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Artificial intelligence in focus: assessing awareness and perceptions among medical students in three private Syrian universities

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Abstract

Background Artificial intelligence (AI) has gained significant attention and progress in various scientific fields, especially medicine. Since its introduction in the 1950s, AI has advanced remarkably, supporting innovations like diagnostic tools and healthcare technologies. Despite these developments, challenges such as ethical concerns and limited integration in regions like Syria emphasize the importance of increasing awareness and conducting more targeted studies.

Methods A cross-sectional study was conducted to evaluate medical students' preparedness and readiness to use AI technologies in the medical field using the Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS_MS). The scale comprises 22 items divided into 4 domains: ethics, vision, ability, and cognition, with responses rated on a five-point Likert scale, higher scores indicate greater readiness. Data were collected through electronic and paper questionnaires distributed over a period of 20 days.

Results The study included 564 medical students from various Syrian universities, of whom 77.8% demonstrated awareness of AI in the medical field. Significant differences in AI awareness were observed based on academic GPA ($p = 0.035$) and income level ($p = 0.016$), with higher awareness among students with higher GPA and income levels. Statistically significant differences were found between students aware of AI and those unaware, as well as between students with experience using AI and those without, across all domains of readiness, including cognition (t = -10.319, $p < 0.001$), ability (t = -11.519, $p < 0.001$), vision (t = -6.387, $p < 0.001$), ethics (t = -7.821, $p < 0.001$), and the overall readiness score (t = -11.354, $p < 0.001$).

Conclusion Integrating AI into medical education is essential for advancing healthcare in developing countries like Syria. Providing incentives and fostering a culture of continuous learning will equip medical students to leverage AI's benefits while mitigating its drawbacks.

Keywords Artificial intelligence, MAIRS_MS, Machine learning, Deep learning, Medical students, Syria

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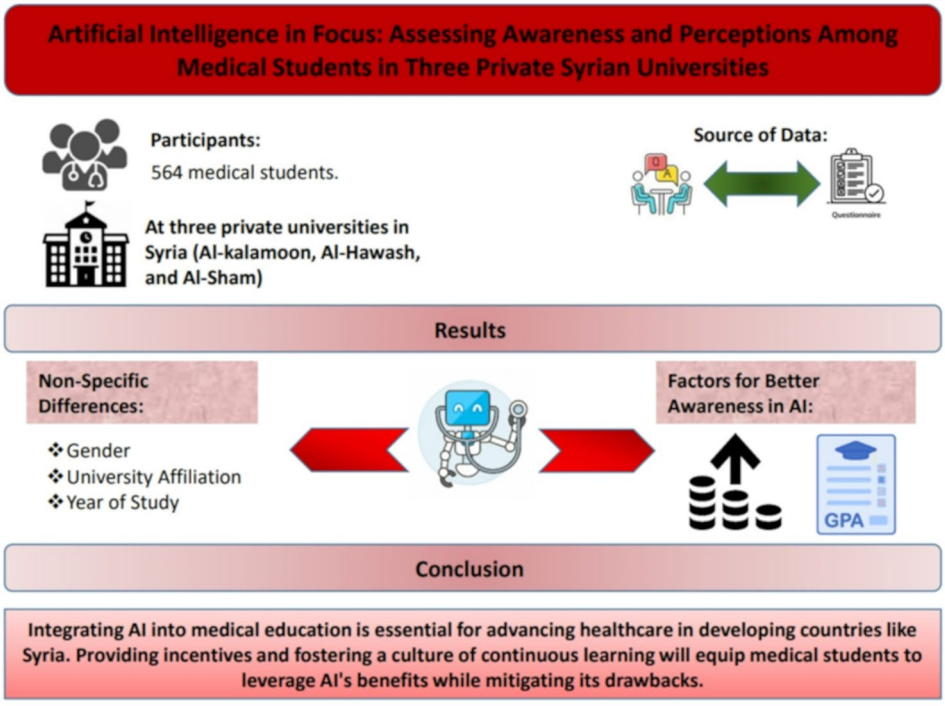
Graphical abstract



