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ORIGINAL ARTICLE

Scientific research in biomedical studies: insights and barriers at the University of Sarajevo

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ABSTRACT

Aim The position of science and scientific research in Bosnia and Herzegovina (B&H) is unfavourable. University education lacks research programs, hindering students from developing critical evaluation skills.
Methods This cross-sectional study examined knowledge, attitudes, experience and perceived barriers towards scientific research among biomedical students and recent graduates at the University of Sarajevo in B&H. A self-reporting questionnaire was distributed via social networks and among students from all years of the Medical, Dentistry, Pharmaceutical faculties, the Faculty of Health Sciences, and the Faculty of Science, as well as recent graduates.
Results The survey was completed by 243 participants. The mean knowledge score of 4.3/11 was noticed; 216 (96%) believed research was necessary for healthcare improvement. Although 147 participants (65.3%) attended courses on research methodology, only 63 (28%) engaged in scientific research at their faculties. Only 5 (8.5%) employed graduates participated in research at their jobs. Almost half, 99 (44%) participants consulted scientific papers only upon recommendation. The majority of participants, 199 (82.2%), reported they experienced barriers to conducting research in B&H.
Conclusion Biomedical students and graduates demonstrated limited research knowledge, but had positive attitudes and acknowledged significant barriers. Improved faculty curricula in research areas and more opportunities are needed.

Keywords: biomedical research, Bosnia and Herzegovina, curriculum, students

INTRODUCTION

Scientific research programs during university education help students develop skills in critically evaluating new information, communicating and disseminating findings which advance medical knowledge (1). The need to develop research skills was recognized at the universities in developed countries, therefore research courses and projects are integral parts of the curriculum (2). These programs offer structured research activities with support systems, along with extracurricular research opportunities (3,4). Active measures are being taken to incentivize medical graduates to pursue these roles at clinical-academic career paths (5,6)

Unfortunately, research is not highly prioritized in developing countries, and its importance is not sufficiently emphasized (7). This issue is evident in Bosnia and Herzegovina (B&H) (8). Medical training in B&H is offered at six universities, each following a similar curriculum. Despite the University of Sarajevo's status as the top university in B&H, its publication output and investment in research and development are markedly lower than those in the neighbouring countries (9). Medical programs in B&H do include modules on scientific research methodology, but the programs are largely theoretical. While some universities require diploma theses, their rigor and research focus vary, often emphasizing literature reviews over hands-on research experience.

The unfavourable situation in B&H has been recognized, and strategies for strengthening research have been proposed (8). These include initiatives such as the development strategy and research rewards based on the scientific research outcome. Actively involving medical students and health professionals in research is seen a key opportunity to revitalize academic medicine (10,11), and this can especially hold for B&H.

The aim of this study was to assess research knowledge of biomedical students and graduates at the University of Sarajevo (B&H), identify gaps in their education, explore their attitudes towards research, and examine their previous experiences and challenges.

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MATERIALS AND METHODS

Patients and study design

A cross-sectional survey among biomedical students and recent graduates of the University of Sarajevo in B&H in December 2021 was conducted. The study population included students from all years of the Medical, Dentistry, Pharmaceutical Faculties, the Faculty of Health Sciences, and the Faculty of Science, as well as graduates who completed their studies within the past five years. The self-reporting questionnaire was adapted from previous studies and tailored to the local context (12–15). Before being distributed to the study population, it was pretested with a pilot group of 20 students, graduates, and associate staff from all faculties. This test was aimed at evaluating the questionnaire's clarity, logical flow, and content, and it was revised based on the feedback received. The questionnaire was distributed online via social networks and among groups consisting of the study population, using a Google Forms link (Supplemental Digital Content 1). Participation was voluntary. It took participants approximately 20 minutes to complete the questionnaire. An informed consent was obtained from all survey participants and confidentiality ensured.

The study was approved by the Ethical Committee University of Sarajevo.

Methods

The introductory part of the questionnaire explained the aim of the survey and assured the participants of the anonymity of their responses. The questionnaire consisted of five sections.

The first section collected sociodemographic data, including age, gender, education status, faculty, and grade point average (GPA).

The second section assessed participants' knowledge of scientific research through eleven multiple-choice questions, each with a single correct answer evaluating basic understanding of study types, databases, and research and statistical terminology. Correct answers were scored as 1 point each, with incorrect answers scored as 0, leading to the maximum possible score of 11.

