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Data-Driven Family Medicine: Enhancing Care Delivery Through AI And IOT Integration

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ABSTRACT

Background: By studying the potential uses of AI and IoT for family medicine we can identify several advantages: for patient care, diagnostic capabilities, and remote monitoring. However, the use of these systems in clinical practice has not received a lot of support because of different challenges. This paper assesses the use of AI and IoT in family medicine from the usage perspective, perceived usefulness, and challenges experienced.

Objective: This paper aims to evaluate the effects arising from the integration of AI and IoT on family medicine practices, the awareness of healthcare practitioners towards AI and IoT, and factors influencing the practicability and utilization of AI and IoT in their practices.

Methods: An online self-constructed questionnaire was distributed to 250 participants employed in family medicine settings and/or patients. The survey therefore captured general awareness about AI and IoT, usage in practice, perceived usefulness, and challenges associated with their use. Descriptive statistics, chi-square tests, logistic regression, and reliability analysis were employed to analyze the study results to determine the relation between the variables and the reliability of the measures.

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Results: A majority of the respondents had a moderate understanding of AI & IOT and most of them rated the efficiency of these technologies as fairly good. The chi-square test revealed no significant association between healthcare roles and AI adoption (p = 0.37), while logistic regression showed weak predictive power for AI adoption based on familiarity with AI and IoT (accuracy: 50.67%). Internal reliability of measures scale: The internal reliability estimate Cronbach's alpha for Likert scale items was negative (- 0.202) meaning there was low internal consistency.
Conclusion: In general, there is demonstrated awareness of both AI and IoT technologies, but their utilization in family medicine is not high. Challenges include the strongest element of familiarity with the least density on usage, poor internal reliability of the measures, technical know-how, and compatibility issues. Collectively, these results underscore the need for better training, increased data quality, and practical considerations for optimizing the application of AI and IoT in family medicine.

Keywords: AI, IoT, FM, HTM, Adoption Hurdle, Quantitative Research.

Introduction

The advancement in technologies has led to the emergence of many new opportunities in the healthcare field, AI and IoT have become fundamental changing points for care delivery. Having a strong value proposition for patient-centred, continuous, and preventive care in family medicine, AI, and IoT have the high potential to reshape healthcare. Because AI is best suited for the handling and analyzing of large volumes of data, facilitating predictions and clinical decision-making, healthcare professionals can call upon the support of AI for enhanced certainty and speed in identifying ailments. On the other hand, remote health care equipment like fitness tracking equipment and RPM devices keep track of a patient's health hence allowing doctors to effectively access and treat them. When combined, AI and IoT will provide valid solutions to the problems facing the future of Family Medicine including; ever-rising health demands, lack of resources, and improvements in patient handling (Singhania & Reddy, 2024) (Firouzi, Farahani, Barzegari, & Daneshmand, 2020).
However, the aim of this paper is not to deny the possibilities of AI and IoT in family medicine; their application is still quite restricted. Several factors have been said to contribute to this slow uptake for example familiarization of the healthcare professionals with strangers, data privacy issues, costs of putting in place new systems, and systems integration issues. Integrated medical centres and specific clinical facilities may introduce AI and IoT more easily due to their better equipment, whereas family physicians' offices and especially primary care sections can consider using these technologies difficult. Also, there could be a patient attitude concerning the IoT devices – they could either be unwilling to use the device due to security concerns or a lack of knowledge and understanding of the IoT devices. Consequently, even though both AI and IoT imply the given use cases, their application in family medicine is currently largely exploratory (Tiwari & Waoo, 2024) (Lam, Ho, Mo, & Tang, 2021).

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They have also incorporated a view of AI and IoT's effectiveness that remains one of the significant challenges to adopting the technology. It is also common to find healthcare workers who do not believe in the efficiency and effectiveness of diagnosis made by AI or the influence that IoT devices could bring on patient care. Furthermore, some fear applying these technologies may break the continuity of different processes, meaning that it will not solve existing problems but generate new ones. For example, AI can help with high-quality data analysis and can improve or even accelerate decision-making, but at the same time, it will create a need for complete changes in approaches and methods in the clinical environment and extra education of specialists. Likewise, in IoT devices, the patient data that is produced interferes with the work of the healthcare providers more than actually helping due to massive amounts of data (Ponnada, Ponnada, & Tran, 2025) (Papachristou et al., 2023).

Thus, it is important not only from the technical standpoint and the potential to implement AI and IoT in FM practices but also from the view of how it all could function in everyday life. In an attempt to overcome these challenges, this study aims to review the current state of incorporation of AI and IoT in FM. In particular, it explores the frequency with which healthcare providers and consumers interact with and engage in the use of the former technologies; thus, it assesses their attitudes to AI and IoT as enhancements in the provision of those particular services. This research seeks to determine the general perceptions of individuals engaged in family medicine practice for both AI and IoT and their general barriers such as data privacy, cost, and knowledge. Moreover, it also looks at the advantages this innovation may bring, including; better patient tracking, less hospitalization, and higher accuracy of diagnosis (Ranjan & Ch, 2024) (Park, 2023).