Background

Recently, artificial intelligence (AI) has emerged prominently across various scientific fields, particularly medicine, technology, and engineering. Its integration into medical education holds immense importance as it equips future healthcare professionals with essential knowledge and tools to navigate AI-driven advancements effectively. By fostering familiarity with AI, medical students can better prepare for the evolving landscape of patient care. Its journey to peak advancement began with the development of modern computers in the 1950s, spearheaded by influential scientists such as Alan Turing [1]. By the early 1970s, AI had been integrated into medicine, notably aiding in accurate disease diagnosis [2]. Remarkably, ChatGPT reached 100 million users within less than six months, reflecting its rapid growth and partial or full adoption in numerous applications [3]. Machine learning and deep learning algorithms have been trained to interpret and analyze various radiological images and diseases, enabling autonomous diagnosis in the future [4]. Between 1997 and 2015, fewer than 30 AI-based medical devices were approved by the U.S. Food and Drug Administration (FDA). However, by mid-2021, this number had surged to over 350 devices, underscoring the substantial advancements in medical technology for healthcare [5]. Nonetheless, numerous challenges accompany AI's use and applications, particularly those involving ethical dilemmas, patient privacy violations, and potential errors that could threaten patient lives. Regardless of AI's significant advancements in diagnostics and treatments, it remains incapable of surpassing the human brain's complexity [6].

Given that many Middle Eastern countries are classified as low- to middle-income, the concept of AI and related educational materials remain limited or virtually absent in some nations, such as Syria [7]. The objective of this study is to assess the level of awareness regarding AI among medical students in three private universities in Syria. The research aims to understand their knowledge and perceptions, contributing to the enrichment of medical literature and addressing research gaps within Syria. Additionally, it seeks to provide a comprehensive understanding of students' attitudes towards AI, particularly in a region that has endured over a decade of war, significantly impacting its infrastructure, education, and healthcare services. Notably, this is the first study of its kind to focus on these specific institutions.

Methods of study

Study design and participants

A cross-sectional study was conducted to assess the readiness of medical students to utilize artificial intelligence technologies in the medical field. A total sample of 564 medical students from three private universities in Syria (Al-Kalamoon University, Al-Hawash University, and Al-Sham University) participated in the study. The choice

of private universities was intentional, as they typically have more standardized curricula, better-resourced infrastructure, and greater exposure to emerging technologies compared to public institutions in Syria, which may face systemic challenges such as overcrowding and limited resources. This selection criterion aimed to minimize variability in educational quality and ensure a more homogeneous assessment of AI readiness.

These students represented all years of medical education, from year one to six. The first three years comprised the pre-clinical stage focusing on foundational subjects such as anatomy and physiology, while the last three years represented the clinical stage involving advanced subjects such as internal medicine, surgery, and pediatrics. This comprehensive representation ensured inclusivity across various stages of medical education.

Data collection procedures

The study employed electronic and paper questionnaires distributed through official platforms of medical colleges, social media channels such as WhatsApp and Telegram, and after lectures. To minimize distractions and optimize focus, data collection occurred in quiet locations like university libraries. Participants were extensively informed about the study's significance and objectives, with clear explanations provided for each questionnaire item by a specialized research team. Written consent was obtained from participants, and oral consent was secured for students completing questionnaires through official online platforms.

Exclusion criteria

- Medical students not enrolled in the specified private universities.
- Students who chose not to provide informed consent.
- Participants who withdrew or partially completed the questionnaire.

The study spanned 20 days, from January 1, 2025, to January 21, 2025. Participants completed the questionnaires independently, following detailed instructions, ensuring a self-reported methodology. The process took approximately 5 min per participant.

Quality assurance and ethical considerations

Rigorous auditing and verification procedures were conducted post-data entry to ensure data completeness and eliminate biases from face-to-face interviews. Ethical approval was obtained from the Institutional Review Board at Al-Kalamoon University (ID number: 720/2025).

Tools/instruments

The study used the Medical Artificial Intelligence Readiness Scale for Medical Students (MAIRS_MS), a validated 22-item questionnaire divided into ethics (3 items), vision (3 items), ability (8 items), and cognition (8 items). Each item was rated on a 5-point Likert scale ranging from "1 (Strongly Disagree)" to "5 (Strongly Agree)." Total scores across all subscales range from 22 to 110, with higher scores indicating greater AI readiness. The scale showed high reliability (Cronbach's $\alpha = 0.87$) in previous studies [8]. The questionnaire was translated into Arabic using back-to-back translation to ensure accuracy.

It included **two sections**:

1. **Demographic Information**: Including variables such as gender, age, academic year, GPA, and AI awareness/experience (yes/no responses).
2. **MAIRS_MS Assessment**: Structured questions evaluating AI readiness in the defined domains.

