Assessing Readiness for mHealth Adoption in Coronary Artery Disease Management: Iraq Case Study

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Abstract

Chronic diseases (CDs) have become as significant as communicable diseases due to their rising mortality rates and long-term effects. Coronary artery disease (CAD), one of the most common NCDs, is increasingly concerning due to its impact on both death rates and overall health. Managing CAD typically requires professional care and lifestyle changes, which may be inaccessible to some patients due to financial constraints or difficulty in modifying their habits. However, remote health solutions, like mobile applications, could help CAD patients improve their condition and lower risks. In Iraq, the willingness of CAD patients to use mHealth apps has not been explored. This study examines existing mHealth readiness models and incorporates additional factors that consider the needs of CAD patients and the Iraqi context. This will be achieved by adapting a questionnaire based on expert feedback and distributing it to CAD patients in Iraq.

Keywords: Chronic diseases; Coronary artery disease; Mobile applications; mHealth, Iraq

1. Introduction

Coronary artery disease (CAD) is a leading cause of death globally, including in Iraq, where it accounts for 32.5% of chronic disease mortality [1, 2]. Despite overall declines in mortality rates, CAD-related deaths are increasing [3]. Effective CAD management requires a multifaceted approach encompassing exercise, medication, and lifestyle modifications such as smoking cessation and dietary changes [4, 5]. Recent research highlights the importance of intervention programs that assess readiness for change to facilitate successful lifestyle modifications [6].

Mobile health (mHealth) technologies, using mobile devices for healthcare and public health, encompass an estimated 325,000 health applications [7]. While smartphone penetration in Iraq is approximately 70%, mHealth adoption remains relatively low, although initiatives such as Asiacell's text-based health information service are demonstrating progress [8]. The mHealth technologies offer potential benefits in CAD management, assisting with recovery, monitoring health metrics, and improving medication adherence [9]. However, significant barriers persist, including language barriers, limited app availability, and low user familiarity. Iraqi cardiologists generally support mHealth but advocate for increased promotion and integration within the healthcare system. The underutilization of mHealth technology for managing coronary artery disease (CAD) in Iraq stems from factors such as limited patient technological literacy, language barriers, and inadequate support from healthcare

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organizations. This study investigates the sociocultural and technological factors influencing mHealth app adoption readiness among Iraqi patients.

The research aims to answer three key questions:

- What factors influence the readiness to adopt mHealth apps in Iraq?
- How can a model be developed to assess readiness for mHealth adoption in CAD management?
- What recommendations can improve the adoption of mHealth apps for CAD?

This study aims to explore factors influencing mHealth readiness for CAD management among Iraqi patients, develop a model to assess this readiness and provide recommendations to improve mHealth app adoption and utilization among this population. Furthermore, the main contributions of this study can be listed as follows:

- Identification of Readiness Factors: Examines critical factors influencing the readiness of Iraqi coronary artery disease (CAD) patients to adopt mHealth solutions.
- Development of an Assessment Model: Proposes a tailored model integrating mHealth readiness frameworks with additional factors relevant to CAD management in Iraq.
- Survey-Based Analysis: Utilizes a structured questionnaire, refined through expert feedback, to gather empirical data from CAD patients in Iraq.
- Practical Recommendations: Offers evidence-based recommendations to improve mHealth adoption and enhance CAD management through digital health solutions.

2. Related Works

World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) recognize a minimal direct genetic contribution to CAD development—no single gene causes it—genetic factors influencing rapid fat metabolism may predispose individuals to CAD [10]. Primary risk factors remain poor diet, physical inactivity, and substance abuse, including smoking; genetics play an indirect, rather than direct, causative role [11]. The mHealth leverages mobile devices to expand access to medical services, bridging the gap between growing populations and limited healthcare resources [12]. Its benefits include improved disease management and treatment, particularly in underserved areas. Widespread mobile network coverage (97% globally) and LTE access (82%) make mHealth a cost-effective approach to enhancing healthcare delivery and disease management, especially in resource-constrained settings [13, 14]. Smartphones are central to mHealth due to their advanced capabilities and widespread adoption [15]. Iraq's high mobile phone ownership, exceeding 37 million subscribers by 2020, demonstrates substantial potential for mHealth integration [16]. Furthermore, in [17], it has been found that 72% of Iraqis consider mobile phones essential for emergencies and communication, reinforcing this potential.

