Leveraging The Artificial Intelligence Tools And Techniques In The Early Diagnosis And Effective Management/Treatment Of Diabetes[1]

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ABSTRACT

Artificial intelligence (AI) has the potential to revolutionise patient care and enhance results in the treatment of diabetes, particularly in Malaysia, where the disease is a significant public health concern. However, patient perceptions greatly influence the uptake and efficacy of AI in healthcare. The knowledge gap about these attitudes is addressed in this research. The main objective of this study is to find out how diabetic patients feel about the employment of AI tools and their applications in diabetes management. Additionally, this study looked at how diabetic patients understood and accepted AI. In-depth interviews with seventeen diabetes patients from Hospital Tengku Ampuan Rahimah Klang (HTAR), Malaysia, were conducted as part of this qualitative study. The interview took place between August 8, 2023, and August 22, 2023, for two weeks. Every interview was audio recorded and verbatim transcribed. ATLAS.ti version 8 was then used to code and organise the transcribed material. Thematic analysis was carried out in compliance with accepted data analysis guidelines. Interviews with participants revealed three main themes about the patients' opinions about using AI in diabetes treatment. These topics included perceived need, acceptance, and advantages of using AI tools. Most interviewees said they had a favourable opinion of using AI tools. The results of this study provide the foundation for a theoretical framework that aims to comprehend patients' opinions regarding AI applications in diabetes care, focusing on the social, technological, and health experiences that shape these opinions.

INTRODUCTION

Artificial intelligence (AI) has drawn much attention lately, and its uses in healthcare are constantly growing. AI is frequently mentioned as potentially transforming the healthcare sector [1] completely. By providing individualised features for self-management and facilitating communication between patients and medical providers, digital health solutions have been developed to help control diseases [2]. Meanwhile, it has been shown that wearable technology and smartphone apps can raise blood glucose levels in patients, promote self-management practices, enhance medication adherence, and boost clinician satisfaction [2]. Commercial incentives and physician attitudes are just two of the many elements influencing the development and use of AI in healthcare [3,4]. The relationships between users, infrastructures, technologies, and practitioners may have a greater impact on trustworthiness than the precision and certainty of the technology itself. On the other hand, nothing is known about how patients view these applications and whether they are worried. This study aimed to determine patients' views on AI in diabetes care and investigate their attitudes about using AI in diagnosis and treatment.

APPLICATION OF ARTIFICIAL INTELLIGENCE IN DIABETES CARE

Artificial intelligence (AI) is a broad field within computer science focused on developing theories, methods, technologies, and application systems that simulate, enhance, and extend human intelligence in machines [5]. An early definition of artificial intelligence (AI) is making a machine behave in ways that would be called intelligent if a

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human were so behaving [6]. AI also can be defined as a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation [7].

The rising prevalence of diabetes has emerged as a significant global health issue in the 21st century. In this scenario, the advent of AI, a key digital health technology, can assist in managing diabetic patients who cannot attend in person physician appointments and enhance patient self-management [8].

Artificial intelligence (AI)–assisted applications have been increasingly used in medical and healthcare settings over the past five years [9]. Most of these medical AI systems were designed for clinician use rather than direct patient engagement [9]. It can be useful in the management of diabetes [10]. For example, AI is already being used to predict the risk of diabetes based on genomic data, diagnosis of diabetes based on electronic health record (EHR) data, and diagnosis of diabetic retinopathy [10]. More healthcare service companies are investing in AI-integrated mobile health devices and apps to boost patient safety, elevate practice quality, improve patient care management, and reduce healthcare costs [11]. AI-assisted diabetes care can be illustrated as in Fig. 1 [8].

Fig. 1. Illustration of AI-assisted diabetes care [8].

Table I shows examples of AI applications or tools for diabetes care.

AI applications/tools	Authors/Researchers	Functions/Tasks
PEPPER Adaptive Bolus Advisor	Avari et al. 2021 [16,17]	AI aids in precise and adaptive treatment decisions, thus supporting better glycemic outcomes.
Advanced Bolus Calculator for Type 1 Diabetes	Unsworth et al., 2023 [16,17]	AI aids in precise and adaptive treatment decisions, thus supporting better glycemic outcomes.
AI-based dietary management and continuous glucose monitoring	Park et al., 2020 [18]	AI provides real-time, actionable insights, fostering a proactive approach to diabetes self-management.

AI applications or tools not only provide information and guidance to diabetic patients but also tailor themselves to each patient's unique needs and preferences, fostering improved health outcomes through increased engagement and self-management [19,20].

