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ORIGINAL ARTICLE

Knowledge, Attitude, and Practice of Mobile Health (mHealth) Among Healthcare Providers in Puducherry, India: A Facility-Based Cross-Sectional Study

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Abstract

Introduction: Mobile health (mHealth) promises to enhance healthcare delivery in resource-constrained settings, yet provider adoption remains suboptimal. This study assessed knowledge, attitudes, and practices (KAP) related to mHealth among healthcare providers in a tertiary care hospital in Puducherry, India. **Methods:** A cross-sectional survey was conducted from September to November 2024 among 410 randomly selected providers. A face-validated, semi-structured questionnaire captured demographics, digital device ownership, information-seeking behavior, and mHealth KAP. Descriptive statistics summarized responses; associations with awareness were analyzed using chi-square tests, with $p<0.05$ considered significant. **Results:** Universal smartphone ownership (100%) contrasted with low mHealth awareness (34.9%, 95% CI: 30.4%–39.6%) and minimal clinical use (16.1%, 95% CI: 12.9%–20.0%) of mHealth applications. While 82.0% (95% CI: 77.9%–85.4%) were willing to use mHealth, only 13.4% (95% CI: 10.5%–17.1%) had prescribed apps to patients. Medical (OR: 2.89, p=0.004) and dental (OR: 3.66, p=0.002) professionals exhibited higher awareness than pharmacists. Computer/laptop ownership (OR: 4.02, $p<0.0001$), combined mobile data and Wi-Fi access (OR: 3.78, $p<0.001$), and frequent health information seeking (OR: 42.73, p=0.0028) were strong predictors of awareness. Colleagues served as the primary information source (69.2%). **Conclusion:** Targeted digital literacy programs, institutional support, and streamlined integration of mHealth into clinical workflows are essential to bridge the gap between willingness and practice in resource-limited settings.

Keywords: mHealth, digital health, Health care workers, Telemedicine, Digital literacy

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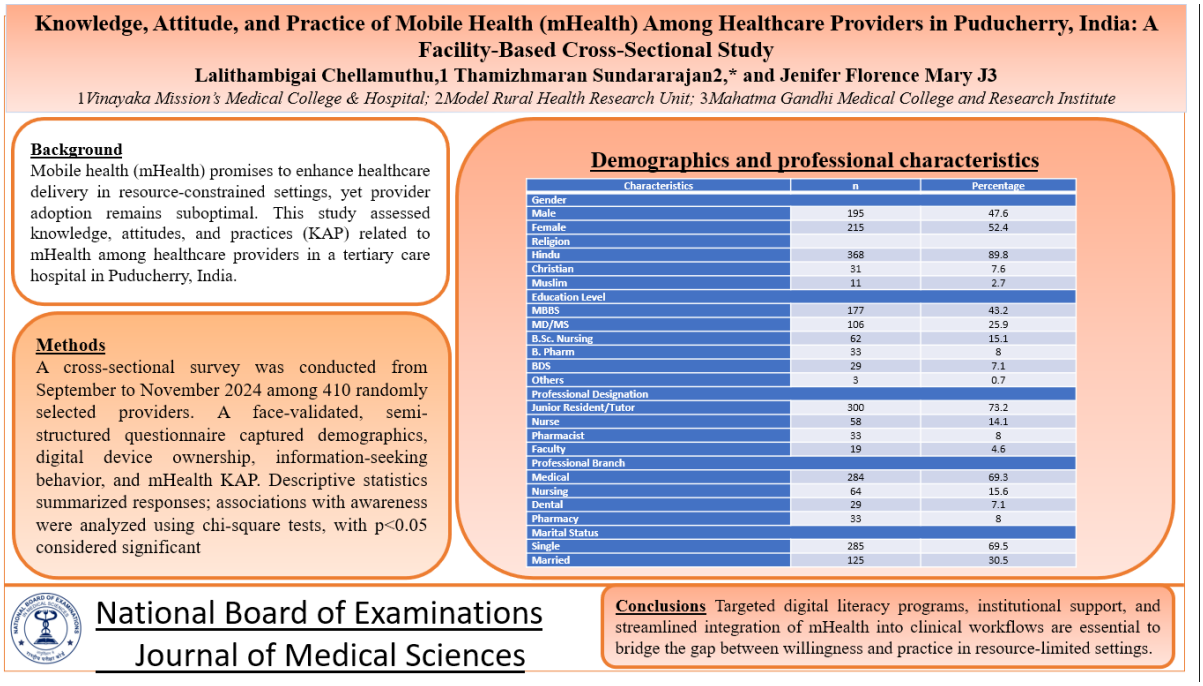
Graphical Abstract