Development of Health Information Systems in Iraq

Before 2003, Iraq's healthcare sector lacked modern technological infrastructure. Since 2004, the Ministry of Health (MoH) has implemented electronic systems and software to improve health information management [18], though these remain fragmented and require further development. The MoH is actively pursuing a strategic plan for system integration and upgrading. This study will develop an mHealth model to facilitate app usage within this evolving context.

Successful mHealth integration for chronic disease management requires careful consideration of patient readiness to prevent implementation inefficiencies [19]. Readiness varies across demographics, influenced by factors such as age, culture, and digital literacy—older adults and certain minority groups may exhibit lower adoption rates [20]. Marital status, education level, and overall health status also impact readiness [21]. A thorough assessment of these factors is crucial for effective mHealth implementation [22, 23].

Organizational Readiness

Individual mHealth readiness encompasses both the willingness and ability to adopt new technologies [24] (see Fig. 1). Individual responses to technological change vary significantly, impacting overall readiness [25]. mHealth interventions, such as monitoring applications and medication reminders, offer substantial potential for improving chronic disease management and healthcare efficiency [26]. However, effective mHealth implementation also depends on the preparedness of the healthcare system itself, including provider awareness and resource availability [27].

The authors in [28] adapted a model for AI adoption in AgriTech, emphasizing human-machine collaboration, AI strategy, and technological infrastructure. However, the model's reliance on data from a single conference and the lack of input from international experts limit its generalizability.

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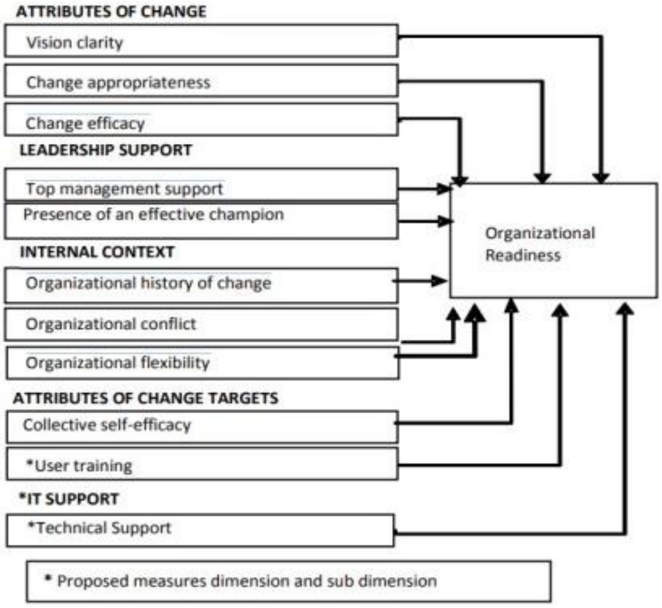

Figure 1. Proposed organizational readiness model

Indonesian mHealth readiness model (see Fig. 2) comprises four dimensions—people, engagement, technology, and motivation—encompassing 13 variables [29]. The model emphasizes technological readiness, focusing on ease of use and affordability, factors particularly relevant given Indonesia's high smartphone penetration and the abundance of health applications. The model also considers the influence of competing Information Technology (IT) interests on adoption

