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Research Article

Evaluating the Use of Internet of Things Technologies in Chronic Diseases From the Perspective of Healthcare Providers

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ABSTRACT

The healthcare sector has experienced notable advancement through the adoption of Internet of Things (IoT) technologies, particularly in chronic disease management. This study aimed to evaluate healthcare providers' perceptions of the benefits and challenges associated with IoT implementation. A cross-sectional study was conducted among 150 healthcare providers using a structured questionnaire to assess perceived benefits and barriers to IoT adoption. The findings indicated a consensus regarding the significant potential of IoT technologies, with 70 participants acknowledging the role of these technologies in improving patient monitoring. However, major barriers to implementation were identified, including a lack of skilled personnel and weak technical capacity (79.3%), inadequate policies (76.7%), and high costs (60.6%). Despite positive awareness of IoT benefits, effective integration into healthcare systems requires addressing human and structural challenges by ensuring adequate infrastructure, qualified personnel, and clear regulatory frameworks.

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1. Introduction

Modern smart applications have become increasingly prevalent following the COVID-19 pandemic and are now extensively utilized across various sectors, including healthcare. Among the most influential technological advancements of the modern era is the Internet, which has laid the foundation for more advanced digital innovations such as the IoT.

IoT refers to an ecosystem of interconnected smart devices including sensors, smartphones, and radio-frequency identification (RFID) tags that enable continuous communication between objects and individuals across time and space. This interconnectedness allows for the delivery of a wide range of services tailored to users' specific needs. In healthcare, IoT technologies significantly enhance efficiency and effectiveness by transforming traditional systems into integrated, data-driven care models.

IoT plays a crucial role in supporting personalized healthcare interventions, facilitating the sharing of healthcare plans across regions, enabling continuous care delivery, improving prognostic accuracy, and enhancing patient adherence to treatment regimens. By promoting improved clinical outcomes and higher-quality care, this comprehensive and dynamic approach is particularly beneficial for individuals with chronic diseases [6]. Given the rising prevalence of chronic conditions—especially in low- and middle-income countries—there is an urgent need for technology-based solutions that support active disease management [7,8]. In this context, IoT technologies have emerged as one of the most promising tools for improving healthcare quality while simultaneously reducing associated costs [6,9].

Despite the substantial potential of IoT, significant gaps remain in the literature regarding healthcare professionals' perceptions, awareness, and adoption of these technologies. Limited attention has been paid to understanding providers' knowledge of IoT, their current usage patterns, the perceived benefits, and the challenges encountered during implementation [10]. Addressing these gaps is essential to ensure the effective integration of IoT into clinical practice.

Accordingly, this study aims to explore healthcare professionals' perspectives on the use of IoT technologies in the management of chronic diseases. Specifically, it examines their level of knowledge and awareness, the extent of IoT adoption within healthcare organizations, and the types of IoT devices and systems currently in use. Furthermore, the study investigates perceived impacts such as reductions in hospital admissions, earlier detection of health deterioration, and improved patient compliance, thereby providing insight into the clinical value and practical applicability of IoT systems [11,12].

In addition, this research seeks to identify key barriers to effective IoT implementation, including inadequate infrastructure, workforce shortages, high implementation costs, data security and privacy concerns, and the absence of clear regulatory frameworks. Beyond offering evidence-based practical recommendations, the study aims to contribute to a broader strategic framework that supports informed decision-making and fosters sustainable digital innovation in the healthcare sector. Ultimately, this work aspires to bridge existing knowledge gaps by providing a comprehensive understanding of how healthcare professionals perceive and utilize IoT technologies in the management of chronic diseases.

The integration of Internet of Things IoT technologies has significantly advanced healthcare systems, particularly in chronic disease management. Prior studies have examined the capabilities of IoT in improving patient monitoring, data security, and clinical outcomes.Secure and scalable IoT architectures have been proposed to support healthcare data management. Notably, the LoRaChainCare framework combined LoRaWAN, blockchain, and IPFS technologies, demonstrating low reductions in HbA1c levels, improved cardiovascular risk detection, and decreased hospital admissions among high-risk patients using AI-powered IoT solutions [13]. Additionally, IoT-based user tracking systems have achieved high accuracy in applications such as movement analysis and fall detection [20].

