Research Article

Laboratory Professionals' Perspectives on Artificial Intelligence in Laboratory Medicine: Insights from a National Survey in Albania

Helena Lame[1,2*], Nevila Heta[1,2], Valbona Tole[1,2], Arba Coraj[1,2], Etleva Refatllari[1,2], Irena Korita[1,2], Mirela Lika[1,2], Ersida Kapllani[1,2], Anyla Bulo[1]

[1]*Laboratory Department, Faculty of Medicine, University of Medicine, Tirana*
[2]*Laboratory Networks, University Hospital Center "Mother Teresa", Tirana, Albania*

Article Info

[*]***Corresponding Author:***
Helena Lame
E-mail: helena.lame@umed.edu.al
Rruga e Dibres, Nr. 371, Tirana 1005, Albania
Phone: +355692993335

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Abstract

Introduction: While Artificial Intelligence (AI) is transforming Laboratory Medicine, successful AI integration depends on the readiness of healthcare professionals. This study aimed to assess the perspectives of Albanian laboratory professionals toward AI integration in medical laboratories.

Methods: We conducted a cross-sectional, voluntary, and anonymous survey using Google Forms. The survey link was distributed to all members of the Albanian Society of Clinical Biochemistry and Laboratory Medicine and their affiliated staff. The survey explored General Information and Demographics, Digital Properties and Health Data Access, and Perspectives on Artificial Intelligence in Medical Laboratories. Responses were automatically collected over four weeks and were analyzed to investigate laboratory professionals' perspectives.

Results: A total of 220 laboratory professionals completed the survey. 30% of participants were laboratory doctors and 70% were laboratory technicians. Participants expressed a generally optimistic outlook on AI integration in medical laboratories, believing it could streamline routine workflows and save time (74%), simplify repetitive tasks (70%), reduce work-related stress (61%), improve analytical accuracy and precision (57%), and reduce costs and enhance efficiency (49%). The main barriers to AI integration were considered high cost of implementation, the lack of appropriate IT infrastructure, the lack of specialized staff, and ethical considerations. Significant differences were observed among various subgroups, but interest in AI training prevailed among the majority of respondents.

Conclusion: This survey highlights a generally positive perspective on AI among laboratory professionals in Albania, alongside a strong interest in AI education. According to the survey respondents, strengthening digital infrastructure and promoting training programs will be essential for AI integration in laboratory medicine.

Introduction

Artificial Intelligence (AI) is increasingly transforming Laboratory Medicine, offering tools that enhance diagnostic accuracy, automate repetitive tasks, and support clinical decision-making [1, 2]. Applications such as machine learning, image recognition, and natural language processing have shown promise in areas like quality control, test selection, results prediction, generation and interpretation, and workflow optimization [3, 4, 5]. However, the adoption of AI in laboratory settings is uneven across countries and healthcare systems. Progress is often hindered by fragmented digital infrastructure, limited interoperability, and a lack of national strategies for digital health integration [6, 7].

In addition to technical capacity, successful AI integration relies on the readiness, acceptance, and engagement of healthcare professionals. The active contribution of laboratory professionals is key to providing accurate data analysis and interpretation [1]. Human trust toward AI's potential plays a central role in determining how digital tools are used in practice and real-world implementation, yet studies examining professionals' awareness, attitudes, and training needs related to AI remain limited [8, 9].

Understanding the current level of knowledge, digital preparedness, and perceived barriers is essential to developing national policies and regulatory frameworks that support the responsible modernization of the healthcare system [6]. This study aimed to assess the perspectives of Albanian laboratory professionals toward AI integration in medical laboratories, using a national cross-sectional survey to explore attitudes, digital infrastructure, and training interest.

Materials and methods

The voluntary and anonymous survey was conducted using Google Forms. The survey link was distributed via email and WhatsApp to all members of the Albanian Society of Clinical Biochemistry and Laboratory Medicine (ASoLaM). In Albania, medical laboratories are legally required to have a Technical Director who is a licensed Medical Doctor specialized in Laboratory Medicine, all of whom are members of ASoLaM. These Technical Directors were asked to distribute the survey to their affiliated staff and confirmed the dissemination of the survey link. The target population included all laboratory doctors (Medical Doctors, MD, specialized in Laboratory Medicine) and technicians currently practicing in Albania.

