Assimilation of Digital Health by Family Physicians in Canada

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Abstract

Background: In recent years, governments, medical associations and other health care stakeholders have advocated digital health as a promising avenue to reduce inefficiencies, improve the delivery of health care services, increase the quality of primary care, and detect and manage infectious diseases. The present study aims to investigate the assimilation of digital health by family physicians, going beyond the simple adoption of these technologies to further understand the breadth and depth of their use in clinical practice for the diagnosis, treatment and prevention of disease, and for the monitoring of chronically-ill patients.

Methods: The study was designed as an online survey. After conducting a pre-test of the questionnaire instrument, an invitation to participate in the study was sent to 7,664 members of the Quebec Federation of General Practitioners. The online questionnaire was developed on the Qualtrics survey platform. Data was collected from 768 family physicians, representing a 10% response rate.

Results: Findings show that a large majority of the sampled physicians have yet to assimilate digital health within their medical practice. This is true in terms of both the physicians not incorporating digital health technologies into their routine work patterns and their not using these technologies to their full potential. The minority of respondents who showed a somewhat higher level of assimilation were motivated by patients' greater requests related to digital health (e.g. for online consultations) and a greater chronic care caseload, and are characterized by their greater need for digital health training and their younger age, and use an EMR system that includes more functionalities (e.g. pharmaceutical advisers/prescribers).

Conclusions: This study has policy implications in terms of the need for greater motivation and training of family physicians in order for them to make more extensive and innovative use of digital health technologies in their medical practice, for greater interoperability and integration of the digital health tools made available to them, and for greater awareness of their patients' emerging attitudes and behaviors with regards to digital health. These implications make even more sense in the context of the current Covid-19 pandemic.

Background

Governments in countries such as Canada and the United Kingdom have undertaken major transformations of their national health care systems in the face of the ever-increasing health care costs associated with rising numbers of citizens affected by chronic illnesses such as heart disease, COPD and diabetes, and with the aging of their populations [1]. The most important reforms implemented by these countries aim to strengthen the primary care sector to improve access to care, quality of care and patient satisfaction, reduce inefficiencies in the provision of primary care services, and increase the productivity and overall performance of primary care providers [2]. In this regard, family physicians (FPs) have borne the brunt of achieving cost reductions and quality improvements in primary care, as they have seen their role expand from the diagnosis and treatment of disease to a greater emphasis on disease prevention and the monitoring of chronically ill patients [3]. Moreover, in meeting these challenges, countries such as Canada have turned to digital health, i.e. the use of digital technologies as a lever for improving the performance of their national health care systems [4].

Digital health is broadly defined to comprise eHealth, i.e. health information technology (HIT) and systems such as electronic medical records (EMR) and electronic health records (EHR), mobile health (mHealth), telehealth and telemedicine, including patient-wearable sensors and smart medical devices [5]. Digital health also includes HIT-based systems and medical apps that support clinical decision-making systems (CDMS) as well as artificial intelligence (AI) and machine learning (ML) [6]. In the last decade, national governments, with the support of medical associations and other health care stakeholders, have advocated digital health as one of the most promising avenue to reduce inefficiencies, improve the delivery of health care services, increase the quality of primary care provided to their populations, and detect and manage infectious diseases such as Covid-19 [7]. In particular, digital health technologies are intended to provide FPs with a holistic view of their patients' health condition through fuller and quicker access to patient and populational health data, allow for a greater personalization of their medical practices, and improve patient outcomes by facilitating disease prevention, early diagnosis, and management of chronic illnesses [8].

Given the above considerations, the present study aims to investigate the *assimilation* of digital health technologies by FPs in Quebec, going beyond the adoption and diffusion of these technologies to further understand the breadth and depth of their use in clinical practice for the diagnosis, treatment and prevention of disease, and for the monitoring of chronically-ill patients. The assimilation of digital health is conceptualized here in terms of its *routinization* and *infusion* by FPs. Routinization refers to the extent to which FPs have incorporated their use of digital technologies into their daily clinical practice to improve the efficiency and timeliness of the health care services delivered to their patients [9]. Infusion is defined as the extent to which FPs make extensive, integrative and innovative use of digital technologies to improve the quality and effectiveness of the care services provided to their patients [10]. Thus, the two research questions to be answered by this study are: In what manner and to what extent have FPs assimilated digital health in their medical practices? and What individual, motivational, and work-related factors influence the assimilation of digital health by FPs?

