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Are the pharmacy students of Pakistan well-equipped to take up the digital transformation of pharmacy profession? A cross-sectional analysis

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ABSTRACT

The digitization of healthcare system requires pharmacy students to develop skills and competencies in digital health technologies for health service provision. However, there is limited evidence assessing the preparedness of pharmacy students in Pakistan for digital health practice.

Objective: This study was aimed to assess pharmacy students' digital health literacy and familiarity with digital health tools and technologies to take up the digital transformation of the pharmacy profession.

Methods: A cross-sectional survey was conducted among pharmacy students across Pakistan using a validated questionnaire from July to September 2024 distributed through in-person as well as online means. Descriptive and inferential statistics were performed.

Results: A total of 73.6% (n = 416) of respondents reported that they had not received digital health education through a course in their pharmacy school. Inadequate knowledge of digital health tools and lack of confidence in digital health service delivery was reported. Students who had received digital health education exhibited greater familiarity and more frequent use of digital resources. General search engines were the most preferred sources of health-related information, while YouTube was the highest-ranked social media platform. Despite limited exposure, 48.3% (n=273) students plan to pursue a career in digital health and 85% (n=481) supported the integration of digital health education in the curriculum. Univariate regression analysis showed significant associations of female gender, KPK and AJK residence with digital health tool familiarity, while Islamabad residence was significantly associated with the frequency of digital resource use.

Conclusion: The current pharmacy curriculum lacks the provision of digital health education and contributes to limited preparedness of pharmacists for digital transformation of pharmacy practice. The positive association between education and familiarity and use of technology highlights the need for integration of practice-based learning and exposure to tools and technologies in the curricula.

Keywords: Digital health, Digital health education, Pharmacy education and curriculum, FIP Development Goals

Introduction

Healthcare is an ever-evolving profession with continuous advancements being made in every domain from diagnostics to treatment, prevention to rehabilitation, diet and nutrition to promoting healthy lifestyle habits; all with a common goal of achieving better patient-oriented treatment outcome. Digital Health is defined by the World Health Organization (WHO), as "the field of knowledge and practice associated with the development and use of digital technologies to improve health". Digital health tools including e-health, m-health (mobile health), telehealth, wearable devices, bots, electronic health records and health information systems have led to improved patient care and better overall health status of the population (Karnoe, Furstrand et al. 2018) and the utilization of data for future research and development. Pharmacists, being the first-line healthcare providers, are required to have updated information about all the technological advancements being made to transform the global healthcare system.

The UN Sustainable Development Goals (SDGs) promote global health and well-being, while the International Pharmaceutical Federation (FIP) supports this vision through its Development Goals. FIP Development Goal 20 (Digital Health) focuses on integrating advanced technologies into healthcare delivery (FIPDG20 2020). FIP Development Goal 1 focuses on strengthening academic capacity through education and training programs that promote expertise, research, interdisciplinary collaboration, and access to evidence-based resources (FIPDG1 2020). This enables pharmacists to be digitally literate and occupationally efficient in the skills needed for the digital revolution (MacLure and Stewart 2018).

Despite the growing need for digitization, pharmacy curriculum has been reported to lack the inclusion of digital health education in more than half of the countries included in FIP study conducted globally (Mantel-Teeuwisse, Meilianti et al. 2021). Furthermore, significant gaps in educational content were also observed in those institutes offering DH courses (Wong, Hekimyan et al. 2024). However, multiple initiatives have aimed at incorporating the fundamental concepts of DH technologies, their applications and perceived benefits in pharmacy practice, and exposure to the DH tools (Alowais, Rudd et al. 2024). In the USA, hands-on training on EHR was provided to a batch of pharmacy students, the outcome of this was improved knowledge and confidence of students in the use of DH tools (Wasynczuk and

Sheehan 2021) (VanLangen, Elder et al. 2020). In Germany, pharmacy students learned to use wearable health technologies for remote monitoring and outcome assessment in patients with diabetes and hypertension (Kinny, Schlottau et al. 2024). The Government of Pakistan's National Digital Health Framework 2022–2030 aims to strengthen digital health strategies and establish an integrated, value-driven healthcare system. Despite gaps in healthcare accessibility, Pakistan's rapidly growing telecommunications sector offers opportunities to expand services through e-health, m-health, and other digital initiatives. Efforts include the introduction of health information and hospital management systems, pharmacy automation, e-prescriptions, telemedicine, and COVID-19 digital tools such as health dashboards, telehealth portals, and hospital-bed availability applications (HPSIU 2021).

