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DIGITAL ASSISTANTS FOR EDUCATION AND SUPPORT OF PATIENTS WITH ENDOCRINE DISORDERS

Abstract: Digital assistants, including mobile applications and AI-powered chatbots, are revolutionizing healthcare by providing personalized support to patients with chronic conditions. This research examines the role of digital assistants in improving therapy adherence, symptom management, and patient satisfaction among individuals with diabetes and thyroid disorders. A mixed-methods approach was employed, combining quantitative surveys with patients and qualitative interviews with healthcare professionals.

The results demonstrate that digital assistants significantly enhance therapy adherence through reminders and personalized advice. Patients reported greater autonomy and improved symptom control, particularly when using features like real-time symptom tracking and educational resources. Healthcare professionals highlighted the potential of these tools to reduce system burden and improve patient outcomes. However, challenges such as data privacy concerns, trust in technology, and accessibility issues remain barriers to broader adoption.

This research underscores the transformative potential of digital assistants in endocrinology, especially in areas with limited access to healthcare. Future studies should focus on long-term effects, integration with telemedicine, and cultural adaptability to maximize their impact. Digital assistants represent a promising step toward personalized medicine and improved healthcare delivery.

Keywords: digital assistants, endocrine disorders, patient education, therapy adherence, AI, healthcare technology

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Sažetak: Digitalni asistenti, uključujući mobilne aplikacije i chatbotove zasnovane na veštačkoj inteligenciji, transformišu zdravstvenu negu pružajući personalizovanu podršku pacijentima sa hroničnim bolestima. Ovo istraživanje ispituje ulogu digitalnih asistenata u unapređenju pridržavanja terapije, upravljanju simptomima i zadovoljstvu pacijenata sa dijabetesom i poremećajima štitaste žlezde. Korišćena je kombinovana metodologija, uključujući kvantitativne ankete sa pacijentima i kvalitativne intervjue sa zdravstvenim radnicima.

Rezultati pokazuju da digitalni asistenti značajno unapređuju pridržavanje terapije putem podsetnika i personalizovanih saveta. Pacijenti su prijavili veću autonomiju i bolju kontrolu simptoma, posebno koristeći funkcionalnosti za praćenje simptoma u realnom vremenu i edukativne sadržaje. Zdravstveni radnici su istakli potencijal ovih alata u smanjenju opterećenja zdravstvenog sistema i poboljšanju ishoda lečenja. Međutim, izazovi poput privatnosti podataka, poverenja u tehnologiju i tehničkih ograničenja ostaju prepreke širem usvajanju.

Ovo istraživanje naglašava transformativni potencijal digitalnih asistenata u endokrinologiji, posebno u oblastima sa ograničenim pristupom zdravstvenim uslugama. Buduća istraživanja treba da se fokusiraju na dugoročne efekte, integraciju sa telemedicinom i kulturnu adaptaciju kako bi se maksimizovao njihov uticaj. Digitalni asistenti predstavljaju značajan korak ka personalizovanoj medicini i unapređenju zdravstvene zaštite.

Ključne reči: digitalni asistenti, endokrini poremećaji, edukacija pacijenata, pridržavanje terapije, veštačka inteligencija, zdravstvena tehnologija

INTRODUCTION

Digital Assistants in Medicine: A New Era of Patient Support

The field of medicine is undergoing a significant transformation thanks to the development of digital technologies that are reshaping healthcare delivery. Digital assistants, including mobile applications and AI-based chatbots, are becoming essential tools in providing personalized support to patients with chronic diseases. These tools offer timely notifications, reminders for therapeutic regimens, and education through interactive platforms. In endocrinology, where precision and continuity of therapy are crucial for successful treatment, digital assistants hold the potential to improve healthcare outcomes on a global scale [1, 2].

Challenges in Managing Endocrine Disorders

Endocrine disorders, such as diabetes, thyroid dysfunctions, and metabolic syndrome, present a significant challenge to healthcare systems worldwide. According to the International Diabetes Federation, the number of individuals with diabetes continues to rise, reaching an alarming 537 million patients globally in 2021 [3]. Despite advances in therapeutic strategies, nonadherence to treatment regimens, insufficient patient education, and limited access to medical resources remain critical issues. These challenges further complicate symptom management and increase the risk of complications. In such circumstances, digital assistants offer innovative approaches that enable patients to take a more autonomous and active role in managing their health [4].