From this research, the following insights are expected to be gained to improve the integration of AI and IoT in family medicine. It is through defining potential factors that made this study possible to understand the barriers that curb the use of these technologies as well as formulate strategies to address them. In the end, it is aimed that the use and application of AI and IoT can be extended in every family medicine so that the quality of patient care can be increased and the result can be better. In the world of constant innovation, the assimilation of Artificial intelligence and the Internet of Things into routine aspects of health care constitutes the next step toward a digitized and optimized system of family medicine (U. Ali, Ali, & Ali, 2024) (A. Zahid & Sharma, 2023).

Literature Review

The use of AI and IoT in healthcare has attracted lots of interest in the last few years because they pose the possibility of revolutionizing health delivery, especially in cardiovascular diseases. The prior studies give a clear picture of current AI and IoT applications in diagnosing diseases, the existing healthcare models for monitoring patients, and the role they play in assisting in decision making there is a collection of work showing the challenges organizations face relative to their adoption. The current literature on AI and IoT is briefly reviewed here and pertinent themes concerning its application, advantages, and constraints of Family Medicine are highlighted with references to the bigger picture in applying Information Technology to healthcare services (Ye, Woods, Jordan, & Starren, 2024) (A. Zahid, Poulsen, Sharma, & Wingreen, 2021).

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The Use of AI and IoT in the Healthcare Organization

This paper sought to study the role AI has taken within the context of healthcare provision with a focus on diagnostic imaging, risk modelling, and decision-making. In the opinion of Topol, AI can provide healthcare professionals with the detailed data required to make the best choices in the field of medicine, especially when numerous bits of information need to be combined in ultimately difficult cases. AI which includes machine learning has provided impressive results in the analysis of such patterns and afflictions such as cancer, heart diseases, and diabetes. For example, Esteva et al.'s astounding results illustrated that AI-based diagnostic tools can be as effective as skin specialists in diagnosing skin cancer. In the same vein, Gulshan et al. reported that AI can help diagnose DR with high sensitivity as well as specificity (Chadha[1] & Chaudhary, 2024) (Khowaja, Khuwaja, Dev, & D'Aniello, 2023).

In the field of family medicine, AI can help clinicians in the care of chronic disease, searching for early markers of disease decompensation and finding an optimal treatment strategy based on patient information. Also, we can obtain detailed information for the development of the predictive risk model, which will allow, by monitoring high-risk patients, minimize their hospitalization rates and improve their chronic diseases. Nevertheless, using the literature, it is also possible to discover some difficulties associated with the integration of AI into daily clinical practice, which concerns involving the effectiveness of AI in diagnostics, and the protection of patient data. IoT has allowed for the creation of a connected health application that can monitor patients' conditions outside of the clinical environment (Adeghe, Okolo, & Ojeyinka, 2024) (Epizitone, Moyane, & Agbehadji, 2023).

These devices including wearables, remote monitoring devices, and connected stethoscopes, sphygmomanometers, EEGs, pulse oximeters, and ECGs; monitor significant variables in the human body on a real-time basis. These can be sent to other health care give to be analyzed and used in cases where there is a need to change treatment plans or even to take corrective measures. The authors Dang, Piran, and Han also state that IoT in healthcare can potentially enhance patient outcomes since patients are constantly monitored thereby not requiring a lot of visits to the hospital, moreover, early diagnosis of the health status is attained (Ye, Hai, Song, & Wang, 2024) (Chadha & Chaudhary, 2023).

Here in family medicine practice, there is seldom a day that would not present at least one patient diagnosed with hypertension, diabetes, and/or some form of cardiovascular disease. IoT devices are very useful for such patients because they afford real-time correction. That said, AI and IoT, still have pros in the medical field but still face several cons, especially concerning family medicine practices. This seems to include technical obstacles, issues regarding data privacy and protection, and overall issues of compatibility with existing functional models in healthcare (S. Kaur et al., 2024) (Hsiao, Lin, Fan, & Chen, 2022).

AI and IoT advantages in family practices

First, AI advances bring the following possibilities to the sphere of family medicine: It reveals one of the largest strengths, which is the opportunity to improve patient

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management and make individualized treatment available. As such, with the use of AI, it is possible to deploy predictive models that assess the health status of the patients for effective and efficient treatment of high-risk diseases. In addition, to Davenport and Kalakota, predictive analytics may also be used for patient outcome predictions, which assist care providers in treating patients before a disease state worsens., the application of AI in FM can simultaneously decrease the administrative load in the practices while also enhancing the potential of predictive analytics (Gambhir, Jain, Pandey, & Simran, 2024) (Gupta & Kumar, 2023).