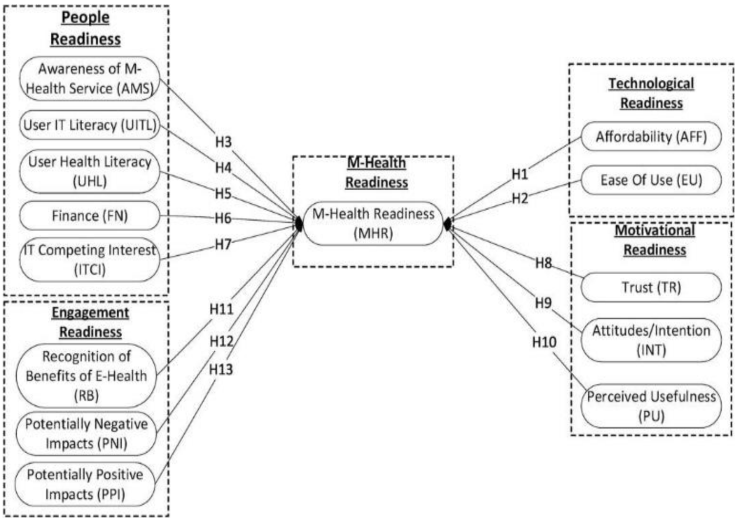

Figure 2. Conceptual models

3. Critique of Previous mHealth Readiness Models and Study Relevance

This study examines individual mHealth readiness for coronary artery disease (CAD) management in Iraq. Adapting elements from existing models to the Iraqi context, it incorporates concepts of change appropriateness and self-efficacy regarding technology, recognizing the need for personalized mHealth adaptation. It also integrates factors of ease of use, affordability, and ICT literacy, acknowledging the importance of accessible technology within Iraq's context of high smartphone penetration and variable digital literacy. Factors such as engagement readiness are excluded due to their limited relevance to the specific health focus (CAD management) and the Iraqi context [29]. The study thus concentrates solely on factors directly influencing individual mHealth adoption for CAD management.

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4. Critical Factors Affecting mHealth Readiness

Sociocultural factors significantly influence mHealth adoption, impacting communication, treatment adherence, and health outcomes. Community characteristics such as ethnicity, age, education level, and income play a crucial role; higher education and income are often associated with increased IT and mHealth service utilization [30]. Sociocultural beliefs, particularly trust and confidence in technology, are essential for successful adoption; mHealth solutions must be user-friendly and reliable to foster trust. Lifestyle variations, such as those between urban and rural populations, also affect mHealth app readiness. Furthermore, technological appropriateness is critical, with internet connectivity and affordability being key determinants [31]. Poor connectivity and high costs can impede mHealth adoption, especially among lower-income groups. Understanding these sociocultural and technological factors is crucial for effective mHealth implementation, particularly in diverse settings such as Iraq.

5. Proposed Methodology

This study employs a positivist research paradigm, prioritizing objective, measurable knowledge through quantitative methods. This approach is suitable for evaluating healthcare personnel's mHealth readiness, aiming to quantify user readiness and generate empirical evidence. A Design Research (DR) methodology (see Fig. 3) is utilized, employing a hypothetico-deductive approach to develop and test hypotheses derived from existing theories. The study follows a structured operational framework to address mHealth application readiness in Iraq, focusing on problem determination, motivation, objective definition, and design. A rigorously validated questionnaire (including pilot testing and reliability analysis), translated and culturally adapted for the Iraqi context, assesses demographics, smartphone usage, and technology acceptance. Data collection utilizes purposive sampling of Iraqi mobile phone users aged 60 and older. Descriptive and structural equation modelling will analyse the data to assess readiness factors, ensuring relevance and accuracy.

