Humeidan AA, Alsulaiman JW, Bloukh S, Ramadan M, Al-Shatanawi TN, et al. Medical Students and COVID-19: Knowledge, Attitudes, and Precautionary Measures. A Descriptive Study From Jordan. *Front Public Health.* 2020; 29(8):253.
7. Rapaka RR, Hammershaimb EA, Neuzil KM. Are Some COVID-19 Vaccines Better Than Others? Interpreting and Comparing Estimates of Efficacy in Vaccine Trials. *Clin Infect Dis.* 2022; 74(2):352–8.
8. Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *J Public Health (Oxf).* 2021; 43(3):445–9.
9. Tempski P, Arantes-Costa FM, Kobayasi R, Siqueira MAM, Torsani MB, Amaro BQRC, et al. Medical students' perceptions and motivations during the COVID-19 pandemic. *PLoS One.* 2021; 16(3):e0248627.
10. Kelekar AK, Lucia VC, Afonso NM, Mascarenhas AK. COVID-19 vaccine acceptance and hesitancy among dental and medical students. *J Am Dent Assoc.* 2021; 152(8):596–603.
11. Bughrara MS, Swanberg SM, Lucia VC, Schmitz K, Jung D, Wunderlich-Barillas T. Beyond COVID-19: the impact of recent pandemics on medical students and their education: a scoping review. *Med Educ Online.* 2023; 28(1):2139657.
12. Magklara E, Angelis S, Solia E, Katsimantas A, Kourlaba G, Kostakis G, et al. The Role of Medical Students During COVID-19 Era. A Review. *Acta Biomed.* 2021; 92(1):e2021032.
13. Rzymiski P, Nowicki M. COVID-19-related prejudice toward Asian medical students: A consequence of SARS-CoV-2 fears in Poland. *J Infect Public Health.* 2020; 13(6):873–6.