Given the present dearth of knowledge on the nature and extent of digital health assimilation in family medical practices and its influencing factors, the present study is the first to address these issues in Canada. Digital health has become all the more relevant in the context of the Covid-19 pandemic, as FPs across the country have been asked to use telehealth tools to conduct online consultations with their patients [11].

Methods

This study was designed as an online survey. As described below, we followed best practices on web-based survey methodology [12, 13]. The survey questionnaire was built following a review of empirical research on the adoption and assimilation of digital health in primary care [e.g. 14-17] and a series of structured interviews with six FPs practising in different regions of Quebec, Canada. Each physician was interviewed about the questionnaire's format and instructions as well as the wording of the questions and possible answers, to ensure they were interpreted as intended by the research team. Following these interviews, the core constructs were mapped, as shown in Figure 1. Then a pre-test of the questionnaire was also conducted with nine board members of the Quebec Federation of General Practitioners (QFGP). Following some minor adjustments to the survey instrument, the study received final approval from the HEC Montréal's ethics committee. A copy of the survey instrument is provided in Appendix I.

An invitation to participate in the study was sent on September 19, 2018 to 7,664 QFGP members through the federation's monthly newsletter. The invitation contained a hyperlink directing the participants to the questionnaire through a secure Web site. The online questionnaire was developed on the Qualtrics survey platform [18]. Two reminder letters were sent to all targeted physicians 14 and 21 days after the initial invitation.

Data was collected from 768 FPs, representing a 10% response rate. Of these questionnaires, 231 were excluded due to missing data, leaving a final sample size of 537 valid data sets. Low response rates raise the possibility of non-response bias, so the potential for such bias was first assessed by comparing the 235 "late" respondents (i.e. respondents who had received the reminder) with the 302 "early" respondents [19]. Analyses of variance indicate that there are no statistically significant differences between these two sets of respondents in terms of their demographic characteristics and their assimilation of digital health. While this must be interpreted as an encouraging sign, researchers must remain vigilant about response rates if they are uncertain about sample representativeness [20]. So as a second step we compared the demographic characteristics of our respondents with those of the target population, i.e. QFGP members. Our sample was found to be statistically representative of the population in terms of physician age, gender, region, and length of professional experience. In short, these two assessments indicate that sampling error is unlikely, and thus give confidence that our sample approximates the characteristics of the target population [21].

Of the 537 survey respondents, 65% were women. As for age, 39% of respondents were in their 50s, 18% in their 40s, and 15% in their 30s. Respondents had 24 years' experience in the medical profession on average, with a minimum of 1 year and a maximum of 54 years. Most of the FPs was French speaking (94%). The average time to complete the questionnaire instrument was approximately 12 minutes.

Component-based structural equation modeling (SEM) was used to empirically explore the causal paths implied in our conceptual framework. As implemented in SmartPLS software, the PLS (partial least squares) technique was chosen for its robustness with regard to the distribution of residuals and its greater affinity for exploratory rather than confirmatory research purposes when compared to covariance-based SEM techniques [22]. Further details related to the PLS-SEM analysis may be found in Appendix II.

Results

Nature and extent of FPs' assimilation of digital health

Table 1 presents the descriptive statistics and indices of reliability and multicollinearity of the research variables. The main descriptive message emanating from the data is that a large majority of FPs in Quebec have yet to assimilate digital health technology into their medical practice. This is true both in terms of the physicians incorporating digital health technology into their routine work patterns (routinization), and in terms of their using this technology to its full potential (infusion).