A non-probability, voluntary response sampling method was employed. The required sample size was calculated using an open-source calculator (OpenEpi, Version 3.01) based on the following assumptions: an estimated laboratory professional population size of 2000 individuals, a 5% margin of error, and a 99% confidence level. This calculation yielded a required minimum sample size of 154 participants. This sample size calculation was performed for the overall study population; analyses conducted at the subgroup level were exploratory and not specifically powered. Although a maximum number of respondents was encouraged, participation remained entirely voluntary throughout the survey period.

The questionnaire was reviewed by two laboratory medicine experts for face and content validity and pre-tested by five laboratory professionals to ensure clarity and comprehensibility.

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki [10]. As the survey was anonymous, voluntary, involved no medical intervention, posed no risks to participants, and collected no identifiable personal data, ethics committee approval was not required. Data collection and handling complied with relevant data protection regulations.

The final questionnaire consisted of 25 questions, organized into three sections:

1. General Information and Demographics (six questions)
2. Digital Properties and Health Data Access (five questions)
3. Perspectives on Artificial Intelligence in Medical Laboratories (fourteen questions).

A working definition of Artificial Intelligence was introduced at the beginning of the survey. Responses were automatically collected over a four-week period (July 16 to August 13, 2024). Data analysis was conducted using Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA) and IBM SPSS Statistics v.27 (IBM Corp., Armonk, NY, USA). Survey results were tallied for each question and expressed as percentages. For multiple response questions, percentages were calculated for each response option and may exceed 100%. Analyses were stratified by age, gender, professional role (doctors vs. technicians), laboratory type (public vs. private), laboratory size (<500 vs. >/=500 samples/day), and accreditation status (yes vs. no/in process). Differences in response distribution across these subgroups were analyzed using the Pearson Chi-square test. Two-sided p-values <0.05 were considered statistically significant, with results interpreted cautiously in the context of multiple comparisons.

Results

General Information and Demographics

A total of 220 laboratory professionals completed the survey. Participants' ages ranged from 21 to 66 years, with a mean age of 37.9 years (standard deviation [SD]:10.7). The highest number of responses was recorded in the 21-30 and 31-40 age groups, comprising 69 and 68 individuals, respectively.

Regarding workplace settings, 71% were employed in public laboratories, including:

- 43.5% in University Hospital Center laboratories,
- 46% in Regional Hospital laboratories,
- 9% in Municipality Hospital laboratories and
- 1.5% in Ambulatory Polyclinic laboratories.

The remaining 29% worked in private laboratory settings. Concerning quality standards, most of the respondents worked in laboratories accredited according to ISO 15189. Participant characteristics are summarized in Table 1.

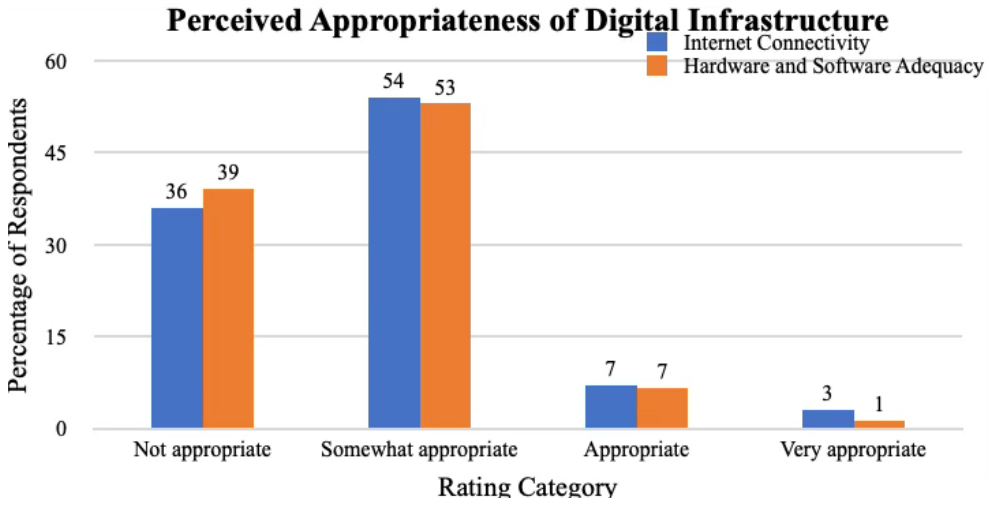
Table 1: Characteristics of survey respondents (n=220).

