

Article

Not peer-reviewed version

Knowledge and Attitudes Toward Mpox Among Medical Students in Bulgaria and North Macedonia: A Cross-Sectional Study During the 2022 Global Outbreak

[Vanya Rangelova](#)*, [Dejan Jakimovski](#), [Magdalena Baymakova](#), [Meri Hristamyan](#), [Martina Moskova](#), Sara Sariyan, [Iliia Tsachev](#), [Ani Kevorkyan](#)

Posted Date: 13 March 2026

doi: 10.20944/preprints202603.1026.v1

Keywords: medical students; Mpox; Bulgaria; North Macedonia; knowledge; attitudes; emerging infectious diseases



Preprints.org is a free multidisciplinary platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This open access article is published under a [Creative Commons CC BY 4.0 license](#), which permit the free download, distribution, and reuse, provided that the author and preprint are cited in any reuse.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Article

Knowledge and Attitudes Toward Mpox Among Medical Students in Bulgaria and North Macedonia: A Cross-Sectional Study During the 2022 Global Outbreak

Vanya Rangelova ^{1,*}, Dejan Jakimovski ^{2,3}, Magdalena Baymakova ⁴, Meri Hristamyan ¹, Martina Moskova ⁵, Sara Sariyan ^{6,7}, Ilia Tsachev ^{8,9,10} and Ani Kevorkyan ¹

- ¹ Department of Epidemiology and Disaster Medicine, Faculty of Public Health, Medical University of Plovdiv, 4002 Plovdiv, Bulgaria
- ² Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, 1000 Skopje, North Macedonia
- ³ University Clinic for Infectious Diseases and Febrile Conditions, 1000 Skopje, North Macedonia
- ⁴ Department of Infectious Diseases, Military Medical Academy, 1606 Sofia, Bulgaria
- ⁵ Center of Transfusion Hematology, Military Medical Academy, 1606 Sofia, Bulgaria
- ⁶ Department of Diagnostic Imaging, Faculty of Medicine, Medical University of Plovdiv, 4002 Plovdiv, Bulgaria
- ⁷ SMDL Mediscan, 4002 Plovdiv, Bulgaria
- ⁸ Department of Clinical Science, Faculty of Veterinary Medicine, Medical University, 5800 Pleven, Bulgaria.
- ⁹ Department of Microbiology, Infectious and Parasitic Diseases, Faculty of Veterinary Medicine, Trakia University, 6000 Stara Zagora, Bulgaria.
- ¹⁰ Department of Agricultural and Forestry Sciences, Bulgarian Academy of Sciences, 1040 Sofia, Bulgaria
- * Correspondence: vanya.rangelova@mu-plovdiv.bg; Tel.: +359883403683

Abstract

Mpox re-emerged as a global public health concern during the 2022 international outbreak, underscoring the necessity of preparedness among future healthcare professionals. This study sought to evaluate knowledge and attitudes toward Mpox among medical students in Bulgaria and North Macedonia. A cross-sectional, online survey was conducted from May to September 2022 among undergraduates attending medical universities in both nations. The questionnaire evaluated demographic variables, knowledge of Mpox, and attitudes toward conspiracy theories associated with the emerging infectious disease. A total of 1,313 students participated, with a mean age of 22.6 ± 4.4 years and 63.7% being female. While 56.3% of respondents were familiar with Mpox, hardly 16.9% indicated having received formal or specialized information regarding the disease. Significant information deficiencies were observed: merely 38.1% accurately acknowledged that antibiotics are ineffective against Mpox, and 25.0% were knowledgeable of the availability of vaccinations for prophylaxis. Common misconceptions regarding transmission and resemblances to other vesicular illnesses were prevalent. Attitudinal research indicated significant uncertainty and partial support for conspiracy theories concerning new pathogens. The findings reveal inadequate readiness among prospective healthcare workers and highlight the necessity to enhance medical education on emerging infectious illnesses to facilitate early detection, risk communication, and epidemic preparedness in Southeastern Europe.

Keywords: medical students; Mpox; Bulgaria; North Macedonia; knowledge; attitudes; emerging infectious diseases

1. Introduction

Mpox (formerly known as monkeypox) is a zoonotic disease caused by the human Mpox virus, a DNA virus belonging to the genus Orthopoxvirus [1]. The disease was initially reported in 1958 in captive cynomolgus monkeys at the Statens Serum Institute in Copenhagen, Denmark [2]. The Democratic Republic of Congo detected the first human case several years later, in 1970 [2]. Subsequently, the disease spread to Central and West Africa, and by 2003 it extended beyond the African continent [3]. In May 2022 the cases of Mpox infection increased across 30 countries, and by the end of July the World Health Organization (WHO) declared a multinational outbreak of international concern [4]. As of January 2026, there have been 179,612 laboratory-confirmed Mpox cases, including 483 deaths, from 145 countries across all six WHO regions [5].

While historically transmitted through direct or indirect contact with infected animals (including bites, contact with infectious fluids, or consumption of inadequately cooked bushmeat), the 2022 outbreak was characterized by sustained human-to-human transmission, primarily through close skin-to-skin contact during sexual activity [6]. Clinically, the disease is generally self-limited, with the formation of lesions, skin nodules, or a diffused rash progressing through macular, papular, vesicular, and pustular stages over 2–4 weeks [6]. However, it may be severe in certain populations, including children, pregnant women, or immunocompromised individuals. In severe cases of mpox, the skin lesions can disseminate to different parts of the body, including the oral cavity, cornea, and even the genitals [7]. The incubation period of the disease ranges from 5 to 21 days, with symptoms persisting for up to 4 weeks [2].

