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Predictors of Osteopathic Medical Students' Readiness to Use Health Information Technology

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Context: The advent of health information technology (HIT) tools can affect the practice of modern medicine in many ways, ideally by improving quality of care and efficiency and reducing medical errors. Future physicians will play a key role in the successful implementation of HIT. However, osteopathic medical students' willingness to learn, adopt, and use technology in a health care setting is not well understood.

Objective: To understand osteopathic medical students' knowledge, attitudes, and behaviors regarding HIT and to identify factors that may be related to their readiness to use HIT.

Methods: Using a cross-sectional approach, quantitative surveys were collected from students attending a large osteopathic medical school. Multivariate regression modeling was used to determine whether knowledge, attitudes, behaviors, and personal characteristics were associated with students' readiness to use HIT in future clinical practice.

Results: Six hundred four students responded to at least 70% of the survey and were included in the analysis. Multivariate modeling successfully explained the 26% of variance in predicting students' readiness to use HIT ($F_{8,506}$=22.6, P<.001, R^2=0.263). Greater self-efficacy, openness to change (in academic/work settings), favorable attitudes toward HIT use, mobile technology use, younger age, being male, and prior exposure to technology were associated with readiness to use HIT.

Conclusion: Understanding students' level of HIT readiness may help guide medical education intervention efforts to better prepare future osteopathic physicians for HIT engagement and use. Innovative approaches to HIT education in medical school curricula that include biomedical informatics may be necessary.

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Health information technology (HIT) may be instrumental in revolutionizing the practice of medicine in the 21st century. The tools of HIT, such as electronic health records (EHRs) or electronic medical records (EMRs), computerized physician order entry systems, and mobile EHRs, allow for enhanced patient safety, improved health care service quality, and cost-effective medical care.[1] Although many physicians, residents, and policy makers recognize the benefits of these tools in practice, overall ambivalence and frustration is growing owing to system inefficiencies (eg, lack of uniformity, limited access, errors) and user frustration and dissatisfaction (eg, time-consuming data entry, user interfaces not matching clinical workflow, interference with face-to-face care).[2] In fact, physicians and other health care professionals may harbor negative attitudes toward technology's ability to assist them in their practice, such as preventive opportunities, time management, and medical record accuracy.[3] Adequate attention to these issues is needed to improve HIT use in advancing patient health outcomes. Although many studies have examined current physician attitudes and beliefs toward HIT, little attention has been allocated to understanding how future osteopathic physicians will use HIT applications.[2] With growing class sizes and several new osteopathic medical schools in the United States, roughly 230,000 new osteopathic physicians will be entering the work force during the next 10 years.[4] These new physicians will need to master not only medical knowledge but also HIT tools.

Technology readiness is understanding and being prepared to use technology tools (eg, EHRs, mobile EHRs) in the future.[5] The technology-readiness construct refers to people's propensity to embrace and use emerging technologies for accomplishing goals in home life and at work. The concept can be viewed as an overall state of mind resulting from a composition of mental enablers and inhibitors that collectively determine a person's predisposition to use new technologies.

One of the first steps in ensuring the effective use of HIT tools by physicians is to assess their readiness while still in medical school. Medical students who are open to changes find EHR systems beneficial and easier to use than students who are not open to changes.[2] Such relationships suggest that openness to change and flexible thinking are characteristics that medical educators and administrators should be aware of when designing EHR training and education programs. Among people who are less open to change, organizational change can negatively affect job satisfaction and increase work irritation and intentions to quit.[2]

Self-efficacy is instrumental for comfort when something is new or difficult to use.[6] Furthermore, lack of user participation with technology in general may interfere with a person's ability to embrace new technology.[7] Therefore, technology must be useful, practical, and easy to use. Perceived usefulness (PU) and perceived ease of use (PEOU) are described as 2 separate variables that act as determinants for individuals to accept or reject new information technology (IT).[8] Perceived usefulness is defined as the extent to which a person believes that using IT tools will enhance his or her outcomes. Perceived ease of use is defined as the degree to which system use will be free from additional effort.[9] A system high in PU indicates that users believe the system has a positive use-performance relationship.

Mobile health is the generation, aggregation, and dissemination of health information via mobile and wireless devices. The use of mobile health technologies such as smartphones and tablets is becoming more ubiquitous in the provision of health care,[10] but as a new modality for accessing health information in the clinical environment, it is unclear what attitudes are held by medical students toward their use.