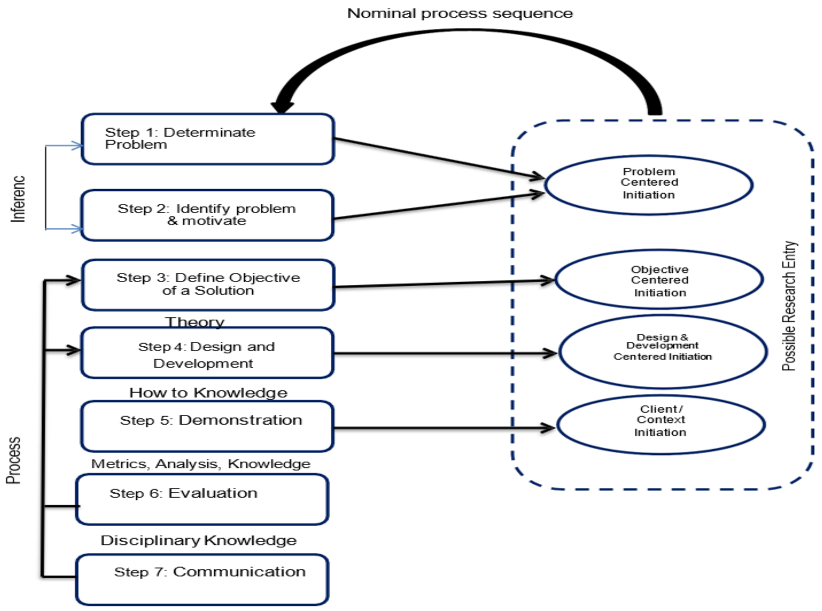

Figure 3. Research design

This study adapts the models in the literature to address individual needs and health aspects related to CAD management. Previous studies organizational technology adoption model is adapted to the individual level by incorporating Change Appropriateness and Self-Efficacy (reframing "Change Efficacy"), focusing on individual perceptions and confidence in adopting mHealth. User-centric mHealth readiness model is modified to emphasize Technological Appropriateness, including ease of use, affordability, and ICT literacy, to better address the needs of older users. Sociocultural factors, such as lifestyle and education level, are also integrated into the resulting model (see Fig. 4).

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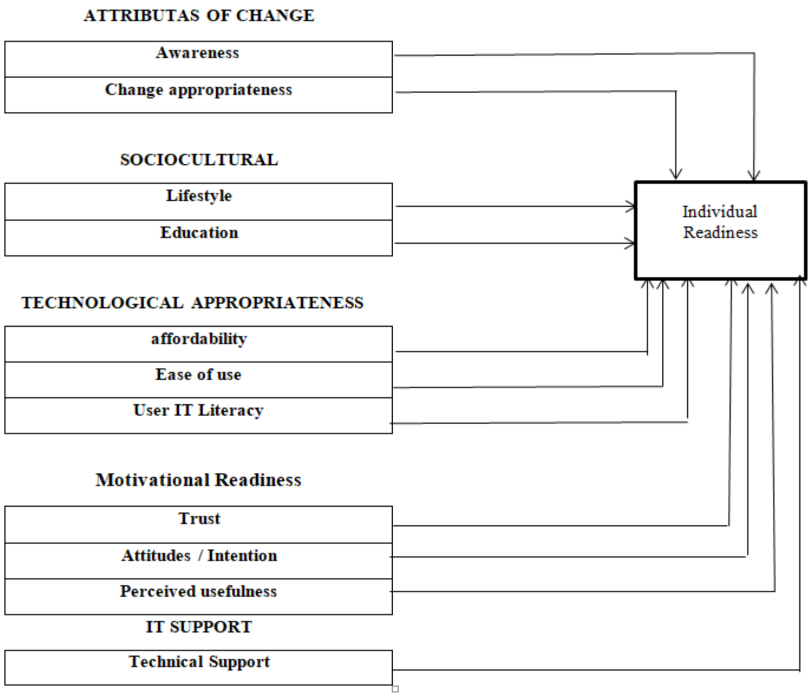

Figure 4. The proposed an individual readiness model

6. Analysis

The sample size required for the study was larger than 160 to avoid sampling errors and ensure reliable results. Of the 395 questionnaires distributed, 349 were returned, resulting in an 88.35% response rate, which Baruch and Holtom (2008) classify as excellent [32]. Missing data was effectively handled by designing the questionnaire to require mandatory responses, ensuring complete information. A Microsoft Excel spreadsheet was used to check for suspicious response patterns, and no straight-line responses were found, confirming the responses were valid. Data normality tests revealed no significant issues with skewness or kurtosis, with minor deviations for a few indicators (See Table I), which were deemed acceptable, and the indicators were retained [33].

Table 1: Normality Test (Skewness and Kurtosis)

Factors	**Standard deviation**	**Excess kurtosis**	**Skewness**	**Number of observations used**	**Cramér-von Mises p value**
Ai1	0.733	1.453	-0.301	349.000	0.000
Ai2	0.556	2.321	-0.680	349.000	0.000
Ai3	0.550	3.845	-0.479	349.000	0.000
Ai4	**0.640**	**1.334**	**0.478**	**349.000**	**0.000**
IT1	0.684	1.865	-0.101	349.000	0.000
IT2	0.608	1.666	-0.275	349.000	0.000
IT3	0.626	1.573	-0.297	349.000	0.000
IT4	0.628	1.218	-0.221	349.000	0.000