Despite being preventable through smallpox-derived vaccines (e.g., JYNNEOS and ACAM2000), global awareness and knowledge about Mpox remain low, especially in non-endemic regions [8]. Previous studies among healthcare workers and students have revealed poor to moderate knowledge levels. University students and faculty, as an informed and important demographic, significantly contribute to the dissemination of accurate information regarding infectious diseases. Understanding knowledge and attitudes toward Mpox among medical students and future healthcare professionals is essential for strengthening outbreak preparedness and improving public health responses [9, 10].

Although Mpox was declared to be a public health emergency of international concern by the World Health Organization (WHO) in 2022, the outbreak was largely concentrated in countries in Western Europe, North America, and South America. In Eastern Europe, including the Balkans, reported cases remained sporadic and limited. For instance, Bulgaria reported fewer than 10 confirmed cases, and North Macedonia reported none or only isolated suspected cases during the outbreak [11, 12]. Given the low national disease burden, there has been minimal emphasis on Mpox in public health campaigns or academic curricula in these countries, which may account for students' limited exposure to in-depth information about the infection.

The aim of the present study was to assess the knowledge and attitudes of Mpox among medical students from Bulgaria and North Macedonia. To the best of our knowledge, this is the first questionnaire-based survey on Mpox in these two Southeastern European countries.

2. Materials and Methods

2.1. Study Design and Setting

A cross-sectional, web-based survey was conducted between May and September 2022 to assess Mpox-related knowledge and attitudes toward emerging and re-emerging infectious diseases among undergraduates enrolled in medical universities or faculties in Bulgaria and North Macedonia. Eligible participants were students aged 18 years or older who were pursuing degrees in medicine, dentistry, pharmacy, or other health-related disciplines at accredited institutions in the two countries.

The questionnaire was developed using Google Forms, and the survey link was distributed to potential respondents. To ensure accessibility for all participants, the instrument was available in

Bulgarian, English, and North Macedonian. Recruitment was carried out through chain-referral sampling initiated via the authors' professional networks, including four authors who serve as instructors at accredited medical universities/faculties in Bulgaria and North Macedonia. Participation was voluntary and uncompensated. All questionnaire items were mandatory to minimize item non-response.

2.2. Study Questionnaire Design

Following a thorough review of the relevant literature, the research team—comprising two epidemiologists (each with postgraduate education in Epidemiology and Biomedical Statistics) and two infectious disease specialists (each with postgraduate education in Infectious Diseases and Tropical medicine)—adapted the questionnaire for the study's objectives. During the development process, the team carefully evaluated the clarity, relevance, and appropriateness of all items, ensuring that the questions were suitable for the anticipated participants' training background and level of proficiency.

The item-level Content Validity Index (I-CVI) [13] was determined by the ratio of experts who rated each item as 3 or 4. Items with an I-CVI of 0.78 or above remained unmodified in accordance with established criteria for panels including 3 to 5 experts. Items having an I-CVI ranging from 0.70 to 0.77 were modified for clarity in accordance with expert feedback. The Scale-level Content Validity Index (S-CVI/Ave) was determined by averaging the Item-level Content Validity Indices (I-CVIs) for all items within each domain. All three domains (demographics, knowledge, attitudes) attained an S-CVI/Ave of more than 0.90, signifying excellent content validity.

The structured questionnaire consisted of three major sections:

1. Demographic information – sex, age, country of birth, university and year of study, main academic discipline.
2. Knowledge of Mpox – 9 items evaluating knowledge about the virus, its transmission, clinical characteristics, and prevention. The questions were adapted from Harapan et al. [14]. Correct responses received a score of 2, incorrect responses were scored as 0, and "I do not know" was given a score of 1.
3. Attitudes toward conspiracy beliefs regarding emerging diseases—eight items assessing respondents' perceptions of global and local responses to outbreaks. A 5-point Likert scale was used ("Strongly agree" = 5 to "Strongly disagree" = 1), with a maximum score of 40. We adopted survey items from a study by Freeman et al. [15] on SARS-CoV-2 conspiracy beliefs. Higher scores indicated a greater embrace of conspiracy beliefs regarding virus emergence and subsequent intervention measures.

Forward-backward translation was used to convert the questionnaire from English to Bulgarian and North Macedonian. Two separate bilingual translators (native speakers of the target language fluent in English and medical terminology) forward translated each target language. A reconciliation meeting compared the two forward translations and agreed on a preliminary version.

After translation, a bilingual expert panel (n=2 per language) checked each version for cultural appropriateness and conceptual equivalence to ensure that items retained their meaning in Bulgaria and North Macedonia. Medical terminology (e.g., "Mpox," "monkeypox," transmission routes) and culturally sensitive conspiracy notions were given special care.

Internal consistency reliability was assessed for the knowledge scale (9 items) and attitude scale (8 items) using Cronbach's alpha coefficient. For the knowledge scale, Cronbach's alpha was 0.75, indicating acceptable internal consistency. For the attitude scale measuring conspiracy beliefs, Cronbach's alpha was 0.80, indicating good internal consistency.

The three-tier scoring method for knowledge items (correct=2, incorrect=0, "I do not know"=1) was implemented to distinguish between active disinformation (incorrect answers) and a lack of knowledge ("I do not know" responses). This approach acknowledges that recognising doubt may demonstrate superior cognitive awareness compared to confidently conveying inaccurate information, with implications for educational interventions.

