ORIGINAL ARTICLE

Disparities in the practical and ethical implications of artificial intelligence in clinical practices determined by demographic data

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ABSTRACT

Background: The evolution of artificial intelligence (AI) has transformed the provision of healthcare services. However, researchers have not thoroughly examined its practical and ethical implications in Saudi Arabia's rural healthcare settings. Thus, this study aims to assess the AI integration-related challenges among healthcare professionals based on the demographic locations of the healthcare institutions.

Methods: It employed a cross-sectional study design among 400 physicians and nurses, utilizing a structured online questionnaire. Frequency, mean, and standard deviation were utilized for descriptive data analysis. Independent *t*-tests and analysis for variance (ANOVA) were utilized for inferential analysis.

Results: The majority of the 400 respondents were medical doctors (n = 295, 73.8%). Most participants were from governmental health facilities (n = 348, 87.0%), followed by private (n = 30, 7.5%), and then military (n = 22, 5.5%). 88.0% of the participants were from urban healthcare settings (n = 353, 88.0%). Higher significance means were found pertaining to the AI concerns and ethical considerations associated with respondents working in urban areas compared to rural areas (M = 3.55, p = 0.010; M = 3.69, p = 0.032). No difference was reported in terms of the type of healthcare facilities (p = 0.169, p = 0.613).

Conclusion: Despite the wide integration of AI-based solutions in urban healthcare institutions, concerns and ethical considerations are significantly higher. Accordingly, future studies are warranted to assess the impact of AI integration on rural healthcare providers' attitudes and behaviors.

Keywords: Artificial intelligence, healthcare, clinical practice, digital health transformation.

Introduction

Nowadays, cutting-edge technologies, especially those supported with artificial intelligence (AI), have transformed the global healthcare landscape. It is simply defined as the involvement of machines and computer systems that are able and capable of mimicking humans in performing tasks [1]. AI has facilitated and provided new innovative opportunities around different aspects of patient care [2]. AI revolutionized multiple clinical domains, including diagnosis and treatment, patients' health monitoring, big data analytics and prediction, drug discovery, and other areas that have been developed day by day.

Conversely, healthcare settings in rural areas experience other challenges hindering the delivery of high-quality healthcare [3]. According to Bell et al. [4], healthcare facilities in rural areas, even in developed countries such as the United States of America, have a shortage of clinical staff, low and limited clinical experience and expertise, as

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well as accessibility-related issues. Responding to these obstacles, AI can highly transform healthcare delivery in rural areas by enhancing remote consultation and patient diagnosis and promoting accessibility to expertise [5.

Despite the potential impact of AI in medical practices, healthcare providers raise some concerns and ethical considerations. Participants in the study by Gundlack et al. [6] perceived impersonality, data security, and fear of errors as the main concerns. The study of Udegbe et al. [1] concluded with some other factors, including legal, interoperability, accessibility, and human-AI interaction. While participants in the study by Ghadiri et al. [7] expressed concerns that overdependence on AI might reduce their clinical competencies.

Addressing such concerns and challenges maximizes the benefits of AI integration in clinical practices and eventually achieves clinical excellence and ensures patient safety. While a substantial number of studies have been conducted to address the practical and ethical challenges of AI integration in rural healthcare settings [8], no study has been found at the national level in Saudi Arabia that correlates the presence of these challenges based on the demographic data of the population. Therefore, the current study aims to analyze the distinct levels of AI challenges based on demographic information, specifically focusing on the types of healthcare organizations and their locations.

Methodology

A cross-sectional study was employed to identify differences in the ethical and practical considerations of physicians and nurses in integrating AI in clinical practice based on demographic data. It enabled the current study to collect data from multiple sources at the same time [9]. The study was conducted from March 2025 to June 2025.

Population and samples

The study targeted all physicians and nurses working at different healthcare facilities in the Kingdom of Saudi Arabia. However, physicians or nurses who were assigned administrative tasks during the study period, as well as other healthcare professionals, including dentists, were excluded. Convenience sampling was employed. A sample size of 385 respondents was estimated using the statistical formula $n = Z^2P(1 - P)/d^2$, where $Z = 1.96$ for a 95% confidence level, $p = 0.5$ for an assumed proportion, and $d = 0.05$ as the margin of error.

