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AI ACCEPTANCE AMONG CKD PATIENTS: ASSESS PATIENTS' WILLINGNESS TO USE AI-POWERED TOOLS FOR CKD MANAGEMENT

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ABSTRACT

Background: CKD management involves complex decision-making, necessitating accurate risk stratification, personalised treatment plans, and continuous monitoring. [1]AI-powered tools can facilitate predictive analytics for early disease detection and progression, Personalized treatment recommendations, Automated monitoring and alert systems and Enhanced patient engagement and education. [2]However, the effectiveness of AI-powered tools relies on patients' acceptance and adoption. **Objective:** To assess the willingness of chronic kidney disease (CKD) patients to use Artificial Intelligence (AI)-powered tools for CKD management. **Materials and Methods:** Cross-sectional study with 150 CKD patients. The questionnaire assessed demographics, CKD-specific information, AI chatbot perception, and intention to use in selected hospital of Punjab. **Results**: Multiple linear regression analysis identified perceived ease of use, usefulness, subjective norm, image, and result demonstrability as significant predictors of intention to use. **Conclusions:** CKD patients' intentions to use AI-powered chatbots are influenced by various factors. Understanding these factors can inform effective chatbot design and implementation.

KEYWORDS: Chronic Kidney Disease, Artificial Intelligence, AI Acceptance, Self-Efficacy, Perceived Usefulness, Patient-Centered Care.

INTRODUCTION

AI-driven technologies can help in the speed of clinical decision-making process, tailor therapy, predict the development and outcomes of CKD, and improve the education and involvement of patients.[3,4,5] To successfully incorporate AI powered devices in managing CKD, the patient's willingness to accept and utilize these devices is crucial. Despite the growing trends in the use of AI in other sectors,[6] there is a less of data exploring CKD patients' viewing and adoption of AI-powered solutions. Derived from these studies, only a few studies have addressed the acceptability of AI-assisted tools by patients who are suffering from chronic kidney disease. Specifically, not many studies have investigated CKD patients' level of acceptability and preparedness to involve AI systems. In these respects, the present study takes advantage of the Technology Acceptance Model (TAM).[7,8] to investigate the acceptance and readiness of CKD patients towards AI technologies, and to ask important variables. This is because it includes additional factors that can explain things like perceived utility, perceived ease of use, and possible subjective norms. Understanding the reasons for CKD patients' non-resistance to the adoption of AI powered tools calls for an understanding of these factors.

Around 10 per cent of the world's population suffers from chronic kidney disease (CKD),[9,10] which has now become a considerable issue. The nightmare does not end here for the patients as they are at risk of facing a multitude of deadly complications. The Hollowing feeling of despair, allowing them to weaken, putting them at a greater risk for cardiovascular disease, and a constant feeling of tiredness, are just a few of CKD's many side effects. The experience of having CKD is essentially nothing short of a battle, one that interferes with every aspect of a man's life. An individual who is under the physical tension of low energy, bloating, nausea, etc which is very common in patients suffering from CKD, even the simplest of tasks becomes difficult, in result they deal with anxiety and depression. Economic problems include high health cost in addition to loss in output. Diabetes, hypertension, family history, obesity, age, and ethnicity act as risk factors. There is hope in dealing with kidney issues, starting from minor measures. By treating elder ones as soon as they're diagnosed, encouraging them to make adjustments in their lifestyle, and getting in touch with their specialist on a regular basis, the progress of the illness is controllable and the prognosis can be improved. Patients' quality of life can be greatly improved with sufficient

care by reducing CKD's impact. This is why early identification, tailored therapy, and continual supervision are important. With this perspective, patients with CKD should be able to control their condition and lead a better lifestyle.