2.3. Statistical Analysis

Descriptive statistics were applied to both quantitative and qualitative variables. Continuous data were presented as means with standard deviations or, when distributional assumptions were not met, as medians with interquartile ranges (25th–75th percentile). Categorical variables were summarized as frequencies and percentages (n, %). Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. For the knowledge and attitude scales, internal consistency reliability was assessed using Cronbach's alpha coefficient, with values >0.70 considered acceptable.

Between-group comparisons for non-normally distributed continuous variables were conducted using the Mann-Whitney U test, while differences in proportions between two groups were evaluated using the Z-test. Statistical tests were considered significant if the p-value was less than 0.05.

All data management and statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA; released 2017).

3. Results

3.1. Characteristics of the Respondents

A total of 1,313 students took part in the study. Among them, 63.7% (n = 836) identified as female. The mean age of participants was 22.63 years, with a standard deviation of 4.44 years, reflecting a predominantly young adult cohort. Around one-fifth of the respondents (n = 265; 20.2%) were enrolled in medical universities based in North Macedonia. The largest proportion of students were pursuing degrees in medicine (71.1%, n = 933), followed by dental medicine (12.3%, n = 161), while the remaining participants were studying in other health-related academic programs. Regarding academic year distribution, nearly one-third of the students (30.0%, n = 394) were in their fifth year of study. First-year students made up 11.9% (n = 156), and 7.5% (n = 98) were in their final, sixth year. The majority of respondents were affiliated with the Medical University of Plovdiv, accounting for 60.4% of the total sample. Among the students from North Macedonia, the predominant share was studying at the University of Skopje, comprising 17.7% (n = 232) of all participants.

Table 1. Demographic characteristics of study respondents (n=1313).

Variable	All respondents (n=1313) n, (%)
Age, mean±Std	22.63 ± 4.440
Gender, n (%)	
Male	473 (36.0)
Female	840 (64.0)
University	
Medical University of Sofia	255 (19.4)
Medical University of Plovdiv	793 (60.4)
Medical University of Skopje	232 (17.7)
Medical University of Stip	33 (2.5)
Major	
Medicine	933 (71.1)
Dental Medicine	161 (12.3)
Pharmacy	145 (11.0)
Other	74 (5.6)
Year of study	

1 st year	156 (11.9)
2 nd year	154 (11.7)
3 rd year	305 (23.2)
4 th year	205 (15.6)
5 th year	394 (30.0)
6 th year	99 (7.5)

3.2. Knowledge About Human Mpox

Table 2. This is a table. Tables should be placed in the main text near to the first time they are cited.

The respondents exhibited a moderate level of understanding of Mpox. The median score on the 9-item Mpox knowledge questionnaire was 12 points, signifying a partial yet insufficient comprehension of the disease. A significant majority of participants demonstrated general knowledge, although their understanding of transmission mechanisms, clinical symptoms, and preventative methods was notably deficient.

More than half of the respondents (56.3%, n = 739) reported having heard about Mpox before, indicating moderate general knowledge. However, only 16.9% (n = 222) reported receiving specific or specialized information about Mpox. This contrast shows that awareness was mostly basic and not supported by formal educational exposure, probably reflecting the low incidence of Mpox in Bulgaria and North Macedonia during the study period.

Multiple significant knowledge deficiencies were recognized. Only 38.1% of respondents accurately identified that antibiotics are ineffective against Mpox, and hardly 25.0% acknowledged the availability of a vaccine for the protection of human Mpox infection. Moreover, confusion between Mpox and other vesicular diseases was apparent, as less than fifty percent of respondents accurately recognised the similarities between Mpox and chickenpox. These findings demonstrate a restricted comprehension of illness distinction and preventive methods, which are crucial for early detection and epidemic response.

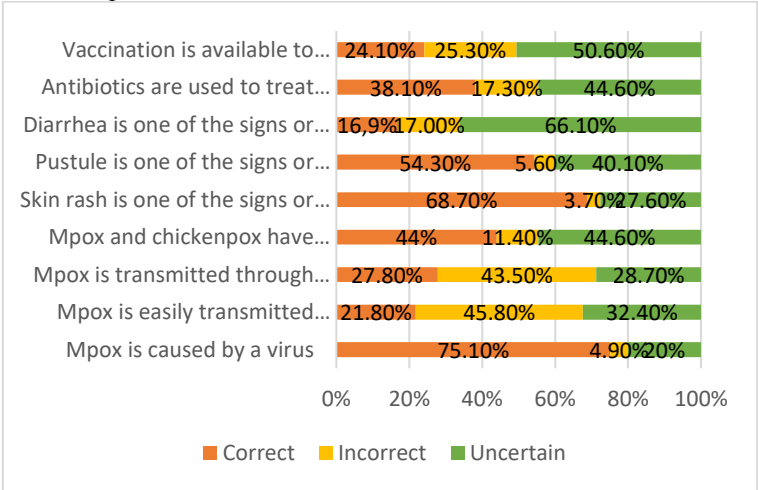


Figure 1. Overall level of knowledge of human Mpox among study respondents. (n=1313).*Incorrect statements regarding human Mpox.

Statistically significant differences in Mpox knowledge were observed across age and sex groups. Older participants demonstrated significantly higher levels of knowledge compared with younger respondents. Differences by sex were less pronounced; however, females performed better on several individual knowledge items.