Introduction

The global healthcare landscape is undergoing unprecedented digital transformation, with mobile health (mHealth) emerging as a cornerstone of modern healthcare delivery systems. Defined by the World Health Organization as "the practice of medicine and public health supported by mobile devices," mHealth encompasses a broad spectrum of technologies including smartphones, wearable devices, and health applications that facilitate healthcare information exchange, remote monitoring, and clinical decision support [1,2]. The global mHealth market, valued at $17.92 billion in 2019, is projected to expand at a compound annual growth rate of 45% through 2027, reflecting its increasing integration into healthcare systems worldwide [3]. Healthcare providers play a pivotal role in mHealth adoption and implementation, serving as key intermediaries between digital health technologies and patient care delivery.

However, substantial barriers persist in healthcare professional adoption of mHealth solutions, particularly in resource-limited settings. Systematic reviews have identified technological, individual, and organizational factors as primary determinants influencing healthcare provider acceptance of mobile health technologies. Key barriers include inadequate technical infrastructure, privacy and security concerns, limited digital literacy, time constraints, and insufficient organizational support [4,5]. In India, the government's Ayushman Bharat Digital Mission (ABDM), launched in 2021, represents a landmark initiative to create an integrated digital health ecosystem supporting universal health coverage. Despite registering over 400 million beneficiaries and 190,000 healthcare professionals by 2023, significant implementation gaps remain, particularly regarding healthcare provider engagement and adoption patterns [6]. Knowledge,

attitude, and practice (KAP) studies provide essential insights into healthcare provider readiness for digital health integration, informing targeted interventions to enhance adoption rates. Understanding healthcare providers' mHealth KAP is crucial for successful digital health transformation, particularly in developing countries where infrastructure challenges and resource constraints may impede implementation [7,8]. While several studies have examined mHealth adoption globally, significant knowledge gaps remain regarding healthcare provider readiness in Indian Union Territories, particularly within the Ayushman Bharat Digital Mission (ABDM) framework. This study assessed mHealth knowledge, attitudes, and practices among healthcare providers in Puducherry, India, contributing evidence to optimize digital health strategies in similar resource-constrained settings.

Methodology

A Facility-based analytical cross-sectional study was conducted at a health care facility in Puducherry, India, over three months (September–November 2024), among the healthcare providers, who were employed at the study site during the study period were eligible, and willingness to participate and provision of written informed consent were included in the study and those uncontactable after three departmental visits were excluded. Using a simple random sampling approach, 393 participants were targeted based on the World Health Organization's sample size formula ($n= Z^2_{1-\alpha/2}\ pq/d^2$), considering that 58.5% of healthcare providers would recommend m-health, and assuming a 95% CI, and absolute precision of 5%, adjusted for 5% nonresponse. The study involved a stratified random sampling approach. Healthcare Worker Selection required stratification by professional branch (Medical, Dental, Nursing, Pharmacy), utilizing simple random sampling within these categories.

A pre-tested, semi-structured, face-validated questionnaire—developed through literature review and expert consultation—captured demographics, digital device ownership, information-seeking behaviour, and mHealth KAP. The instrument was pilot-tested among 20 healthcare providers outside the study population and refined for clarity and content validity.

Primary outcomes included awareness of mHealth applications, attitudes toward their use in patient management, and self-reported usage for clinical care. Digital device ownership, information sources, and frequency of health information seeking were recorded as explanatory variables. Data integrity and participant confidentiality were rigorously maintained throughout the study.

Questionnaires were assigned unique identifiers and direct personal identifiers were stored separately from the research data. All electronic data were secured on encrypted, password-protected drives with access restricted exclusively to the core research team based on role-based access protocols. Following entry and validation, a fully de-identified analysis dataset was created for all subsequent statistical procedures.