Statistical analysis

Data were analyzed using SPSS Inc software, version 27. Descriptive statistics were used to summarize the demographic characteristics of the participants. Independent samples t-tests were performed to compare the mean scores of AI readiness across different groups, including those with and without AI experience.

Results

Demographic data of participants

This study included 564 students, with key demographic characteristics summarized in Table 1. Briefly, the majority of participants were male (57.6%), aged 20 years (20.6%), and enrolled in the basic academic years (53.3%). The sample was drawn from multiple universities, with the highest representation from Al-Hawash Private University (42.5%). Regarding academic performance, 45% of participants had a medium GPA (2.5–3), while 77.8% demonstrated awareness of AI applications in medicine. A subset (27.8%) reported prior experience using AI tools. For comprehensive details, see Table 1.

Multiple aspects of readiness to engage with artificial intelligence

The results showed that cognitive cognition had the highest mean score (21.10 ± 6.26), followed by ability (18.77 ± 6.31), vision (7.73 ± 2.58), and ethics (5.85 ± 2.53). The overall mean score of students' readiness for AI was 53.45 out of 110. For more details on the distribution of results in these domains see Table 2.

Table 1 Demographic characteristics of participants

Category	Subcategory	*N* (%)
Gender	Male	325 (57.6%)
	Female	239 (42.4%)
Age Group	18	35 (6.2%)
	19	72 (12.8%)
	20	116 (20.6%)
	21	87 (15.4%)
	22	104 (18.4%)
	23	71 (12.6%)
	24 and more	79 (14.0%)
Clinical/Basic Year	Basic Years (1st-3rd)	301 (53.3%)
	Clinical Years (4th-6th)	263 (46.6%)
University	Al-Hawash Private	240 (42.5%)
	Al-Kalamoon Private	167 (29.6%)
	Al-Sham Private	157 (27.8%)
Year of Study	First Year	80 (14.2%)
	Second Year	104 (18.4%)
	Third Year	117 (20.7%)
	Fourth Year	74 (13.1%)
	Fifth Year	131 (23.2%)
	Sixth Year	58 (10.3%)
GPA	Less than 2	14 (2.5%)
	2–2.5	113 (20.0%)
	2.5–3	254 (45.0%)
	3–3.5	137 (24.3%)
	3.5–4	46 (8.2%)
Awareness of AI Usage	Yes	439 (77.8%)
	No	125 (22.2%)
Experience with AI	Yes	157 (27.8%)
	No	407 (72.2%)
Income Level	Low	102 (18.1%)
	Medium	341 (60.5%)
	High	121 (21.5%)

The relationship between demographic characteristics and AI awareness

The results revealed statistically significant differences in AI awareness based on academic GPA ($p = 0.035$), with awareness rates increasing as GPA increased. For example, the awareness rate was 64.3% among students with a GPA below 2, rising to 89.1% among students with a GPA between 3.5 and 4. Additionally, income level had a significant impact on awareness ($p = 0.016$), with awareness rates higher in the high-income group (86.8%) compared to the low-income group (71.6%) (see Table 3).

Differences between individuals based on awareness and experience

The results of the independent samples t-test showed significant differences between individuals who were aware of AI and those who were not, across all domains, including cognition (t = -10.319, $p < 0.001$), ability (t = -11.519, $p < 0.001$), vision (t = -6.387, $p < 0.001$), ethics (t = -7.821, $p < 0.001$), and the overall score (t = -11.354, $p < 0.001$). Similarly, significant differences were observed between individuals with experience in using AI and those without such experience across all domains, including cognition (t = -6.888, $p < 0.001$), ability (t = -7.480, $p < 0.001$), vision (t = -4.123, $p < 0.001$), ethics (t = -3.871, $p < 0.001$), and the overall score (t = -7.155, $p < 0.001$).

Non-significant variables

In addition to the significant findings, the analysis revealed that certain demographic and academic variables did not demonstrate statistically significant associations with AI readiness. Specifically, gender differences were not significant across any of the measured domains, including cognitive cognition, ability, vision, ethics, or overall readiness. Similarly, university affiliation—whether students were from Al-Hawash Private University, Al-Sham Private University, or Al-Kalamoon Private University—did not significantly influence AI readiness. Furthermore, neither the year of study nor age group showed meaningful differences in students' readiness to engage with AI. These results indicate that while factors such as GPA and income level play a notable role in shaping AI readiness, other variables like gender, university, academic year, and age may have limited impact in this context.