Table 2. Level of knowledge regarding human Mpox among respondents based by age and sex.

Human Mpox Knowledge Item	Response	Age		p-Value	Sex		p-Value
		<21 years (n=528)	>21years (n=785)		Male (n=473)	Female (n=840)	
Mpox is caused by a virus.	Correct	322	644	<0.001	359	627	0.853
	Incorrect	(61.0)	(82.0)		(75.9)	(74.6)	
	Do not know	33 (6.2)	32 (6.7)		26 (5.5)	39 (4.7)	
		173 (32.8)	89 (11.3)		88 (18.6)	174 (20.7)	
Mpox is easily transmitted among humans.	Correct	78 (14.8)	209	<0.001	128	159	0.002
	Incorrect	(23.9)	(30.4)		(29.4)	(26.9)	
	Do not know	217 (41.1)	354 (45.1)		193 (40.8)	378 (45.0)	
		185 (35.0)	189 (24.5)		141 (29.8)	236 (28.1)	
Mpox is transmitted through the bite and saliva of an infected monkey.	Correct	126	239	<0.001	139	226	0.419
	Incorrect	(23.9)	(30.4)		(29.4)	(26.9)	
	Do not know	217 (41.1)	354 (45.1)		193 (40.8)	378 (45.0)	
		185 (35.0)	189 (24.5)		141 (29.8)	236 (28.1)	
Skin rash is one of the signs or symptoms of human Mpox.	Correct	330	572	<0.001	300	602	0.005
	Incorrect	(62.5)	(72.9)		(63.4)	(71.7)	
	Do not know	18 (3.4)	31 (3.9)		24 (5.1)	25 (3.0)	
		180 (34.1)	182 (23.2)		149 (31.5)	213 (25.3)	
Mpox and chickenpox have similar signs and symptoms.	Correct	201	377	<0.001	185	393	0.012
	Incorrect	(38.1)	(48.0)		(39.1)	(46.8)	
	Do not know	44 (8.3)	105 (13.4)		65 (11.6)	84 (10.0)	
		283 (53.6)	303 (38.6)		233 (49.3)	363 (43.2)	
Pustule is one of the signs or symptoms of human Mpox.	Correct	258	455	<0.001	234	479	0.024
	Incorrect	(48.9)	(58.0)		(49.5)	(57.0)	
	Do not know	24 (4.5)	49 (6.2)		32 (6.7)	41 (4.9)	
		246 (46.6)	281 (35.8)		207 (43.8)	320 (38.1)	
Diarrhea is one of the signs and symptoms of human Mpox.	Correct	58 (11.0)	164	<0.001	90 (19.0)	132	0.303
	Incorrect	(15.1)	(20.9)		(16.5)	(15.7)	
	Do not know	390 (73.9)	143 (18.2)		305 (64.5)	145 (17.3)	

		478			563		
		(60.9)			(67.0)		
Antibiotics are used to treat human Mpox.	Correct	130	371	<0.001	196	305	0.048
	Incorrect	(24.6)	(47.3)		(41.4)	(36.3)	
	Do not know	95 (18.0)	131		67 (13.8)	159	
		303	(16.7)		212	(18.9)	
		(57.4)	283		(44.8)	376	
			(36.0)			(44.8)	
Vaccination is available to prevent human Mpox.	Correct	85 (16.1)	232	<0.001	110	207	0.549
	Incorrect	128	(29.5)		(23.2)	(24.6)	
	Do not know	(24.3)	204		113	219	
		315	(26.0)		(23.9)	(26.1)	
		(59.6)	349		250	414	
			(44.5)		(52.9)	(49.3)	

The analysis of attitudes on conspiracy beliefs revealed considerable ambivalence among students regarding the origins and management of emerging infectious illnesses. The predominant response among participants was the neutral choice (“neither agree nor disagree”) for almost all topics, signifying uncertainty rather than a definitive acceptance or rejection of conspiracy theories. For example, 39.8% of students neither agreed nor disagreed with the statement that the global spread of Mpox was attributable to guys who engage in sexual interactions with men, while 23.6% agreed and 10.6% totally agreed with this idea.

A considerable portion of the sample demonstrated belief in laboratory-origin theories and deliberate population-control narratives. Approximately 31.2% agreed or fully agreed that many viruses have been artificially created in laboratories, while 25.8% supported the claim that the spread of infections is a deliberate strategy by organizations to reduce the human population. Similarly, 30.0% of participants agreed or strongly agreed that lockdowns promote the economic or political objectives of "shadow organizations," while 39.2% indicated that the media occasionally disseminates inaccurate or misleading information regarding infectious diseases and control measures.

Table 3. Conspiracy beliefs of the respondents regarding human Mpox (n=1313).