Data were entered into Microsoft Excel 2021 and analysed using R software (ver. 4.3.2) Descriptive statistics summarized categorical variables as counts and percentages. Continuous variables were reported as means ± standard deviation. Associations between categorical variables and mHealth awareness were examined

using Chi-square or Fisher's exact tests as appropriate. A p-value <0.05 was considered statistically significant.

The Institutional Ethics Committee approved the study protocol. Participants received information on study objectives, and confidentiality was assured. Written informed consent was obtained prior to participation, and data were anonymized during analysis. Continuous monitoring and regular data audits ensured adherence to the study protocol and minimized measurement bias.

Results

The study successfully recruited 410 healthcare providers achieving the target sample size with universal smartphone ownership among participants.

Participant Characteristics

The mean age of the study population was 27 years (±4.79 SD). The cohort was nearly balanced in terms of gender, comprising 52.4% females and 47.6% males. The cohort was predominantly composed of medical practitioners, with junior residents and tutors constituting the largest group (73.2%). A significant portion of the participants held an MBBS degree (43.2%), followed by MD specialists (21.0%) and B.Sc. Nursing graduates (15.1%). The demographic and professional details are provided in Table 1.

Table 1. Demographics and professional characteristics

Characteristics	n	Percentage
Gender		
Male	195	47.6
Female	215	52.4
Religion		
Hindu	368	89.8
Christian	31	7.6
Muslim	11	2.7
Education Level		
MBBS	177	43.2
MD/MS	106	25.9
B.Sc. Nursing	62	15.1
B. Pharm	33	8
BDS	29	7.1
Others	3	0.7
Professional Designation		
Junior Resident/Tutor	300	73.2
Nurse	58	14.1
Pharmacist	33	8
Faculty	19	4.6
Professional Branch		
Medical	284	69.3

Nursing	64	15.6
Dental	29	7.1
Pharmacy	33	8
Marital Status		
Single	285	69.5
Married	125	30.5

Digital Technology Adoption and Information-Seeking Behaviour

All participants were found to own a smartphone, demonstrating 100% mobile device penetration among the healthcare providers surveyed. A significant majority of participants had extensive mobile usage experience, with the primary means of internet access being mobile data, either alone or in combination with Wi-Fi. A high frequency of mobile phone use for seeking health information was reported, with internet search engines, books and pamphlets, and online medical forums being the most frequently accessed channels. Further details on the digital technology ownership, mobile usage patterns, and health information-seeking behaviours are provided in Table 2.

Table 2. Digital Technology Adoption and Information-Seeking Behavior

Variable	n	Percentage
Digital Device Ownership		
Smartphone	410	100
Computer/Laptop	224	54.6
Smart Watch	129	31.5
iPad/Tablet	182	44.4
Mobile Phone Usage Duration		
> 5 years	153	37.3
5-10 years	166	40.5
> 10 years	91	22.2
Internet Access Method		
Mobile data only	212	51.7
Both mobile data and Wi-Fi	185	45.1
Wi-Fi only	13	3.2
Health Information Seeking Frequency		
High	244	59.5
Low	161	39.3
Never	5	1.2
Information Channels Used		
Internet search engines	303	73.9
Books/Information pamphlets	255	62.2
Online medical forums	192	46.8
Social networking sites	184	44.9
Media	173	42.2

mHealth Knowledge Assessment

More than one third (34.88, n= 143, 95% CI: 30.4%-39.6%) of surveyed healthcare providers were aware of mHealth applications. Among this group, knowledge varied in depth, with 63.6% aware of free apps, 49.0% of paid apps, and 56.6% familiar with Government of India-approved applications. The primary source of this information was colleagues (69.2%), followed by media (42.7%) and scientific sessions (15.4%). The most recognized application area was health promotion (68.5%), followed by health service delivery (56.6%) and human resources (24.5%).

Attitudes Toward mHealth Integration

A significant majority, 82.0% (95% CI: 77.9%-85.4%), were willing to use mobile devices for patient management. Similarly, 74.6% (95% CI: 70.1%-78.7%) agreed that mobile devices could be utilized for transmitting symptom data, which could potentially reduce the need for in-person hospital visits. Notably, only a small percentage, 28.5% (95% CI: 24.3%-33.1%), supported patients using these devices for self-diagnosis without professional oversight, indicating a prudent and professionally cautious approach to clinical care.

mHealth Practice Implementation

Within the last year, only 16.1% (95% CI: 12.9%-20.0%) of providers had used mHealth in their patient care, and a smaller percentage, 13.4% (95% CI: 10.5%-17.1%), had prescribed mHealth applications to patients. Of the providers who did use mHealth, over half (51.5%) engaged with the applications at least once daily, with an additional 16.7% using them multiple times a day. Usage patterns were dominated by health promotion activities (81.8%), while other applications, such as health service delivery (27.3%) and human resources (9.1%), saw minimal adoption.