Methodology

Study design and Setting

A cross-sectional study was designed to assess digital health literacy among pharmacy students. The study was conducted across four provinces (Punjab, Sindh, KPK, Balochistan), Azad Jammu Kashmir and Islamabad Capital territory of Pakistan. The study population comprised of the Doctor of Pharmacy (Pharm D) students. PharmD students of public and private universities of all provinces of different professional years were sampled. Non-probability convenience sampling was done ensuring that the students were represented according to population of the provinces.

Study tool

A survey questionnaire adopted from the FIP Digital Health in Pharmacy education survey and Digital Capabilities Framework (DCF) devised by Health Education England (HEE) was used with some modifications for our region and preferences. Permission was obtained from FIP Global Pharmaceutical Observatory to adopt the questionnaire developed and used by them in their study. The HEE framework is available on the NHS website with free access.

A structured questionnaire was used for data collection from students. The validated tools were tested for reliability (Cronbach's alpha, $\alpha = 0.897$) after conducting a pilot test on 10% (n=51) of the total sample size. Pilot test responses were excluded from final data.

Ethical approval

Ethical approval was taken from the Ethical Review Committee of Hamdard University (Ref. No. ERC-FOP-05-11). Data collection from the students of universities was conducted after permission from the respective Deans/HoDs of the department. Similarly, written informed consent was taken from all the respondents. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Participation was voluntary and privacy of respondents and confidentiality of information was ensured at each step of the study.

Data collection

Validated questionnaires were distributed among respondents through electronic and physical means from July to September 2024. Electronically, Microsoft Forms questionnaires were sent through WhatsApp, emails, pharmacists' Facebook groups and LinkedIn contacts. A total of 571 responses were collected from students across Pakistan.

Data analysis

After collection, the data was sorted for any missing information. The final number of valid responses came out to be 565. The data was statistically analyzed using Microsoft Excel and IBM SPSS (Statistical Package for Social Science) software, version 27. Descriptive statistics comprising frequency and percentages were calculated for categorical variables. A normality test was performed to determine if the sample data was normally distributed. The chi-square test for Independence, Mann-Whitney test and Kruskal Wallis tests were performed to find associations and differences among various variables. The probability value (*p*-value) for the level of significance was considered as <.05.

Scores were calculated for questions assessing pharmacy students' familiarity with digital health tools using a Likert scale (1 = Very unfamiliar, and 5 = Very familiar). Similarly, responses for frequency of use of digital resources were scored as 1 = less than once per week, and 5 = more than once per week. RII was selected as it provides a standardized approach for ranking responses obtained through Likert-scale questions and facilitates comparison of the relative importance of different factors (Opele 2021). The RII was calculated using the equation:

$$\mathrm{RII} = \frac{\sum W}{A \times N}$$

where ∑W is the total weighted score assigned by respondents, A denotes the highest weight on the Likert scale (5 = Strongly Agree), and N represents the total number of respondents.

Results

Demographic characteristics

A total of 565 valid responses were recorded from pharmacy students. The breakdown of respondents' demographics can be seen in Table 1.

Table 1. Pharmacy students' demographics

Demographics	Categories	Number (%)
Gender	Females	312 (55)
	Males	253 (45)
Province of study	Punjab	189 (33)
	Islamabad	134 (24)
	KPK	108 (19)
	Sindh	101 (18)
	AJK	22 (4)
	Balochistan	11 (2)
Sector of university	Private sector	318 (56)
	Public sector	247 (44)
Professional year of study	1st Professional year	6 (1)
	2nd Professional year	4 (0.7)
	3rd Professional year	6 (1)
	4th Professional year	174 (31)
	5th Professional year	271 (48)
	Recent graduates	110 (19.4)

Exposure to digital health education

The findings indicated limited exposure to digital health education in pharmacy schools. Of the 565 respondents, 416 (73.6%) reported that they had not received a digital health course as part of their pharmacy education, while 149 (26.4%) reported having received such education. In addition, 393 (69.6%) respondents had completed a computer studies course during their pharmacy education, and 170 (30.1%) had received digital health education through sources outside their university. The distribution of students' exposure to digital health education is summarized in Table 2.