Inclusion and exclusion

The study included physicians and nurses working in various healthcare facilities across the Kingdom of Saudi Arabia, including those affiliated with the Ministry of Health, military institutions, universities, and private sectors. Individuals assigned to administrative tasks were excluded from the study.

Research instrument

A closed-ended online questionnaire was developed by a subject matter expert and was voluntarily validated by three subject matter experts to ensure its validity. The proposed questionnaire includes 29 questions divided into four sections: demographics (7 questions), practitioners' experience with AI (5 questions), practitioners' concerns about the integration of AI in clinical practice (10 questions), and ethical challenges of integrating AI in clinical practice (7 questions). After obtaining the Institutional Review Board (IRB) approval, the questionnaire was randomly piloted on 30 selected practitioners from different healthcare institutions, who met the inclusion criteria, to conduct the face validity and ensure a higher internal consistency (reliability) score using the Cronbach alpha coefficient.

Collection of data

The data collection process commenced when the Institutional Review Board (IRB) approval was obtained. The questionnaire was distributed online via the Google Form on different social media, including X (formerly Twitter), WhatsApp, Telegram, and LinkedIn. To ensure confidentiality, all collected responses were deidentified, stored, and kept confidential. To ensure the participant's right to participate, the questionnaire included a question on whether the candidates agree to voluntarily participate in the study or not. Apart from this, the participants were informed that they had the right to withdraw at any point, and their responses would then be excluded immediately.

Data analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY). The descriptive data were analyzed using the frequency, mean, and standard deviation. The inferential analysis was analyzed using the independent *t*-test and the one-way analysis for variance (ANOVA).

IRB statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the IRB of the General Directorate of Health Affairs in Madinah (IRB log No.: 09-24, 04 October 2024).

Results

Out of the participants who responded from different locations in Saudi Arabia, the majority were male healthcare professionals. In terms of the position, physicians make up the majority of the sample compared to nurses. The findings reveal that most of the respondents were working in governmental hospitals, while a minority were from private or military ones. Furthermore, the results show that more than two-thirds of participants were from urban areas (Table 1).

The table below describes participants' use and awareness of AI. The results indicate that while healthcare professionals' awareness of AI is considerable, its integration in clinical practices remains limited. A few of the respondents reported consistent use of AI in their daily work, while most indicated rare or no integration

of such technology. Findings show that perceptions of both benefits and AI-related risk were notably strong among physicians and nurses. Furthermore, most of the healthcare professionals revealed an awareness of how to apply AI within their specialties (Table 2).

Table 1. *Demographic statistics of study participants.*

	***N* (%)**
Gender	
Male	228 (57.0%)
Female	172 (43.0%)
Type of position	
Medical Doctor	295 (73.8%)
Nursing	105 (26.3%)
Type of healthcare institution	
Governmental hospitals	348 (87.0%)
Military clinic	22 (5.5%)
Private practice	30 (7.5%)
Location of healthcare institution	
Urban area	352 (88.0%)
Rural area	48 (12.0%)

Table 2. *Participants' perspectives of the use of AI.*

	***N* (%)**
Frequency of AI use in clinical practice	
Daily	86 (21.5%)
Weekly	50 (12.5%)
Occasionally	128 (32.0%)
Never	136 (34.0%)
Are you willing to use "AI" tools in your clinical practice?	
Yes	298 (74.5%)
No	102 (25.5%)
Are you aware of the potential benefits of using AI?	
Yes	322 (80.5%)
No	78 (19.5%)
Are you aware of the potential concerns of using AI?	
Yes	284 (71.0%)
No	116 (29.0%)
Do you know there is an area for using AI in your specialty?	
Yes	248 (62.0%)
No	152 (38.0%)

Difference in the physicians'/nurses' concerns of AI among locations of healthcare institutions

The study findings showed that physicians and nurses working in urban healthcare institutions had higher concerns about AI compared to those in rural ones. This difference is statistically significant. Furthermore, the results indicate that location plays a meaningful role in shaping attitudes towards AI. In terms of the equal variances, it was satisfied, confirming the reliability of the test results (Table 3).