The third section evaluated participants' attitudes towards scientific research with seven positive and four negative statements. The participants indicated their level of agreement with each statement using the five-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree) (16).

The fourth section focused on participants' experience in scientific research. It collected information about prior involvement in scientific research, presentations, and publications through a mix of YES/NO and multiple/choice questions detailing the nature of the involvement.

The fifth section explored perceived barriers to scientific research in B&H. The participants assessed their perceptions of 11 potential institutional and personal barriers, rating each on a four-point scale (considering huge barrier, major barrier, minor barrier, and not barrier at all).

Statistical analysis

Data were exported to an Excel sheet, where they were checked for missing and invalid values, before being coded. Descriptive statistics were presented as frequencies, percentages, means and standard deviations (SD). In the analysis of attitudes, "strongly agree" was assigned score 5, whereas "strongly disagree" score 1. For negative statements, these scores were reversed, with "strongly agree" receiving score 1 and "strongly disagree" score 5. A total score for attitudes was calculated for each participant and an average score across all study statements. To identify differences in mean knowledge and attitudes towards biomedical research across different demographic and academic groups (age, sex, study year, educational status, GPA, and previous research experience and education), independent t-test, χ^2 test, ANOVA and post-hoc test were used. A $p<0.05$ was considered statistically significant.

RESULTS

The survey was completed by 243 respondents. As the Google Forms link was shared freely without tracking how many people received it, the total number of recipients was unknown, and the response rate could not be estimated. After excluding participants who graduated more than five years ago, 225 participants remained, of whom 166 (73.8%) were students; 173 (76.9%) were females. The average age was 25.1± 3.2 years. The majority of the participants, 168 (74.7%) were students or graduates of the medical faculty. The average GPA of the participants was 8.38 ± 0.57, categorized as above and below average, using a cutoff value of 8.4 (Table 1).

Table 1. Demographic characteristics of 225 study participants

Variable	Value
Age mean ± SD (years)	25.1 ± 3.2
Female (No; %)	173 (76.9)
GPA mean ±SD	8.38 ± 0.57
Faculty (No; %)	166 (73.8)
Faculty of Medicine	168 (74.7)
Faculty of Dentistry	38 (16.9)
Faculty of Health Sciences	11 (4.9)
Faculty of Pharmacy	5 (2.2)
Faculty of Veterinary Medicine	2 (0.9)
Faculty of Science	1 (0.4)
Year of the study (No; %)	
First	2 (1.2)
Second	13 (7.8)
Third	40 (24.1)
Fourth	34 (20.5)
Fifth	47 (28.3)
Sixth	30 (18.1)
Graduates	59 (26.2)
Years since graduation (mean ± SD)	1.97 ± 1.2
Employment positions of graduates	
Physician	31 (52.5)
Pharmacist	2 (3.4)
Lecturer	2 (3.4)
Laboratory technician	1 (1.7)

GPA, grade point average

The average score for participants' knowledge of scientific research was 4.3 ± 2.5 for participants who answered each MCQ question correctly. One hundred twenty-six (51.7%) participants were scored between 4 and 7 (moderate knowledge), 90 (37.2%) between 0 and 4 (low knowledge), and 27 (11.1%) between 8 and 11 (high knowledge) (Table 2).

There were no significant differences in knowledge scores between genders (p=0.87). However, participants with above-average GPA scored significantly higher (Table 3). This difference related to GPA remained significant when stratified between students and graduates (p=0.01 and p=0.04, respectively). Those participants who had an education in scientific research methodology during their studies, those who participated in a research project either during their studies or their workplace, or presented or published a paper had significantly higher knowledge scores (p<0.001) (Table 3).

The average attitudes score was 4.2 ± 0.42. Two hundred sixteen (96.0%) participants agreed (strongly or moderately) that scientific research was necessary for health care improvement, 209 (95.0%) agreed with the statement that they wanted to participate in research, and 178 (79.8%) agreed with the statement that conducting research was difficult and demanding. One hundred twenty-two (56.2%) felt confident reading and interpreting scientific papers, and 165 (75.0%) reported feeling confident to search scientific literature to support their clinical decisions.

There were no significant differences in attitude scores between genders, age groups, GPA groups, student status, education in scientific research methodology, participation in research projects, or paper publication/presentation (Table 3).