PATIENTS' ATTITUDES TOWARD AI TOOLS

Patient attitudes toward using AI tools can affect their willingness to use the technology [12]. Some patients may feel uncomfortable with the idea of using AI tools instead of talking to a human doctor, whereas others may welcome the convenience and accessibility of the tools. Patients with negative attitudes towards technology may also be less likely to use AI tools for self-assessing. The role of AI in diabetes care is anticipated to increase in the future. This technology should also be embraced by patients who are important but still neglected stakeholders [13]. Therefore, since AI is increasingly used in health care, understanding the patients' attitudes toward AI tools in diabetes care is necessary. At present, it is still unknown how patients view the applications of AI in diabetes care in terms of acceptability, needs, and benefits. This knowledge is crucial to define preconditions for the development of AI tools and provide insight into whether there is a need for patient education on this subject.

METHODOLOGY

This study employed qualitative research methodology. We conducted interviews to examine diabetic patients' attitudes toward AI applications in diabetes care. From August 8, 2023, to August 22, 2023, subjects were recruited from the diabetes clinic using purposive sampling until saturation of themes was achieved. Subjects were over 18 years of age, fluent in Bahasa Melayu and/or English, and received RM10 for their involvement. The inclusion criteria used in this study were: B40 (net income of below RM5,250 per month) and M40 (net income of between RM5,250 and RM11,819 per month) group of Malaysian adults living with type 2 diabetes mellitus (DM) (duration >1 year) able to describe their situation in Malaysia. Each subject gave verbal consent at the start of the interview. This study was approved by the Medical Research and Ethics Committee, Malaysia Ministry of Health. Table II shows the demographic characteristics of the participants with type 2 diabetes.

TABLE II. DEMOGRAPHICS CHARACTERISTICS

		Frequency (n)	Percent (%)
Age	18 – 25 years old	-	-
	26 – 35 years old	2	11.8
	36 – 49 years old	9	52.9
	50 – 65 years old	6	35.3
	Total	**17**	**100**
Gender	Male	3	17.6
	Female	14	82.4
	Total	**17**	**100**
Ethnic	Chinese	-	-
	Indian	5	29.4
	Malay	12	70.6
	Bumiputra Sabah	-	-
	Bumiputra Sarawak	-	-
	Others	-	-
	Total	**17**	100
Marital Status	Single	4	23.5
	Married	11	64.7
	Divorced	2	11.8
	Widowed	-	-
	Total	**17**	**100**
Monthly household income	RM 5,250 and below	13	76.5
	RM 5,250 – RM 11,819	4	23.5
	RM 10,971 and above	-	-
	Total	**17**	**100**
How many members are in your household?	1 - 5	17	100
	6 - 11	-	-
	Total	**17**	**100**
Level of education	No formal education	-	-
	Primary school	1	5.9
	Secondary school	13	76.5
	Certificate / Diploma	1	5.9

	Bachelor and above	2	11.8
	Total	**17**	**100**
Weight	49 – 61 kg	2	11.8
	62 - 74 kg	3	17.6
	75 – 87 kg	8	47.1
	88 – 100 kg	4	23.5
	Total	**17**	**100**
Height	140 – 150 cm	3	17.6
	151 – 161 cm	6	35.3
	162 -172 cm	6	35.3
	173 – 183 cm	2	11.8
	Total	**17**	**100**
Do you have any diseases other than Type 2 diabetes?	Yes	9	52.9
	No	8	47.1
	Total	**17**	**100**
Do you have experience in using technology to monitor diabetes?	Yes	3	17.6
	No	14	82.4
	Total	**17**	100

RESULTS

Demographic characteristics of the participants (i.e., patients) with type 2 diabetes are shown in Table IIS. The majority of the participants were female (82.4%). Following Braun and Clarke's [15] six-phase framework for thematic analysis (as shown in Table III), the phases are not strictly linear, allowing for movement back and forth between them.

TABLE III SIX-PHASE FRAMEWORK

Step 1: Become familiar with the data Step 2: Generate initial codes Step 3: Search for themes	Step 4: Review themes Step 5: Define themes Step 6: Write-up

The results from the interviews on AI in general, patients' views on AI for diabetes care are varied. For example, to patients, it is unclear the differences between AI and social media (such as Facebook and YouTube). They are unsure about AI, and some have mentioned that they feel there is no immediate need to understand artificial intelligence.

Concerning AI tools in diabetes care, based on the data extraction and interpretation, we have identified four key domains of patients' attitudes as follows.