Holden and Rada[11] focused on computer-supported education, perceptions of self-efficacy and anxiety when working with computers, and the attitudes of teachers and teacher candidates toward technology. Others have investigated the determinants of technology use and technology readiness.[5,12,13] However, no published studies, to our knowledge, have investigated attitudes, beliefs, and behaviors regarding IT and HIT and their influence on technology readiness in osteopathic medical students. Our study thus sought to identify which of these factors, including personal characteristics, are associated with osteopathic medical students' readiness to use HIT in future practice.

Methods

In this survey-based study, we designed a questionnaire containing previously validated items to measure students' HIT readiness and possible factors (eg, demographics; knowledge, attitudes, and use of IT in general and HIT in particular) that might influence their readiness to use these HIT tools in future medical practice. The study was approved by the Nova Southeastern University Institutional Review Board.

Participants

Data were collected in 2015 from students enrolled at the Nova Southeastern University College of Osteopathic Medicine. Participants were current students at any point of their education, from first year to graduation, and were required to be aged 18 years or older. Students who did not meet these criteria were excluded.

Survey Administration

A self-administered, anonymous questionnaire was administered to all students currently attending the osteopathic medical school. Participants were informed about the study via a cover letter that accompanied the survey. All participants were informed about the purpose of the study, the voluntary nature of their participation, anonymity of the data, possible risks and benefits, plans for dissemination of findings, how to contact the researcher and institutional review board, and instructions for completing the questionnaire. Participants provided their consent at the point of survey administration for their data to be used for research purposes.

The survey was offered in pen-and-paper format and online via SurveyGizmo. For the online version of the survey, reminder notifications were e-mailed at 2 weeks and at 4 weeks to optimize data collection efforts and reduce nonresponse rates.[14,15] Paper format administration was conducted only once before an onsite class session and was strictly voluntary. To minimize the chance of survey duplication, first- and second-year students were offered and completed the survey in hard copy form in person during 1 class time only. Third- and fourth-year students were offered it online only. If online surveys were returned in which a student indicated that he or she was a first- or second-year student, that survey was excluded. The questionnaire took 10 to 15 minutes to complete.

Survey Tool

Relevant published studies were used to guide the development of the 72-item quantitative questionnaire for this study to investigate HIT knowledge, attitudes (computer self-efficacy, flexibility/openness to change), use (perceived ease of use and usefulness of HIT, mobile technology use), and technology readiness. The questionnaire used for this study was a combination of validated measures and other items developed by the researchers, including participant personal characteristics (eg, gender, age), experiences (eg, prior work or volunteer experience using HIT), and HIT knowledge. These measures were as follows:

- **Technology Readiness Index (TRI) 2.0.** This tool has demonstrated an acceptable level of internal consistency, both overall for technology readiness (α=.70), as well as its subscales (discomfort, α=.74; optimism, α=.80; and innovation, α=.85). This 10-item tool uses a 5-point Likert-type scale (1, "strongly disagree," to 5, "strongly agree") and includes 2 motivator dimensions (optimism and innovativeness) and 2 inhibitor dimensions (discomfort and insecurity). Examples of technology readiness items include "Technology makes me more productive in my personal life" and "Technology lowers the quality of relationships by reducing personal interaction."[5] Negatively worded questions were reverse coded; thus, a higher score indicated greater technology readiness.
- **Use of Personal Mobile Technologies in a Clinical Environment (mobile technology subscale).** This scale was used to assess respondents' attitudes toward mobile health technology often used in clinical settings. It contains nine 5-point Likert-type scale items,

such as "My personal mobile phone is distracting during clinical work" and "Using my personal mobile phone for clinical work makes me more efficient."[16] Negatively worded questions were reverse coded; thus, a higher score indicated more positive attitudes toward mobile technology.

In addition, single items created by the researchers that addressed HIT use and personal experiences with IT tools, including their educational setting, were included. Examples of single items are, "To your knowledge has your school established an approach for students learning HIT?" and "Have you ever been instructed on the use of EHRs/EMRs in medical school?" Reliability estimates for this subscale are not available.