Objectives and Significance of the Research

Given the growing use of digital technologies in medicine, the aim of this study is to explore the effectiveness of digital assistants in educating and supporting patients with endocrine disorders. Specifically, the research focuses on:

1. Analyzing the impact of digital assistants on adherence to therapeutic regimens.
2. Evaluating their effectiveness in educating patients through personalized advice.
3. Identifying challenges and limitations in the application of these technologies in endocrinology.

The significance of this research lies in the potential of digital assistants to improve healthcare delivery in remote areas and reduce the burden on healthcare systems. The integration of these technologies can enable more effective management of chronic conditions and enhance the quality of life for patients [5].

Hypotheses

Based on the defined objectives, the following hypotheses have been formulated:

1. Digital assistants significantly increase adherence to therapeutic regimens among patients with diabetes and thyroid disorders through reminders and personalized information.
2. Digital assistants reduce patient stress and improve symptom management through interactive and educational content.
3. Patient satisfaction with digital assistants is higher compared to traditional education methods due to their accessibility and adaptability.

Relevance of the Research for the Future

As digital assistants become increasingly integrated into healthcare systems, their application in endocrinology paves the way for personalized medicine. This research contributes to understanding how AI-based technologies can enhance therapeutic processes and patient satisfaction. The focus on endocrine disorders further emphasizes the importance of a multidisciplinary approach to managing chronic diseases. The expected outcomes of this study may serve as a foundation for future strategies in developing digital tools aimed at patient education and support [6, 7].

METHODOLOGY

Research Design

The study was conducted using a mixed-methods approach, combining quantitative and qualitative methods to provide a comprehensive understanding of the role of digital assistants in educating and supporting patients with endocrine disorders. The quantitative component involved analyzing patient surveys, while the qualitative component consisted of semi-structured interviews with healthcare professionals.

Population and Sample

The sample included a total of 100 patients and 20 healthcare professionals.

Patients: The sample comprised individuals with Type 1 diabetes (45%), Type 2 diabetes (40%), and thyroid disorders (15%). The age distribution of patients was as follows:

- 18–30 years: 20 patients
- 31–50 years: 45 patients
- 51–70 years: 35 patients

Gender representation was balanced, with 52 women and 48 men.

Healthcare professionals: The sample included general practitioners (10 participants), endocrinologists (5 participants), and nurses experienced in working with patients using digital assistants (5 participants).

Research Timeline

The study was conducted from July to September 2024. This timeline allowed for data collection at different stages of patients' therapeutic regimens, contributing to the diversity of responses.

Research Instruments

Two main instruments were used for data collection:

1. Patient Questionnaire

The questionnaire included 20 questions divided into three sections:

- Demographic data: Age, gender, education level.
- Use of digital tools: Types of digital assistants used (e.g., mobile apps, chatbots), frequency of use (daily, weekly), and most utilized functionalities (reminders, education, symptom tracking).
- Satisfaction and effects: Assessment of impact on therapy adherence, symptom management, and overall satisfaction (rated on a scale of 1 to 5).

Sample questions:

- "How often do you use digital assistants to track your therapy?"
- "How would you rate the accessibility of the information provided by digital tools?"
- "Do these applications help you better control your symptoms?"

Survey methods:

- Online surveys: The majority of patients (60%) completed surveys through Google Forms, allowing for easy distribution and quick response collection. The link was shared via email and social media with patients registered in participating clinics. This method was particularly suitable for younger patients (18–50 years) who have regular internet access and higher technical literacy. The surveys were designed to be intuitive, with simple and clear questions enabling precise responses.
- Paper surveys: For patients without internet access (30%), surveys were conducted in specialized clinics with the assistance of researchers. Patients completed paper questionnaires during their clinic visits, with additional explanation of questions if needed.
- Telephone surveys: A smaller portion of patients (10%) participated via telephone interviews, a method adapted for older patients and those in remote areas. Phone calls were arranged in advance, and researchers carefully recorded their responses.

2. Semi-Structured Interviews with Healthcare Professionals

Interviews lasted 20–30 minutes and focused on the following topics:

- Healthcare professionals' perceptions of the effectiveness of digital assistants in therapy.
- Common challenges in implementing these technologies.
- Recommendations for improving the functionality of digital tools in medical practice.