Recent research has focused on privacy-preserving IoT frameworks, including federated learning approaches, which achieved high predictive performance while ensuring data security [15]. Studies on user acceptance further indicate that trust and perceived

usefulness are key factors influencing the adoption of IoT-based healthcare services [16]. techniques for real-time monitoring and individualized risk prediction in chronic diseases such as cardiovascular disorders, diabetes, and cancer [12]. However, ethical concerns, data privacy issues, and algorithmic bias remain critical challenges. Large-scale literature analyses using hybrid methods, including LDA and Fuzzy AHP, identified cardiovascular diseases and diabetes as the primary domains for IoT intervention, particularly in developing countries [15]. Systematic reviews have emphasized the benefits of integrating IoT with artificial intelligence (AI) and machine learning disease management outcomes, enhanced patient safety, and reduced healthcare costs through IoT adoption [14]. have highlighted positive perceptions among healthcare providers, reporting improved Further reviews have demonstrated the transformative role of wearable sensors, remote monitoring devices, and AI-enabled systems in improving early detection of health deterioration and supporting clinical decision-making [13,14]. Quantitative evidence shows cost, low latency, and high energy efficiency, thereby enabling secure and scalable healthcare data exchange [10].

This study aims to address the knowledge gap by providing in-depth insights into the perceptions and use of IoT technologies in chronic care, with a focus on generating realistic, evidence-based proposals to help promote the strategic and sustainable implementation of these technologies in healthcare facilities. This is intended to guide policy decisions and shape subsequent innovations in the digital health experience.

2. Methodology

2.1 Study Design

The study was a cross-sectional study and it took place during a duration of about one month. The research involved six large healthcare centers in the Eastern Region (Martyr Mohammed Al-Maqrif Hospital Ajdabiya and Shahwan Rural Hospital, Al-Zawitina Rural Hospital, 1200 Hospital, Children Hospital, and Heart Hospital).

2.2 Study Participants

The study population included all healthcare professionals working in the aforementioned facilities. Participants included all qualified individuals, such as doctors, nurses, administrators, technicians, and other healthcare workers.

2.3 Sample and Data Collection

Data were collected using a structured questionnaire adapted from established instruments used to assess IoT applications in healthcare.. This questionnaire was modified and developed by the researchers to align with the objectives of the current study. assess the internal consistency. The resulting alpha coefficient was .86, indicating good internal consistency and reliability for the scale. The questionnaire contained close and open type of questions in Arabic, broken into number of main categories:

First: General information (gender, age, educational qualifications, job title, years of experience).

Second: Knowledge and awareness of IoT technologies in healthcare.

Third: The role of IoT technologies in chronic disease management.

Fourth: Challenges facing the application of IoT.

Fifth: Suggestions and recommendations.

The total sample size was 150 participants from various healthcare facilities, and the sample was randomly assigned to eligible participants.

2.4 Data Analysis

Statistical Package for the Social Sciences (SPSS) version 23 was used in the analysis of the collected data. The analysis involved the involvement of the descriptive statistics which have been described as frequency tables and percentages as the data which were used to summarize the characteristics of the sample and what the participants that were included in the survey answered to the questions asked. A five- point Likert scale was also the approach of asking questions on questions to determine the attitude and behavior of the participants.

2.6 Ethical Considerations

The required permission of the respective administration of healthcare facilities was sought over all prior to data collection. A full policy of anonymity was implemented to protect the privacy and confidentiality of the participants, since during the survey no personal information that would allow speculating about their information was gathered.

3. Results

This section presents the results obtained from the questionnaire administered to the study participants. The results are structured to provide a detailed demographic profile of the participants followed by examine their attitudes regarding the adoption of IoT technologies for chronic disease management. The findings are organized into two main domains: i) Demographic Characteristics: which outlines the general composition of the study population, and, ii) Attitudes toward IoT adoption: which encompass participants' familiarity with IoT technologies as well as their perceived benefits and challenges related to the integration of IoT solutions into healthcare practices.

Table1. Relative distribution of participants by age group

Age	Frequency	Percent(%)
< 30 years	38	25.3%
30 - 40	76	50.7%
41 - 50	22	14.7%
> 50 years	14	9.3%
Total	**150**	**100.0%**

Table 1 shows the age distribution of the 150 participants. It is evident that the most represented age group is 30-40 years at 50.7%, while participants older than 50 years represented the smallest proportion (9.3%).

Figure 1, delineates the occupational stratification of the study cohort, comprising 150 healthcare professionals. The distribution reveals a pronounced predominance of clinicians, with Physicians constituting the largest subgroup (n=68, 45.3%). Nursing personnel represent the secondary cohort (n=32, 21.3%), followed by Health Services Administrators (n=20, 13.3%). Health Informatics specialists (designated as IT Officers) comprise a minimal proportion (n=5, 3.3%), while a residual heterogeneous category ("Other") encompasses 16.7% (n=25) of participants, suggesting a degree of occupational heterogeneity within the sample's structural composition

The data presented in Figure 2,reveals a strikingly low level of adoption of IoT technologies for patient monitoring among the healthcare facilities represented in this study. A mere 13.3% of respondents (n=20) confirmed the active use of such technologies within their institutions. In stark contrast, the overwhelming majority 86.7% of participants (n=130) reported no current implementation of IoT-based patient monitoring systems.