A total of 147 participants (65.3%) had an education in scientific methodology and biostatistics during their studies. However, only 63 (28.0%) participated in conducting scientific research at their faculties. Nineteen (8.4%) submitted a scientific paper to a journal, and 38 (16.9%) presented a paper at a congress. Only 5 (8.5%) employed participants engaged in research projects at their workplaces. Regarding reading habits, 99 participants (44%) reported that they read scientific papers when dealing with a topic or clinical problem only when being recommended, 28 (12.4%) that they sometimes read papers on their own, 72 (32%) often, and 16 (7.1%) always (Table 4).

A majority of participants, 200 (82.2%), reported facing barriers in conducting scientific research in B&H. Lack of support and motivation at the faculty/workplace, lack of finances, lack of time, lack of equipment, lack of education in scientific research, difficulties in statistical analysis of data, lack of focus on research in comparison to educational activities at faculty and workplace, and limited approach to literature and databases were identified as huge and major institutional barriers in B&H by majority of our participants (Table 5). Lack of knowledge in methodology and statistics, lack of time, lack of money, lack of mentors and lack of support for ideas were identified as huge and major personal barriers.

Table 2. Knowledge scores for each multiple choice questions (MCQ)

Question		No (%) of participants who gave a correct answer
1.	What does incidence represent?	168 (74.7)
2.	Which of these is an example of case report study?	139 (61.8)
3.	What is a review paper?	115 (51.1)
4.	Which of the following is not an online database?	96 (42.7)
5.	What is h-index?	85 (37.8)
6.	What does chi square measure?	79 (35.1)
7.	What is bias?	78 (34.7)
8.	What is a P value?	73 (32.4)
9.	When is regression analysis used in statistics?	55 (24.4)
10.	Which study offers the highest level of evidence?	48 (21.3)
11.	Which software/programming language cannot be used for statistical data processing?	26 (11.6)

Table 3. Comparison of attitudes, barriers, and knowledge scores in the study population

Characteristics		Knowledge* (mean ± SD)	p	Attitude† (mean ± SD)	p	Barriers‡ (mean ± SD)	p
Gender	Male	4.33±2.8	0.87	3.71±0.58	0.96	1.84±0.48	0.12
	Female	4.26±2.4		3.70±0.41		1.72±0.47	
Student status	Student	3.95±2.37	0.01	3.71±0.40	0.86	1.8±0.5	0.55
	Graduated	5.2±2.58		3.69±0.57		1.85±0.43	
Grade Point Average	Above average	4.89±2.49	0.01	3.69±0.39	0.72	1.82±0.42	0.43
	Below average	3.69±2.35		3.72±0.51		1.87±0.49	
Study year	First year	1.50±2.12	0.006	3.37±0.88	0.015	1.72±0.41	0.44
	Second	2.46±2.03		3.42±0.42		1.74±0.72	
	Third	3.85±2.52		3.75±0.36		1.85±0.42	
	Forth	3.41±2.22		3.86±0.43		1.83±0.48	
	Fifth	4.85±2.23		3.68±0.26		1.71±0.46	
	Sixth	4.07±2.13		3.65±0.50		1.87±0.56	
Education on research methodology	Yes	4.78±2.49	<0.001	3.68±0.48	0.16	1.78±0.49	0.12
	No	3.12±2.03		3.77±0.37		1.89±0.44	
Participated in research project	Yes	5.32±2.53	<0.001	3.75±0.44	0.20	1.72±0.42	0.017
	No	3.65±2.24		3.67±0.46		1.87±0.51	
Presented or published a paper	Yes	5.52±2.38	<0.001	3.79±0.47	0.16	1.81±0.5	0.77
	No	3.97±2.42		3.68±0.45		1.84±0.4	

*Knowledge score is the number of correct answers out of 11 questions; †Attitude score was calculated: strongly agree =5, agree =4, no opinion =3, disagree =2, strongly disagree =1; for negative statements strongly disagree =5, disagree =4, no opinion =3, agree =2, strongly agree =1; higher score indicates more positive attitude; ‡Barriers scores were calculated: huge barrier =3; major =2; minor =1; mot a barrier =0