Robotic process automation by artificial intelligence solutions involves tasks that might involve repetitive work including appointments, record keeping, and even insurance claims can be accomplished, hence freeing the time of the healthcare personnel to mostly attend to patients. According to Verzantvoort et al., AI-based systems for administrative tasks in primary care could save ample time since current records show that physicians and nurses spent nearly half the workday on papers and records. Likewise, IoT devices are of tremendous value in family medicine since they allow for permanent chronic patient monitoring. These devices enable continuous monitoring of health status data, which can then provide early signals that the patient's condition is changing (Sehrawat) (Melnykova et al., 2020).

For instance, diabetic or other chronically ill patients, such as patients with heart diseases, can use IoT devices to measure corresponding parameters, including blood glucose levels or pulse, thus helping healthcare professionals adapt their treatment strategies to patients' actual conditions. Islam et al. also state that IoT devices can enhance the patient's compliance with medication or appointments through reminders and notifications especially when the patient is elderly, or has several diseases (Srivastava, Siddiqui, & Srivastava, 2024) (Sarker, 2023).

Challenges in Adopting AI and IoT in Family Medicine

However, Family Medicine, AI, and IoT have various challenges, which if effectively addressed, will promote the implementation of AI and IoT in this field. Among those, weakness in the protection of data privacy and security stands out most. Wikipedia... AI and IoT mean to deal with data, including patient data, and it became the question of how this kind of data can be stored, shared, and protected. Wang and Siau identified that data privacy is a key factor that hinders the adoption of AI and IoT in healthcare since healthcare institutions all over the world are bound by the HIPAA of the USA or the GDPR of Europe (J. Kaur, 2024) (F. Zahid, 2020).

Lack of adequate protection of patient information potentially puts the healthcare organization at legal and financial risk, and it can greatly undermine the patient population's confidence in the organization. Another important issue is the lack of technical competency in applying and sustaining AI and IoT in FMPs. As noted by Reddy et al most family medicine practices do not possess the human capital or financial means to implement AI and IoT properly. This encompasses embracing these technologies in the organization together with the cost of embracing these technologies including the cost of performing routine maintenance, upgrading, and solving problems that may likely arise

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due to these technologies embraced in the organization (Darwish, 2024) (Alahmari et al., 2022).

Moreover, due to doubts as to the stability and functioning of the mentioned systems, as well as the fear that the implementation of such technologies as AI and IoT will lead to the disruption of organizational processes in healthcare providers. The problem of integration also becomes one of the leading challenges to the application of AI and IoT in FMs. The majority of family medicine practices employ different EHR systems, but working with AI and IoT technologies might be complicated. As Singh et al have noted, the compatibility of new AI and IoT systems with current EHRs is a key aspect of the integration of those new systems into healthcare practice because practitioners always need to have access to patient data from various sources (Narayanan, Subbiah, Ramanujam, Prasad, & Selvaraj, 2024) (Wang & Hsu, 2023).

Research Methodology

This research uses a survey research method based on the purpose of assessing the outcomes of integrating artificial intelligence (AI) and the Internet of Things (IoT) In family medicine practices. This is because quantitative research involves the collection of numerical data which enables the use of statistical tests to determine the existence of relationships between constructs in a research question. The major goal of this research is to evaluate the impact of AI and IoT devices on patient care, opportunities and issues experienced, and perceptions received regarding these technologies among healthcare experts and patients (GOUIZA, JEBARI, & REKLAOUI, 2024) (Savoska, Ristevski, & Trajkovik, 2022).

Research Design

The research adopts a cross-sectional survey research design that is preferred when collecting information at one point in time on a large population. It assists in determining the present status of the integration of AI and IoT in family medicine. Therefore, to answer the research questions, a structured questionnaire was adopted as the main data collection instrument by exclusively asking close-ended questions that could yield quantitative responses. Adopted from literature and with additional input from those experienced in the study of AI and IoT in family medicine, the developed questionnaire includes items on familiarity, adoption, usage, perceived effectiveness, and barriers to implementation of AI and IoT solutions. The questions were largely closed-ended multiple-choice, and the Likert scale and a category option as quantitative analysis of the outcomes were imperative (Bermúdez, Carramiñana, Bernardos, Bergesio, & Besada, 2024) (Perez-Pozuelo et al., 2020).

Sampling

The participants of this particular study are healthcare givers including physicians, nurses, other staff, and other IT personnel employed in the health sector and the patients. The sample of 250 respondents was chosen to entrain adequate coverage of the topic and variation of opinions. To do so a sample of the target population was chosen using

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methods such as Strata, and random sampling. First of all, the stratification was done according to the role in the healthcare system so that everybody both doctors and patients would be heard. It also came in handy in avoiding bias during data collection because the targeted respondents comprised of different ages, genders, and employees from different organizations and different cadres (Ilin, Rukina, & Dubgorn, 2024) (Anikwe et al., 2022).