Findings from the bivariate analysis indicated that several factors significantly influence mHealth awareness (***Table 3***). Notably, professionals in the Medical and Dental branches were significantly more aware of mHealth than those in Pharmacy, with odds ratios of 2.89 ($p=0.004$) and 3.66 ($p=0.002$) respectively. Similarly, individuals with senior designations, specifically Assistant/Associate Professors (OR: 7.71, $p=0.001$) and Junior Residents/Tutors (OR: 4.27, $p<0.001$), showed a much higher awareness compared to pharmacists.

Digital device ownership also played a crucial role, with those owning computers/laptops (OR: 4.02, $p<0.0001$) and smartwatches (OR: 2.18, $p=0.0004$) being significantly more aware of mHealth. Furthermore, access to the internet via both mobile data and Wi-Fi (OR: 3.78, $p<0.001$) and a high frequency of using mobile phones for health information (OR: 42.73, $p=0.0028$) were strong predictors of awareness. The use of certain channels for health information, such as Internet search engines (OR: 4.92, $p<0.001$) and online medical forums (OR: 1.54, $p=0.0372$), also correlated with higher mHealth awareness.

Table 3. Factors associated with the mHealth awareness among the study population

Variable	mHealth Awareness		OR (95% CI)	p-value
	Yes n (%)	No n (%)		
Gender				
Female	79 (36.74)	136 (63.26)	1.19 (0.79-1.79)	0.4051
Male	64 (32.82)	131 (67.18)		
Branch				
Medical	111 (39.08)	173 (60.92)	2.89 (1.16-7.21)	0.004
Dental	13 (44.83)	16 (53.17)	3.66 (1.16-11.52)	
Nursing	13 (20.31)	51 (79.69)	1.3 (0.44-3.82)	
Pharmacy	6 (18.18)	27 (81.82)	1	
Designation				
Asst./Asso. Professor	12 (63.16)	7 (36.84)	7.71 (2.13-27.88)	0.001
JR/Tutor	112 (37.33)	188 (62.67)	4.27 (1.70-10.73)	
Nurse	13 (22.41)	45 (77.59)	1.3 (0.44-3.82)	
Pharmacist	6 (18.18)	27 (81.82)	1	
Digital Device Ownership				
Computers/laptops				
Yes	108 (48.21)	116 (51.79)	4.02 (2.56-6.31)	<0.0001
No	35 (18.82)	151 (81.18)		
Smart watch				
Yes	61 (47.29)	68 (52.71)	2.18 (1.42-3.35)	0.0004
No	82 (29.18)	199 (70.82)		
Ipad/Tablets				
Yes	63 (34.62)	119 (65.38)	0.9794 (0.65-1.47)	0.9206
No	80 (35.09)	148 (64.91)		
Duration of mobile phone usage				
>10 years	34 (37.36)	57 (62.64)	1.19 (0.69-2.05)	0.8153
5-10 years	58 (34.94)	108 (65.06)	1.07 (0.68-1.71)	
>5 years	51 (33.33)	102 (66.67)		
Internet access				
Both	92 (49.73)	93 (50.27)	3.78 (2.43-5.86)	<0.001
Wifi	7 (53.85)	6 (46.15)	4.46 (1.43-13.92)	
Mobile data	44 (20.75)	168 (79.25)	1	
Frequency of mobile phone usage for health information				
High	101 (41.39)	143 (58.61)	42.73 (10.33-176.8)	0.0028
Low	40 (24.84)	3 (60)		