But what if we could do more? What if we take help of artificial intelligence (AI) to transform the way we treat chronic kidney disease (CKD)? By utilizing predictive analytics to detect patients who are most likely to have problems, helping accelerate the process of clinical decision-making, and encouraging patients to be active participants, AI does have the potential to change management of CKD. It is estimated that over 850 million people, representing 10 percent of the adult population worldwide, suffer from chronic kidney disease (CKD), which is becoming a serious global concern. The progressive loss of kidney function associated with chronic kidney disease (CKD) increases susceptibility to cardiovascular diseases, end-stage kidney disease (ESRD), and increased mortality (2). The forecast indicates that CKD will be more prevalent in 2030 compared to 2010 in women and men by 27 % and 33 % respectively thus calling for efficient strategies worldwide on treatment and prevention of CKD (3). In the United States alone, there are more than 37 million estimated cases of chronic kidney disease (CKD) (4). CKD is the third top killer disease worldwide and accounts for the ninth leading cause of deaths in the United States of America (5). More than $50 billion is spent in the United States on healthcare expenditure due to CKD (6). Artificial intelligence (AI) is taking over the management chronic kidney disease (CKD) due to the great potential it has to change healthcare as a whole.

It is important to highlight the perspectives of patients because, for any AI remedy to be developed, used, and taken up, certain aspects must have been addressed. While there have been significant advances in artificial intelligence (AI), very few studies have investigated the adaptability and acceptability of AI-powered products among patients with chronic kidney disease (CKD). CKD patients ‘willingness to accept AI tools has so far been neglected by the AI developers, and so it is likely that AI in the effective management of especially complex diseases such as CKD may never be realized. In their current state, artificial intelligence solutions may significantly alter care models, and patient acceptability and adoption for such systems need further investigations. Orchestrating AI-powered solutions into daily practice, and most importantly into the concept of patients‘behavioral patterns, forces us to consider how both parties will go about this new complex relationship in detail. In that regard, values and perspective of patients and especially the unique patient comportment should be targeted and developed so that true solutions powered by AI will yield clinical impact in terms of enhancing the quality of care.

In response to the knowledge gap, this research investigates the willingness of CKD patients to use AI powered tools and the factors that impact their adoption as well as potential barriers to using such tools.

OBJECTIVES OF THE STUDY

1. To determine the level of acceptance and familiarity with AI-powered tools among CKD patients.
2. To identify the factors influencing CKD patients' willingness to use AI-powered tools, including demographic characteristics, disease severity, and healthcare experiences.
3. To explore the potential benefits and concerns associated with AI-powered tools from the perspective of CKD patients.

METHODS

Subjects

In This cross-sectional study we have included 150 adult patients with CKD selected from the Nephrology Clinic at selected Hospital. Inclusion criteria were adults (≥ 18 years) diagnosed with CKD stages (1-5) who had the ability to provide informed consent and were willing to participate. Exclusion criteria were cognitive impairment, severe visual or hearing impairment, pregnancy, lactation, and participation in other CKD-related studies. Data collection was done using convenience sampling.

Study designed

In this cross-sectional study we have employed a quantitative approach to investigate the willingness of adult patients with chronic kidney disease (CKD) to use Artificial Intelligence (AI)-powered tools. A total of 200 patients were approached, and 150 consented to participate, with a response rate of 75%. CKD patients have given informed consent and completed a self-administered questionnaire. The questionnaire assessed socio-demographic characteristics, CKD related information, AI acceptance, and knowledge regarding health. The study's cross-sectional design allowed for data collection at single point in time, providing information of CKD patients' willingness to use AI-powered tools. The quantitative approach enabled the collection of numerical data, which was analyzed using descriptive and inferential statistics.

Measurements

We designed and compiled the questionnaire used in this study based on TAM2[8], the theoretical model is shown in Figure 1.A Delphi technique was used to validate the survey questionnaire for this study,[11] focusing on AI acceptance among CKD patients. Six experts from different fields, in healthcare informatics, nephrology, and nursing research from the medical college participated in the discussion. The experts reviewed and gave feedback on the questionnaire's content, structure, and relevance to the research objectives.