Table 2. Digital health education in pharmacy school

Details	Response	N (%)
Taken a course on DH in pharmacy school	No	416 (74)
	Yes	149 (26)
	No	395 (70)

Taken a course on DH from other sources (institution/online)	Yes	170 (30)
Taken a course on computer studies in pharmacy school	No	172 (30)
	Yes	393 (70)
Ways of DH lecture ever being delivered in Pharmacy schools	**In a classroom setting**	
	No	348 (62)
	Yes	217 (38)
	In a practice setting, e.g., hospital	
	No	510 (90)
	Yes	55 (10)
	In a virtual setting	
	No	519 (92)
	Yes	46 (8)

Digital Health knowledge, confidence and curriculum exposure

The limited educational exposure was reflected in students' perception of digital health technologies. Almost 72.39% (n = 409) of respondents rated their knowledge of digital health tools/services as inadequate, and 68.50% (n = 387) had low confidence in their skills to deliver DH services after graduation. Assessment of the curriculum related to digital health concepts and skills in the pharmacy degree program demonstrated gaps in concepts and competencies. The digital health concepts and skills reported as part of pharmacy education are presented in Figure 1.

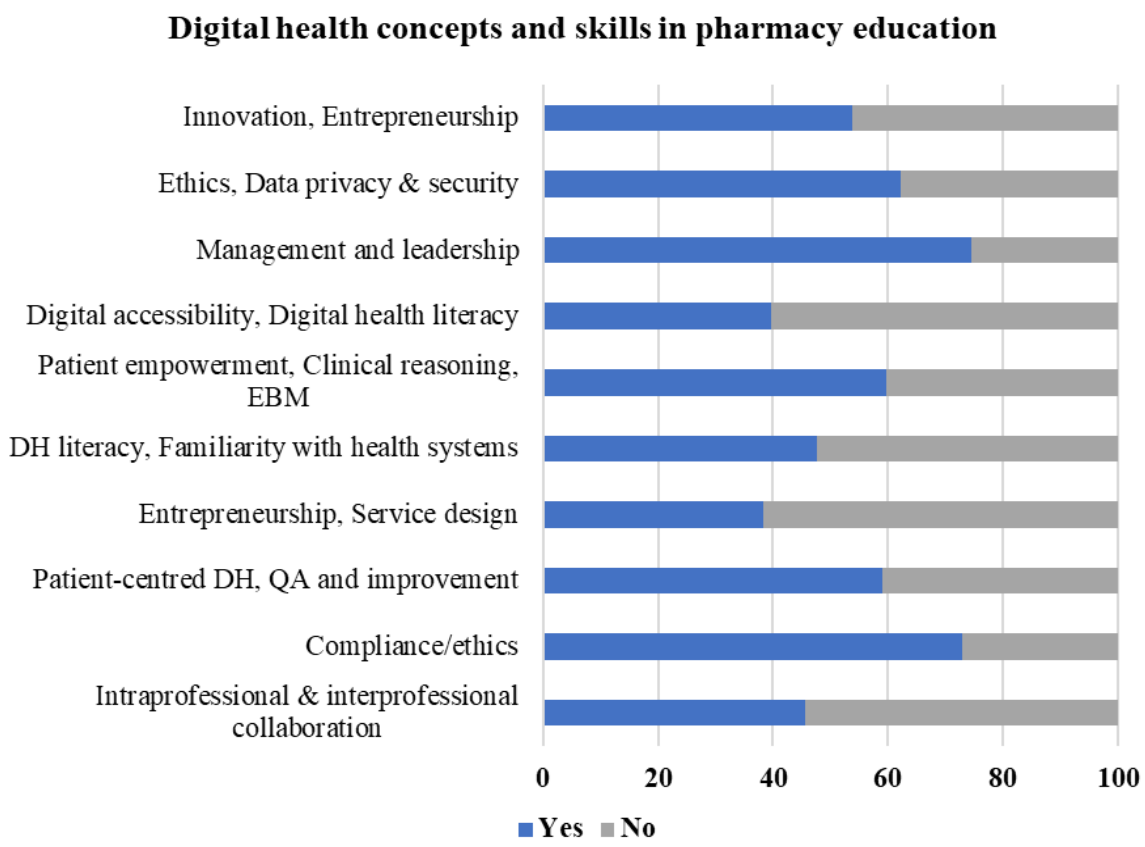


Figure 1. Digital health concepts and skills studied in pharmacy education

It has been observed that the PharmD curriculum taught in different provinces has variations with regard to health education concepts. Although no significant association was observed in the course of ethics and compliance (Chi-squared test for independence, $\chi 2$ (5, N = 565) = 8.143, p =.149) across provinces, statistically significant associations were seen in courses related to Innovation, creativity, Entrepreneurship (p<.001), Management and leadership (p<.01), digital accessibility, digital health literacy (p<.05), Patient empowerment, Clinical reasoning and decision-making Evidence-based digital medicine (p<.05).