Table 4. Experience in scientific research of the study population

Questions	Answer	No (%)
Did you have education in scientific research methodology or biostatistics as a compulsory subject during your studies?	YES	147 (65.3)
	NO	78 (34.7)
Have you participated in education in scientific research methodology outside of class?	YES	39 (17.3)
	NO	186 (82.7)
Have you ever participated in the implementation of a scientific research project at your faculty (if you are not currently studying, it refers to the period when you were a student)?	YES	63 (28)
	NO	162 (72)
Have you ever participated in the implementation of a scientific research project outside your faculty (if you are not currently studying, it refers to the period when you were a student)?	YES	40 (17.8)
	NO	185 (82.2)
If you are employed, have you ever participated in the implementation of a scientific research project at your workplace?	YES	5 (8.5)*
	NO	54 (91.5)*
If you are employed, have you ever participated in a scientific research project outside of your workplace?	YES	6 (10.2)*
	NO	53 (89.8)*
Have you ever, alone or within a group, submitted a research proposal to your institution (faculty, workplace, ethics committee)?	YES	147 (65.3)
	NO	78 (34.7)
Have you ever presented your own work at a congress?	YES	38 (16.9)
	NO	187 (83.1)
Have you ever submitted a paper for publication in a journal?	YES	19 (8.4)
	NO	206 (91.6)
Have you ever published a paper in a journal?	YES	19 (8.4)
	NO	206 (91.6)
How often do you read scientific papers published in journals when dealing with a topic/problem?	Always	16 (7.1)
	Often	72 (32.0)
	Sometimes	28 (12.4)
	Only if someone recommends me an article	99 (44.0)
	I do not look for solutions in papers, I use other literature or other opinions	10 (4.4)

*The percentage refers to the population of participants who graduated

Table 5. Participants' perceived institutional barriers for conducting scientific research

Perceived institutional barriers	No (%) of participants				
	Huge barrier	Major barrier	Minor barrier	Not at all	No opinion
Lack of funding	131 (58.2)	47 (20.9)	18 (8)	6 (2.7)	16 (7.1)
Lack of equipment at the university/workplace	110 (48.9)	68 (30.2)	22 (9.8)	11 (4.9)	8 (3.6)
Lack of training in scientific methodology	109 (48.4)	64 (28.4)	34 (15.1)	9 (4)	6 (2.7)
Lack of time due to overload	95 (42.2)	69 (30.7)	42 (18.7)	10 (4.4)	6 (2.7)
Lack of support and motivation at the university	83 (36.9)	79 (35.1)	36 (16)	13 (5.8)	7 (3.1)
Difficulties in processing statistical data	73 (32.4)	61 (27.1)	49 (21.8)	19 (8.4)	16 (7.1)
Lack of focus on research in relation to educational activities at the faculty	75 (33.3)	87 (38.7)	38 (16.9)	10 (4.4)	12 (5.3)
Lack of recognition and appreciation for innovative researchers	69 (30.7)	77 (34.2)	47 (20.9)	9 (4)	14 (6.2)
Lack of focus on research in relation to clinical activities in the workplace	61 (2.1)	77 (34.2)	35 (15.6)	9 (4)	17 (7.6)
Difficulty finding a mentor	42 (18.7)	82 (36.4)	69 (30.7)	14 (6.2)	10 (4.4)
Lack of access to literature and databases	38 (16.9)	71 (31.6)	58 (25.8)	40 (17.8)	11 (4.9)
Difficulties in getting approval from the ethics committee	36 (16)	68 (30.2)	42 (18.7)	21 (9.3)	43 (19.1)
Difficulties in writing research proposals	21 (9.3)	69 (30.7)	78 (34.7)	29 (12.9)	22 (9.8)
Difficulties in choosing a topic	11 (4.9)	52 (23.1)	99 (44)	53 (23.1)	7 (3.1)

DISCUSSION

This study is the first to assess the knowledge, attitudes, and barriers to scientific research among biomedical students and graduates at the largest university in B&H, University of Sarajevo. Our findings reveal a significant gap in both research knowledge and practical skills, along with a high number of perceived barriers. However, positive attitudes towards research suggest a strong potential for improvement if adequate resources and support are provided.

While the majority of participants exhibited only moderate to low levels of scientific research knowledge, these findings align with those from other developing countries. For instance, high knowledge scores were reported at 13.5% in India (17), 16.9% in Saudi Arabia (13), 9.1% in Pakistan (18), and even 4% in Malaysia (15). However, we observed a notably positive disposition towards scientific research among the participants. This indicates that biomedical students and graduates recognize the importance of research for improving medical practice, consistent with studies in Southeast (19,20) and Western Europe (21).

A pivotal factor influencing student attitudes is the presence of specific educational interventions, showed that students' attitudes towards research became more positive after attending a scientific methodology course (22).