In terms of routinization, the sampled physicians either rarely or occasionally seek medical information by searching the web or using a mobile app. For those who do so more frequently, medical information is mostly obtained from online pharmaceutical advisers/prescribers, medical calculators, and medical guidelines. Also, physicians very rarely use online sources of medical information. Those who use such sources more frequently rely essentially on mobile apps such as Epocrates and BMJ Best Practice. A great majority of physicians engage in no or limited online consultation activities with patients and other physicians, whether through secure or unsecured communication software (e.g. Reacts, Skype). They rarely or occasionally exchange medical information or images via secured or unsecured email (e.g. Outlook), text messaging or social media (e.g. Messenger) with patients and other physicians.

In terms of their infusion of digital health, the sampled physicians very rarely or rarely consult the data collected by their patients through mobile apps or smart devices. In this regard, the devices most used by patients include smart bracelets (for physical activity tracking and sports training), smart pedometers, and smart glucometers (for diabetes tracking). Note that the two main reasons given by respondents for not consulting such data is that most of their patients do not collect this type of data (44% of respondents) and that they lack knowledge about such mobile apps and smart devices (17%). The FPs also perceive the overall benefits of using digital health technology to be of no or slight importance. In this regard, the two most important benefits are that digital health technology allows FPs to discuss the goals to be achieved (e.g. blood glucose level, blood pressure) with their patients, and that it supports better clinical decision-making. Finally, a slight majority of the sampled physicians (55%) indicate that they are open to using artificial intelligence (AI) for medical diagnosis purposes.

Individual, motivational, and work-related factors of digital health assimilation

As shown in Figure 2, the causal paths inferred from the conceptual framework were tested by assessing the path coefficients (β) estimated by the SEM procedure as executed by the SmartPLS software. The performance of the theoretical model of interrelationships between the five research constructs was assessed by the strength and significance of the path coefficients (β) and the proportion of explained variance (R^2), as befits PLS's focus on prediction and concern with generalization [23]. Further details on the SEM procedure can be found in Appendix II.

Given the results of the causal analysis provided by the SEM procedure, an initial finding is the positive and significant path coefficients linking the FPs' motivations to their routinization ($\beta = 0.29$, $p < 0.001$) and infusion ($\beta = 0.27$, $p < 0.05$) of digital health in their daily medical practice. Here, the primary factors that motivate FPs to assimilate digital health are their patients' requests and behaviors with regard to digital health technology. The two most frequent patient requests in this regard are making an appointment online for a consultation and communicating with their physician by email or text messaging. The two most frequent patient behaviors are seeming more anxious and needing to be reassured due to information that they found on the web, and exploring treatment modalities, medication or natural medicine options found on the web (other than those prescribed by their physician). Another significant motivational factor linked to a greater assimilation of digital health by FPs is the size of their chronic care caseload (as a percentage of total caseload).

Second, individual differences in terms of the FPs' digital health training needs, age, teaching position, and health self-tracking behavior directly influence their routinization of digital health ($\beta = 0.42$, $p < 0.001$). Thus, greater incorporation of digital health technology into an FP's clinical work pattern requires the acquisition of more knowledge on the various technologies if they are to be used to their full potential. In this regard, their two most important needs are related to acquiring knowledge on the effective integration of mobile apps and smart medical devices into their daily practice (85% of respondents) and on the range of apps and devices that are most useful (84%). The physicians who have acquired this knowledge tend to be younger, occupy a teaching position in a medical faculty, and use digital health technology for personal self-tracking purposes.

A third result concerns the influence of the contextual characteristics of the physicians' medical practice on their infusion of digital health technology ($\beta = 0.17$, $p < 0.05$). Here, the one characteristic that truly matters is the digital health capability of the EMR system used by FPs [24]. In this regard, the digital health functionalities most available within the physicians' EMR systems are pharmaceutical advisers or prescribers (59% of respondents), medical calculators (34%), and medical guidelines (10%), such as Diabetes Canada's clinical practice guidelines. Thus, the more these EMR functionalities are available to physicians, the greater their ability to make extended use of digital health technology.