Familiarity with Digital Health tools

Pharmacy students reported moderate level of familiarity with digital health tools with an overall mean familiarity score of 21.50 ± 5.69 (max. score 35).

It was observed that those respondents who have taken any course on digital health were more familiar with the DH tools than those who haven't (Mann-Whitney U Test U = 40459.00, p<.001). However, no statistically significant differences were observed across provinces (p= .057), gender (p= .113) or students versus recent graduates (p=.239).

Respondents who had received digital health education reported better self-knowledge of DH tools irrespective of the medium through which they had taken the course; classroom setting ($\chi 2$ (2, N = 565) = 45.18, p<.001), practice setting ($\chi 2$ (2, N=565) = 13.12, p <.01) and virtual setting ($\chi 2$ (2, N=565) = 9.67, p<.01).

Use of digital technologies and information sources

Despite lack of formal education, 70.61% (n = 399) students use digital technologies to stay updated with the latest pharmacy information and 79.82% (n = 451) use them to enhance their professional knowledge. General search engines e.g. Google and Yahoo etc. (94.33%, n = 533) are the preferred sources of health-related information for pharmacy students, followed by AI-powered tools e.g. Bing, ChatGPT, and NLM chatbots (84.07%, n = 475). The online sources used by students to search for health-related information are illustrated in Figure 2.

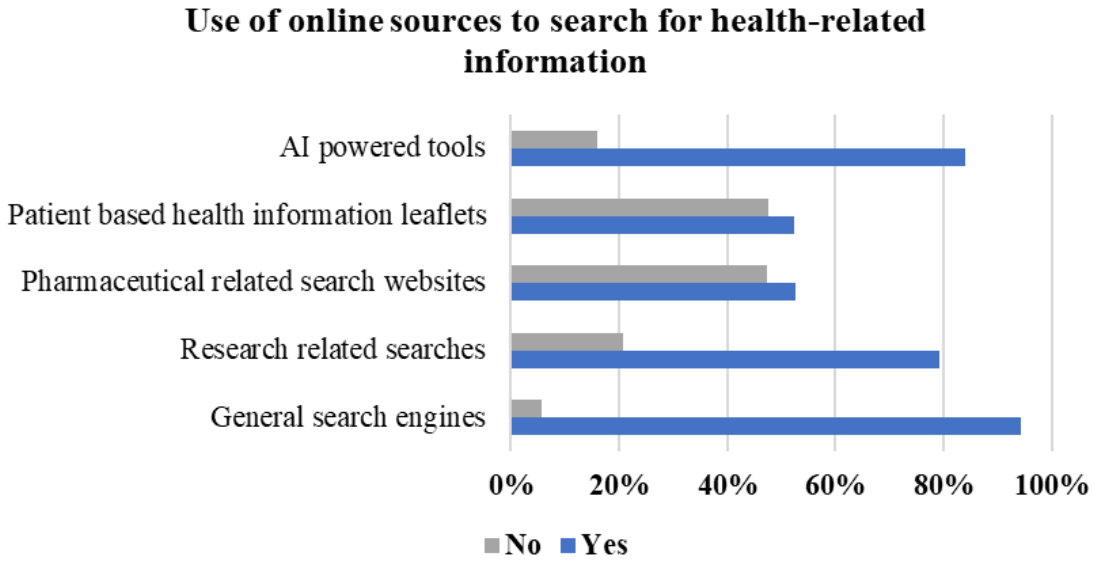


Figure 2. Use of online sources to search for health-related information by the students

Preference of Social Media Platform for Health-related information

Students use social media platforms to obtain health-related information and enhance their knowledge. Respondents from different provinces showed varying preferences which were assessed through Relative Importance Index (RII) ranks (Formula 1) as shown in figure 3.