Conspiracy belief statements	Completely disagree (n, %)	Disagree (n, %)	Neither agree nor disagree (n, %)	Agree (n, %)	Completely agree (n, %)
Mpox spread worldwide due to the role of men having sex with men.	138 (10.5)	203 (15.5)	523 (39.8)	310 (23.6)	139 (10.6)
I am skeptical of the official explanation for the causes of Mpox.	76 (5.8)	236 (18.0)	692 (52.7)	247 (18.8)	62 (4.7)
I do not trust the information I receive from experts on emerging infectious diseases.	232 (17.7)	616 (46.9)	316 (24.1)	109 (8.3)	40 (3.0)
Many bacteria, viruses, parasites, and fungi have been created in laboratories.	104 (7.9)	295 (22.5)	505 (38.5)	325 (24.8)	84 (6.4)

The spread of infectious pathogens (bacteria, viruses, parasites, and mycoses) is a deliberate attempt by some organizations to reduce the human population.	174 (13.3)	335 (25.5)	465 (35.4)	252 (19.2)	87 (6.6)
The lockdown as a response to emerging infections aims to ensure destabilization and control over the economy and financial system of a large part of the countries around the world.	169 (12.9)	325 (24.8)	426 (32.4)	278 (21.2)	115 (8.8)
The lockdown is a way and means to change society to satisfy the financial and economic interests of certain "shadow" organizations.	166 (12.6)	361 (27.5)	455 (34.7)	239 (18.2)	92 (7.0)
Very often, the media purposefully provides incorrect information about certain infections and measures to contain them.	89 (6.8)	241 (18.4)	415 (31.6)	398 (30.3)	170 (12.9)

An independent samples t-test was performed to compare overall Mpox knowledge scores and conspiracy beliefs between students aged based on age groups and gender. Students older than 21 years (n = 785) demonstrated a higher mean knowledge score (M = 12.11, SD = 2.61) compared with students younger than 21 years (n = 528; M = 11.31, SD = 2.28). The analysis revealed a statistically significant difference in overall Mpox knowledge between the two age groups ($t(1224.45) = -5.89, p < 0.001$). The analysis revealed a statistically significant difference in overall knowledge scores between genders ($t(1311) = -2.53, p = 0.012$). Male students (n = 473) had a mean knowledge score of 11.56 (SD = 2.53), whereas female students (n = 840) demonstrated a higher mean score of 11.92 (SD = 2.49). There were no statistically significant differences between the groups regarding conspiracy beliefs.

Figure 2 Boxplots showing the dynamics of overall Mpox knowledge and conspiracy beliefs among medical students by age and sex.

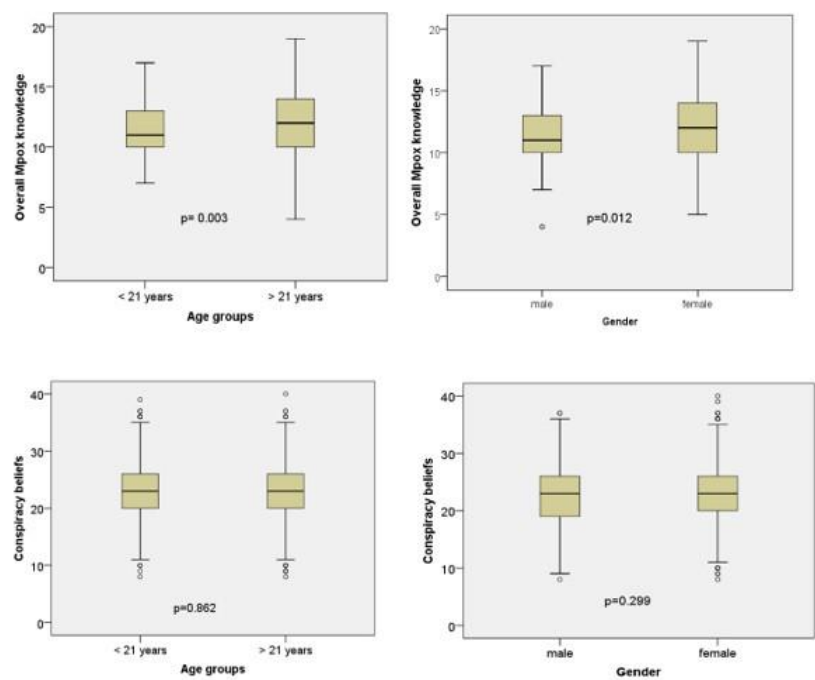


Figure 2. This is a figure. Schemes follow another format. If there are multiple panels, they should be listed as: (a) Description of what is contained in the first panel; (b) Description of what is contained in the second panel. Figures should be placed in the main text near to the first time they are cited.

4. Discussion

The main findings of the study were generally unsatisfactory levels of knowledge regarding Mpox among the students in Bulgaria and North Macedonia. The knowledge level was better in the group of students above 21 years of age, and females tend to show better understanding regarding the mechanisms of transmission and main symptoms and signs of the Mpox infection. Other researchers have reported similar findings [9, 10, 14, 15]. This may indicate more cumulative exposure to clinical education, enhanced engagement with health-related information, or gender disparities in risk perception and information-seeking behaviors. Nonetheless, significant misconceptions persisted among senior students, indicating systemic deficiencies in the undergraduate medical curriculum concerning infectious diseases. University students in medical universities are expected to have better knowledge regarding emerging and reemerging infectious diseases [16, 17]. The insufficient incorporation of emerging viral illnesses, such as Mpox, in the curricula of health education institutions in the studied countries may be a contributing factor to the existing information gaps about this escalating issue. The comparatively low national Mpox burden in Bulgaria and North Macedonia is believed to have contributed to the low level of awareness. In contrast to Western Europe and North America, where the 2022 outbreak triggered substantial media coverage and public health messages, Mpox garnered less attention in Southeastern Europe. Other emerging illnesses in Europe, such as Zika virus and Ebola, have also been linked to low local incidence and limited disease knowledge [1, 18].