This study's final finding lies in the positive and significant path coefficient ($\beta = 0.21$, $p < 0.05$) linking FPs' routinization of digital health to their infusion of digital health. This result is in line with the notion that routinization, as a pre-condition for infusion within the technology assimilation process, provides a facilitating context for FPs to make a more extensive, integrative and innovative use of digital health technology [25].

Discussion

The purpose of the present study was to better understand FPs' digital health practices and needs, and it has produced important findings in this regard. First and foremost, a large majority of the sampled FPs have yet to assimilate digital health in their medical practices. This is true both in terms of not incorporating digital health technologies into routine work patterns and not using these technologies to their full potential. Second, the minority of FPs with a somewhat higher level of assimilation are motivated by greater requests from patients for digital health (e.g. for online consultations) and a heavier chronic care caseload. They are also characterized by a greater need for digital health training and their younger age, as well as their use of an EMR system with many functionalities (e.g. pharmaceutical prescribers).

Further observations can be made on the FPs' attitudes toward digital health. On the one hand, the main reason these physicians are reluctant to make digital health an integral part of their medical practice is that they fear this could increase anxiety among their patients. However, they do see the interest in using telehealth tools to discuss treatment options and goals with their patients. In the rare cases where their patients use connected objects, this is mostly bracelets to track physical activity, pedometers and glucometers. On the other hand, the FPs surveyed mostly use the web or the mobile apps on their smartphones or tablets to consult medical guidelines or pharmaceutical prescribers.

Overall, these findings corroborate the observation made in most OECD countries that digital health technologies remain underexploited by health care professionals, whereas, paradoxically, "the proportion of adults seeking health information online more than doubled between 2008 and 2017," and the governments of these countries have looked to patient-recorded outcome measures (PROMs) to evaluate health care services and outcomes [26, 27]. The findings highlight a similar situation in Canada, wherein most FPs have yet to use digital health technologies in a significant way, while an increasing proportion of the adult population is using technologies such as mobile apps and smart devices for the self-tracking and managing of personal health data [28].

The initial implication of these findings is that if FPs are to develop the capacity to incorporate digital health technologies into their daily clinical routines and exploit these technologies to their fullest potential, they must first be educated in digital health as medical students, and then receive training on digital health as health care professionals [29]. In other words, in the new health care world brought about by the Covid-19 pandemic, digital health literacy and self-efficacy are competencies now required of both physicians and patients [30]. It is worth noting, however, that these competencies do not appear explicitly in the CanMEDS physician competency framework, and that the digital health training available to physicians may lack breadth and depth [31, 32]. Moreover, this training should enable FPs to develop, in collaboration with other health care professionals and patients, innovative digital solutions in response to their changing needs and in support of their evolving role as providers of "high-quality, compassionate, and timely care" [33].

This study's results have additional implications for institutional actors in the development and deployment of digital health in Canada, as they seek to guide and support FPs in their adoption and assimilation of digital technologies. First, national and provincial health institutions could collaborate on developing and implementing an evidence standards framework for digital health technologies, similar to the one developed in the United Kingdom by the National Institute for Health and Care Excellence [34].

This would enable a more agile evaluation of these technologies in primary care settings, as well as render them more meaningful to FPs and add value to such use. Second, with regard to these physicians' acceptance of – and access to – digital technologies within their medical practice, there needs to be an emphasis on the interoperability and integration of newer technologies within existing EMR systems. For instance, institutional actors such as Canada Health Infoway could encourage EMR vendors to design their systems to be compatible with the mobile apps and smart devices that allow FPs to better monitor their chronically ill patients [35]. Finally, patient portals such as the *Carnet santé Québec* portal and the province-wide interoperable EHR system could be better exploited by FPs, since such portals contain patient health information that is useful to clinical decision-making, including data on medication, medical imaging and lab test results and, eventually, PROMs-type information for patient monitoring [36].