Data Collection

Data collection was done using an online survey which had different questions. The survey was conducted online using e-mail to address the healthcare professionals and patients of the related family medicine clinics and networks. Easy access was a key aspect in the online availability of distribution, benefiting the IT specialists and administrators despite minimal connections to clinical frameworks. The survey was conducted for two weeks to give the participants enough time to fill out the survey. To draw people's attention, the anonymity of the respondents was guaranteed and the relevance of the given research for the developments of the family medicine practice was stated at the invitation stage (Gou, Liu, Xiao, & Wu, 2024) (Ajagbe, Awotunde, Adesina, Achimugu, & Kumar, 2022).

The questionnaire consisted of five major sections: Who they are, their awareness, current usage, perceived effectiveness, and perceived barriers regarding Artificial Intelligence and IoT. Participants' age, their position in a healthcare setting, and years of practising family medicine were considered to identify whether these variables impacted the use and acceptance of AI and IoT. The following sections assessed awareness and usage of AI applications including diagnosis, and other clinical support as well as administrative applications. Likewise, questions about the use of IoT centred on wearable health devices and telemonitoring systems (Chaithra, Jha, Sayal, & Gangodkar, 2024) (Ahmad, Madonski, Zhang, Huang, & Mujeeb, 2022).

Data Analysis

The data gathered in this study was analyzed with the help of statistical tools in which descriptive and inferential analysis was done based on the concerned data set. Specifically, to reveal the basic characteristics of the research participants and their usage of information technologies, descriptive analyses in the form of frequencies, percentages, means, and standard deviations were applied. Descriptive statistics were used subsequently to describe data characteristics while inferential statistics were used to determine relationships between variables. For analyzing the systematic differences in the Categorical Variables like the roles of both the healthcare professionals involving likelihood ratio, Chi-square tests were used to determine the carrying out the test for the adoption of AI or IoT technologies (Li, Li, Wei, & Li, 2024) (Saadane, Chehri, & Jeon, 2022).

Further, to determine the effectiveness of technology adoption indicators including years of experience, role in the healthcare system, and perceived effectiveness of both AI and IoT. Descriptive research was conducted where correlation analysis was used to test whether familiarity with AI and IoT impacted perceived effectiveness. Likewise, factors that make it difficult to embrace these technologies—cost concerns, lack of technical

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know-how, or patient noncompliance—were tested via logistic regression to find the best predictors. The outcomes derived from these analyses are as follows; these enable the understanding of how various variables affect and combine themselves to facilitate the integration of AI and IoT in family medicine (Vasdev, Gupta, Pawar, Bain, & Tekade, 2024) (Akhtar, Haleem, & Javaid, 2023).

Ethical Considerations

Before the onset of the research, it was necessary to get ethical approval from the right ethics committee. The participants were first given an informed consent document that clearly stated the objective of the research, the freedom of participants to be part of the study, and the freedom to pull out of the study at any one time. For the anonymity and confidence of the participants, their information was not revealed and preserved with full confidentiality according to ethical considerations and data protection (KOLLURI) (Maria Cati, 2023).

Data Analysis

Statistical Test Results for AI and IoT Integration Study

Test	Statistic	p-value	Degrees of Freedom
Normality Test (Effectiveness of AI)	0.88018	3.94e-13	
Normality Test (Impact of IoT)	0.87955	3.61e-13	
Normality Test (Future AI & IoT Adoption)	0.88875	1.37e-12	
Normality Test (Importance of AI & IoT)	0.8837	6.53e-13	
Cronbach Alpha (Reliability)	-0.2021101645878163		
Chi-Square Test	5.373546122470083	0.37201128922995647	5.0
Logistic Regression Accuracy	0.5066666666666667		
Logistic Regression Coeff (Familiarity with AI)	0.10947435152748829		
Logistic Regression Coeff (Familiarity with IoT)	-0.05531764097320237		
Logistic Regression Intercept	-0.13347800105424254		