Characteristic		No.	%
Sex			
	Male	21	9,5
	Female	199	91,5
Age (years)			
	21-30	69	31,4
	31-40	68	30,9
	41-50	49	22,3
	51-60	31	14,1
	61-70	3	1,3
Role			
	Laboratory Doctor	66	30
	Laboratory Technician	154	70
Workplace type			
	Public	156	71
	Private	64	29
ISO 15189 Accreditation Status			
	Yes	121	55
	No	25	11,4
	In process	74	33,6
Sample Volume (/day)			
	>/=500	54	24,5
	<500	166	75,5

Digital Properties and Health Data Access

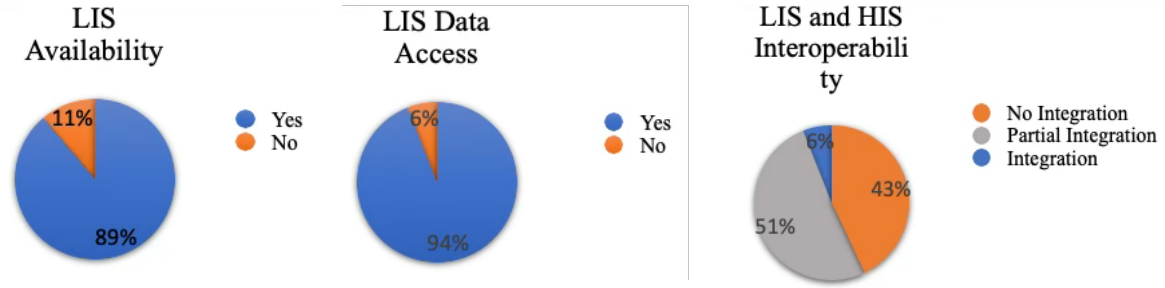
Participants were asked to evaluate the quality of digital infrastructure in their laboratories. Their perceptions of the appropriateness of internet connectivity (speed and stability), and the adequacy of available hardware and software are presented in Figure 1.

Figure 1: Perceived Appropriateness of Digital Infrastructure for AI Integration.



A Laboratory Information System (LIS) was reported to be implemented in the laboratories of 89% of respondents. Results on professionals' ability to extract patients' laboratory data from the LIS, as well as on system interoperability, both partial integration with data from other diagnostic departments (e.g., microbiology or pathology) and integration with other institutional health databases, are presented in Figure 2.

Figure 2: LIS availability, data accessibility, and systems interoperability.



When asked about their access to supplementary clinical data, 33% of respondents stated that they lacked access to data beyond laboratory results. Alternatively, 12% of the participants declared they could access patients' electronic health records, 48% received relevant information from the referring clinicians, and 18% obtained data directly through outpatients' anamneses.

AI-related applications were:

- Auto-verification of laboratory test results (18%),
- Digital image analysis (15%),
- Pre-analytics (13%), and
- Reviewing patients' risk profiles for certain conditions (9.5%).

Perspectives on Artificial Intelligence in Medical Laboratories

Participants' perspectives on the use of artificial intelligence in medical laboratories are reported in this section. In addition to overall descriptive results, subgroup analyses were performed to assess differences according to gender, age, professional role, laboratory type, laboratory size, and laboratory accreditation status.