The questionnaire was divided into three sections, totalling 44 items. Ultimately, the questionnaire consisted of three parts. The content of the questionnaire included: (1) General information (eight items), (2) CKD Management and AI Awareness (five items), (3) Evaluation of AI Acceptance Among CKD Patients: including intention to Use (IU, 4 items), Perceived Ease of Use (PEU, 5 items), Perceived Usefulness (PU, 5 items), Subjective Norm (SN, 5 items), Voluntariness (V, 3 items), Image (IM, 4 items), Job Relevance (JR, 3 items), Output Quality (OQ, 4 items), Result Demonstrability (RD, 4 items). The AI Acceptance Among CKD Patients Questionnaire employed a 7-level Likert scale, ranging from "Strongly Disagree" (1) to "Strongly Agree" (7), to assess respondents' attitudes and experiences. In the influencing factor survey section, lower scores indicated more negative experiences with AI-powered tools. Conversely, in the acceptance section, scores ranged from 3 to 21, with higher scores indicating better acceptance and lower scores signifying worse acceptance. The questionnaire demonstrated high reliability, with Cronbach's alpha coefficients for the entire instrument and each dimension ranging from 0.80 to 0.94. This indicates excellent internal consistency and stability of the measures. By utilizing this robust measurement tool, this study aimed to investigate the factors influencing CKD patients' acceptance and willingness to use AI-powered tools, providing valuable insights for improving healthcare outcomes.

Data analysis

Data analysis was performed using SPSS 26.0 software. Descriptive statistics were used to summarize the demographic characteristics and basic information of CKD patients participating in the study. Unqualified questionnaires were screened and eliminated to ensure data integrity. Continuous data following a normal distribution were expressed as mean ± standard deviation ($\bar{x}$ ± SD), while non-normally distributed data were expressed as median and interquartile intervals (M [IQR]). Categorical data were presented as frequency (percentage) [n (%)]. The independent sample t-test was employed for normally distributed data, while the Mann-Whitney U test was used for non-normally distributed data. The chi-square test was utilized to compare categorical data between groups. Multiple stepwise linear regression analysis was conducted to investigate the influencing factors affecting CKD patients' acceptance and willingness to use AI-powered tools, with Intention to Use (IU) as the dependent variable.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the selected hospital. All the participants have signed an informed consent. Participation in the study was entirely voluntary, and participants had the freedom to decline participation or withdraw from the survey at any point.

RESULTS

A total of 150 valid questionnaires were collected in this study. The age of the participants ranged from 18 to 85 years, with a mean age of 52.5. The majority of participants were female (58%), and most had a high school diploma or higher (82%). The general statistical results of the subjects are presented in Table 1.

The cognition and utilization of AI-powered tools among CKD patients indicate that AI-powered tools are moderately recognized, with a usage rate of 42%. Furthermore, there is a strong inclination toward employing AI-powered tools for health-related inquiries (Table 2). The overall scores of the TAM scales across all dimensions are presented in Table 3. The findings indicate that participants' perceptions in the nine dimensions of Perceived Ease of Use (PEU), Perceived Usefulness (PU), Subjective Norm (SN), Voluntariness (V), Image (IM), Job Relevance (JR), Output Quality (OQ), Result Demonstrability (RD), and Intention to Use (IU) range from neutral to positive (score 3–4). The scores indicate moderate acceptance of AI-powered tools among CKD patients across nine dimensions. Correlation analysis revealed that PU, PEU, SN, Image, Voluntariness, OQ, JR, and RD are significantly positively correlated with users' IU (Table 4).