Difference in the ethical challenges of AI among locations of healthcare institutions

In Table 4, physicians and nurses working in urban healthcare institutions reported higher ethical challenge levels about AI (3.69 ± 0.66, n = 352) compared with those in rural institutions. This difference was statistically significant, t(398) = 2.15, p = .032, 95% CI (0.02, 0.41). The non-significant Levene's test (p = 0.603) indicates that the assumption of equal variances was met, so the standard independent samples t-test results are appropriate.

Difference in the physicians'/nurses' concerns of AI among types of healthcare institutions

One-way ANOVA was performed to compare the effect of group membership on the mean scores. The results indicated that there was no statistically significant difference in the mean scores of physician/nursing concerns on AI between the groups, F(2, 397) = 1.79, p = 0.169 (Table 5).

Difference in the ethical challenges of AI among types of healthcare institutions

One-way ANOVA was conducted to examine differences in the mean scores of the ethical challenges of AI among the three groups. The results indicated that there was no statistically significant difference in the mean scores between groups, F(2, 397) = 0.49, p = 0.613 (Table 6).

Discussion

This study aimed to identify the level of disparity in practical and ethical considerations in clinical practices based on demographic data among physicians and nurses at different healthcare facilities in Saudi Arabia. The

Table 3. *Independent samples test related to the AI concerns.*

		Levene's test for equality of variances		***t*-test for equality of means**							
						Significance				***95% confidence interval of the difference***	
		F	***Sig.***	***t***	***df***	***One-sided p***	***Two-sided p***	***Mean difference***	***Std. error difference***	***Lower***	***Upper***
Physicians/ nursing concerns on AI	Equal variances assumed	3.731	0.054	2.575	398	0.005	0.010	0.22424	0.08710	0.05301	0.39547
	Equal variances not assumed			2.729	62.919	0.004	0.008	0.22424	0.08216	0.06006	0.38843

Table 4. *Independent samples test related to the AI challenges.*

		Levene's test for equality of variances		t-test for equality of means							
						Significance				95% confidence interval of the difference	
		F	*Sig.*	*t*	*df*	One-sided *p*	Two-sided *p*	Mean difference	Std. error difference	Lower	Upper
Ethical challenges of AI	Equal variances assumed	0.270	0.603	2.152	398	0.016	0.032	0.21537	0.10010	0.01858	0.41215
	Equal variances not assumed			2.254	62.397	0.014	0.028	0.21537	0.09556	0.02438	0.40636

Table 5. *One-way ANOVA results related to the physicians/ nursing concerns on AI.*

	Sum of squares	df	Mean square	*F*	Sig.
Between groups	***1.157***	***2***	***0.579***	***1.788***	***.169***
Within groups	128.502	397	0.324		
Total	129.659	399			

Table 6. *One-way ANOVA results related to the ethical challenges of AI.*

	Sum of squares	df	Mean square	*F*	Sig.
Between groups	0.420	2	0.210	0.491	0.613
Within groups	169.983	397	0.428		
Total	170.403	399			

study revealed that the mean score of AI concerns and ethical challenges among physicians and nurses working in urban areas is higher than that of those in rural healthcare settings. Moreover, it indicated that there was no significant difference in the same variables among types of institutions, whether governmental, military, or private. Such findings necessitate an in-depth discussion at a detailed level.

First, regarding the difference in the practical and ethical considerations among the locations of healthcare organizations, the current study showed a significant difference. It reported that physicians and nurses working in urban areas have higher mean scores about their concerns and ethical challenges compared to those working in rural areas. The results indicated that participants from rural healthcare institutions had no issues hindering the implementation of AI in clinical practices. This phenomenon might be because of the small percentage of participants from rural areas (12%), representing seven times less than those participants from urban areas (88%). Therefore, such a minority does not reflect the real population. Furthermore, those in urban areas have the highest opportunities to attend AI educational sessions; hence, they are more knowledgeable in AI-related topics when compared to participants from rural areas. In terms of practical experience, new technologies are highly adopted by organizations in the urban areas compared to those in rural areas. Thus, those working in these settings are more familiar with AI-related concerns and ethical challenges and are at a higher rate of reporting such challenges.