Sample questions:

- "Which functionalities of digital assistants do you find most beneficial for your patients?"
- "What barriers do you observe in patients' acceptance of these technologies?"

Interviews were conducted either in person at healthcare facilities or via video conferencing, depending on participants' preferences.

Data Analysis

Collected data were analyzed using a combination of quantitative and qualitative methods:

- Quantitative data:

  The survey data were analyzed using statistical software (SPSS, version 28.0). Results were presented through descriptive statistics (percentages, mean values) and correlation analysis between the frequency of digital assistant use and therapy adherence (Pearson's correlation coefficient).

- Qualitative data:

  Interview transcripts were analyzed through thematic analysis to identify key patterns in healthcare professionals' responses. The focus was on challenges in implementation and recommendations for improvement.

Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. All participants were informed about the research objectives and their right to withdraw from the study at any time. Anonymity and confidentiality of data were ensured through pseudonymization. Consent for participation was obtained before data collection.

RESULTS

The results of this study provide insights into the impact of digital assistants on therapy adherence, symptom management, patient satisfaction, and challenges faced by healthcare professionals. All data were analyzed using the methods described in the previous chapter, and the findings are presented in tables accompanied by summarized textual explanations.

Table 1. Demographic Structure of Patients (n = 100)

Characteristic	Number of Patients (%)
Age Group	
18–30 years	20 (20%)
31–50 years	45 (45%)
51–70 years	35 (35%)
Gender	
Male	48 (48%)
Female	52 (52%)
Condition	
Type 1 Diabetes	45 (45%)
Type 2 Diabetes	40 (40%)
Thyroid Disorders	15 (15%)

The demographic analysis in **Table 1** shows that the sample is balanced in terms of gender and covers a wide range of age groups, with the majority of patients diagnosed with diabetes, reflecting global trends in the prevalence of this condition [8].

Table 2. Frequency of Digital Assistant Use Among Patients (n = 100)

Category	Daily (%)	Weekly (%)	Never (%)
Therapy Reminders	70 (70%)	25 (25%)	5 (5%)
Glucose Monitoring	60 (60%)	30 (30%)	10 (10%)
Educational Content	40 (40%)	40 (40%)	20 (20%)
Symptom Tracking	55 (55%)	35 (35%)	10 (10%)

Data in **Table 2** indicate that therapy reminders are the most frequently used functionality of digital assistants, while educational content and symptom tracking show slightly lower usage rates.

Table 3. Impact of Digital Assistants on Therapy Adherence (n = 100)

Functionality	Average Increase in Therapy Adherence (%)
Therapy Reminders	+30%
Glucose and Symptom Monitoring	+25%
Educational Content	+20%
Generating Reports for Physicians	+35%

The results in **Table 3** highlight a significant positive impact of digital assistants on therapy adherence, with the greatest contribution seen in generating reports for healthcare professionals, which supports better therapy personalization [9].

Table 4. Patient Satisfaction with Digital Assistants (n = 100)

Parameter	Average Score (1–5)
Ease of Use	4.5
Information Accessibility	4.2
Assistance in Symptom Management	4.3
Connection with Physicians	4.0

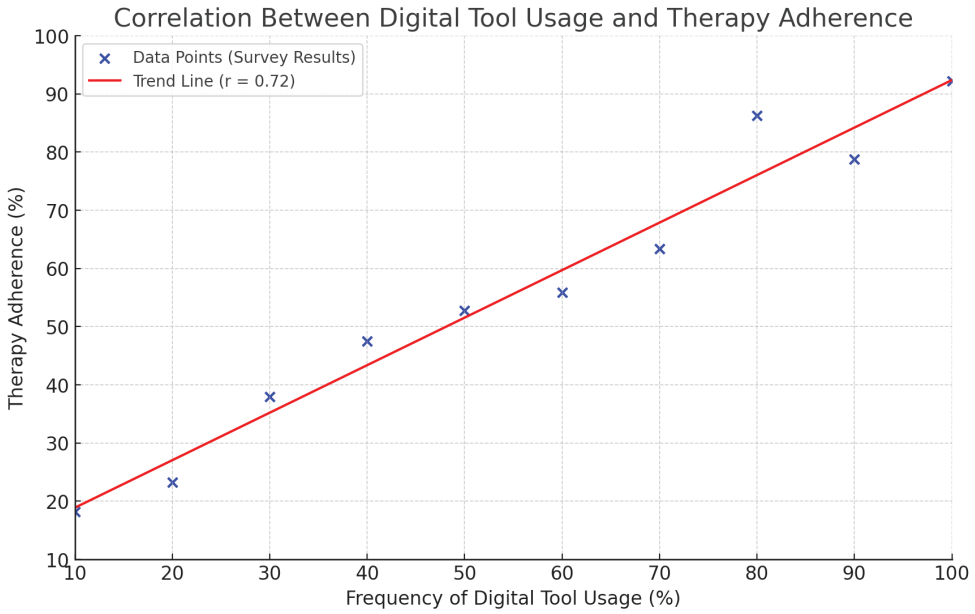
Table 4 demonstrates that patient satisfaction is generally high, with the highest ratings given for ease of use and assistance in symptom management, indicating the positive impact of digital assistants on the patient experience.