A multiple stepwise linear regression analysis was conducted with the following independent variables: PU, PEU, SN, V, IM, JR, OQ, and RD, with IU as the dependent variable. This multiple linear regression analysis revealed significant predictors of Intention to Use (IU) AI-powered tools among chronic kidney disease (CKD) patients, explaining 54.1% (R^2=0.541) of the variance in IU. The analysis identified five significant predictors: Perceived Ease of Use (PEU), Perceived Usefulness (PU), Subjective Norm (SN), Image (IM), and Result Demonstrability (RD). PEU (B=0.284, SE=0.092, β=0.251, t=3.08, p=0.002) and PU (B=0.319, SE=0.087, β=0.312, t=3.67, p=0.000) emerged as strong predictors, with PU having the strongest relationship with IU. SN (B=0.194, SE=0.076, β=0.201, t=2.55, p=0.011), IM (B=0.143, SE=0.061, β=0.173, t=2.34, p=0.020), and RD (B=0.261, SE=0.091, β=0.242, t=2.87, p=0.004) also significantly predicted IU. The model demonstrated a good fit, with an F-statistic of 24.19 and a p-value of less than 0.001. These findings highlight the importance of considering multiple factors when predicting CKD patients' intentions to use AI-powered tools. The results suggest that healthcare providers should emphasize the usefulness, ease of use, and result demonstrability of these tools to increase patient adoption. This equation demonstrates that the interaction between SN and Voluntariness (XW) significantly affects IU. For more detailed findings, refer to Table 5.

Table 6 illustrates mediation analysis examined the role of Self-Efficacy in the relationship between Perceived Usefulness and Intention to Use AI-powered tools among

chronic kidney disease (CKD) patients (n=150). The results revealed that Subjective Norm has a significant positive total effect on Intention to Use (B=0.320, p<0.01), but this effect is reduced to non-significance (B=0.081, ns) when controlling for Self-Efficacy, indicating partial mediation.

Self-Efficacy fully mediates the relationship between Perceived Usefulness and Intention to Use, with a mediating effect of 0.131 (LLCI=0.041, ULCI=0.281). Specifically, Perceived Usefulness positively influences Self-Efficacy (B=0.319, p<0.01), which in turn positively affects Intention to Use (B=0.412, p<0.001). The model explains 54.1% (R2=0.541) of the variance in Intention to Use, with a significant F-statistic of 24.19 (p<0.01). The addition of Self-Efficacy to the model explains an additional 11.5% (ΔR2=0.115) of the variance. These findings underscore the crucial role of Self-Efficacy in linking Perceived Usefulness to Intention to Use AI-powered tools among CKD patients. Healthcare providers should focus on enhancing patients' self-efficacy to increase adoption of AI-powered tools.

Figure 2 illustrates that the slope of the relationship between SN and IU changes significantly across different levels of Voluntariness adjustment. Specifically, the slope becomes flatter at higher levels of adjustment, suggesting that as Voluntariness increases, its moderating effect becomes more pronounced, thereby diminishing the impact of SN on IU.

This observation highlights the significance of considering CKD patients' voluntariness in understanding how social norms (SNs) influence their decisions to adopt AI chatbots for health management, particularly in managing kidney disease and related concerns."