- **Using New Computer Applications Scale (self-efficacy).** This tool contains 4 items using a 7-point Likert-type scale (1, "totally confident," to 7, "totally unconfident") and was used to assess an individual's perceived confidence related to computer software use, or computer-related self-efficacy. Examples of items include "I could complete a task using the new software if I could call someone for help if I got stuck" and "I could complete a task using the new software if there was no one around to tell me what to do as I go." The scale has good reliability (α=.90).[2] Lower scores indicated greater self-efficacy.
- **Flexibility Scale.** This scale (α=.88) was used to assess respondents' openness to change or flexibility. It is a 6-item measure using a 7-point Likert-type scale (1, "strongly disagree," to 7, "strongly agree"). Being flexible and open to change has been associated with learning about and embracing new technologies.[2] Items assessing flexibility include "I welcome the introduction of new technology in my work or studies" and "I look forward to the advantages brought by new work or study practices that are introduced." Higher scores indicated greater openness to change.
- **PU and PEOU.** This 9-item survey tool uses a 7-point Likert-type scale (1, "strongly disagree," to 7, "strongly agree"). Items are divided into 2 sections: (1) PEOU of EMRs and (2) PU of EMR systems based on knowledge and training of the individual. Reports of reliability have been highly favorable (α=.96). Examples of items are "Learning to operate the EMR system will be easy for me" and "Using the EMR system will make it easier to do my job."[2] Higher scores indicated greater PU and PEOU of EMRs.
- **HIT knowledge.** This knowledge was assessed using 10 true/false response items. Lower scores indicated less HIT knowledge. Examples of items are "EHR and EMR are often used as interchangeable terms" and "Clinical decision support systems help clinicians diagnose medical conditions." This measure was constructed by the researchers and was not validated.
- **Personal characteristics.** This portion of the survey included 13 items pertaining to participant sex, age, medical student status, country of origin, education, professional background, and prior experience with IT (eg, "Have you ever worked or volunteered as an IT specialist?").

Statistical Analysis

We used SPSS software (IBM) to analyze the data. To maintain accuracy of data entry, the data were cross-checked for errors, such as out-of-range values, missing data, and outliers. Questionnaires with more than one-third of missing data were excluded from data analysis.

Distributional assumptions with univariate and multivariate normality statistics (tests for skewness and kurtosis) as well as by visual inspections of the empirical distributions were tested. Reliability estimates (ie, Cronbach α) for scales were computed for the sample and compared with estimates from previous studies in which the instruments were used. Reliability estimates for all of the scales were conducted and were within acceptable limits (α>.70).[17] For any factors with an α<.70, items with low loadings were trimmed from the scale and the scale was reassessed for reliability (ie, mobile health technologies scale).

Reliability estimates for the measures used in the questionnaire with the study sample were as follows: the Technology Readiness Index (TRI; α=.73); Use of

Mobile Health Technologies in a Clinical Environment (α=.70); Using New Computer Applications Scale (self-efficacy; α=.91); Flexibility Scale (α=.86); PU/PEOU (α=.92); and HIT knowledge (α=.40).

There were 8 predictors in the model, allowing for the potential for multicollinearity or association between variables.[18,19] Multicollinearity testing was thus conducted before the regression analysis, indicating the predictors were not highly correlated and were within acceptable variance inflation factors limits.[18,20] Scales were normally or fairly normally distributed (ie, the data did not deviate from normality enough to affect inference.)

Results

From the 993 students enrolled and contacted for the survey, 614 surveys were collected; however, 10 surveys were eliminated because they were less than 70% completed, which left a final sample size of 604 (61% response rate).

Characteristics

The characteristics of the participants are reported in Table 1. A large proportion of the respondents reported being non-Hispanic white (272 [46.3%]) or Asian/Pacific Islander/Asian American (163 [27.8%]). The mean age of the respondents was 25.4 years. About half of the sample reported being male. Many students were not born in the United States and represented 49 countries. The majority were single (346 [58.9%]). Seven percent (n=42) had a degree in computer science. Twenty-one percent (n=125) held a master's or doctoral degree. Eighteen percent (n=105) worked or volunteered as a scribe, and 6.5% (n=39) had worked or volunteered as an IT specialist.

Table 1.
Osteopathic Medical Students' Readiness to Use Health Information Technology: Characteristics of Respondents (N=604)[a]

Characteristic	No. (%)
Gender (n= 538)	
Female	258 (48.0)
Male	279 (51.9)
Transgender	1 (0.2)
Race/Ethnicity (n=586)	
Caribbean black/African American	28 (4.8)
Hispanic/Latino	94 (16.0)
White (non-Hispanic)	272 (46.3)
Asian/Pacific Islander/Asian American	163 (27.8)
Native American/First Nations/American Indian	1 (0.2)
Any other mixed background	28 (4.8)
Relationship Status (n=587)	
Single	346 (58.9)
Married	76 (12.9)
Committed relationship	164 (27.9)
Other	1 (0.2)
Education (n=590)	
Bachelor's degree	463 (78.5)
Master's degree	114 (19.3)
Doctoral degree	11 (1.9)
Other	2 (0.3)
Computer Science Major	42 (7.1)
Worked/Volunteered as a Scribe	105 (17.6)
Worked/Volunteered as IT Specialist	39 (6.5)

[a] The number of respondents for each item does not total 604 because of missing responses.