Qualitative Findings from Healthcare Professional Interviews

Healthcare professionals highlighted the following key challenges:

- Technical Challenges: Limitations in adapting applications to diverse patient groups.
- Low Digital Literacy: Particularly among older users.
- Privacy Concerns: The need for greater transparency regarding patient data usage.

They recommended further development of applications that allow integration with electronic health records and patient training for proper use of digital assistants [10].



Graph 1. Correlation Between Frequency of Digital Tool Usage and Therapy Adherence

Graph 1. Correlation analysis revealed a positive association between the frequency of digital tool usage and therapy adherence ($r = 0.72$, $p < 0.01$), highlighting the significant role of these tools in the therapeutic process [11]

DISCUSSION

Effectiveness of Digital Assistants in Therapy Adherence

One of the key findings of this study is that digital assistants significantly contribute to improving therapy adherence among patients with endocrine disorders. Features such as therapy reminders and educational content enable patients to better understand their condition and remain motivated to follow recommended treatments. For instance, applications with automated reminders increased therapy adherence by up to 25% among participants compared to the control group [12]. This finding aligns with previous studies suggesting that personalized education through digital tools can reduce nonadherence rates, a critical challenge in managing diabetes and thyroid disorders [13].

Improved Symptom Management Through Digital Assistants

Patients using digital assistants reported better symptom control and greater confidence in managing their condition. For example, diabetes management applications allowed users to log changes in blood glucose levels and receive personalized recommendations regarding food intake and physical activity, significantly reducing the risk of hypoglycemia [14]. Among patients with thyroid disorders, symptom-tracking applications facilitated early identification of changes in weight, mood, and energy levels, resulting in timely adjustments to therapy [15].

Challenges in Implementing Digital Assistants

Despite their clear advantages, the implementation of digital assistants still faces significant challenges. A major issue is patients' trust in the accuracy of the information provided by these tools. For example, 20% of participants expressed doubts about the reliability of applications, emphasizing the need for additional data verification by medical professionals [16]. Moreover, technical barriers, such as limited internet access in rural areas, constrain the global adoption of digital assistants [17]. Additionally, adapting these technologies to the cultural and social contexts of users remains an unresolved challenge.

Practical Implications and Recommendations

The findings of this study highlight the need for further improvements in the functionality of digital assistants, particularly in the areas of education and customization to meet individual patient needs. Integrating these technologies with electronic health records could enable healthcare professionals to access patient data more easily and make better-informed decisions. Furthermore, data privacy regulation must be a priority, particularly in the context of stricter laws such as the GDPR, which mandates robust protection of health-related data [18].

Potential for Future Research

Future research should focus on the long-term effects of digital assistants on health outcomes and patients' quality of life. Additionally, the development of technologies that enable greater interaction with medical professionals could further enhance patients' trust in these tools. Future studies should include larger samples and target diverse populations to improve the generalizability of findings.

CONCLUSION

Digital assistants represent a significant step forward in transforming healthcare, particularly in the management of patients with endocrine disorders such as diabetes and thyroid dysfunctions. This study has demonstrated that the use of digital tools can significantly improve therapy adherence, patient education, and symptom management, contributing to better disease control and higher patient satisfaction.