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LS3	0.570	2.031	-0.209	349.000	0.000
LS4	0.645	0.353	-0.025	349.000	0.002
Ls1	**0.888**	**-0.430**	**-0.064**	**349.000**	**0.002**
Ls2	0.689	0.341	-0.343	349.000	0.000
Ls5	0.758	0.820	-0.351	349.000	0.000
aff1	**0.901**	**-0.069**	**-0.301**	**349.000**	**0.001**
aff2	0.693	0.901	-0.320	349.000	0.000
aff3	0.723	0.060	-0.298	349.000	0.004
aff4	**0.614**	**0.598**	**0.197**	**349.000**	**0.004**
aff5	0.770	0.894	-0.297	349.000	0.000
aw1	0.756	0.695	-0.043	349.000	0.000
aw2	0.549	2.927	-0.807	349.000	0.000
aw3	0.578	1.295	-0.139	349.000	0.000
aw4	0.657	2.355	-0.090	349.000	0.000
ca1	0.874	-0.773	0.064	349.000	0.000
ca2	**0.755**	**0.792**	**0.221**	**349.000**	**0.000**
ca3	0.634	0.588	-0.032	349.000	0.001
ca4	0.586	0.019	-0.148	349.000	0.088
ca5	0.955	0.114	-0.791	349.000	0.000
ed1	0.771	0.469	-0.327	349.000	0.000
ed2	0.719	0.927	-0.477	349.000	0.000
ed3	0.668	2.203	-0.333	349.000	0.000
ed4	0.641	1.687	-0.102	349.000	0.001
ed5	0.552	1.781	-0.422	349.000	0.000
eou1	0.711	0.411	-0.333	349.000	0.000
eou2	0.557	2.202	-0.579	349.000	0.000
eou3	0.597	1.582	-0.356	349.000	0.000
eou4	0.775	1.665	-1.010	349.000	0.000
eou5	0.805	0.680	-0.399	349.000	0.000

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ir1	0.711	1.169	-0.207	349.000	0.000
ir2	0.690	1.985	-0.151	349.000	0.000
ir3	0.620	1.461	-0.233	349.000	0.000
ir4	0.600	2.694	-0.083	349.000	0.000
pu1	0.685	2.059	0.153	349.000	0.000
pu2	0.673	1.540	0.183	349.000	0.000
pu3	0.647	1.087	-0.385	349.000	0.000
pu4	0.670	5.088	0.894	349.000	0.000
pu5	0.653	1.820	-0.310	349.000	0.000
pu6	**0.956**	**-0.075**	**-0.734**	**349.000**	**0.000**
pu7	0.738	0.902	-0.182	349.000	0.000
tr1	0.765	2.003	-0.669	349.000	0.000
tr2	0.633	1.582	-0.323	349.000	0.000
tr3	0.629	1.090	-0.237	349.000	0.000
tr4	0.745	2.140	-0.379	349.000	0.000
tr5	0.782	0.474	-0.386	349.000	0.000
ts1	0.680	1.202	-0.046	349.000	0.000
ts2	0.656	1.132	-0.192	349.000	0.000
ts3	0.618	2.468	-0.318	349.000	0.000
ts4	0.575	2.646	-0.324	349.000	0.000
ts5	0.646	1.298	-0.077	349.000	0.000

To ensure accurate data analysis, outliers were checked by calculating z-scores for each construct's highest and lowest cases. In [34], it was mentioned that a z-score beyond ±3.29 indicates an outlier. The z-score analysis showed no outliers, confirming that the data was consistent and within expected ranges. This consistency supports the reliability of the data and ensures that statistical models, such as PLS-SEM, were not skewed by extreme values. All z-scores were within the critical threshold, indicating the dataset was free from significant outliers (Please refer to Table II). The data analysis was conducted in two stages. First, the measurement model was evaluated for loadings, reliability, and validity. Then, the structural model was analyzed to test the hypotheses using criteria such as path coefficients, R^2, f^2 effect size, and Q^2 predictive relevance. Bootstrapping analysis was performed to obtain critical statistics and confidence intervals for the hypotheses. The conceptual model for PLS analysis is shown in Fig. 5.