The results of this study should be interpreted with caution, given some methodological limitations. First, the data set used in the present study is from a single country, limiting the generalizability of the findings. Thus, the advancement of knowledge on this pivotal topic could benefit from similar studies carried out in other regions. Second, due to the cross-sectional nature of the survey, a full assessment of the variation of FPs' assimilation of digital health over time, especially during and after the Covid-19 pandemic, was not feasible. Third, while our focus was on the predictors of digital health assimilation, future research could investigate the effects or consequences of such assimilation on various factors such as the doctor-patient relationship, the quality of care, the productivity of physicians, and how FPs are providing care and practicing medicine.

Conclusions

This study is the first to examine the assimilation of digital health by FPs in Quebec, Canada. Our findings provide a comprehensive picture of the clinical context, attitudes and behaviors of FPs regarding digital health prior to the Covid-19 crisis. Study findings have policy implications in terms of the need for enhanced motivation and more training of these physicians in order for them to make more extensive and innovative use of digital health technologies in their medical practices, for increased interoperability and integration of the digital health tools made available to them, and for greater awareness of their patients' emerging attitudes and behaviors with regard to digital health. Countries like Canada and the United Kingdom are among the many that have responded to the Covid-19 pandemic by stepping up digital health initiatives as a way to maintain continuity in essential health care services and allow for the telemonitoring of patients. As a result, FPs will need to assimilate more digital technologies, at a faster rate, in the coming years.

List Of Abbreviations

AI: artificial intelligence

CDMS: clinical decision-making system

EHR: electronic health record

EMR: electronic medical record

FP: family physician

HIT: health information technology

mHealth: mobile health

ML: machine learning

PLS: partial least squares

QFGP: Quebec Federation of General Practitioners

SEM: structural equation modeling

Declarations

Ethics approval and consent to participate

Ethics approval for this study has been obtained from the Institutional Review Board of HEC Montréal on June 13, 2018. Informed consent was obtained from all participants. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

GP and MPP contributed equally to the conception and design of the study. The literature review was performed by MPP, GP, JB and LR. Data collection was under the responsibility of GP and MPP. Data analyses were performed by LR and JB. All authors contributed to the writing of the manuscript. Each author read and approved the final manuscript.

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Tables

Table 1. Reliability, multicollinearity, and descriptive statistics of the research variables

Research constructs						
Research variables	**α**	**VIF**	**mean**	**sd**	**min**	**max**
Digital health routinization						
Use of digital medical information[a]	0.85	1.28	2.7	0.8	1	5
Use of digital medical sources (# sources)	-	1.23	1.1	0.7	0	5
Digital communication-consultation with patients and other physicians (# types of digital comm-consultation used)	-	1.09	0.9	1.0	0	6
Digital health infusion						
Consultation of data collected by patients through m.apps-sm.devs[b]	-	1.88	1.6	1.0	1	5
Perceived benefits of mobile apps-smart devices[c]	0.98	1.90	2.0	1.2	1	5
Openness to AI for medical diagnosis (-1: no \ 0: uncertain \ 1: yes)	-	1.04	0.46	0.65	-1	1
Physician characteristics						
Age (1: =< 30 y. \ 2: 30-39 \ 3: 40-49 \ 4: 50-59 \ 5: 60-69 \ 6: □= 70 y.)	-	1.12	3.7	1.2	1	6
Gender (1: female, 0: male)	-	1.10	0.65	-	0	1
Teaching position (1: yes, 0: no)	-	1.03	0.34	-	0	1
Digital health training needs (# needs)	-	1.01	4.5	1.8	0	6
Self-health tracking behaviour (0: no \ 1: yes, usual \ 2: yes, digital)	-	1.01	0.6	0.8	0	2
Physician motivations						
Total caseload (# patients)	-	1.08	978	577	0	3500
Chronic care caseload[d]	1.00	1.06	3.4	1.0	1	5
Patients' digital health requests[d]	0.70	1.48	1.5	0.4	1	3.1
Patients' digital health behaviours[d]	0.90	1.42	2.3	0.7	1	4.9
Patients' use of smart devices[d]	0.77	1.37	1.3	0.2	1	2
Medical practice characteristics						
EMR system's digital health capability (# digital functionalities)	-	1.01	1.3	1.5	0	8
Peripheral (vs. central) regional location (1: yes \ 0: no)	-	1.01	0.54	-	0	1
	-	1.02	0.12	-	0	1