(1) Perceived acceptability

Perceived acceptability is related to the belief of patients that AI tools are appropriate, suitable, and satisfactory for them. Patients mention they can accept AI tools, and are happy to use them. They do not worry about the technology and have positive expectations towards the tools. Patients also acknowledge that they are always ready to participate in the intervention program based on MySejahtera (i.e., a mobile application developed by the Malaysian government to manage and mitigate the spread of COVID-19) health status. Overall, the domain of perceived acceptability underlines the importance of understanding and addressing the subjective views and beliefs of patients regarding AI tools for diabetes care to ensure well-received in improving health outcomes.

(2) Perceived need

Perceived need is related to how patients recognize their health requirements and the necessity for intervention through the use of AI tools. Patients say that AI tools can inform them about their blood sugar levels and appropriate foods to eat.

Patients also mention AI tools can provide them with positive and negative messages about their health status. These messages can serve as important alerts, prompting patients to take various actions. To sum up, the domain of perceived need mainly refers to how patients recognize and acknowledge the necessity for medical intervention and management facilitated by AI technology.

(3) Perceived benefit

Perceived benefit is related to the patients' recognition and valuation of the advantages provided by AI technologies in managing their health. Patients note that AI can provide them with continuous alerts and better health monitoring. Some patients report that they can save their time and cost. With AI tools, they will only see the doctors when their health status is flagged as needing professional intervention, whether due to unusual symptoms or specific alerts or reminders for potential complications. Most patients also think that AI tools will ease diabetes care, and assist them when nobody is around to help them.

This approach leverages AI for continuous monitoring and early detection, ensuring that patients receive timely and appropriate care. In conclusion, for diabetes patients, perceived benefits from AI tools include various practical, emotional, and health-related aspects.

(4) Perceived trust

Perceived trust is related to the belief that patients have in the reliability, accuracy, and usefulness of AI technologies in managing their condition. Trust is a critical factor influencing the adoption and effective use of AI tools. Patients express worries about AI use and its prediction accuracy. To them, human touch is better than AI. The patients express their concerns about how to implement the AI tools, especially to people who are not technology savvy. Patients report that they are not worried about data privacy. Perceived trust forms the cornerstone of adopting AI tools in healthcare, particularly for diabetes management. It fosters confidence in the accuracy, reliability, and usefulness of these tools. Recognizing the potential of AI technologies is crucial for transforming the lives of patients with diabetes and other chronic conditions
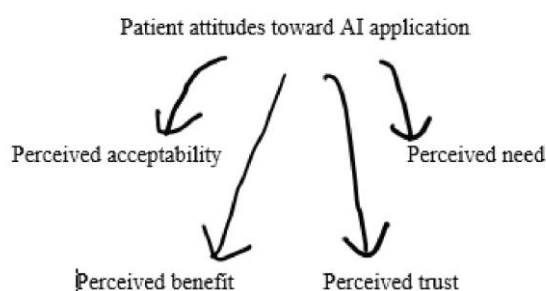

Fig. 2 shows the four domains of patient attitudes toward AI applications or tools in diabetes care.

The results of this exploratory study suggest that patients' attitudes toward AI tools in diabetes care are multifaceted and influenced by various factors. While some patients may express enthusiasm and openness toward AI tools in their diabetes care, others may exhibit scepticism or concerns. Based on these four domains, it can be concluded that: (a) patients are more likely to embrace AI tools if they find them suitable (acceptability), (b) recognize their health needs and the value of AI interventions (need), (c) see advantages such as continuous monitoring and cost savings (benefit), and (d) trust the reliability and accuracy of the technology (trust). These four domains identified in the exploratory study can indeed serve as a basic framework for understanding patients' attitudes toward AI tools in diabetes care. Understanding patient attitudes allows for the development of AI tools that are more aligned with patient preferences, leading to better personalization of care and potentially improved adherence to management plans. If patient attitudes are not considered, AI tools might be designed based on a one-size-fits-all approach, which may not address the diverse needs and preferences of different patients, leading to lower effectiveness and satisfaction. Addressing these implications involves actively listening to patient feedback, designing AI tools that are user-centric, and ensuring that the integration of AI into diabetes care is done in a way that aligns with patient values and concerns. The study had several limitations. Firstly, the findings are derived from data collected from patients at a diabetes clinic, making them not fully representative of the entire patient population. Secondly, the sample size was limited to 17 patients, which was adequate for qualitative analysis but insufficient for making definitive conclusions about patient attitudes in other

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clinical scenarios. Future research could test the results of this qualitative study using a quantitative approach with a larger sample size.

CONCLUSION

The four identified domains of patients' attitudes towards the use of AI tools in diabetes care can serve as a framework for patient education. Additionally, they can guide future quantitative research to align patients' expectations with the development and implementation of AI tools in diabetes care.

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