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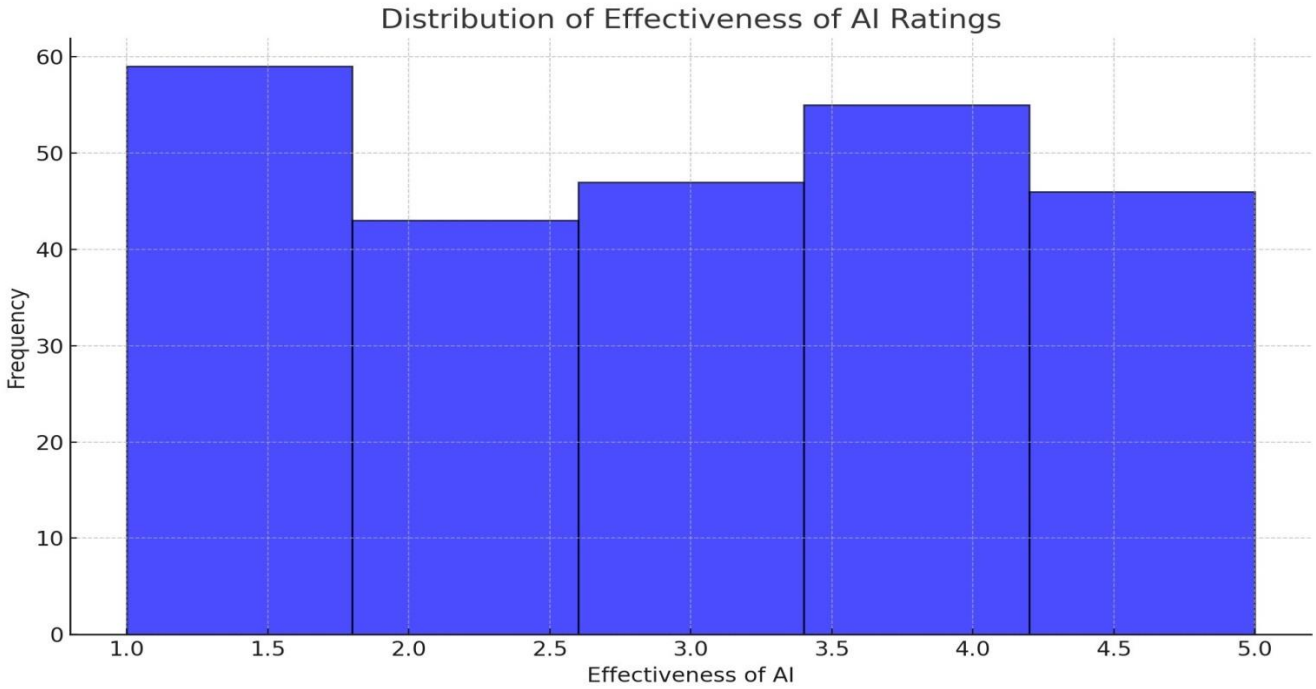