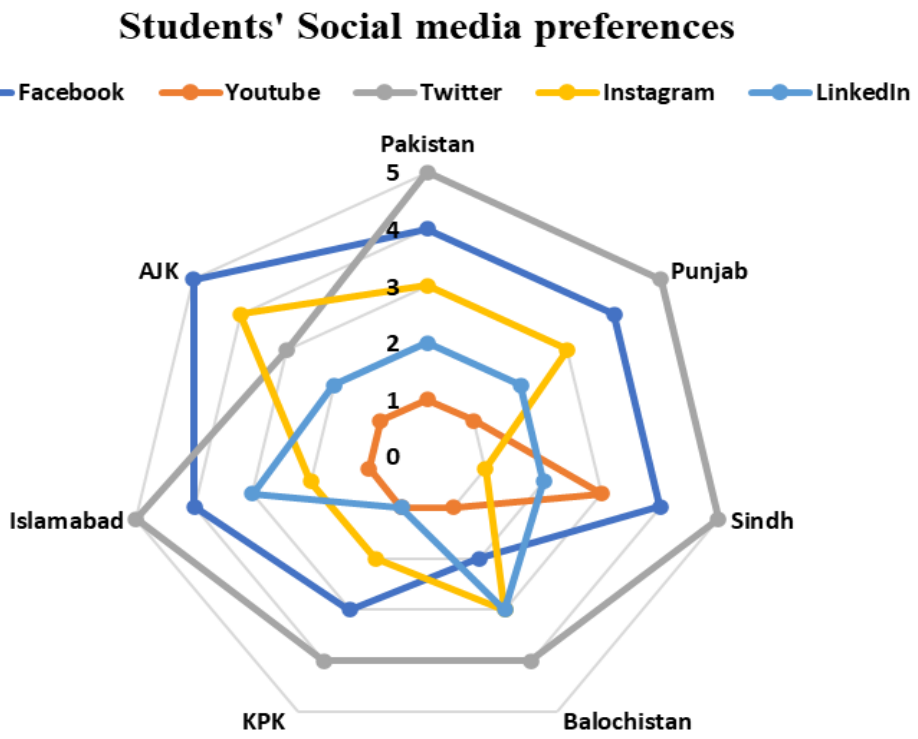


Figure 3. The Relative Importance Index (RII) of students' social media preferences across Pakistan and its provinces.

The relative importance index (RII) was used to rank students' preferences for social media platforms. Higher RII values indicate greater preference, with rank 1 assigned to the platform with the highest RII value. The RII values and corresponding ranks are presented in Figure 3.

With respect to m-health tools, 83.71% (n = 473) respondents were aware of health-related mobile applications but only 17.17% (n = 97) reported regular personal use. It was observed from the responses that despite being aware of some digital health tools, their use and application by students was limited and a statistically significant association was observed between the two variables (Chi-squared test for independence, $\chi 2$ (4, N = 565) = 71.04, p<.001). This emphasized the need for introduction of practical training about the use and applications of these mobile apps in health education.

Frequency of digital resource utilization

The frequency of digital resource and tool use for educational purposes was evaluated among pharmacy students. The mean utilization score was 11.41 ± 6.10 out of a maximum of 35. Usage varied significantly across provinces (Kruskal–Wallis test: $\chi^2(5, N = 565) = 13.69$, $p < 0.05$). Post hoc analysis identified significant differences between Islamabad and KPK ($p < 0.01$), Sindh and KPK ($p < 0.05$), and Islamabad and Punjab ($p < 0.05$).

Gender was not significantly associated with frequency of digital-resource use (B=-0.186, 95% CI: -0.473 to 0.101, p=0.203).

Respondents who had taken a course on digital health exhibited more frequent use of digital resources than those who hadn't taken any course (Mann-Whitney U Test $p<.01$). This shows the effectiveness of digital health course in enhancing the use of DH tools in daily practice. Similarly, students exposed to classroom setting ($p<.01$) or a practice setting ($p<.01$) for digital health education demonstrated increased frequency of use of digital resources. However, virtual setting ($p>.05$) didn't show any significant effect.

Support for digital health education and future career interests

A significant majority of respondents reported the lack of guidance or support in DH skills and employment opportunities from their pharmacy school (73.63%, n = 416) as well as from national or regional pharmacy associations (72.92%, n = 412). However, they exhibited great interest in digital health as about half of the respondents (48.31%, n = 273) aspire to plan a career focused on digital health in pharmacy practice.