A significant finding of this study is the pronounced ambivalence regarding statements related to conspiracy theories. For most respondents, the predominant response was “neither agree nor disagree,” reflecting uncertainty rather than a clear rejection of conspiracy theories. Although robust support for conspiratorial beliefs was confined to a minority of students, a significant proportion expressed partial agreement with assertions concerning the laboratory origins of pathogens, intentional population control, economic manipulation via lockdowns, and media disinformation.

With the introduction of the SARS-CoV-2 virus, conspiracy theories about the emergence or reemergence of infectious viruses have grown in popularity. Conspiracy beliefs can have harmful implications because people who endorse them may refrain from engaging in acceptable health behaviors [19-22]. Authors have implicated that even individuals with higher education, including healthcare professionals, are susceptible to conspiracy beliefs, especially during times of scientific ambiguity and swiftly changing evidence [15, 22]. Conspiracy theories are frequently linked to diminished faith in public health authorities, less compliance with preventative measures, and a decreased willingness to vaccinate [10, 22].

The observed uncertainty among students regarding conspiracy beliefs may be due to poor training in critical appraisal of scientific information and minimal exposure to formal debates on disinformation and infodemics [23, 24]. Systematic reviews of medical education indicate that although students are proficient in locating health information, they exhibit deficiencies in critical evaluation skills, underscoring the necessity for improved instruction in scientific literacy and critical thinking [25, 26]. Educational strategies that include health literacy training, science communication skills, and misinformation identification have demonstrated effectiveness in enhancing medical students' capacity to critically assess health information [23, 27, 28].

The acceptance of statements attributing Mpox transmission to men who have sex with males is also alarming, as it risks perpetuating stigma and discrimination—an issue previously observed during both the HIV/AIDS epidemic and the Mpox outbreak [29,30]. The homophobic portrayal of Mpox in public health communications has been recognized as a significant contributor to stigma, hindering outbreak management and adversely affecting the mental health of impacted communities [31, 32].

These findings indicate that there is an urgent need for comprehensive curriculum reform to incorporate emerging infectious diseases, critical evaluation skills for scientific data, training on health misinformation and infodemics, and anti-stigma education into medical school programs. Educational initiatives must prioritize evidence-based methodologies in infectious disease epidemiology, employ various instructional modalities such as e-learning platforms, and incorporate practical training in assessing the veracity of health information [24, 33, 34].

5. Limitations

This study has several limitations that should be acknowledged. First, its cross-sectional nature prevents causal inference, and the observed connections must be regarded as descriptive rather than explanatory. Second, the utilization of convenience and chain-referral sampling may constrain the generalizability of the results, especially given the over-representation of students from specific universities. Third, all the data came from people who reported it themselves, which could lead to recall bias and social desirability bias.

Additionally, the survey was conducted during the early phase of the 2022 Mpox outbreak, when scientific knowledge and public communication were still evolving. Knowledge levels and attitudes may have changed subsequently as more information became available. Finally, while the knowledge scoring system allowed differentiation between incorrect answers and uncertainty, it may not fully capture the depth or clinical applicability of respondents' understanding.

Despite these limitations, the large sample size, inclusion of students from two neighboring countries, and use of previously validated survey instruments strengthen the reliability and relevance of the findings. To the best of our knowledge, this is the first questionnaire-based survey on Mpox in these two Southeastern European countries.

6. Conclusions

In the current research, we found that it is necessary to increase the awareness of students (and the general population) about Mpox. This fact highlights the necessity for the national health authorities in Bulgaria and North Macedonia to conduct an information campaign. These findings

reveal substantial knowledge gaps among future healthcare professionals and emphasize the urgent need to strengthen medical curricula and targeted training on emerging infectious diseases to enhance outbreak preparedness, early detection, and effective risk communication in Southeastern Europe. The implementation of adequate and timely health policies in the field of “Zoonoses and Public Health” has a direct impact on the personal health and quality of life of every citizen.

Author Contributions: Conceptualization, V.R. and D.J.; methodology, V.R.; software, V.R.; validation, V.R. and M.H.; formal analysis, V.R.; investigation, V.R., D.J., M.B., M.M., and S.S.; resources, V.R.; data curation, V.R. and M.H.; writing—original draft preparation, V.R. and M.B.; writing—review and editing, V.R., D.J., M.B., M.M., M.H., I.T., S.S., A.K.; visualization, V.R.; supervision, A.K.; project administration, V.R.; funding acquisition, M.H. All authors have read and agreed to the published version of the manuscript.

Funding: The study received an ethical exemption from the Ethics Committee as it met one of the criteria for exemption (an anonymous survey or interview that does not involve the collection of identifiable data). The study complies with the principles of the Declaration of Helsinki for medical research involving human subjects.

Institutional Review Board Statement: The study received an exemption from the Ethics Committee as it met one of the criteria for exemption (an anonymous survey or interview that does not involve the collection of identifiable information). The study complies with the principles of the Declaration of Helsinki for medical research involving humans [35].