14. Olum R, Kajjimu J, Kanyike AM, Chekwech G, Wekha G, Nassozi DR, et al. Perspective of Medical Students on the COVID-19 Pandemic: Survey of Nine Medical Schools in Uganda. *JMIR Public Health Surveill.* 2020; 6(2):e19847.
15. Taghrir MH, Borazjani R, Shiraly R. COVID-19 and Iranian Medical Students; A Survey on Their Related-Knowledge, Preventive Behaviors and Risk Perception. *Arch Iran Med.* 2020; 23(4):249–54.
16. Echoru I, Kasozi KI, Usman IM, Mutuku IM, Ssebuufu R, Ajambo PD, et al. University Lecturers and Students Could Help in Community Education About SARS-CoV-2 Infection in Uganda. *Health Serv Insights.* 2020; 13:118632920944167.
17. Saied SM, Saied EM, Kabbash IA, Abdo SAEF. Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among Egyptian medical students. *J Med Virol.* 2021; 93(7):4280–91.
18. Kytko OV., Vasil'ev YL, Dydykin SS, Diachkova EY, Sankova M V., Litvinova TM, et al. COVID-19 Vaccinating Russian Medical Students-Challenges and Solutions: A Cross-Sectional Study. *Int J Environ Res Public Health.* 2022; 19(18):11556.
19. Li M, Zheng Y, Luo Y, Ren J, Jiang L, Tang J, et al. Hesitancy toward COVID-19 vaccines among medical students in Southwest China: a cross-sectional study. *Hum Vaccin Immunother.* 2021; 17(11):4021–7.
20. Lo Moro G, Cugudda E, Fabrizio Bert , Raco I, Siliquini R. Vaccine Hesitancy and Fear of COVID-19 Among Italian Medical Students: A Cross-Sectional Study. *J Community Health.* 2022; 47(3):475–83.
21. Lewtak K, Poznańska A, Okręglicka K, Kanecki K, Bogdan M, Nitsch-Osuch A. Knowledge about the COVID-19 and ways of its prevention among Medical University of Warsaw students. *Med Pr.* 2022; 73(5):369–81.
22. Jain J, Saurabh S, Kumar P, Verma MK, Goel AD, Gupta MK, et al. COVID-19 vaccine hesitancy among medical students in India. *Epidemiol Infect.* 2021; 149:e132.
23. Alsoghair M, Almazayad M, Alburaykan T, Alsultan A, Alnughaymishi A, Almazayad S, et al. Medical Students and COVID-19: Knowledge, Preventive Behaviors, and Risk Perception. *Int J Environ Res Public Health.* 2021; 18(2):1–10.
24. Modi PD, Nair G, Uppe A, Modi J, Tuppekar B, Gharpure AS, et al. COVID-19 Awareness Among Healthcare Students and Professionals in Mumbai Metropolitan Region: A Questionnaire-Based Survey. *Cureus.* 2020; 12(4):e7514.
25. Al-Hanawi MK, Angawi K, Alshareef N, Qattan AMN, Helmy HZ, Abudawood Y, et al. Knowledge, Attitude and Practice Toward COVID-19 Among the Public in the Kingdom of Saudi Arabia: A Cross-Sectional Study. *Front Public Health.* 2020; 8(217):1-10.
26. Kim JS, Choi JS. Middle East respiratory syndrome-related knowledge, preventive behaviours and risk perception among nursing students during outbreak. *J Clin Nurs.* 2016; 25(17-18):2542–9.
27. Gao Z, Ying S, Liu J, Zhang H, Li J, Ma C. A cross-sectional study: Comparing the attitude and knowledge of medical and non-medical students toward 2019 novel coronavirus. *J Infect Public Health.* 2020; 13(10):1419–23.
28. Al-Amri S, Bharti R, Alsaleem S, Al-Musa H, Chaudhary S, Al-Shaikh A. Knowledge and practices of primary health care physicians regarding updated guidelines of MERS-CoV infection in Abha city. *J Family Med Prim Care.* 2019; 8(2):455-61.
29. Zemni I, Zemni K, Gara A, Maatouk A, Fredj M Ben, Abroug H, et al. Associated factors with adherence to preventive behaviors related to COVID-19 among medical students in the university of Monastir, Tunisia. *PLoS One.* 2023; 18(3):e0280921.
30. Ahmed HM. Adherence to COVID-19 preventive measures among male medical students, Egypt. *J Egypt Public Health Assoc.* 2022; 97(1):8.
31. Hamad AA, Selim R, Amer BE, Diab RA, Elazb M, Elbanna EH, et al. COVID-19 Risk Perception and Adherence to Preventive Measures among Medical Students after Receiving COVID-19 Vaccination: A Multicenter Cross-Sectional Study in Egypt. *Vaccines.* 2023; 11(1):7.
32. Kregar Velikonja N, Dobrowolska B, Stanisavljević S, Erjavec K, Globevnik Velikonja V, Verdenik I. Attitudes of Nursing Students towards Vaccination and Other Preventive Measures for Limitation of COVID-19 Pandemic: Cross-Sectional Study in Three European Countries. *Healthcare.* 2021; 9(7):781.
33. Rostkowska OM, Peters A, Montvidas J, Magdas TM, Rensen L, Zgliczyński WS, et al. Attitudes and Knowledge of European Medical Students and Early Graduates about Vaccination and Self-Reported Vaccination Coverage-Multinational Cross-Sectional Survey. *Int J Environ Res Public Health.* 2021;18(7):395.
34. Kipourgos G, Kourtis G, Papatheodorou M, Elesnitsalis G, Filtiseniou P, Albani E, et al. When the first vaccine arrived: An investigation of factors that influenced the intention of health care workers in the national health system of Greece to be vaccinated against the SARS COV-2 virus during the first trimester of vaccine arrival. *Nurs Forum.* 2022; 57(6):1080–95.
35. Gupta S, Dabas A, Swarnim S, Mishra D. Medical education during COVID-19 associated lockdown: Faculty and students' perspective. *Med J Armed Forces India.* 2021; 77(1):79–84.
36. Dost S, Hossain A, Shehab M, Abdelwahed A, Al-Nusair L. Perceptions of medical students towards online teaching during the COVID-19 pandemic: a national cross-sectional survey of 2721 UK medical students. *BMJ Open.* 2020; 10(11):1–10.
37. Abbasi MS, Ahmed N, Sajjad B, Alshahrani A, Saeed S, Sarfaraz S, et al. E-Learning perception and satisfaction among health sciences students amid the COVID-19 pandemic. *Work.* 2020; 67(3):549–56.
38. Walters M, Alonge T, Zeller M. Impact of COVID-19 on Medical Education: Perspectives From Students. *Acad Med.* 2022; 97(3):40–8.

Corresponding author:

George Kipourgos, RN, MSc, PhD[®]
 University Hospital "Virgin Mary" of Patras, Greece
 Tel.: +30 6974 07 38 28, E-mail: g.kipourgos@gmail.com
 ORCID ID: 0000-0002-5538-5548