A useful comparison of urban-based to rural-based healthcare settings was conducted and studied by Abdullah and Fakieh [10]. Despite the advanced technical infrastructure, the study reported that healthcare providers perceived high concern scores about the AI technology. This conclusion is supported by the scoping review study of Brown and Davis [11], which revealed that the implementation of AI-based systems in rural areas is neglected. Therefore, ignoring rural healthcare facilities leads to losing the opportunity for staff to engage in the digital transformation and adoption of AI into different aspects of patient care.

It has been believed that healthcare professionals' perceptions of AI use in rural areas have always been a worldwide challenge. Therefore, disparity among urban and rural health services may be lessened by promoting medical AI technologies in developing countries' rural areas. Perhaps the solution is to set up a multilevel medical AI service network along with infrastructure development [3].

Second, our study disclosed that there is no significant difference in the concerns and ethical challenges among types of institutions. This implies that physicians and nurses working in governmental, military, and private hospitals have no different mean scores. It might be related to the health transformation programs and initiatives derived from the Saudi Vision 2030, where AI is a technology that has an inevitable role in revolutionizing healthcare in Saudi Arabia.

The current study aligns with the findings of Li et al. [12], which was conducted in China. It revealed that there was no statistically significant difference between university and non-university hospitals in terms of the AI worries and concerns. This finding contradicts the study by Hasan et al. [13], which revealed that healthcare professionals who work in governmental sectors were more likely to have more concerns than those in private ones. Moreover, it was also evident in another study in Pakistan conducted by Sajjad et al. [14], where it was reported that participants from public institutions were representing higher scores in comparison to those in the private sector.

Strengths

The current study seems robust due to the following strengths. First, it introduced and addressed the disparities concept, which focuses on the assessment of AI utilization in rural-based healthcare settings. Consequently, the results will support the implementation of data-informed interventions. Second, it included a sample from different Saudi Arabian healthcare settings and locations, which expands the relevance of its insights. Third, it utilized an independent *t*-test and ANOVA statistics. These tests clearly examined the difference between the perspectives of physicians and nurses on AI concerns and ethical challenges based on demographic variables.

Limitations

Nevertheless, some factors limit the findings of our study. One of the major limitations was that the study was confined to physicians and nurses, and other healthcare professionals were not included. Additionally, the study did not differentiate between three levels of healthcare organizations, which are primary healthcare, secondary hospitals, and tertiary hospitals. Such information might help policy- and decision-makers in future strategic plans. Third, the lower response rate from physicians and nurses working in the rural areas. Several factors may have contributed to the lower response rate in rural areas. It might have negatively affected the real presentation of the population.

Recommendations

Future research is also needed to bridge the knowledge gap and provide evidence for why scores in rural areas were mostly lower than those in urban areas; this issue requires more attention regarding the use of AI among healthcare professionals. Furthermore, leadership support and other stakeholders' participation are fundamental to the successful integration and application of AI in healthcare institutions and in clinical practices specifically, as they may help tackle the exclusive challenges faced by rural areas and ensure equitable access to AI technologies through different healthcare facilities.

Conclusion

This study revealed variation in AI-related concerns and ethical considerations among healthcare professionals working in urban-based healthcare institutions. This can be attributed to the level of awareness, support for education and training on AI-related tracks, availability of resources, and collaboration among key stakeholders, as well as leadership support for AI integration, along with fostering a culture of adoption of AI. Further research is warranted to accurately assess and examine the impact of AI integration on the attitude and behavior of healthcare professionals working in rural areas.

Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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Consent to participate

Written informed consent was obtained from all the participants.

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the General Directorate of Health Affairs in Madinah (IRB log No: 09-24, 04 October 2024).

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Supplementary content (If any) is available online.

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