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

Data Availability Statement: Data will be provided on request.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Riccò, M.; Ferraro, P.; Camisa, V.; Satta, E.; Zaniboni, A.; Ranzieri, S.; Baldassarre, A.; Zaffina, S.; Marchesi, F. When a Neglected Tropical Disease Goes Global: Knowledge, Attitudes and Practices of Italian Physicians towards Monkeypox, Preliminary Results. *Trop. Med. Infect. Dis.* **2022**, *7*, 135. <https://doi.org/10.3390/tropicalmed7070135>
2. Mitjà, O.; Ogoina, D.; Titanji, B.K.; Galvan, C.; Muyembe, J.J.; Marks, M.; Orkin, CM. Monkeypox. *Lancet*. **2023**, 401(10370):60–74. [https://doi.org/10.1016/S0140-6736\(22\)02075-X](https://doi.org/10.1016/S0140-6736(22)02075-X).
3. Bunge, E.M.; Hoet, B.; Chen, L.; Lienert, F.; Weidenthaler, H.; Baer, L.R.; Steffen, R. The Changing Epidemiology of Human Monkeypox—A Potential Threat? A Systematic Review. *PLoS Negl. Trop. Dis.* **2022**, *16*, e0010141. <https://doi.org/10.1371/journal.pntd.0010141>.
4. World Health Organization. WHO Director-General Declares Mpox Outbreak a Public Health Emergency of International Concern. 2024. Available online: <https://www.who.int/news/item/14-08-2024-who-director-general-declares-mpox-outbreak-a-public-health-emergency-of-international-concern> (accessed on 30 January 2026).
5. Global Mpox Trends, 2026. Available online: https://worldhealthorg.shinyapps.io/mpx_global/#sec-global (accessed on 01 20 February 2026).
6. Titanji, B.K.; Hazra, A.; Zucker, J. Mpox Clinical Presentation, Diagnostic Approaches, and Treatment Strategies: A Review. *JAMA*. **2024**;332(19):1652–1662. <https://doi.org/10.1001/jama.2024.21091>.
7. Riad, A.; Attia, S. Monkeypox-Related Oral Manifestations and Implications: Should Dentists Keep an Eye Out? *J. Med. Virol.* **2023**, *95*, e28091. <https://doi.org/10.1002/jmv.28091>.
8. Nuzzo, J.B.; Borio, L.L.; Gostin, L.O. The WHO Declaration of Monkeypox as a Global Public Health Emergency. *JAMA* **2022**, *328*, 615–616. <https://doi.org/10.1001/jama.2022.12513>
9. Alshahrani, N.Z.; Mitra, S.; Alkuwaiti, A.A.; Alhumam, M.N.; Altmimi, S.M.B.; Alamri, M.H.M.; Albalawi, Z.A.S.; Almorgi, M.W.; Alharbi, H.K.D.; Alshahrani, S.M. Medical Students' Perception Regarding the Re-Emerging Monkeypox Virus: An Institution-Based Cross-Sectional Study From Saudi Arabia. *Cureus* **2022**, *14*, e28060. <https://doi.org/10.7759/cureus.28060>

10. Sallam, M.; Al-Mahzoum, K.; Dardas, L.A.; Al-Tammemi, A.B.; Al-Majali, L.; Al-Naimat, H.; Jardaneh, L.; AlHadidi, F.; Al-Salahat, K.; Al-Ajlouni, E.; et al. Knowledge of Human Monkeypox and Its Relation to Conspiracy Beliefs among Students in Jordanian Health Schools: Filling the Knowledge Gap on Emerging Zoonotic Viruses. *Medicina* **2022**, *58*, 924. <https://doi.org/10.3390/medicina58070924>

11. European centre for Disease Control and Prevention (ECDC), Communicable Diseases Threats Report, 17 February 2023. Available online: https://www.ecdc.europa.eu/sites/default/files/documents/communicable-disease-threats-report-17-feb-2023_0.pdf (accessed on 30 January 2026).

12. Health Ministry: Two monkeypox cases confirmed in Bulgaria, June 23, 2022. Available online: <https://sofiaglobe.com/2022/06/23/health-ministry-two-monkeypox-cases-confirmed-in-bulgaria/> (accessed on 30 January 2026).

13. Polit, D.F.; Beck, C.T.; Owen S.V. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Res Nurs Health*. **2007**;30(4):459-467. <https://doi.org/10.1002/nur.20199>.

14. Harapan, H; Setiawan A.M.; Yufika A, et al. Knowledge of human monkeypox viral infection among general practitioners: a cross-sectional study in Indonesia. *Pathog Glob Health*. **2020**;114(2):68-75. <https://doi.org/10.1080/20477724.2020.1743037>.

15. Freeman, D.; Waite, F.; Rosebrock, L.; Petit, A.; Causier, C.; East, A.; Jenner, L.; Teale, A.-L.; Carr, L.; Mulhall, S.; et al. Coronavirus conspiracy beliefs, mistrust, and compliance with government guidelines in England. *Psychol. Med*. **2020**, *52*, 251–263. <https://doi.org/10.1017/S0033291720001890>.

16. Doan, D.A.; Nguyen, T.T.X.; Le G.B.; Phuong, T.L.; Nguyen, P.L.; Dinh, DX. Knowledge and attitudes of medical and pharmacy university students regarding monkeypox: a multicenter, cross-sectional study in Vietnam. *BMC Med Educ*. **2024**. 24(1):807. <https://doi.org/10.1186/s12909-024-05805-4>.

17. Yu, L.; Shen, Y.; Liu, M.; Ma, J.; Long, J.; Zheng, D. Evaluation of monkeypox knowledge and attitudes among Chinese medical students. *BMC Public Health*. **2024**;24(1):745. <https://doi.org/10.1186/s12889-024-18259-6>.

18. Mullan, J.; Burns, P.; Weston, K.; McLennan, P.; Rich, W.; Crowther, S.; Mansfield, K.; Dixon, R.; Moselen, E.; Osborne R.H.. Health literacy amongst health professional university students: a study using the Health Literacy Questionnaire. *Education Sciences*, **2017** 7(2), 54. <https://doi.org/10.3390/educsci7020054>.