Table 2: Z-Score for highest and lowest cases from each construct

Factors	Observed min	Observed max	Number of observations used
Ai1	-2.489	2.094	349.000
Ai2	-2.320	1.745	349.000
Ai3	-2.469	1.962	349.000
Ai4	-1.737	2.131	349.000
IT1	-1.922	2.698	349.000
IT2	-2.171	2.356	349.000
IT3	-2.246	2.066	349.000
IT4	-2.061	2.211	349.000
LS3	-2.315	2.414	349.000
LS4	-1.928	1.913	349.000
Ls1	-2.228	2.389	349.000
Ls2	-2.092	2.132	349.000
Ls5	-2.360	2.329	349.000
aff1	-2.527	2.543	349.000
aff2	-2.171	2.025	349.000
aff3	-2.034	1.885	349.000
aff4	-1.832	1.920	349.000
aff5	-2.684	1.929	349.000
aw1	-1.824	2.694	349.000
aw2	-2.052	1.941	349.000
aw3	-2.082	1.639	349.000
aw4	-2.293	2.730	349.000
ca1	-1.797	2.669	349.000
ca2	-1.750	2.497	349.000
ca3	-1.855	2.057	349.000
ca4	-1.739	1.391	349.000
ca5	-2.906	1.524	349.000
ed1	-1.960	2.458	349.000
ed2	-2.292	1.913	349.000

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ed3	-2.488	2.178	349.000
ed4	-2.683	2.000	349.000
ed5	-1.873	1.892	349.000
eou1	-2.286	1.745	349.000
eou2	-2.432	1.643	349.000
eou3	-2.599	1.913	349.000
eou4	-2.951	1.684	349.000
eou5	-2.837	2.185	349.000
ir1	-2.810	2.336	349.000
ir2	-2.032	2.589	349.000
ir3	-2.746	1.829	349.000
ir4	-2.369	2.416	349.000
pu1	-2.447	2.662	349.000
pu2	-2.316	2.772	349.000
pu3	-2.049	1.684	349.000
pu4	-2.039	3.565	349.000
pu5	-2.586	2.409	349.000
pu6	-2.627	1.925	349.000
pu7	-2.574	1.865	349.000
tr1	-2.893	2.650	349.000
tr2	-2.134	2.185	349.000
tr3	-2.281	2.017	349.000
tr4	-2.622	2.846	349.000
tr5	-2.122	2.617	349.000
ts1	-1.816	2.785	349.000
ts2	-2.234	1.927	349.000
ts3	-2.701	2.119	349.000
ts4	-2.293	2.141	349.000
ts5	-2.083	2.156	349.000