University (vs. general) practice setting (1: yes \ 0: no)
Legend. α = Cronbach's reliability coefficient (inappropriate for index — as opposed to scale — variables) [Babbie, 2009] VIF = variance inflation factor *Nota*. VIF = $1/(1-R_i^2)$ {where R_i^2 is the unadjusted R^2 obtained when a formative indicator is regressed against all other indicators of its associated construct} [a] 1: never \ 2: rarely \ 3: occasionally \ 4: often \ 5: continuously [b] 1: very rarely \ 2: rarely \ 3: sometimes \ 4: often \ 5: very often [c] 1: no importance \ 2: slight importance \ 3: moderate importance \ 4: relative importance \ 5: great importance [d] 1: 0% of patients \ 2: <25% \ 3: 25-50% \3: 51-75% \ 4: 51-75% \ 5: ≥75% of patients

Figures

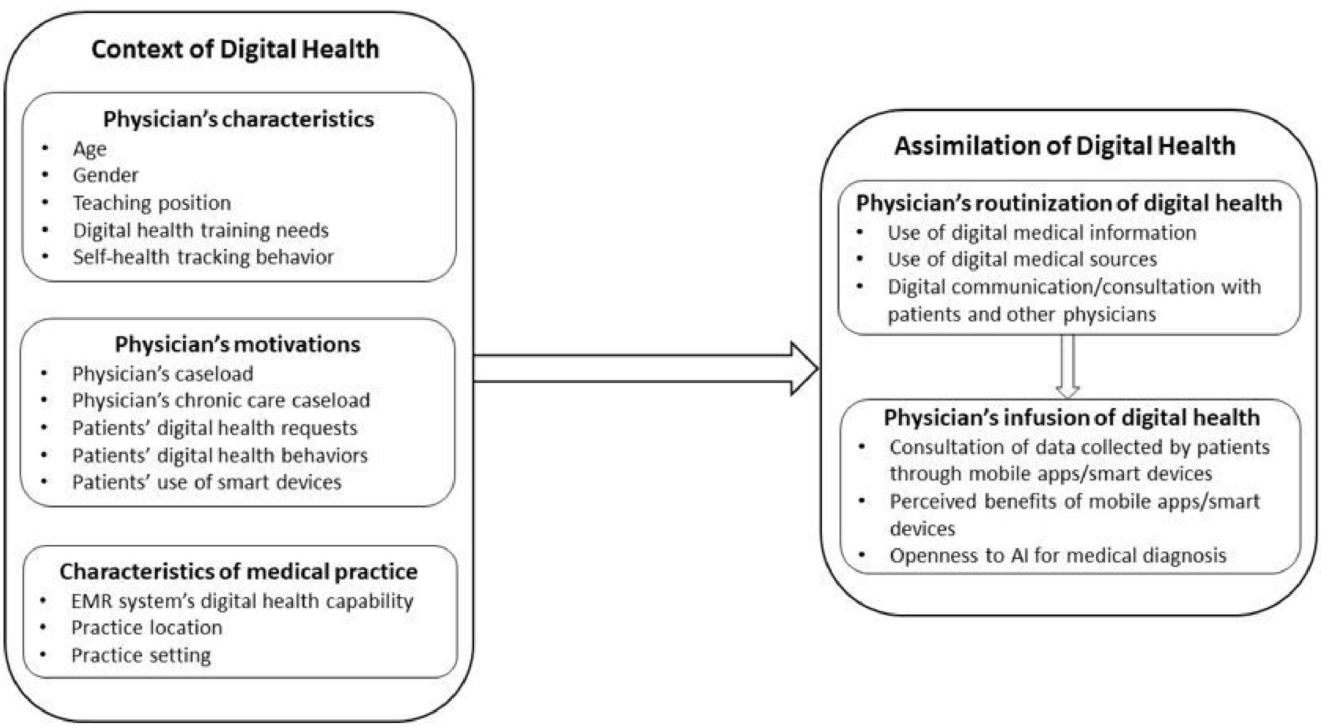

Figure 1

Conceptual Framework

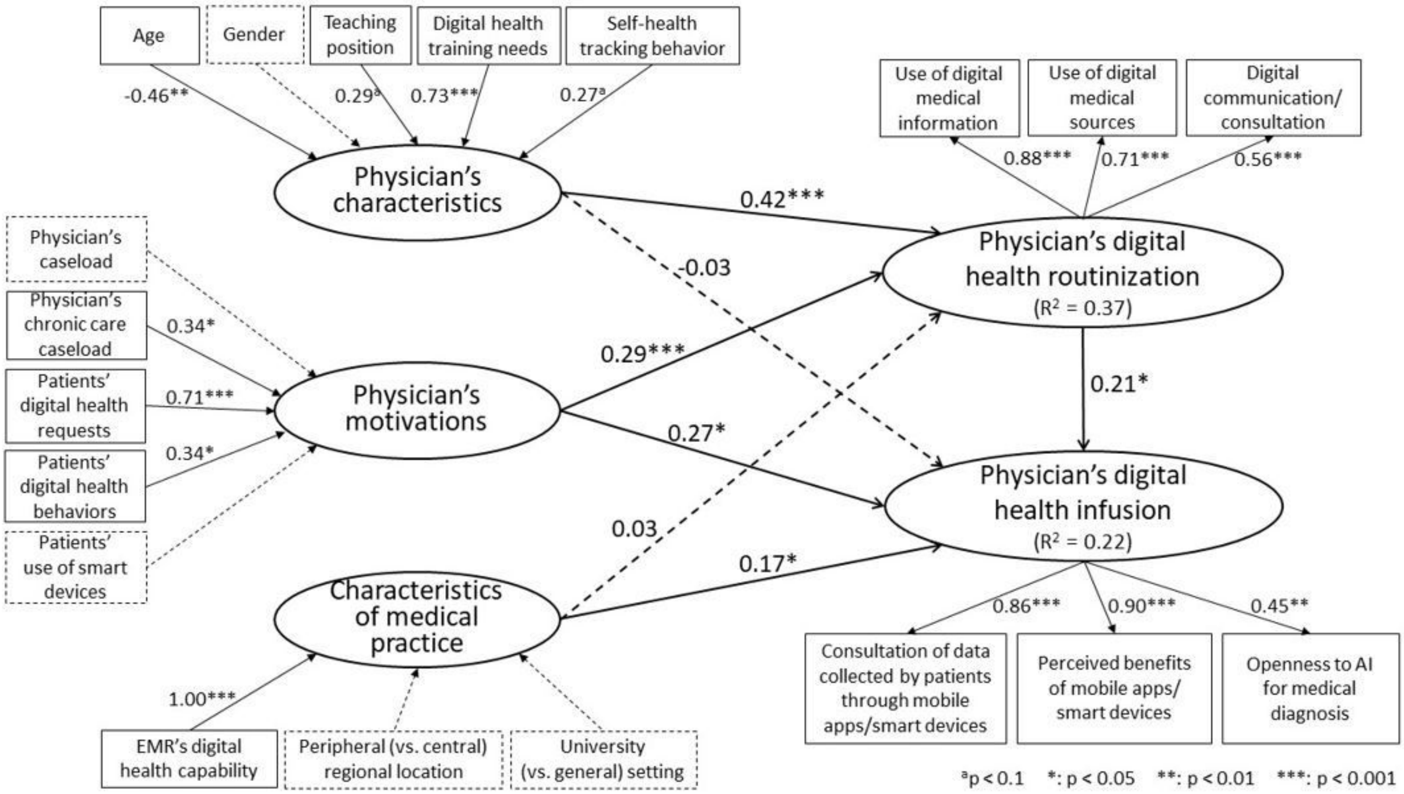

Figure 2

Causal analysis results

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AppendixI.docx
- AppendixII.docx