Knowledge Level of AI Technologies

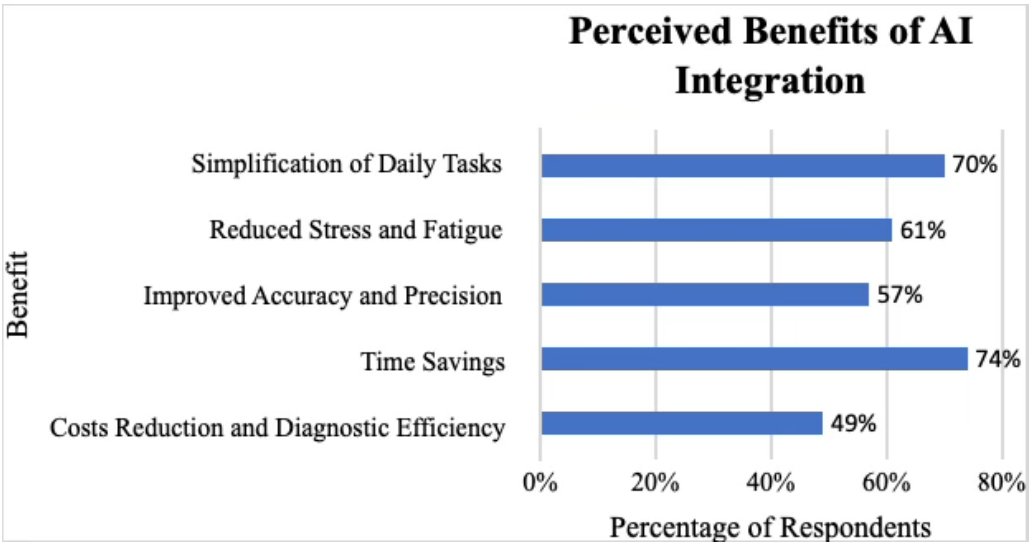
Laboratory professionals were asked to self-assess their knowledge level of AI technologies and evaluate the appropriateness of their knowledge. 56% declared they possessed an appropriate or very appropriate level of knowledge. No statistically significant differences in self-reported AI knowledge level were observed across demographic subgroups. A total of 46% stated there were AI elements already in use in their laboratories. The most frequently cited current

Participants identified laboratory sections that could benefit the most from AI implementation, including Hematology (52%), Clinical Chemistry (43%), Immunology (38%), and Molecular Biology (38%).

Perceived Benefits of AI Integration

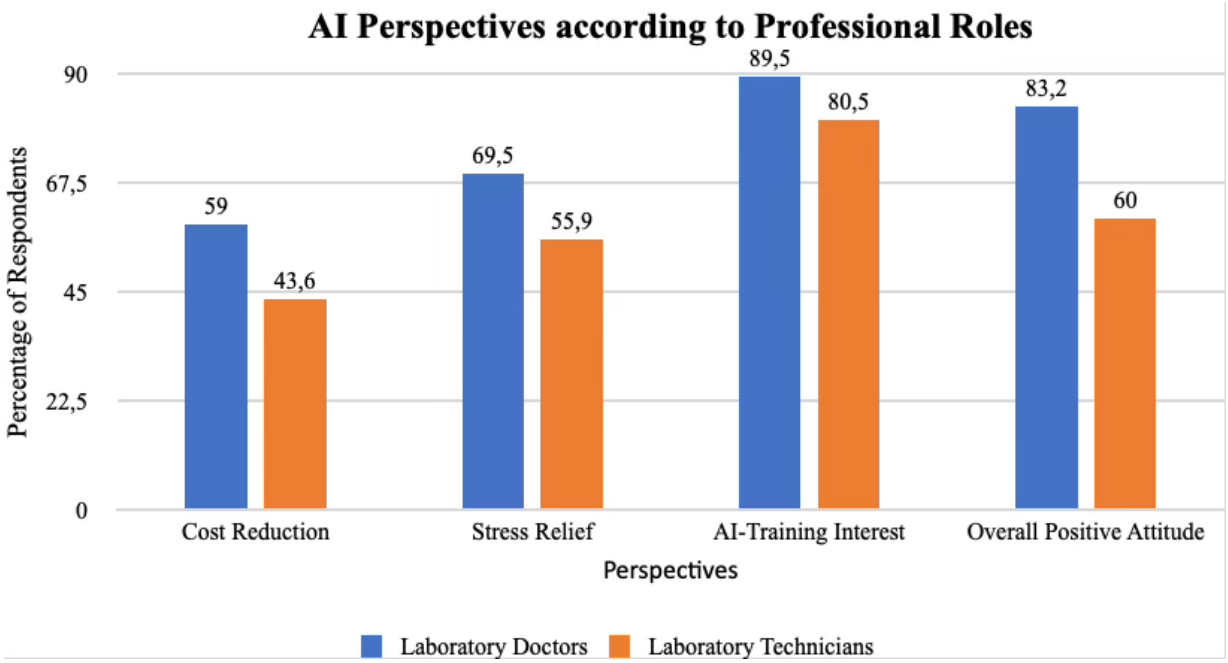
Participants expressed a generally optimistic outlook on AI integration in medical laboratories. Nearly half of the survey respondents (49%) believed AI implementation could reduce operational costs and enhance diagnostic efficiency. 74% stated that AI would streamline routine workflows and save time. Additionally, 57% expected that AI would improve analytical accuracy and precision, while 61% believed AI implementation could reduce work-related stress and fatigue. Furthermore, 70% of participants anticipated that AI would simplify daily and repetitive tasks, thereby allowing personnel to devote more time to creative or interpretive activities.