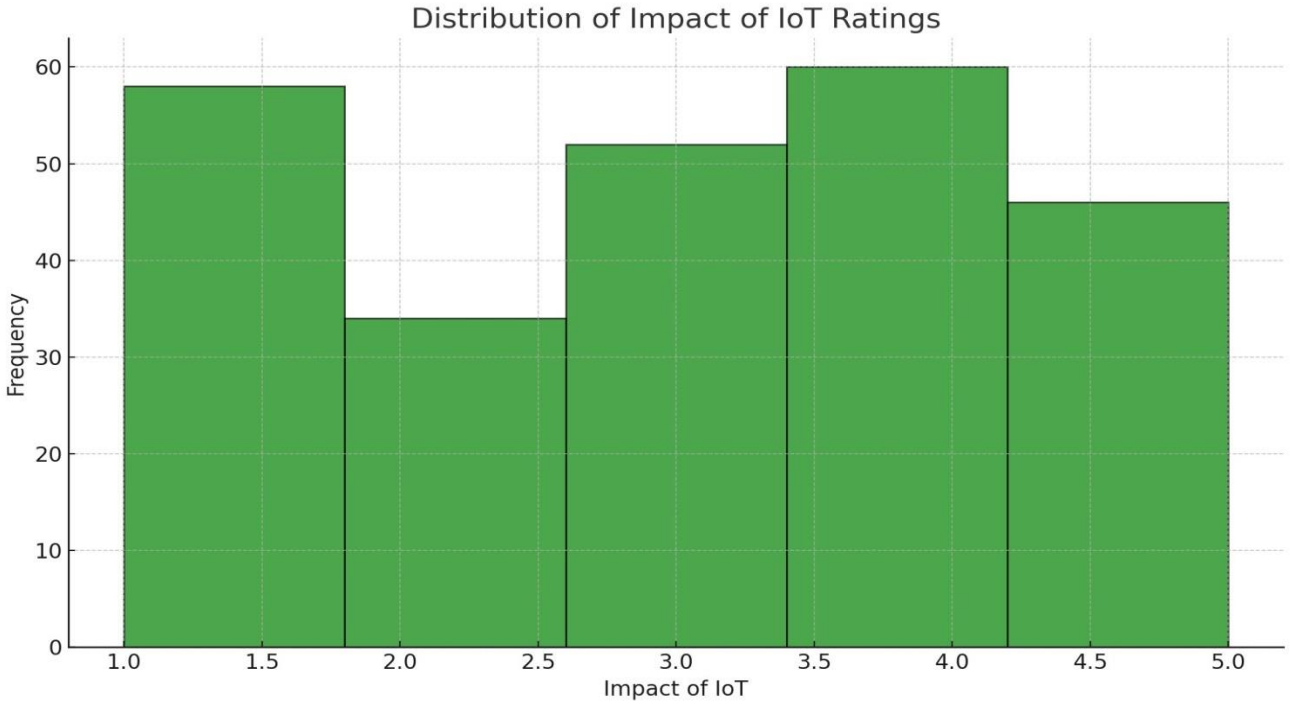

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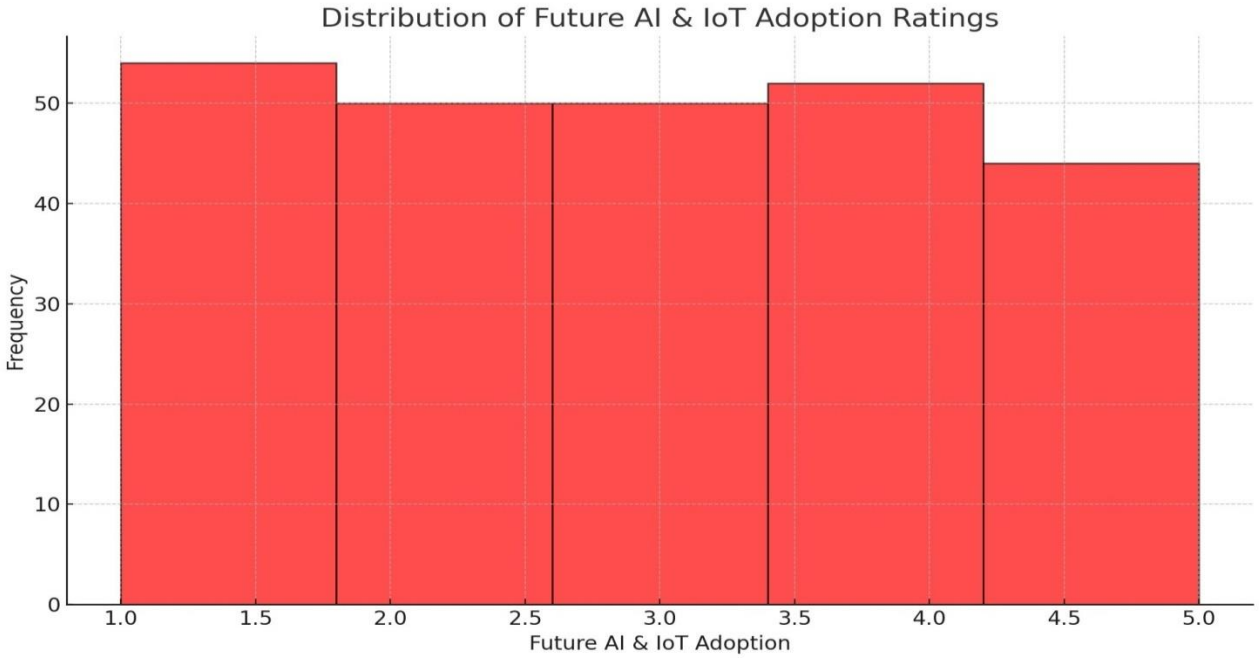