Discussion

This research focused on studying and evaluating the readiness of Syrian medical students at some private universities (Al-Kalamoon, Al-Hawash, Al-Sham) for AI and its use in the medical field through the MAIRS_MS scale, which included a set of questions about cognition, ability, ethics, and vision. AI is defined as the transformation of intelligent behaviors via computers into targeted models with less human intervention [9]. AI branches out from various sciences and fields and is closely related to different disciplines such as computer engineering, statistics, neuroscience, cybernetics, and

Table 2 Subscale scores of AI readiness among medical students

Variable	*N*	Minimum	Maximum	Mean ± SD	Test Value	t-statistic	*p*-value	95% Confidence Interval
Cognition	564	**8**	40	21.10 ± 6.26	24	-11.92	. 001>	20.58 to 21.62
Ability	564	**8**	40	18.77 ± 6.31	24	-22.72	. 001 >	18.24 to 19.30
Vision	564	**3**	15	7.73 ± 2.58	9	-12.45	. 001>	7.51 to 7.95
Ethics	564	**3**	15	5.85 ± 2.53	9	-26.77	. 001>	5.64 to 6.06
Total Scores	564	**22**	110	53.45 ± 15.56	66	-20.35	. 001>	52.16 to 54.74

Table 3 Association between sociodemographic characteristics, previous AI experience, and AI readiness

Variable	Cognition	Ability	Vision	Ethics	Medical AI Readiness
Gender					
Male	21.06 ± 6.41	18.89 ± 6.39	7.87 ± 2.63	6.02 ± 2.61	53.84 ± 16.08
Female	21.15 ± 6.06	18.61 ± 6.22	7.52 ± 2.51	5.63 ± 2.40	52.92 ± 14.84
Age					
18	18.63 ± 6.76	19.65 ± 7.10	6.91 ± 3.07	5.37 ± 3.10	48.23 ± 18.30
19	19.65 ± 6.46	20.34 ± 7.07	6.92 ± 2.89	5.32 ± 3.00	48.90 ± 17.76
20	21.12 ± 6.68	21.68 ± 7.61	7.83 ± 2.95	6.02 ± 3.01	54.12 ± 19.32
21	21.68 ± 6.84	22.08 ± 7.52	7.74 ± 2.94	5.97 ± 3.05	54.55 ± 19.01
22	22.34 ± 7.77	22.34 ± 8.71	7.99 ± 3.38	5.92 ± 3.58	55.42 ± 22.31
23	22.08 ± 6.04	22.08 ± 6.67	8.21 ± 3.02	6.11 ± 2.83	56.07 ± 16.92
24 and more	20.34 ± 10.60	20.34 ± 10.04	7.87 ± 3.87	5.86 ± 3.91	52.75 ± 28.20
Study Year					
First Year	22.21 ± 7.38	22.80 ± 8.09	8.58 ± 3.36	8.82 ± 3.28	62.52 ± 20.40
Second Year	22.92 ± 7.15	23.76 ± 7.32	9.29 ± 3.12	9.16 ± 3.16	65.15 ± 19.06
Third Year	22.77 ± 6.56	23.65 ± 7.07	9.04 ± 2.93	9.42 ± 3.05	64.90 ± 18.15
Fourth Year	23.10 ± 7.01	23.44 ± 7.30	9.17 ± 2.81	9.47 ± 3.31	65.19 ± 18.85
Fifth Year	22.14 ± 6.37	23.12 ± 7.01	8.89 ± 2.91	9.25 ± 2.88	63.42 ± 17.46
Sixth Year	21.83 ± 6.04	22.77 ± 6.67	9.01 ± 3.02	9.27 ± 2.83	62.90 ± 16.92
University					
Al-Hawash Private	22.65 ± 6.97	23.51 ± 7.33	9.13 ± 3.10	9.19 ± 3.05	64.49 ± 18.91
Al-Sham Private	22.23 ± 6.84	23.26 ± 7.27	8.53 ± 2.94	9.23 ± 3.01	63.27 ± 18.97
Al-Kalamoon Private	23.07 ± 7.71	22.96 ± 7.59	8.92 ± 3.34	9.34 ± 3.30	64.30 ± 20.39
Awareness of AI Usage					
Yes	19.77 ± 5.41	17.30 ± 5.28	7.37 ± 2.44	5.43 ± 2.24	49.87 ± 13.17
No	25.78 ± 6.78	23.94 ± 6.94	8.98 ± 2.69	7.34 ± 2.90	66.03 ± 16.76
Experience with AI					
Yes	18.29 ± 5.36	15.71 ± 4.95	7.01 ± 2.49	5.20 ± 2.14	46.22 ± 12.62
No	22.18 ± 6.25	19.95 ± 6.39	8.00 ± 2.57	6.11 ± 2.62	56.24 ± 15.70
GPA					
Less than 2	20.69 ± 7.71	21.80 ± 7.62	8.10 ± 2.97	8.70 ± 3.46	59.30 ± 20.31
2–2.5	21.78 ± 6.33	22.74 ± 7.25	8.75 ± 3.06	8.93 ± 3.12	62.21 ± 18.53
2.5–3	22.92 ± 6.52	23.51 ± 6.91	9.02 ± 2.87	9.44 ± 2.98	64.90 ± 17.66
3–3.5	23.11 ± 6.81	24.02 ± 7.25	9.42 ± 3.02	9.49 ± 2.99	66.05 ± 18.15
Income Level					
Low	20.69 ± 7.71	21.80 ± 7.62	8.10 ± 2.97	8.70 ± 3.46	59.30 ± 20.31
Medium	21.78 ± 6.33	22.74 ± 7.25	8.75 ± 3.06	8.93 ± 3.12	62.21 ± 18.53
High	22.92 ± 6.52	23.51 ± 6.91	9.02 ± 2.87	9.44 ± 2.98	64.90 ± 17.66