Figure 3: Perceived Benefits of AI Integration among Laboratory Professionals.



Comparisons across subgroups showed that statistically significant differences in perceived AI benefits were observed only for professional role and laboratory size.
Laboratory Doctors more strongly associated AI implementation in medical laboratories with cost reduction (p=0.03) and stress relief (p=0.04). A more prominent AI training interest (p=0.04) and an overall more positive attitude toward AI (p<0.01) were observed among laboratory doctors compared with laboratory technicians.

Figure 4: Differences in AI Perspectives according to Professional Roles of the Respondents.



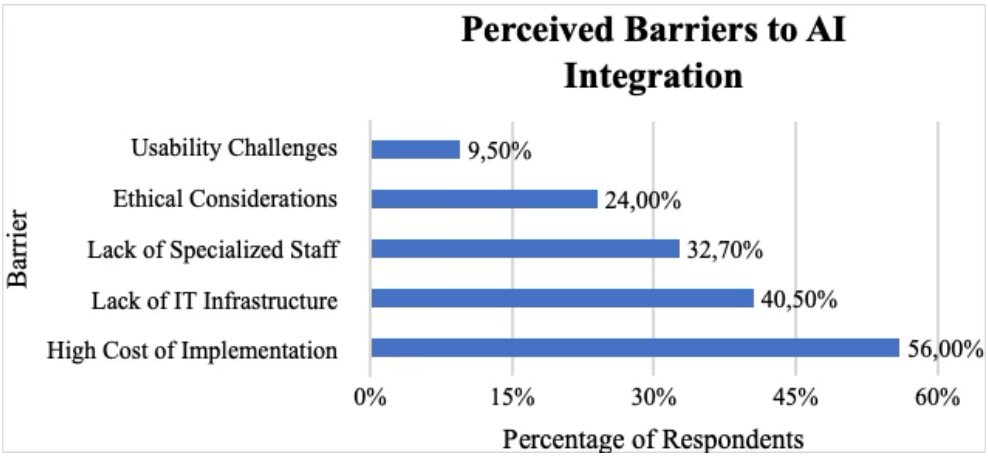
Significant differences also emerged based on laboratory size. Professionals working in laboratories processing more than 500 samples/day more frequently believed that AI would:

- Reduce operational costs (p=0.007),
- Improve analytical accuracy and precision (p=0.01),
- Save time (p=0.04), and
- Reduce work-related stress and fatigue (p=0.02), compared to those working in smaller laboratories.

Perceived Barriers to AI Integration

The survey investigated the perspectives of the participants on AI integration barriers. 39% of the respondents rated the barriers as "Important" or "Maximal". The most frequently cited barrier was the high cost of initial implementation (56%). Other notable barriers included a lack of appropriate IT infrastructure, a lack of specialized staff, and ethical considerations. No statistically significant differences were observed in perceived barriers to AI integration across demographic subgroups of the study population.

Figure 5: Perceived Barriers to AI Integration among laboratory professionals.



Concerns about Job Displacement

Regarding potential job displacement due to AI:

- 31% of professionals expressed concern about losing their jobs due to AI replacement,
- 43% were not concerned,
- 26% were uncertain and selected "I don't know".