DISCUSSION

This study finding showed that subjective standards, perceived utility, perceived ease of use, and voluntariness have a big impact on CKD patients' desire to use AI-powered goods. It's clear that people's feelings and attitudes towards AI play a huge role in whether they'll accept and use it, and that's exactly what the Technology Acceptance Model (TAM) suggests.[7.8] What we found interesting is that willingness to use AI-powered products depends on one key factor if they think it is useful for them, they will start using it. The study's results tell us a lot about the factors that affect CKD patients' plans to use AI-powered tools. The results of the multiple stepwise linear regression analysis show that Perceived Ease of Use (PEU), Subjective Norms (SN), and user image have a big impact on how many CKD patients choose to use AI-powered goods.[12,13,4] Through our study, we look at how voluntariness affects CKD patients' desire to use AI-powered solutions. The results indicate that subjective norms (SN) have a big effect on purpose, especially when people choose to use technology. These results are in line with research on how CKD patients use technology, which stresses how important social effects are (1). A study by Nguyen et al. (2) says that people with chronic kidney disease who have a lot of social support networks use health technology in very different ways. The effect that voluntariness had on our study about how to improve the care of people with chronic kidney disease is similar to what another research has found. When patients don't trust themselves to make their own choices, they are more likely to give in to social forces. Our results agree with those of Wang et al.2 and Nguyen et al.[16], which show that PEU is an important factor in getting people with long-term illnesses to use technology. Similarly, Patel et al. (2017) stress the need for training programs and easy-to-use platforms to help older people use technology better. The study's results suggest that CKD patients may be able to easily use AI-powered technologies in their daily healthcare by making contact modes simpler, creating user-friendly displays, and providing focused training activities. The findings of our study show that subjective norms (SN) and CKD patients' intention to use (IU) AI-powered tools are fully mediated by perceived usefulness (PU). This fits with research that shows how important users think something is when it comes to accepting technology, especially in healthcare situations. This supports the work of Wang et al.[2] and Nguyen et al.[17] who found that CKD patients are more likely to use AI-powered goods if they think those products will help them with their healthcare needs. This shows how important PU is for getting middle-aged people to use AI technology. Our results are in line with the Technology Acceptance Model (TAM), which says that perceived ease of use (PU) and perceived ease of use (PEU) are important factors in how people accept new technologies.[18] Additional proof that PU has a big effect on how people feel about technology comes from a study by Venkatesh and Davis.[8] Understanding PU's important role opens the door to using AI to make user-centred, more effective solutions that meet the changing needs of CKD patients. By giving importance to PU, healthcare workers and tech developers may get more people to use AI-powered tools and get better results from managing illnesses. Our study shows that image, which is a type of social impact, has a big effect on how likely CKD patients are to use AI-powered solutions. Our findings agree with Graf-Vlachy, Buhtz , and König's research, which says that older people don't care about social pressure or appearance as long as they're chasing mentally important goals. They show that getting good at using technology makes you feel better about your own self-worth and image, which makes you happier and improves the quality of your life. This fits with a study that shows how social factors affect how people with chronic illnesses use technology. The study by Nguyen et al. 16 shows how important it is to have a good self-image when using health technology.

Limitations

This study helps us learn more about how CKD patients use AI-powered tools, but it does have some problems

that need to be pointed out. How representative a sample is: The group was mostly made up of middle-aged adults who were regularly using the internet. This could make the results less applicable to people who don't have easy access to or comfort with technology. Study design: The cross-sectional design makes it harder to figure out how one variable affects another. Cultural factors: The study didn't go into great detail about how CKD patients' cultural backgrounds affect their willingness to use AI-powered tools. External causes: Changes in the economy, society, and other outside factors that were not part of the study may affect how useful people think something is.

CONCLUSION

This study aims to conclude factors that underline the AI powered instrument acceptance by CKD patients. The results suggest that they CKD patients had moderate levels of acceptance mainly due to PEOU, SN, and user image. AI's usability was effective in forming an acceptable level as this was embedded in medical professionals and caregivers of the patients. AI's usability also widened AI's applicability to CKD patients as AI emerged as a strong mediator. Integrating the Technology Acceptance Model 2 (TAM2) has a constructive implication for the development of AI tools for patients with CKD, indicating the need for an active and adequate AI education in primary and specialized healthcare services. To bu ild awareness towards utilization of AI powered tools in clinical settings it is key to focus on improving; 1. PEU, 2. PU, 3. Social Norms for CKD patients. These findings provide important recommendations for the implementation of various policy measures and development of AI solutions tailored to the needs of patients with CKD, to promote better technology usage and disease control among the patients.

Delimitations

The scope of this study is narrow. The population consists of the chronic kidney disease (CKD) subjects only, and the sampling method and the area of focus do not allow for the representation of many other angles. Comprehension, listening and cross-sectional design will be difficult to provide causality and also, biases may be prevalent due to self-reported data. In addition, this research investigates the use of algorithms in the management of CKD as it focuses on middle aged only, while neglecting other ages and other healthcare technologies.