linguistics [10]. Regarding medicine and the healthcare sector, despite increasing concerns and doubts that AI might replace doctors such as radiologists and pathologists, we cannot deny its recent proven ability to improve diagnostic accuracy and develop treatments. A study hypothesized that the common concerns in developing countries about the possibility of replacing doctors with AI might be due to doctors relying on it because of their lack of confidence in their medical knowledge [5]. In contrast, an Indian study reported that more than half of the participants were convinced that AI could not replace doctors [11]. On the other hand, medical professionals in China demonstrated rationality and sufficient awareness of AI, with the majority reporting that it would only partially replace ophthalmologists [12]. AI branches into both machine learning (ML) and deep learning (DL). DL refers to the use of algorithms trained to draw conclusions by being trained on many similar examples [13]. ML technology differs from DL in its ability to learn from a variety of data without the need for pre-specified programming [14]. For example, ML models have been used in many previous studies to predict 5-year survival in various types of cancers such as breast adenoid cystic carcinoma (BACC), laryngeal cancer, and papillary thyroid carcinoma (PTC) [15–17]. In our survey, the results among Syrian medical students showed that AI awareness rates increased with the increase in GPA. For example, the awareness rate was 64.3% among students with a GPA below 2, while it rose to 89.1% among students with a GPA between 3.5 and 4. This may be due to