Laboratory technicians reported greater concern about AI-related job loss than laboratory doctors (p=0.02). Respondents under the age of 40 expressed significantly greater concern about potential job loss due to AI-driven replacement compared to those aged 40 and above (p=0.04). This apprehension was particularly pronounced among laboratory professionals aged 21-30 years, of whom 43.5% reported concern about losing their job as a result of AI implementation. No statistically significant differences were observed among the other subgroups regarding concerns about job displacement.

AI Training Interest and General Attitude toward AI

When queried about their interest in AI-focused training, 84% of respondents indicated willingness to participate. Overall, 67% of all survey participants exhibited a positive general attitude toward AI in Laboratory Medicine. Subgroups' analysis revealed a more positive attitude toward AI among female professionals (p=0.003). Doctors expressed greater interest in AI training (p=0.004) and a more positive general attitude toward AI (p=0.004) compared with technicians. Participants working in private laboratories demonstrated a more positive attitude toward AI than those employed in public laboratories (p=0.04). Similarly, professionals working in larger laboratories showed a more positive attitude toward AI (p=0.03). Participants who rated their AI knowledge as appropriate or very appropriate also exhibited a more positive attitude toward AI in Laboratory Medicine (p=0.001).

Discussion

This national survey provides valuable insights into Albanian laboratory professionals' perspectives on AI implementation in Laboratory Medicine. The results reveal a broadly positive outlook toward AI, with a majority of respondents recognizing its potential to enhance laboratory efficiency, improve analytical accuracy, and reduce workload-related stress. Consistent with our findings, Ardon et al. reported that 64% of surveyed laboratory professionals supported the development of AI augmented diagnostic tools, and most frequently believed AI can reduce errors and enhance efficiency [11]. Similarly, Paranjape et al. found that 90% of respondents expressed positive attitudes toward the value of AI in the diagnostic laboratory medicine [9].

Despite prevailing positive attitudes toward AI, our findings highlight significant gaps between awareness and actual implementation, as well as concerns about costs, infrastructure, and workforce readiness. The current use of AI in Albanian laboratories appears limited, with most respondents working in environments lacking full digital integration and interoperability between LIS and Hospital Information Systems (HIS); 11% of them even work in laboratories without a LIS. Comparable issues were identified in previous European surveys. Nearly 50% of respondents declared having no access to data outside their LIS, according to a comprehensive survey of AI adoption in European laboratory medicine by Cadamuro et al. on behalf of the European Federation of Clinical Chemistry and Laboratory Medicine Working Group on Artificial Intelligence [12]. Similar lack of interoperability was also reported by 65% of participants of the Bellini et al. survey on Italian clinical laboratories [13]. Since it is widely acknowledged the symbiosis between digital transformation and interoperability, this digital fragmentation likely represents a key bottleneck for AI adoption [14, 15].

Barriers to AI implementation, especially concerns about high costs of computational infrastructure, lack of IT support, fear of job displacement, and ethical issues, were generally consistent with previous observations [3, 16]. In line with our findings, the major obstacles identified by Bellini et al. were inadequate infrastructure and a lack of specialized software, followed by poor data integration. However, respondents generally agreed that there is not one single obstacle but many challenges to focus on [13]. While only 31% of our participants clearly expressed concern about job displacement due to AI, fear of job loss was the main concern according to Ardon et al [11]. Furthermore, 75% of respondents in Shami et al.'s [17] survey believed AI would affect future hiring opportunities, with 44.2% thinking lab staff would be replaced by AI. Addressing these foundational barriers will be critical for any effort to scale AI integration in medical laboratories through coordinated national strategies that include investments in digital infrastructure and regulatory frameworks.

An important outcome of this study was the variation in AI perspectives across different subgroups. Laboratory technicians were more worried than laboratory doctors about job loss due to AI replacement. Younger professionals exhibited significantly greater concern about potential job displacement than their older counterparts. These results may reflect differences in professional experience, job security, and long-term career outlook. Younger respondents, particularly those in the early stages of their careers, may perceive themselves as more vulnerable to technological disruptions and less established in roles requiring advanced decision-making, critical thinking, and creative problem-solving, which are less likely to be automated and replaced by AI [4]. In contrast, more experienced professionals might anticipate that the widespread AI integration will occur gradually and not significantly impact their remaining years in the workforce. Additionally, it is believed there will be no replacement for physicians' intuition and expertise gained after many years of professional experience [4]. Respondents from larger laboratories expressed significantly higher expectations for AI benefits, compared with laboratory professionals employed in laboratories processing fewer samples per day. This difference may partly reflect the

greater availability of IT infrastructure and digital systems in larger laboratories, making it difficult to disentangle the effects of laboratory size from those of technological readiness on expectations toward AI. Notably, interest in AI training was significantly more pronounced among laboratory doctors than technicians, reflecting differing roles and expectations within diagnostic workflows. These disparities emphasize the need for tailored communication and training strategies that address specific professional roles and institutional contexts.