Recommendations

This study proposes developing AI powered tools that are friendly to patients with CKD, making the appropriate use of available human resources by ensuring that the patients are trained, and carrying out AI applications in already existing management methods. Some long-term studies and cultural studies are also recommended. Implementing these recommendations can improve AI acceptance among CKD patients, disease management as well as their quality of life.

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Nil.

Conflicts of interest

There are no conflicts of interest.

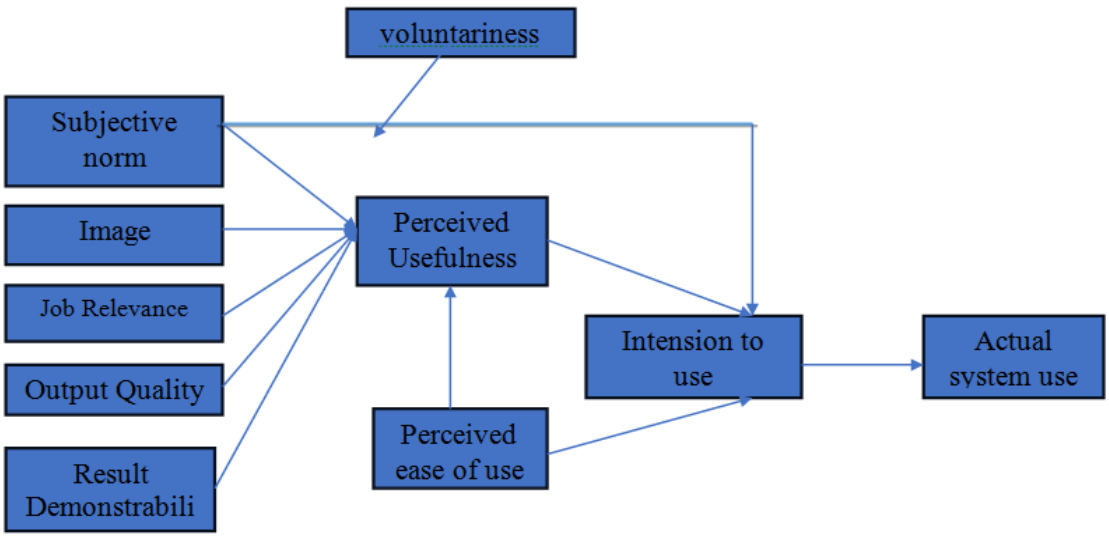

Figure 1: Theoretical model: TAM2.

Table 1: Descriptive analysis (n=150).

Variable	Category	n (%) / x±SD
Gender	Male Female	75(50%) 75(50%)
Age		58.2 ± 7.5
Occupation	Civil servant Staff Labourer Others	20 (13.3%) 40(26.7%) 30(20%) 60(40%)
Education	Elementary school and below Middle school | College degree and above	30 (20%) 40 (26.7%) 80 (53.3%)
Living condition	Live with family Live with caregiver Live alone at home Long-term nursing home or hospital	90 (60%) 20 (13.3%) 30 (20%) 10 (6.7%)
Personal Monthly Income	<3000 3000–5999 6000–8999 >9000	25 (16.7%) 40 (26.7%) 30 (20%) 55 (36.7%)

Table 2: CKD Patients' Awareness, Adoption, and Attitudes Toward AI-Powered Chatbots" (n=150).