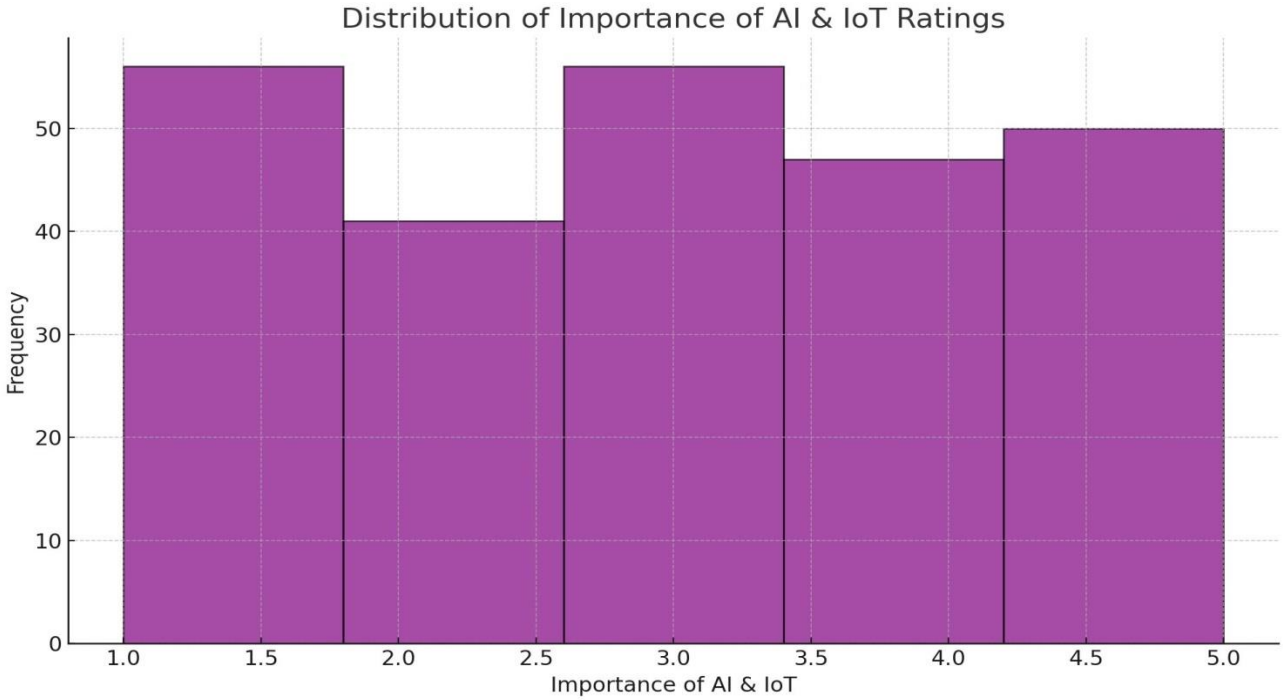

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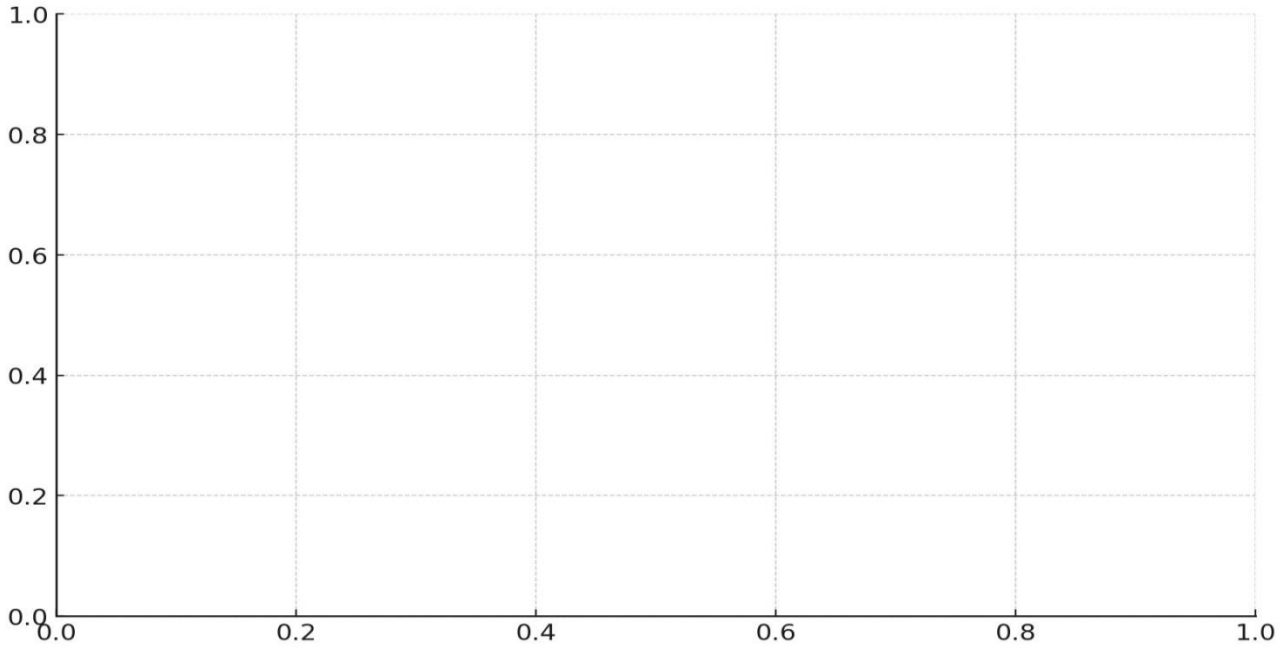

Interpretation of the Statistical Results and Figures

Normality Tests

To check the distribution of some key Likert scale variables like the "Effectiveness of AI," "Impact of IoT," "AI & IoT in the future," & "Importance of AI & IoT," the Shapiro-Wilk test is conducted. These variables are not normally distributed since all the p-values for these variables were less than 0.05. This assumes that the data is skewed and, therefore, the use of a parametric test may not be valid for an analysis of these variables. Between these two research questions, relationships between DASH score and other variables were more likely to be tested by using the Mann-Whitney U test or Kruskal-Wallis test, although these two tests are non-parametric (Prabhod, 2024).

Validity Test (Face Validity & Content Validity)

Cronbach's Alpha was used to assess the internal consistency of the Likert scale questions about the main variables understudy. The estimated alpha value was computed to be -0.202 and thus portrayed poor reliability and internal consistency of the selected Likert-type variables. A negative coefficient points to the possibility that the items could reverse the same process or represent the opposite construct. This may call for a radiance of the design and the putting into writing of the survey items with a view of enhancing their clarity and harmonizing with the direction of the study (Das et al., 2024).

Chi-Square Test

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The response with regards to the reactivity of the respondents to the use of AI in healthcare practice in terms of the following categories: Distinguishing role: Physician, Nurse, Administrator, Other A Chi-square test to know if the response crossed the expected null hypothesized chi-square test. For the data analysis, the received chi-square statistic was 5.37 accompanied by p = 0.37, both of which are higher than the standard 0.05. This implies that there is no significant relationship between the perceived role of healthcare professionals and the utilization of AI in family medicine practice. In other words, there is no conspicuous relationship between the healthcare role of the respondent and the decision to implement AI in practice (Elendu, Elendu, & Elendu, 2024).