The strong interest in AI-focused training shown by the majority of participants reflects a clear willingness to engage with emerging technologies and underscores the need to incorporate AI into medical and laboratory science education. In this study, 84% of respondents indicated readiness to participate in training programs related to AI, reflecting a high level of awareness regarding its growing relevance in Laboratory Medicine. Similar attitudes have been previously reported in other studies, with most respondents showing interest in AI training courses [12, 13]. The medical education system still lacks adequate AI training and understanding of AI methodology, representing a significant barrier in the medium and long-term [16]. As it is evident from our results and previous research, there is a need to introduce and incorporate AI into medical curricula [9, 13]. Integration of foundational AI concepts into undergraduate curricula and postgraduate training, along with offering continuing professional development opportunities, can help reduce knowledge gaps, promote appropriate adoption, and support the ethical implementation of AI in clinical settings [9,13, 14].

Strength of the study

To the best of our knowledge, this study is the first survey of AI perspectives and attitudes within the medical community in Albania. This survey offers a timely insight into the perspectives of laboratory professionals regarding the integration of AI in Laboratory Medicine. A key strength lies in its national scope and design, encompassing professionals from a variety of healthcare settings, including public and private laboratories, as well as regional and university centers. This diversity enhances the generalizability of the findings within the Albanian laboratory context. The inclusion of a broad range of participants by age, role, and institution type contributes to the robustness of the dataset and enables relevant subgroup comparisons. Furthermore, the questionnaire was structured to capture both perceived benefits and concerns related to AI, enabling a balanced investigation of attitudes across different professional demographics.

Limitations of the study

While this survey provides a valuable baseline for assessing AI readiness in Albanian medical laboratories, several limitations must be acknowledged. First, the data are self-reported and may be influenced by social desirability bias or varying levels of understanding of artificial intelligence, potentially leading to misinterpretation of AI-related questions or the misclassification of conventional automation tools as AI. A further limitation is the possibility that professionals employed in the same laboratory discussed the survey among themselves, probably leading to shared interpretations of the questions or influenced responses, potentially biasing the study's results. The observed gender imbalance, with 90.5% of respondents being female, may reflect the actual workforce composition in Albanian laboratories. However, the voluntary nature of participation may limit the generalizability of the findings. Additionally, the survey did not assess the technical specifications or implementation level of AI tools currently in use, restricting insights into practical AI integration. These limitations highlight the need for future research to further evaluate the effectiveness of AI in clinical workflows, assess the outcomes of structured AI training programs, and monitor changes in perceptions as digital maturity evolves.

Conclusion

This national survey highlights a generally positive perspective on AI among laboratory professionals in Albania, alongside a strong interest in AI-focused training and education. These findings offer a foundation for future regulatory policies and educational initiatives aimed at advancing AI-enabled diagnostic services in Albania and similar healthcare systems.

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Artificial Intelligence Usage Statement

The authors declare the use of AI tools (ChatGPT, OpenAI, San Francisco, CA, USA, and Grammarly Inc., San Francisco, CA, USA) to assist in grammar checking, editing the language, and improving clarity in the writing of this manuscript. All scientific content and interpretations remain the sole responsibility of the authors.

Declaration of Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. As the survey was anonymous, voluntary, involved no medical intervention, posed no risks to participants, and collected no identifiable personal data, ethics committee approval was not required.

Author's Disclosures

The authors have nothing to disclose.

Ethical Principles Compliance

This study complies with the ethical principles for medical research involving human subjects, in accordance with the Declaration of Helsinki.