With respect to their future plans, students strongly supported the integration of digital health courses in the pharmacy curriculum. A majority (85.1%, n=481) of respondents agreed to inclusion of courses and 77.17% (n=436) believed that practical training about all the DH tools should be made a part of the pharmacy curriculum.

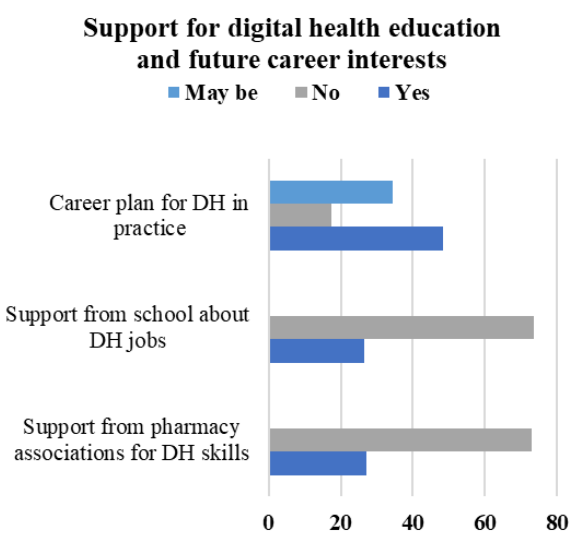
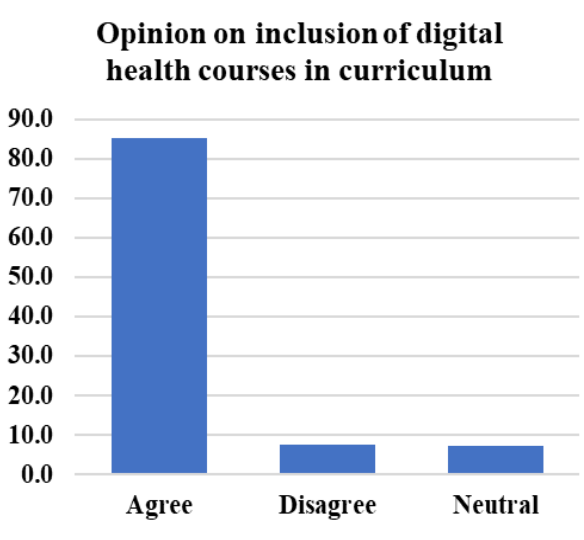


Figure 4. Support received by students about digital health



Students' opinion about the inclusion of DH courses in the pharmacy curriculum

Regression:

Univariate linear regression analyses were performed to examine the associations of gender, province, and professional year with digital health tool familiarity and frequency of digital-resource use. Unstandardized regression coefficients (B), 95% confidence intervals (CIs), and p-values were reported. Categorical variables were entered using predefined reference categories.

For digital-health tool familiarity, univariate regression analysis showed that female students had significantly higher Tool Scores than male students, who were the reference group (B=0.50, 95% CI: 0.12 to 0.88, p=0.01). Compared with students from Punjab, students from KPK (B=-3.729, 95% CI: -7.043 to -0.415, p=0.028) and AJK (B=-1.546, 95% CI: -2.801 to -0.291, p=0.016) had significantly lower Tool Scores. Islamabad, Sindh and Balochistan did not differ significantly from Punjab. Professional year was not significantly associated with Tool Score, with none of the comparisons with the 5th professional year reaching statistical significance.

For frequency of digital-resource use, students from Islamabad had significantly lower Frequency Scores than those from Punjab (B=-0.460, 95% CI: -0.846 to -0.075, p=0.019). Gender was not significantly associated with Frequency Score (B=-0.186, 95% CI: -0.473 to

0.101, p=0.203). KPK, Sindh, AJK and Balochistan did not differ significantly from Punjab. Professional year was also not significantly associated with Frequency Score. These regression comparisons represent individual category contrasts relative to the specified reference groups and should therefore be interpreted separately from the overall group-comparison tests reported above. The univariate regression results for digital health tool familiarity and frequency of digital-resource use are presented in Table 3.