While participants recognized the importance of research, they feel ill-equipped to engage in it effectively, as 79.1% believed that conducting research was difficult and challenging. Only a slight majority (56.2%) was feeling confident in reading and interpreting scientific papers. Studies conducted in Ireland and Canada also reported that students perceived their research-specific skills not as high as their transferable skills (23), and that their training in research skills was insufficient (24). The problem of a passive and observational nature of medical education was also observed in some studies (25), reflecting a broader challenge in medical education.

We observed a discrepancy between educational exposure and practical involvement, with only a quarter of our participants conducting research at their faculties. Similar trends were observed in Romania, Portugal, and the UK where about a half of the participants did not engage in undergraduate research (4,26,27). The value of engaging in research projects extends beyond academic achievements. Students involved in research reported positive responses towards their research experiences and medical science, and also self-reported changes in their practices, and contributed to their university publication output (28). Universities known for research excellence offer more opportunities for students to engage in research (29).

A very low number of our participants presented their research at conferences and even less submitted papers to journals. Students' research projects often result in publishable papers (30), but limited opportunities to participate in such projects hinder submission (27). This highlights the need for more opportunities and support for student research.

Most of our participants reported facing obstacles to scientific research in B&H, including lack of support, funding, time and mentors. A particularly concerning point highlighted by our participants is the difficulty in finding mentors for research projects. Academic staff often lack the capacity to mentor due to teaching responsibilities (30,31). This is especially critical, as effective mentoring is known to significantly enhance students' research skills, boost their enthusiasm for academic careers, and improve their scholarly output. In addition, underdeveloped systems for managing public health data in our country create barriers for research. We hypothesize that these barriers are the reasons why students and graduates leave B&H to pursue research careers, contributing to the "brain drain". Between 2010 and 2019, highly educated individuals accounted for 6% of B&H's net outflow (32).

B&H ranks 95th globally in scientific publications (33), trailing Slovenia (53rd), Serbia (52nd), and Croatia (51st). The substantial gap of over 30 places in the world ranking can be attributed to negligence and ignorance of the B&H authorities towards science and scientific research, as well as lack of awareness among academics about the importance of scientific research (8). The University of Sarajevo, the largest and highest-ranked university in B&H (34), published 2,705 publications in the Web of Science Core Collection between 2019 and 2023 (9), far fewer than top universities in neighbouring countries. For instance, the Clinical Centre of the University of Sarajevo published only 194 articles between 2019 and 2023, up to 20 times less than similar institutions in the neighbouring countries (35). This disparity is mostly due to low institutional support, investing less than 0.2 % of gross domestic product (GDP) for research, compared to Croatia (1.22%), Serbia (0.99%), and Slovenia (2.13%) (36). However, progress is seen at the local level, where certain municipalities have increased research funding, with expected improvements in academic indicators.

The study's limitations include the small sample, the questionnaire's extensive length and time-consuming process, and lack of its standardization. Additionally, since participation was voluntary, respondents may have been more familiar with research topics. As a small-scale study, these findings aim to refine the methodology for future national-level research.

CONCLUSION

Our study is the first conducted at the University of Sarajevo, the largest university in Bosnia and Herzegovina, revealing a significant gap in research knowledge among students and recent graduates of biomedical sciences. Although research course is included in the curriculum, many participants lacked practical involvement in research activities, which limited their preparedness for conducting research. The findings point to a lack of opportunities, mentorship, and institutional support as major barriers. This indicates that the current faculty curricula and infrastructure at the University of Sarajevo are not sufficient to foster research skills. However, the strong positive attitudes observed among participants suggest readiness for improvement if provided with necessary resources. These insights lay the foundation for future national-level studies to further explore and support this potential.

AUTHOR CONTRIBUTIONS

Conceptualization, N.S., M.Š., B.K., I.E.; methodology, N.S., M.Š., B.K., I.E.; software, N.S., B.K.; validation, B.K., B.S.Š, A.K.C.; formal analysis, N.S., B.K.; investigation, N.S., M.Š., B.K., I.E., B.S.Š; resources, N.S., M.Š., B.K., I.E.; data curation, N.S., B.K.; writing—original draft preparation, N.S., M.Š., B.K.; writing—review and editing, A.K.C.; supervision, A.K.C.; project administration, M.Š. All authors have read and agreed to the published version of the manuscript.

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Conflict of interests: None to declare.

SUPPLEMENTAL DIGITAL CONTENT (SDC)

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