This pronounced disparity (13.3% vs. 86.7%) signifies a substantial implementation gap within this sector. It suggests a significant lag between the availability of advanced, data-driven healthcare technologies and their operational integration into routine clinical practice among the surveyed population.

Table 2 shows .healthcare professionals' perceptions of IoT benefits demonstrate a clear hierarchy based on benefit tangibility: Strongest Consensus (70%-66% agreement): Exists for direct clinical applications continuous patient monitoring and reducing hospital visits viewed as IoT's most immediate and validated contributions. Moderate Consensus (62% agreement): Emerges for predictive and adherence functions, indicating recognized potential tempered by perceived implementation complexity.

Weakest Consensus (58% agreement): Surrounds long-term cost reduction, revealing significant skepticism about economic returns despite recognition of clinical value. This gradient suggests practitioners primarily value IoT for solving observable care delivery challenges, while remaining cautious about its indirect benefits until further evidence emerges.

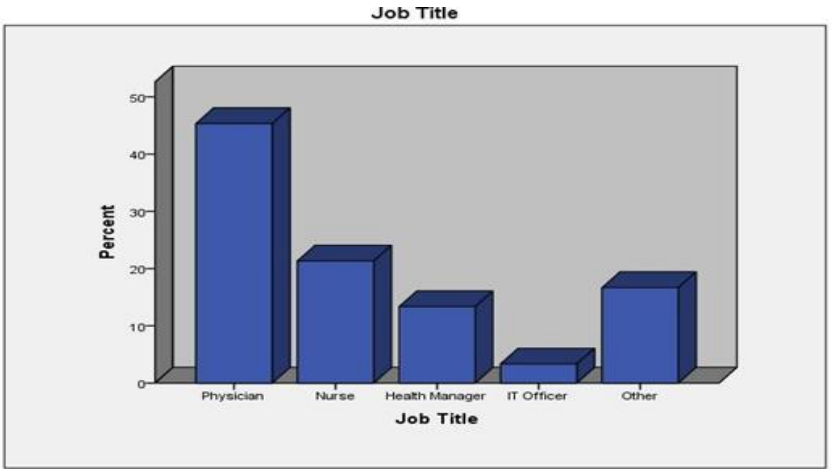


Figure 1: Relative distribution of participants by job title

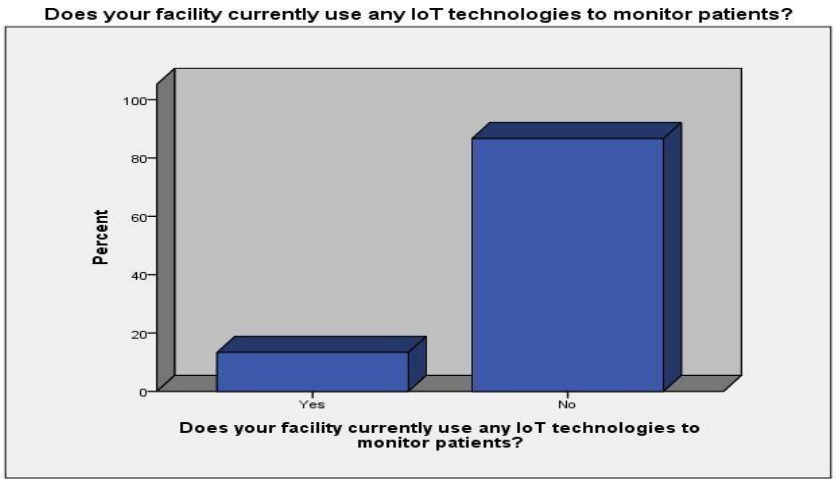


Figure 2: Relative distribution of participants by job title

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
- IoT technologies contribute to improving the monitoring of	2.7%	5.3%	22.0%	51.3%	18.7%

patients with chronic diseases.					
-IoT technologies help reduce the number of patient hospital visits.	2.0%	3.3%	28.0%	47.3%	19.3%
-IoT enables early prediction of patient condition eterioration.	3.3%	6.0%	28.7%	47.3%	14.7%
-IoT technologies contribute to enhancing patient adherence to treatment	3.3%	6.7%	28.0%	47.3%	14.7%
-Applying IoT reduces long-term healthcare costs	3.3%	6.0%	32.7%	40.7%	17.3%

Table 2. Participants' perceptions of the benefits of (IoT) technologies in chronic disease management.