Table 3: Regression Analysis

Regression Analysis among demographics and Digital health tool familiarity			
Variable	**Univariate Analysis**		
	Unadjusted B	**95% CI**	**p-value**
Gender (Male = Reference) Female	0.50	0.12 to 0.88	0.01
Province (Punjab = Reference) Islamabad	-0.358	-1.719 to 1.004	0.606
KPK	-3.729	-7.043 to -0.415	0.028
Sindh	-0.254	-1.591 to 1.083	0.709
AJK	-1.546	-2.801 to -0.291	0.016
Balochistan	0.885	-1.623 to 3.392	0.489
Professional year (5th = Reference) 1st Year	-3.802	-14.990 to 7.386	0.505
2nd Year	-0.340	-3.495 to 2.815	0.832
3rd Year	0.305	-1.888 to 2.499	0.785
4th Year	-0.924	-2.021 to 0.173	0.098
Regression Analysis among demographics and frequency of digital-resource use			
Gender (Male = Reference) Female	-0.186	-0.473 to 0.101	0.203
Province (Punjab = Reference) Islamabad	-0.460	-0.846 to -0.075	0.019
KPK	0.021	-0.397 to 0.438	0.923
Sindh	-0.123	-0.533 to 0.288	0.557
AJK	0.385	-0.385 to 1.155	0.326
Balochistan	-0.251	-1.269 to 0.766	0.628
Professional year (5th = Reference) 1st Year	-1.091	-4.545 to 2.364	0.535
2nd Year	0.832	-0.142 to 1.807	0.094
3rd Year	0..052	-0.625 to 0.729	0.880
4th Year	0.120	-0.218 to 0.459	0.486

Discussion

The rapid digital transformation of healthcare is reshaping pharmacy practice and increasing the need for digital health competencies among future pharmacists. Integrating digital health education into pharmacy curricula is essential to prepare students for emerging technologies and technology-enabled patient care. The present study explored digital health education, familiarity with digital health tools, patterns of digital resource use, and students' preparedness for digital health practice among pharmacy students in Pakistan.

The findings highlight the limited integration of digital health education into pharmacy curricula in Pakistan, with nearly three-quarters of respondents reporting no formal digital health education during their pharmacy studies. This finding is consistent with a multinational FIP study conducted across 39 countries, in which only approximately one-tenth of respondents reported receiving digital health education (Mantel-Teeuwisse, Meilianti et al. 2021). Substantial variation was also observed in the extent and mode of education, with some students receiving practical training while others were exposed only to theoretical instruction. Educational exposure differed across provinces, with students in Islamabad reporting greater exposure than those in other regions. Although the factors underlying these disparities were not investigated, differences in faculty expertise and institutional resources may contribute to the variation. These findings underscore the need for standardized digital health and health informatics curricula to promote consistent competency development among pharmacy graduates (Wong, Hekimyan et al. 2024) (Alhur 2024).

The majority of respondents supported the inclusion of digital health courses and practical training in pharmacy curricula, reflecting recognition of the field's limited representation in current pharmacy education. Furthermore, nearly half expressed an intention to pursue a career in digital health, indicating interest in this emerging area of practice (Poncette, Glauert et al. 2020). These findings align with FIP Development Goal 1, which emphasizes academic capacity development through education and training. Internationally, pharmacy programs have introduced educational approaches to strengthen digital competencies, including training in electronic health records (EHRs), mobile health applications, wearable technologies, and health data interpretation (Wasynczuk and Sheehan 2021) (Kinny, Schlottau et al. 2024). Incorporating similar approaches into pharmacy education may help bridge existing competency gaps and better prepare students for technology-enabled healthcare.

An important finding was the association between digital health education and students' engagement with digital technologies. Students who had received digital health education demonstrated greater familiarity with digital health tools and more frequent use of digital resources in their daily routines. Univariate regression analysis showed that female students had higher digital health tool familiarity scores than male students, while students from KPK and AJK had lower familiarity scores than those from Punjab. For frequency of digital-resource use, students from Islamabad had lower scores than those from Punjab, whereas gender and professional year were not significantly associated with frequency of use. These findings suggest some demographic variation in digital health engagement; however, the observed associations should be interpreted cautiously and do not establish causality.

Although most students were familiar with mobile health applications, their reported frequency of use was relatively low, as reflected by the mean digital resource utilization score. This contrasts with findings from studies in the United States and Canada, where pharmacy students frequently used mobile health applications to retrieve drug-related information (Wallace, Clark et al. 2012, Park, Purnell et al. 2017) and recognized their potential to improve patients' quality of life (Üstün, Söylemez et al. 2020). This difference may reflect variation in educational exposure and patterns of technology use, although these factors were not directly examined in the present study.