Credit Author Statements

Helena Lame: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing-Original Draft, Writing - Review & Editing, Visualization, Project administration
Nevila Heta: Data curation, Writing - Review & Editing, Visualization
Valbona Tole: Investigation, Data curation, Visualization
Arba Coraj: Investigation, Data curation, Resources
Etleva Refatllari: Writing - Review & Editing, Visualization
Irena Korita: Resources, Visualization
Mirela Lika: Investigation, Resources
Ersida Kapllani: Writing - Review & Editing, Visualization
Anyla Bulo: Conceptualization, Writing - Review & Editing, Supervision

Data Availability Statement

The dataset generated and analyzed during this study is available from the corresponding author upon reasonable request.

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Survey: Artificial Intelligence in Laboratory Medicine
'Artificial Intelligence refers to computer systems that mimic human cognition and are capable of performing tasks that typically require human intelligence.'

I. General Information and Demographics (six questions)

1. Respondent's professional profile
a. Laboratory Doctor
b. Laboratory Technician

2. Gender
a. Male
b. Female
c. Other

3. Age

4. Laboratory type
a. University Hospital Center laboratory
b. Regional Hospital laboratory
c. Municipality Hospital laboratory
d. Ambulatory Polyclinic laboratory
e. Private Laboratory

5. ISO 15139 accreditation status of your laboratory
a. Accredited
b. Not accredited
c. In the accreditation process

6. Sample volume per day processed by your laboratory
a. >/= 500
b. < 500

II. Digital Properties and Health Data Access (five questions)

7. How do you evaluate the speed and stability of the internet connection in your laboratory?
a. Very appropriate
b. Appropriate
c. Somewhat appropriate
d. Not appropriate

8. How do you evaluate the adequacy of hardware and software available in your laboratory?
a. Very appropriate
b. Appropriate
c. Somewhat appropriate
d. Not appropriate

9. Which patients' clinical data can you access:
a. I have no access to patients' clinical data
b. Patients' electronic health records
c. Clinical data from the referral clinicians
d. Clinical data obtained directly through the outpatients' anamneses

10. Can you access and extract patients' laboratory data from the LIS?
a. Yes
b. No

11. Is there integration between the LIS and other health databases within your institution?
a. No integration
b. Partial integration (with data from other diagnostic departments, e.g., microbiology or pathology)
c. Integration (with data from other health databases within your institution)

III. Perspectives on Artificial Intelligence in Medical Laboratories (fourteen questions)

12. How do you evaluate your knowledge level of Artificial Intelligence:
a. Very appropriate
b. Appropriate
c. Somewhat appropriate
d. Not appropriate

13. Is Artificial Intelligence actually used in your laboratory?
a. Yes
b. No

14. Which AI-related applications are used in your laboratory?
(open text)

15. Which laboratory sections could benefit the most from AI applications? (multiple choice)
a. Clinical Chemistry
b. Immunochemistry
c. Coagulation
d. Hematology
e. Immunology
f. Urinalysis
g. Microbiology
h. Pathology
i. Molecular Biology
j. Point of Care Testing
k. Other (specify)

16. Do you think AI implementation could reduce costs and enhance diagnostic efficiency?
a. Yes
b. No
c. I don't know

17. Do you think AI implementation would streamline routine workflows and save time?
a. Yes
b. No
c. I don't know

18. Do you think that AI implementation would improve analytical accuracy and precision?
a. Yes
b. No
c. I don't know

19. Do you think that AI implementation could reduce work-related stress and fatigue?
a. Yes
b. No
c. I don't know

20. Do you think that AI would simplify daily tasks, allowing personnel to devote more time to creative activities?
a. Yes
b. No
c. I don't know

21. How do you evaluate the barriers of AI implementation in your laboratory?
a. Minimal
b. Moderate
c. Important
d. Maximal

22. What are the barriers to AI implementation in your laboratory? (multiple choice)
a. High cost of implementation
b. Lack of IT infrastructure
c. Lack of specialized staff
d. Ethical considerations
e. Usability challenges
f. Other (specify)

23. Are you concerned about job loss due to AI replacement?
a. Yes
b. No
c. I don't know

24. Are you interested in an AI training course?
a. Yes
b. No
c. I don't know

25. How is your general attitude toward AI in Laboratory Medicine?
a. Positive
b. Negative
c. I don't know