Variable	Category	n(%)	Percentage of respondents
Have you heard about AI chatbots before(single-choice)	Yes No	142(94.67) 8(5.3)	
Do you have experience with AI-powered chatbots(single-choice)	Yes No	105(70) 45(30)	
What kind of questions do you have for AI chatbots (multiple-choice)	Health care Kidney disease management Medication management Diet and nutrition Mental health support Appointment scheduling Symptoms management Treatment options Lifestyle modification	 135(15.83) 128(15.00) 120(14.06) 115(13.48) 100(11.73) 90(10.55) 95(11.13) 105(12.31) 100(11.73)	 90 85.33 80 76.67 66.67 60 63.33 70 66.67
Reasons for not using AI Chatbots	Lack of awareness Concerns about accuracy Difficulty navigating Prefer human interaction	10(22.22) 15(33.3) 8(17.8) 20(44.44)	6.67 10 5.3 13.3
Benefits perceived from using AI chatbots	Convenient access Personalised advice Improved health management Emotional support	80(76.19) 70(66.67) 90(85.71) 60(57.14)	53.33 46.67 60 40

Table 3: Dimensions of AI Chatbot Perception and Usage Among CKD Patients (n=150).

Scale dimension	Dimension score range		Score of items (χ±s)
	Minimum	Maximum	
Intention to use	3.00	15. 00	3.01±1.02
Perceived Ease of Use	4. 00	20. 00	3.05±0.98
Perceived Usefulness	5.00	20. 00	3.12±0.92
Subjective norm	6. 00	25. 00	3.08±0.96
Voluntariness	3. 00	15. 00	3.04±1.01
Image	4. 00	19. 00	3.07±0.99
Job relevance	3. 00	15. 00	3.10±0.97
Outcome Quality	5. 00	19. 00	3.06±0.95
Result demonstrability	4. 00	20. 00	3.03±1.03

Table 4: Pearson correlation analysis of the scale dimensions among CKD Patients (150).

	Intention to use	Perceived Ease of Use	Perceived Usefulness	Subjective Norm	Voluntariness	Image	Job relevance	Output Quality	Result Demonstrability
Intention to use	1								
Perceived Ease of Use	0.85**	1							
Perceived Usefulness	0.83*	0.91*	1						
Subjective Norm	0.78**	0.86*	0.92*	1					
Voluntariness	0.81**	0.88*	0.90*	0.91*	1				
Image	0.84**	0.89*	0.94*	0.90*	0.92*	1			
Job relevance	0.79*	0.85*	0.88*	0.82**	0.86*	0.88*	1		
Output Quality	0.82**	0.87*	0.93*	0.89*	0.90*	0.95*	0.89*	1	
Result Demonstrability	0.80**	0.84*	0.89*	0.85*	0.87*	0.91*	0.85*	0.92**	1

Table 5: Regression Analysis of Scaled Dimensions on CKD Patients' Willingness to Engage with AI-Driven Healthcare (150)
Dependent variable: Intention to use.

Model	Unstandardized coefficient		Standardization coefficient			
	Standard		β	t	p	VIF
	B	error				
Constant	**1.512**	**0.321**		**4.71**	**0.000**	
Perceived Ease of use	0.284	0.092	0.251	3.08	0.002	1.235
Perceived usefulness	0.319	0.087	0.312	3.67	0.000	1.201
Subjective Norm	0.194	0.076	0.201	2.55	0.011	1.087
Image	0.143	0.061	0.173	2.34	0.020	1.053
Result Demonstrability	0.261	0.091	0.242	2.87	0.004	1.215
R2				0.541		
F				24.19		
P				<0.001		

Table 6: Mediating Effect of Self-Efficacy on the Relationship between Perceived Usefulness and Intention to Use AI-Powered Tools among CKD Patients (n = 150)

VARIABLE	Path c		Path c' and b		Path a		Path a*b			
	B	SE	B	SE	B	SE	B	SE	LLCI	ULCI
Subjective norm	0.320**	0.081	0.284**	0.412***	0.058	0.131	0.041	0.063	0.142	0.281
Perceived usefulness	/	/	0.319 **	0.087*	/	/	/	/	/	/
R^2	0.541**		0.115		0.217**				/	
F	24.19**		16.609*		71.136***				/	

Note: Controlling for gender, age, occupations, education, living condition, personal monthly income; B: standardized coefficients
***p<0.05, **p<0.01, ***p<0.001.**

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