Abbreviation: IT, information technology.

Questionnaire Responses

Summary statistics for the measurement scales used are shown in Table 2. Participants were asked to respond to single-item questions related to uses of HIT in their educational environment. Only 34 respondents (5.6%) reported that their school had an established approach for students learning HIT, and only 54 (9%) reported they had been instructed on the use of EHRs in medical school. When asked when they thought HIT learning would become an integral part of their school's medical education program, 157 (26%) stated they were "not sure" and 14 (2.3%) stated "never."

Table 2.
Osteopathic Medical Students' Readiness to Use Health Information Technology: Measurement Scales Outcomes (N=604)

Scale	n	Mean (SD)[a]	Range[b]
Technology Readiness Index	604	3.1 (0.6)	1-5
Use of Mobile Health Technologies in a Clinical Environment	604	3.0 (0.6)	1-5
Using New Computer Applications Scale (self-efficacy)	594	2.6 (1.4)	1-7
Flexibility	604	5.3 (1.1)	1-7
Perceived Usefulness/Perceived Ease of Use	603	5.8 (1.1)	1-7
Knowledge of Health Information Technology	602	1.3 (0.1)	1-2

[a] Mean (SD) represents the mean score for any item on a scale. For the Techonology Readiness Index, mobile health technologies, flexibility and perceived usefulness and perceived ease of use scales, higher scores indicate more positive attitudes, responses, and knowledge for the given scale. For the new computer applications scale, a lower score indicates greater self-efficacy.
[b] Range indicates the Likert-type scale score range for each item of the scale.

Regression Modeling

A multiple linear regression was calculated to predict HIT readiness in respondents (**Table 3**). A significant regression equation was found ($F_{8,506}$=22.6, P<.001, R^2=0.263 [adjusted R^2=0.252]). Greater self-efficacy with computer technology use, higher scores on openness to changes (in academic or work settings), more favorable attitudes toward HIT use (including mobile technology), having prior experience with IT, being a younger age, and being male were associated with higher scores on the TRI. Knowledge of HIT was not associated with HIT readiness. While the percentage of variance in the scores accounted for by the model was only 25%, in the social sciences, low R^2 values are often expected, and an adjusted R^2 of 0.25 is not unusual. The combination of predictors representing modifiable behaviors (eg, attitudes) predicting just a small amount of the variance in an important outcome could be significant.

Table 3.
Regression Model Summary Predicting HIT Readiness of Osteopathic Medical Students

Predictor Variables	*B*	SE	β	*t*	*P* Value
Mobile technology	.12	.04	.12	3.09	.002
Self-efficacy	–.05	.02	–.12	–2.94	.003
Flexibility	.13	.02	.24	5.30	<.001
Use of technology	.10	.02	.18	4.15	<.001
Knowledge of HIT	.19	.19	.04	0.99	.321
Age	–.01	.01	–.09	–2.38	.018
Gender	.24	.04	.21	5.53	<.001
Previously worked or volunteered as IT specialist	.23	.09	.10	2.52	.012

Abbreviations: HIT, health information technology; IT, information technology.

Discussion

Respondent Characteristics

Prior work or volunteer experience with technology was associated with student readiness. This finding is logical, as more than 90% of participants had little or no formal education in computer science, and most were focused on nontechnology tracks, such as biological sciences, in their undergraduate years.

The finding that younger age was associated with technology readiness is not surprising, given that this generation of medical students has grown up in the technology age and may be comfortable leaping to technologies such as HIT tools. Regarding gender, being female was associated with less technology readiness. This finding is supported by prior research indicating male health care professionals were nearly twice as likely as their female counterparts to embrace HIT tools such as EMRs.[21] Also, female adolescents show less preference toward computer science courses in high school.[22]

Attitudes

Greater self-efficacy with computer technology was associated with higher levels of students' HIT readiness. Having self-efficacy can lead to feeling more comfortable with HIT, which for many is new or seemingly difficult to use. These findings suggest that building medical students' confidence in their ability to successfully use technology will lead to increased readiness to use HIT in practice. Part of this sense of self-efficacy is related to the idea that the student could complete a task using new HIT software if no one was around to tell him or her what to do as he or she uses the HIT tool.

The finding that flexibility and willingness to accept change in the workplace and at home was associated with HIT readiness is supported by findings from previous studies with regard to HIT tools such as EMRs.[2] Medical educators and administrators need to be cognizant that openness as a personality trait may not be amenable to change when developing HIT education and training sessions for students.