their perseverance and studying more than their peers and their interaction with technology and innovations in the field of medicine, which is entirely consistent with the study conducted by Hamad et al. in Jordan [18]. Gender differences play an important research indicator in many survey studies, especially those related to computer engineering [19]. However, we did not notice any qualitative differences between males and females in our study, which contradicts previous studies in both occupied Palestine and Germany, which found that male participants had greater awareness than females [20, 21]. Our study results align with the cross-sectional study conducted in Nepal, which did not show any differences in AI awareness between males and females [22]. In terms of gender, we noticed that most results in most countries range between either both genders having similar awareness or males having more awareness. This calls for the need to provide equal opportunities and training workshops between genders and then measure the level of awareness among them. Perhaps equal results will indeed be observed, or males may have more experience and intelligence than females regarding the use of technology. Syria still suffers from a weakness in various advanced sciences due to the wars and conflicts that have exhausted it for more than a decade (since 2011 until December 8, 2024), which has significantly affected its economy and the level of individual income [23]. This explains, on an international level, the lack of awareness and knowledge in various fields among Syrian medical students. Although the research was conducted in private universities, responses were recorded from students with low incomes. This research confirms the close correlation between low income and lack of AI awareness, which is consistent with a previous study that showed a positive correlation between increased income levels and increased knowledge in southern Vietnam [24]. Additionally, it was found that personal income is one of the main factors affecting students' views on AI. The low awareness in Syria may be primarily attributed to the lack of some educational basics available to students in other countries, such as computer technology, proficiency in the English language, and the early introduction of AI in curricula [25]. Unlike the educational reality in Syria, where medicine is taught in Arabic, and there are no curricula in school or university stages that teach AI techniques. Since artificial intelligence has become the language of the era and a fundamental pillar for the advancement of sciences, it is imperative to seriously focus on its status in developing countries. For instance, AI has recently aligned with the work of dermatologists in accurately diagnosing pathological lesions [1]. We must acknowledge that today, it is essential to have faculty members in our universities and specialists in our hospitals who are proficient in both medicine and AI [26]. In our research, age group, academic year, or university affiliation did not show statistically significant differences in students' readiness to engage with AI. This largely reflects the findings of Hamad et al. [18]. Despite the numerous advantages of AI, it is a double-edged sword, and its drawbacks should be seriously studied before its benefits. These drawbacks include the potential for doctors or medical students to lose confidence in their knowledge, the stagnation of the human mind due to the need to use AI for trivial matters, harm to patients, and breaches of data confidentiality [27]. Overall, the results showed that medical students with prior experience or knowledge of AI were more willing to interact with its use in the medical field. This agrees with an Indonesian study that found students with prior experience in programming during school were more willing to engage with and enhance technology in the healthcare field [28]. Currently, we can gradually begin to bridge the knowledge gap about AI and its branches among students by introducing it as a core subject in medical school [29]. Finally, social and cultural influences are considered a key factor in shaping students' perspectives towards artificial intelligence technologies, as studies conducted in similar environments, such as higher education in Nigeria, have revealed the importance of these dynamics [30]. Therefore, it becomes necessary to study the social dimensions and cultural characteristics in the Syrian context, in line with the unique social and political situations, to gain a deeper understanding of how these factors impact the adoption of technology in educational institutions.

Limitations and future research

One of the main limitations of this study is the sample size, which only included students from three private universities in Syria. This restricts the generalizability of the results to other universities, especially government ones where the educational environment and resources may differ. Future research should aim to include a more diverse sample of universities to provide a comprehensive understanding of students' readiness to engage with AI in the medical field.

Another limitation is the cross-sectional nature of the study, which captures a snapshot of students' readiness at a single point in time. Longitudinal studies are needed to track changes in attitudes and readiness over time, especially as AI technologies continue to evolve and become more integrated into medical education and practice.

Conclusions

It is evident that the integration of artificial intelligence into medical education is crucial for the advancement of healthcare in developing countries like Syria. To enhance students' awareness and engagement with AI, it is recommended to provide incentives such as certificates and

courses in AI, as well as organizing conferences and workshops on the topic. By fostering a culture of continuous learning and innovation in AI, we can ensure that medical students are well-equipped to leverage the benefits of AI while mitigating its potential drawbacks. Ultimately, investing in AI education and training will not only enhance the quality of healthcare but also contribute to the overall development of the healthcare system in developing countries.

Abbreviations

AI	Artificial intelligence
MAIRS_MS	Medical artificial intelligence readiness scale for medical students
FDA	Food and drug administration
ML	Machine learning
DL	Deep learning
BACC	Breast adenoid cystic carcinoma
PTC	Papillary thyroid carcinoma

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Author contributions
Hamdah Hanifa: Conceptualization, Methodology, Writing– original draft, Writing– review & editing, Supervision. Mohammad Atia: Methodology, Writing– original draft. Rawan Daboul: Formal analysis, Writing– original draft. Ahmad Alhamid: Methodology. Aya Alayyoubi: Methodology, Writing– original draft. Hiam Alhaj Naima: Writing– review & editing. Deema Alkassar: Methodology. Murhaf Ghassan Nabhan: Methodology. Basil Alsaleh: Methodology. Farris Abdula: Writing– review & editing, Supervision. All authors have participated in writing the manuscript and reviewed the literature. Dr. Farris Abdula and Dr. Hamdah Hanifa conceived and supervised the conduct of the study. All authors read and approved the final manuscript.

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Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to privacy and ethical considerations but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
All procedures performed in this study involving human participants complied with the institutional and/or national research committee ethical standards and the 1964 Helsinki declaration and subsequent amendments or equivalent ethical standards. The study was designed and conducted in accordance with the ethical principles established by University of Kalamoon. Therefore, ethical approval was obtained from the Institutional Review Board Committee, Faculty of Medicine, University of Kalamoon. ID number: 720/2025. Written informed consent was obtained from all the participants for the participation of this study and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Clinical trial number
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