Never	2 (40)	121 (75.16)	1	
Channels of Health care information				
Internet search engines				
Yes	129 (42.57)	174 (57.43)	4.92 (2.69-9.03)	<0.001
No	14 (13.08)	93 (86.92)		
Social Networking sites				
Yes	67 (36.14)	117 (63.59)	1.13 (0.75-1.70)	0.5562
No	76 (33.63)	150 (66.37)		
Online medical forum				
Yes	77 (40.1)	115 (59.9)	1.54 (1.03-2.32)	0.0372
No	66 (30.28)	152 (69.72)		
Books/pamphlets				
Yes	100 (39.22)	155 (60.78)	1.68 (1.09-2.59)	0.0181
No	43 (27.74)	112 (72.26)		
Media				
Yes	77 (44.51)	96 (55.49)	2.08 (1.38-3.14)	0.0005
No	66 (27.85)	171 (72.15)		
Willing to use mHealth in the management of patients				
Yes	127 (37.8)	209 (62.2)	2.203 (1.21-3.1)	0.0082
No	16 (21.62)	58 (78.38)		
Mobile devices can be used in sending data to doctors about certain physical symptoms in place of direct hospital visits				
Yes	106 (34.64)	200 (65.36)	0.960 (0.60-1.53)	0.8626
No	37 (35.58)	67 (64.42)		
Used mHealth in past 12 months for patient care				
Yes	35 (53.03)	31 (46.97)	2.47 (1.45-4.21)	0.0007
No	108 (31.40)	236 (68.6)		
Prescribed mHealth applications for the patients				
Yes	21 (38.18)	34 (61.82)	1.258 (0.70-2.27)	0.4454
No	109 (32.93)	222 (67.07)		
Self-usage of mHealth applications in past 1 year				
Yes	30 (81.08)	7 (18.92)	10.78 (4.85-25.35)	<0.0001
No	99 (28.45)	249 (71.55)		
Chi-square test was applied				

Discussion

The study's finding that only 34.88% of healthcare providers were aware of mHealth applications aligns with the existing literature from developing countries. This suggests that the study's population, despite positive attitudes, mirrors a broader trend of limited mHealth literacy in resource-constrained settings, where awareness levels typically remain below 40%. The finding is also consistent with the results of a systematic review by Kasaye et al. [9], who reported a pooled digital health literacy rate of 56.0% among health professionals, which, while higher than this study's findings, still indicates a significant portion of the workforce lacks such literacy.

However, the study's results contrast sharply with findings from more developed nations, where awareness is substantially higher. The low awareness rate is particularly striking when juxtaposed with the 100% smartphone ownership among the study's participants. This highlights a critical and consistent gap observed in developing countries: the widespread availability of digital devices does not automatically translate to an equivalent level of knowledge and adoption of mHealth technologies. This finding is further supported by Walle A et al.'s research, which found that despite a high number of participants, only 43.4% of respondents had a favorable attitude toward mHealth technology, reinforcing the idea that device access and positive attitudes do not always lead to high awareness and usage [7].

In comparison, studies such as the one by Wubante et al. [8], which reported that 65.7% of participants had good knowledge and 55.5% had favorable attitudes toward e-PHR systems, provide a clear benchmark from a different context. The high knowledge and attitude scores in that study underscore a stark difference from the current study's findings and emphasize the need for targeted interventions to bridge the knowledge gap.

The finding that 100% of healthcare providers in this study own smartphones is a significant result, surpassing most reported rates in global healthcare literature. This rate aligns with the high ownership levels found in developed countries but exceeds the 85-95% typically reported in developing nations [10,11]. This high adoption rate highlights the rapid digital transformation occurring in urban healthcare facilities in India and is consistent with the country's broader digital health initiatives under the Ayushman Bharat Digital Mission [12,13].

The study revealed significant disparities in mHealth awareness across professional branches, with medical and dental professionals showing 2.89- and 3.66-times higher awareness respectively compared to pharmacy professionals. This finding is consistent with global literature demonstrating that medical professionals typically have higher digital health literacy compared to allied health professionals [10,14].

Similar patterns have been reported in studies by Shekoni et al. [15], and Walle et al.[7] where physicians consistently showed higher mHealth adoption rates compared to nurses and pharmacists. The educational differences between professional programs may explain these disparities, as medical curricula increasingly incorporate digital health components [16,17].

The study identified computer/laptop ownership as a significant predictor of mHealth awareness (OR: 4.02),

supporting findings from Addotey-Delove et al. [18] showed that healthcare providers with computer access were more likely to have adequate digital literacy, while studies had reported similar associations between computer ownership and digital health acceptance. This finding reinforces the importance of digital infrastructure in healthcare settings, as highlighted by systematic reviews identifying technological access as a primary determinant of mHealth adoption [4,17].