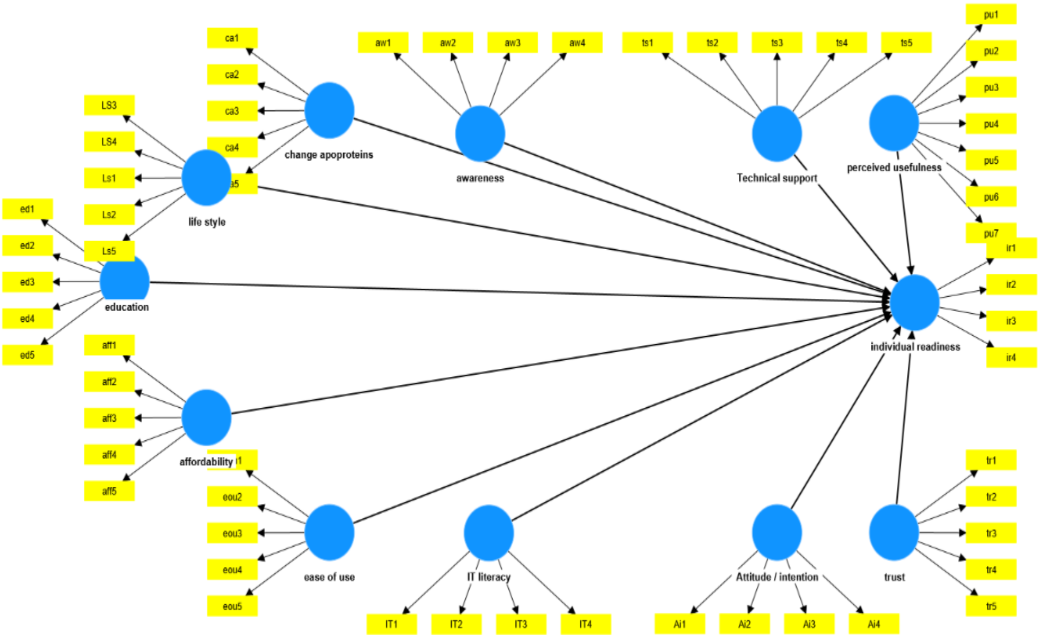

Figure 5. Conceptual model for PLS analysis based on variable

7. Reliability and Validity

The first step in evaluating the measurement model was assessing construct reliability and validity. According to [35], composite reliability (CR) above 0.70 indicates good reliability, and average variance extracted (AVE) above 0.50 suggests that a construct explains more than half of the variance in its indicators. While CR values for all constructs exceeded 0.70, the AVE values for affordability (0.443), change efficacy (0.402), lifestyle (0.484), and perceived usefulness (0.475) were below 0.50, indicating insufficient variance explanation. Items with low loadings, such as ca5, Ls1, and pu6, were removed, improving AVE values and enhancing the model's validity, as detailed in Table III.

Table 3: Construct reliability and validity before removing items

Factors	**Cronbach's alpha**	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
Attitude / intention	0.784	0.792	0.862	0.610
User IT literacy	0.772	0.773	0.854	0.594
Technical support	0.830	0.836	0.880	0.595
affordability	0.677	0.720	0.794	0.443
awareness	0.765	0.781	0.851	0.590
change efficacy	0.602	0.682	0.753	0.402
ease of use	0.765	0.799	0.840	0.516
education	0.794	0.838	0.856	0.545
individual readiness	0.746	0.744	0.840	0.569

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life style	0.727	0.772	0.820	0.484
perceived usefulness	0.802	0.833	0.857	0.475
trust	0.741	0.761	0.827	0.490

8. Discussion and Recommendation

This study analysed factors influencing Iraqi CAD patients' mHealth technology adoption readiness. Of the eleven hypothesized relationships, five proved significant: awareness, affordability, trust, perceived usefulness, and technical support. Awareness emerged as a critical factor, suggesting that increased patient knowledge significantly boosts readiness. Affordability was also vital, indicating substantial economic barriers to adoption, underscoring the need for cost-effective solutions. Trust in mHealth applications was essential, emphasizing the need for user confidence in security and reliability. Perceived usefulness positively influenced readiness, highlighting the importance of demonstrating tangible benefits. Technical support exhibited the strongest positive impact, underscoring the need for ongoing assistance. Conversely, change efficacy, lifestyle, education level, ease of use, user ICT literacy, and attitude/intention were non-significant, suggesting these factors play a less prominent role in Iraqi CAD patients' mHealth adoption readiness. These findings emphasize the importance of focusing on awareness, affordability, trust, perceived usefulness, and technical support to effectively promote mHealth technologies among this population.

This study developed a context-specific mHealth readiness model for Iraqi CAD patients, incorporating the significant factors identified. Recommendations emphasize increasing patient awareness, addressing affordability concerns, building user trust, and providing robust technical support. The research contributes theoretically by extending existing adoption models with context-specific factors and practically by offering actionable insights for stakeholders. Limitations include the cross-sectional study design and potential geographic and self-report biases. Future research should explore long-term impacts, compare regional variations in readiness, and investigate the influence of technological advancements on adoption rates.

9. Conclusion

This study examined the factors influencing the adoption of mobile health (mHealth) applications for managing coronary artery disease (CAD) in Iraq. It found that factors such as education, income, trust in technology, and internet access are key to adoption, while sociocultural differences, especially between urban and rural areas, play a significant role. A model for mHealth readiness in Iraq was developed, emphasizing the need for improved digital literacy, expanded internet access, and culturally appropriate applications. Recommendations include enhancing digital skills, infrastructure, and tailored mHealth tools to improve CAD management in the country.

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