Table 5.. Areas Benefiting from IoT Implementation

Top Areas That Can Benefit from IoT	Responses N	Responses %	% of Cases
Remote cardiology	94	28.5%	66.2%
Predicting early resolution	64	19.4%	45.1%
Patient adherence to treatment	54	16.4%	38.0%
Comprehensive visits and healthcare costs	68	20.6%	47.9%
Medication management	50	15.2%	35.2%
Total	**330**	**100.0%**	**232.4%**

This gradient suggests practitioners primarily value IoT for solving observable care delivery challenges, while remaining cautious about its indirect benefits until further evidence emerges.

Highlights the most important areas that participants believe could significantly benefit from the implementation of IoT technologies are shown in Table 3. Continuous remote monitoring ranked first at 66.2%, followed by comprehensive visits and healthcare costs at 47.9%. Early prediction of solutions came next at 45.1%, followed by treatment adherence at 38%. Medication management ranked last at 35.2%.

4. Discussion

4.1 IoT Awareness and Knowledge of the Technologies

The study revealed a pronounced implementation gap between the theoretical awareness of IoT technologies and their actual utilization in healthcare settings. Despite reporting a high terminological familiarity among participants (60.7%), their self-assessed level of knowledge was predominantly described as limited or average. This discrepancy was practically embodied in the low adoption rate, with only 13.3% of participants reporting the use of these technologies within their facilities..

This finding aligns with an established research trend indicating a persistent implementation gap between technological potential and practical application in healthcare organizations [12,13].The study further provides an explanation for this gap, linking the disparity between awareness and practice to

an inability to address the associated technical and managerial complexities of implementation, as documented in prior literature.

4.2 The views on the Benefits of IoT Technologies

The research findings indicate a broad consensus among medical practitioners regarding the potential benefits of IoT technologies in managing chronic diseases. A majority of participants affirmed the utility of these technologies for patient monitoring (70%), minimizing hospital visits (66.6%), and facilitating the early identification of health deterioration (62%).

These findings are largely congruent with prior research. The potential of IoT technologies to refine disease management outcomes, enhance patient safety, and reduce healthcare expenditures has been corroborated in another study [9]. Furthermore, the current study's results particularly the emphasis on the significance of continuous remote monitoring (66.2%) align with findings related to the implementation of remote monitoring tools and artificial intelligence for preventing early clinical deterioration [12,13]. Additionally, the participants' prioritization of "remote cardiac monitoring" as the most considerable area of benefit corresponds with results from a previous investigation, which identified cardiovascular diseases and diabetes as the most relevant clinical domains for such interventions [11].

5.3 Towards the Difficulties Affecting the Introduction of IoT Technologies

The identification of challenges by the study is one of the most notable findings, as it highlights the direct hindrances to the adaptation of these technologies. The findings indicated that there was a strong agreement that the existing shortage of competent staff and poor technical infrastructure are the highest issues at hand, both standing at 79.3%.Such results support what is found in the literature. Ethical concerns, privacy concerns, and data bias were mentioned by the study participants as the main privacy concerns (55.4%), issues which were also highlighted in a systematic review [10]. The studies aimed at creating options like the LoRaChainCare system guarantees that poor infrastructure and safety points are actual problems scientists attempt to mitigate [8]. Clear regulations are also significant, according to the outcomes of the research in question (76.7%), and this point can be viewed as a major step towards a full operation of these kinds of technologies. Overall, the findings of the current study are quite in line with the global trends that have been discussed by other works. They outline the supposed gains of using the IoT in the medical sphere, as well as outlining a series of basic problems that still prevent the full and successful implementation of such technologies. These findings collectively fulfill the research objectives of addressing the existing knowledge gap and providing a foundation for evidence-based suggestions to promote the strategic application of IoT technologies.

5. Conclusions

This study indicates that healthcare providers are cognizant of the advantages of IoT technologies in chronic disease management, particularly for improving patient monitoring, decreasing hospitalizations, and enabling early intervention. Nonetheless, adoption is hindered by key barriers such as workforce shortages, infrastructural deficits, and concerns over cost, regulation, and data security. This benefit-implementation gap suggests that IoT integration remains at an early phase, requiring systematic planning for successful deployment.

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Conflict of Interest

The authors declare no conflicts of interest.

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