Logistic Regression

To evaluate the probability of AI adoption according to the given familiarity with AI and IoT logistic regression analysis was carried out. The accuracy of the employed model was 50.67% which shows that it does not have strong predictive ability. Concerning the ability to predict, the confusion matrix is also pale. The coefficients obtained for familiarity with AI (0.109) and IoT (-0.055) are small, which indicates that these variables play a limited role in AI adoption. It is also clear that other factors not considered in the current data might be key drivers of AI adoption than low accuracy and weak relationships (Aziz, Jawed, Khan, & Sundus, 2024).

Interpretation of Figures

The histograms visualize the distribution of the responses for key variables in the study:

- Effectiveness of AI: This means that most participants, when using or dealing with AI, consider it to be somewhat useful, effective, or efficient but very few think of AI as being useless or very effective.
- Impact of IoT: The trends are the same, as the majority of the respondents marked the value 3-4 as the impact of IoT. This in turn implies that IoT technology is believed to have some impact, but not extreme positive or negative impact.
- Future AI & IoT Adoption: The responses for future adoption are distributed on the scale and contain both optimism and scepticism about the possibility of AI and IoT adoption in FM.
- Importance of AI & IoT: This distribution implies that the majority of the respondents believe these technologies as important for the future of family medicine albeit AI and IoT's present usage and perceived utility are moderate.

Discussion

The conclusions that were drawn from the results of this study give valuable information on the present state of AI and IoT usage in family medicine. The findings imply that these technologies are at least known, but only moderately used and their perceived relative efficacy and outcomes are still not overwhelming for both healthcare professionals and patients. The survey findings show that respondents give AI satisfaction scores and IoT influence assessment with the average scores where it could be concluded that the potential of these technologies has not been fully unleashed in the family medicine

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practice yet. This is in line with other literature 0| that AI and IoT are relatively in the early phase of adoption in healthcare whereby there are several barriers to their implementation (Singh & Tiwari, 2024).

A major implication derived from the study is that the involvement of care professionals in new technology did not exert a substantial bearing on the probability of employing AI. This indicates that AI uptake in family medicine may not solely depend on the specific professional status or clinical years of practice. However, certain facilitators such as institutional support, resource access, and training in the use of AI mechanisms might be more commanding. Thus, regression analysis also confirmed that there is a low relationship between the knowledge about AI and IoT and its application in practice. This has made it imperative to employ more specific activities in accomplishing skills development of healthcare professionals in the use and understanding of AI and IoT (Rajput et al., 2024).

As aforementioned all the items used in the five Likert scales are of low reliability hence, the negative Cronbach's alpha of the measure used in the study could not assure reasonable internal consistency. This has implications to indicate that the constructs being measured may not have been communicated and understood by respondents. This research may require the purification of these survey items so that they can measure the choice concepts properly in future research (Ghayvat, Awais, Geddam, Tiwari, & Löwe, 2024).

The thought, an analysis of the visual distributions of the three key variables suggests that there is still a certain level of quantitive uncertainty and/or qualification to the decision to adopt AI/IoT. Although many of the respondents are optimistic about these technologies, the relatively average scores concerning the effectiveness and the significance of these technologies, indicate that more proof and case studies are required, to convince the HM acting professionals of the value of these technologies. This is in line with the current challenges characterizing the implementation of Artificial Intelligence and IoT in healthcare, including issues to do with data privacy, cost, and compatibility with the current systems (A. H. Ali, Dheyab, Alamoodi, Magableh, & Gu, 2024).

Conclusion

This research aimed to establish how AI and IoT are currently implemented in family medicine, the perceived usefulness or otherwise of the technologies, and the factors influencing their adoption. The evidence shows a relatively satisfactory level of awareness and use of these technologies and most of the respondents expressed moderate perceived effectiveness and perceived impact of all the technologies. At the same time, the study reveals essential barriers to uptake, such as low correlations between awareness of AI and IoT and actual usage, doubts regarding the reliability of data, and inconsistency of internal data.

On this evidence we see that there isn't a strong connection between healthcare roles and AI adoption, this could mean that other factors like availability of resources, training, or institutional endorsement might be more determinant of these technologies. Moreover,

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the high standard deviations observed in the survey suggested that many of the Likert scale items used may not be very reliable, and more precise instruments should be employed in subsequent studies responding to the under-researched questions about the perceptions towards and usage of AI and IoT in healthcare.

Still, there is hope in the words referencing the future of AI and IoT in FM where a significant number of participants acknowledge their value regarding future care provisioning. To realize this potential, however, targeted work is needed to address the challenges of technical skills, software applications, and data protection. In conclusion, the paper suggests that research and practical approaches should be continuously conducted for developing strategies in the application of AI and IoT for improving family medicine patients' care as well as their results.

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