General search engines, such as Google and Yahoo, were the most preferred online sources of information, followed by AI-powered tools, while YouTube was the preferred social media platform. These findings are consistent with research among medical students in Australia, where online lectures and videos were commonly used to support understanding of new concepts (Wynter, Burgess et al. 2019). Notably, more than four-fifths of respondents reported using AI-powered tools, highlighting their growing role in students' learning practices. However, reliance on AI-generated information raises concerns regarding accuracy and reliability, particularly when compared with established evidence-based resources such as pharmaceutical databases and scientific literature. These findings emphasize the importance of developing students' skills in critical information appraisal, evidence-based information retrieval, digital professionalism, and responsible AI use in pharmacy practice.

Finally, the widespread lack of guidance and institutional support reported by respondents highlights the need for coordinated efforts to strengthen Pakistan's digital health workforce. Collaboration among

the Pharmacy Council of Pakistan, educational institutions, regulatory authorities, and other stakeholders could facilitate the systematic integration of digital health competencies into pharmacy education. Effective implementation of Pakistan's National Digital Health Framework, alongside appropriate institutional support, may further strengthen the digital health capabilities of future pharmacy graduates. International models, such as the Australian Digital Health Agency, may provide useful examples for consideration in developing national digital health initiatives (Wong, Hekimyan et al. 2024).

Several limitations should be considered when interpreting these findings. The use of non-probability convenience sampling may have introduced selection bias and limits the generalizability of the results to pharmacy students across Pakistan. Although participants were recruited from different provinces, the sample may not fully represent the distribution of pharmacy students nationwide. In addition, the online questionnaire relied on self-reported responses, which may be subject to recall and response bias. The cross-sectional design provides a snapshot of students' digital health knowledge, confidence, and educational exposure at a particular point in time; therefore, causal relationships cannot be established. Furthermore, the study assessed students' reported familiarity and frequency of digital resource use rather than objectively testing their digital health competencies. These limitations should be considered when interpreting the findings and highlight the need for future multicentre studies using more representative sampling approaches and objective assessments of digital health skills.

Conclusion

The findings of the present study emphasized the need for initiatives to be taken for the integration of digital health education and practice for pharmacy students in Pakistan. The current pharmacy curriculum lacks educational and practice-based learning on digital health concepts, technologies and tools. However, students have expressed their interest in learning this new dimension of technological revolution in the healthcare sector. Therefore, the pharmacy curriculum should be standardized and upgraded to ensure preparedness of future pharmacy workforce to take up the digital transformation of healthcare in Pakistan.

Limitations of the study

This study was designed to be a cross-sectional study which cannot establish causality. Although the sample of students represents different provinces and sectors of Pakistan and the study achieved its estimated sample size, further extensive data collection could have been performed to increase the generalizability of study results and to achieve comparable representation from all regions. However, the time and financial constraints were the biggest limitation of the study. Despite these limitations, this is one of the first study to provide insight into the digital health literacy and readiness among pharmacy students of Pakistan.

Statements & Declarations:

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No funding was obtained for this project.

Competing Interests:

The authors express no conflicts of interest.

Authors' Contributions:

MI: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Project administration

LA: Conceptualization, Formal analysis, Validation Supervision, Writing & Re-writing. Correspondence.

MA: Conceptualization, Formal analysis, Data curation, Validation, Writing – review & editing.

SS: Data curation, Formal analysis.

EJA: Writing – review & editing, References management.

UI: Methodology, Validation, Resources.

MS: Transcription, Investigation. : Investigation, Formal analysis.

MI: Writing – review & editing.

SS: Data analysis, Data Collection.

MEK: Writing– original draft, Visualization.

MU is guarantor of study.

Availability of data and materials:

Due to the sensitive nature of the data and confidentiality agreements, the full datasets are not public. But de-identified data may be available from the corresponding author upon reasonable request.

Patient and Public Involvement

Patients and members of the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Ethical approval and consent to participate:

Our study does not involve the use of animals and ethical approval was taken from Hamdard University and willing to participate in the study by the written consent of the respondents.

Consent for publication:

Written informed consent was taken from all the patients prior to inclusion in the study.

Declaration of AI:

Generative AI (ChatGPT v4.0) was used solely to improve grammatical structure and flow of the finalized manuscript. All AI-suggested grammatical improvements were carefully reviewed by the authors to ensure the original meaning and scientific integrity of the work were preserved. The authors confirm that no AI tools were used in the study design, data collection, analysis, or conduct.

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