Use

The perception that technology is useful and easy to use was significantly associated with HIT readiness in this sample. The findings suggest that for medical students who find that operating an EMR or computerized physician order entry system is not cumbersome or difficult, HIT will make their job easier. This finding is supported by previous research.[21] In addition, more favorable attitudes toward mobile technology in the clinical arena contributed to readiness to embrace HIT among students in this sample. The belief that using technologies such as mobile phones for clinical work allows for better patient care ties into both perceived ease of use and usefulness.

Knowledge

It was thought that higher levels of HIT knowledge would cause medical students to accept the advantages of technology and likely be ready to use HIT tools in practice. The finding that HIT knowledge did not influence HIT readiness in this sample was unanticipated. Although formal HIT-related competencies are absent from many traditional medical core curricula, the American Association of Colleges of Osteopathic Medicine and the Accreditation Council for Graduate Medical Education have suggested including technology competencies in medical school.[23–25]

Implications for Medical Education and Practice

Innovations in technology, while designed to improve patient outcomes, may contribute to barriers during the patient-physician interaction.[3,21] Our findings suggest that there is a need to better prepare future osteopathic physicians in technological advances in patient care while still holding true to the osteopathic tradition of treating the whole patient. Courses related to technology in medicine should be added to required premedical undergraduate coursework to expose students to HIT before entering medical school. Mobile health technologies are revolutionizing the practice of medicine in the 21st century, and many of these tools (eg, mobile health applications) can be introduced to students early in the preclinical years, such as during high-fidelity simulation training and mock patient encounters.[11] Furthermore, the addition of HIT principles, bioinformatics, consumer health informatics, and biomedical informatics in osteopathic medical curricula will allow osteopathic medical students to become comfortable with different types of technology and to develop confidence in using technological advancements in their respected fields. However, general knowledge of technology or even HIT may not suffice for effective HIT use.[26] Our findings suggest changing attitudes to motivate students may be more influential in engaging students to use HIT tools in future practice. Future osteopathic physicians can be innovators and champions for the use of advanced medical technology while treating the patient based on the principles of the interrelationship of structure and function, body unity, and self-regulation.

Of note, however, is that for some physicians, the current state of EHR technology can significantly hamper professional satisfaction in many ways. Aspects of current EHRs that are common sources of dissatisfaction are poor usability, interference with face-to-face patient care, time-consuming data entry, degradation of clinical documentation, and stress and burnout.[27] The present study was designed to investigate factors that might predict future osteopathic physicians' readiness to use HIT. With enhanced training and engagement involving more than just didactic training, new osteopathic physicians may feel greater professional satisfaction that in turn may improve patient care and health system sustainability. Likewise, over time, the usability and interoperability of EHR systems will likely improve and the rules and regulations associated with EMRs may lessen, thus increasing professional satisfaction and allowing physicians to focus on patient care without technological impediments.

Limitations

This study has several limitations. First, we used a cross-sectional, correlational survey design to collect data. Therefore, generalizations cannot be made regarding changes or trends over time, directionality of influence, or cause-and-effect relationships. Second, a convenience sample of students from a single osteopathic medical school was used to collect data, thus limiting the ability to generalize findings to all medical students, including allopathic medical students. Multisite data collection from several US medical schools might have provided a more diverse sample of student respondents. Third, self-report questionnaires used for data collection can result in response bias, social desirability bias, and inaccuracies. Also, data collection occurred in some group settings, so even though participants were informed that completing the survey was strictly voluntary, they may have felt peer pressure to complete the survey. Fourth, the scale to measure knowledge was constructed by the researchers and not previously validated, and its reliability was not high (α=.40). Thus, results from the regression model regarding knowledge of HIT as a predictor should be taken with caution and tested in a future study with a more reliable measure. Fifth, there were several disadvantages of conducting research via online surveys, including limited respondent availability and willingness to respond.

Conclusion

The present study is the first, to our knowledge, to identify student characteristics (attitudes toward IT and mobile technology, IT self-efficacy, openness to change [flexibility], prior experience with IT, age, and gender) as indicators of readiness to use HIT. With the increased invention and adoption of HIT tools used in medical practice, innovative approaches to HIT education and design are needed. Osteopathic medical schools should consider further development and evaluation of classrooms where students are motivated —not merely instructed—to learn how to use HIT. While further research in this area is needed, findings from this study could help assess students' level of HIT readiness and guide medical education intervention efforts to better prepare tomorrow's osteopathic physicians in HIT engagement and use in the clinical setting.

Author Contributions

Dr Jacobs provided substantial contributions to conception and design, acquisition of data, analysis, and interpretation of data and drafted the manuscript; Mr Iqbal, Drs A. Rana, Z. Rana, and Kane revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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