The study found that 69.2% of mHealth-aware providers obtained information from colleagues, which aligns with established patterns in healthcare technology adoption literature. Peer influence has been consistently identified as a crucial factor in technology acceptance among healthcare professionals [19]. This finding supports the diffusion of innovation theory, where interpersonal networks play critical roles in technology adoption [20].

This also indicated the absence of systematic training programs

Despite 82% of providers expressing willingness to use mHealth for patient management, only 16.1% had actually used mHealth in clinical practice within the past year. This substantial intention-behavior gap is well-documented in mHealth literature globally.

Similar gaps have been reported in systematic reviews, with studies consistently showing that positive attitudes toward mHealth don't necessarily translate to actual usage. Research from rural US healthcare systems reported comparable patterns, with high acceptance rates but limited implementation. Barriers contributing to this gap include time constraints, integration challenges, and lack of institutional support.

The Puducherry study reveals a striking disparity in India's healthcare digital transformation: while 82% of healthcare providers expressed willingness to use mHealth for patient management, only 16.1% had actually implemented it in clinical practice. This substantial intention-behavior gap of approximately 66 percentage points represents one of the most significant implementation challenges facing India's digital health initiatives.

This finding reflects a broader pattern observed across India's healthcare system, where the Ayushman Bharat Digital Mission (ABDM) has registered over 190,000 healthcare professionals but continues to face significant engagement gaps. Similar intention-practice disparities have been documented in other Indian healthcare digitization efforts, where positive attitudes toward digital health technologies don't translate into sustained usage patterns.

The Puducherry study reveals a striking disparity in India's healthcare digital transformation: while 82% of healthcare providers expressed willingness to use mHealth for patient management, only 16.1% had actually implemented it in clinical practice. This substantial intention-behavior gap of approximately 66 percentage points represents one of the most significant implementation challenges facing India's digital health initiatives.

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technologies don't translate into sustained usage patterns [21,22].

A systematic review by Sharma et al had documented low digital literacy among healthcare providers as the most common human resource-related barrier, affecting implementation across multiple states. The Government of India's Digital India campaign has initiated training workshops, but coverage remains insufficient for the vast healthcare workforce [21]. The "Kerala model" for implementing the ABDM offers a promising approach through its localized strategy by developing user manuals in local language and establishing coordinated training committees at both the state and district levels [23].

The evidence from the current study suggests a multifaceted approach to enhance digital health adoption, which includes integrating competency-based digital health training into medical and nursing curricula and establishing peer-to-peer learning networks. Further, the low current usage rates, a quality assurance and monitoring framework to track adoption rates, analyze patient outcomes, and gather provider feedback to ensure the program's long-term effectiveness.

The study's primary strengths include a large and representative sample size, which enhances the statistical power and generalizability of the findings within a tertiary care setting. The use of a pre-tested, face-validated questionnaire and the inclusion of diverse professional branches further strengthen the data quality and allow for comprehensive subgroup analyses. However, this exploratory cross-sectional survey was designed to establish baseline mHealth KAP metrics across multiple care levels in Puducherry and did not prespecify multivariable modelling or full psychometric validation. Future studies should incorporate comprehensive predictor variables and formal instrument validation to enable adjusted analyses and improve measurement precision

Conclusion

Despite universal smartphone ownership and high willingness to integrate mHealth into patient management, actual clinical use among Puducherry healthcare providers remains remarkably low. Key predictors of awareness include device ownership, internet access, and professional designation. Bridging the gap between provider willingness and effective mHealth practice in resource-limited Indian settings requires addressing training, infrastructure, and organizational deficits. This necessitates a comprehensive strategy, including the integration of competency-based mHealth and digital literacy modules into both undergraduate and in-service training. Furthermore, institutional adoption must be aligned with national standards, such as the ABDM framework and registries. Key supportive measures include conducting periodic digital literacy audits and maturity assessments, prioritizing access to workstations/laptops, and establishing peer-led learning networks to maximize colleague influence and sustain practice change

Statements and Declarations

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Conflict of interest

The authors declare no competing interests.

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