19. Castro-Sánchez, E.; Chang, P.W.S.; Vila-Candel, R.; Escobedo, A.A.; Holmes, A.H.; Health literacy and infectious diseases: why does it matter?. *Int J Infect Dis*. **2016**. 43:103-110. <https://doi.org/10.1016/j.ijid.2015.12.019>.

20. Bunge, E.M.; Hoet, B.; Chen, L.; Lienert, F.; Weidenthaler, H., Baer, L.R.; Steffen, R. The changing epidemiology of human monkeypox-A potential threat? A systematic review. *PLoS Negl Trop Dis*. **2022**. 16(2):e0010141. <https://doi.org/10.1371/journal.pntd.0010141>.

21. van Mulukom, V.; Pummerer, L.J.; Alper, S. et al. Antecedents and consequences of COVID-19 conspiracy beliefs: A systematic review. *Soc Sci Med*. **2022**. 301:114912. <https://doi.org/10.1016/j.socscimed.2022.114912>.

22. Ripp, T.; Röer, J.P. Systematic review on the association of COVID-19-related conspiracy belief with infection-preventive behavior and vaccination willingness. *BMC Psychol*. **2022**. 10(1):66. <https://doi.org/10.1186/s40359-022-00771-2>.

23. Almulhem, J.; Aldekhyyel, R. Medical Students' Ability to Assess Health Information Accuracy. *Stud Health Technol Inform*. **2025**. 329:1397-1401. <https://doi.org/10.3233/SHTI251068>.

24. Enders, A.; Klofstad, C.; Diekman, A.; Drochon, H.; Rogers de Waal, J.; Littrell, S.; Premaratne, K.; Verdear, D.; Wuchty, S.; Uscinski, J. The sociodemographic correlates of conspiracism. *Sci Rep*. **2024**. 14(1):14184. <https://doi.org/10.1038/s41598-024-64098-1>.

25. Baralin, A.; Boulares, E.; Tan, S.C.Y.; Shin, Y.J. Identifying Strengths and Weaknesses in Health Literacy among Medical Students: A Systematic Review. *BMC Med Educ*. **2025** 25(1):1424. <https://doi.org/10.1186/s12909-025-07388-0>.

26. Araújo, B.; Gomes, S.F.; Ribeiro, L. Critical thinking pedagogical practices in medical education: a systematic review. *Front Med (Lausanne)* **2024** 11:1358444. <https://doi.org/10.3389/fmed.2024.1358444>.

27. Arora, V.M.; Krishnamoorthi, V.R.; Bloomgarden, E.; Jain, S.; Sunderrajan, A.; Tesema, N.; Zietowski, M.; Farnan, J.; Serritella, S. Restoring Trust in Science and Medicine: Empowering and Educating Future

- Physicians in Science Communication With the Public. *Acad Med.* **2023** 98(6S):S30-S33. <https://doi.org/10.1097/ACM.00000000000005178>.
28. Krohn, K.M.; Crichlow, R.; McKinney, Z.J.; Tessier, K.M.; Scheurer, J.M.; Olson, A.P.J. Introducing Mass Communications Strategies to Medical Students: A Novel Short Session for Fourth-Year Students. *Acad Med.* **2022** 97(7):999-1003. <https://doi.org/10.1097/ACM.00000000000004555>.
 29. World Health Organization. (2024). *Risk communication and community engagement readiness and response toolkit: mpox*. Available online: <https://www.who.int/publications/i/item/9789240091559> (accessed on 30 January 2026).
 30. Thornhill, J.P.; Antinori, A.; Orkin C.M. Monkeypox Virus Infection across 16 Countries - April-June 2022. Reply. *N Engl J Med.* **2022** 387(25):e69. <https://doi.org/10.1056/NEJMc2213969>.
 31. Paterson, A, Cheyne, A.; Tulunay, H.; Orkin, C.; Nutland, W.; Dunning, J.; Stolorow, J.; Gobat, N.; Olliaro, P.; Rojek, A. Mpox stigma in the UK and implications for future outbreak control: a cross-sectional mixed methods study. *BMC Med.* **2025** 23(1):422. <https://doi.org/10.1186/s12916-025-04243-3>.
 32. Linares-Navarro, R.; Sanz-Muñoz, I.; Onecha-Vallejo, V.; Fernandez-Espinilla, V.; Eiros, J.M.; Castrodeza-Sanz, J.; Prada-Garcia, C. Psychosocial impact and stigma on men who have sex with men due to monkeypox. *Front Public Health.* **2025** 13:1479680. <https://doi.org/10.3389/fpubh.2025.1479680>.
 33. Charlier, C.; Johannessen, I.; Mackintosh, C.L.; Wilks, D.; Cauda, R.; Wolf, F.I.; Jeunne, C.L. International infectious diseases teaching to undergraduate medical students: A successful European collaborative experience. *Med Teach.* **2017** 39(9):981-986. <https://doi.org/10.1080/0142159X.2017.1332364>.
 34. Bendezu-Quispe, G.; Torres-Roman, J.S.; Salinas-Ochoa, B.; Hernández-Vásquez, A. Utility of massive open online courses (MOOCs) concerning outbreaks of emerging and reemerging diseases. *F1000Res.* **2017** 6:1699. <https://doi.org/10.12688/f1000research.12639.2>.
 35. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* **2013** 27;310(20):2191-4. <https://doi.org/10.1001/jama.2013.281053>

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.