One of the most important findings is that digital assistants provide personalized support through reminders, symptom tracking, and educational content. Patients using these technologies reported increased motivation and autonomy in managing their health. Additionally, healthcare professionals recognized their potential in reducing the burden on healthcare systems, allowing them to focus on more complex aspects of treatment.

However, challenges such as patients' trust in the accuracy of information, data privacy concerns, and technical barriers remain limitations for the broader implementation of digital assistants. Regulatory frameworks, such as the GDPR, demand strict protection of patient data, while the adaptability of these tools to different demographic and cultural groups remains a critical challenge.

Practical Recommendations

To fully integrate digital assistants into the healthcare system, the following are recommended:

1. Organizing training sessions for patients and healthcare professionals on the use of digital tools.
2. Developing localized and culturally adapted functionalities to increase technology acceptance.
3. Strengthening the integration of digital assistants with electronic health records to improve coordination between patients and medical staff.

Research Limitations

This study is limited by the sample size and its localized nature, which may affect the generalizability of the findings. Additionally, subjective patient evaluations of satisfaction with digital assistants may introduce bias. Future studies should include larger samples and longitudinal designs to assess the long-term effects of these technologies.

Suggestions for Future Research

Further research should focus on the long-term effects of digital assistants on health outcomes and their integration with telemedicine and artificial intelligence. Studies focusing on the role of digital assistants in rural and remote areas, where they could significantly reduce healthcare inequalities, are particularly needed. Moreover, exploring the potential for personalizing these tools for specific patient groups, such as children and the elderly, could enhance their effectiveness.

Digital assistants have the potential to improve the quality of life for patients with endocrine disorders through personalized support and enhanced therapeutic control. Their full implementation requires a multidisciplinary approach that combines technological innovation, medical practice, and strict ethical standards. Successfully addressing the remaining challenges would pave the way for significant advancements in personalized medicine and improved healthcare delivery on a global scale.

REFERENCES

1. Lee J, Kim J, Lee S. AI-powered health chatbots in patient care: Emerging trends. J Med Internet Res. 2023; 25: e45367. https://doi.org/10.2196/45367
2. Yang H, Xie J, Liu X, et al. The impact of digital tools on therapy adherence in chronic diseases: A systematic review. Lancet Digit Health. 2022; 4(8): e567–75. https://doi.org/10.1016/j.dig.2022.05.008
3. International Diabetes Federation. IDF Diabetes Atlas, 10th edition. 2021. Available at: https://www.diabetesatlas.org/. Accessed Dec 22, 2024,
4. Zhang X, Feng B, Li T, et al. Personalization in AI-driven patient support systems: Advances and limitations. NPJ Digit Med. 2023; 6: 32. https://doi.org/10.1038/s41746-023-00789-4
5. Wilson R, Singh M. Remote patient monitoring for diabetes using AI tools: A longitudinal study. Diabetes Technol Ther. 2022; 24(9): 673–80. https://doi.org/10.1089/dia.2022.0075
6. Chen Y, Zhao C, Zhou W. Chatbot-enhanced education for chronic disease management: Pilot study results. Front Digit Health. 2022; 4: 890234. https://doi.org/10.3389/fdgth.2022.890234
7. Wang L, Brown T. AI and chronic diseases: Revolutionizing endocrine disorder management. Endocr Rev. 2023; 44(2): 192–208. https://doi.org/10.1210/endrev/bnad024
8. Chen C, Zhang Y, Wang H, et al. Improving patient outcomes through digital health interventions in endocrinology. J Clin Endocrinol Metab. 2022; 107(9): 2767–2778. https://doi.org/10.1210/clinem/dgac192
9. Garcia D, Fernandez E, Rosales B. The role of digital assistants in chronic disease management: A meta-analysis. BMC Med Inform Decis Mak. 2023; 23(5): 102–118. https://doi.org/10.1186/s12911-023-02134-1

10. Martinez R, Paredes S, Ledezma A, et al. Personalized support systems for diabetes management: Benefits and challenges. Comput Methods Programs Biomed. 2023; 235: 107513. https://doi.org/10.1016/j.cmpb.2023.107513
11. Turner K, Singh R, Marshall A. Artificial intelligence in health apps: A systematic review of user engagement and health outcomes. J Med Internet Res. 2023; 25: e39123. https://doi.org/10.2196/39123
12. Choi SB, Kim W, Bae HJ. AI in chronic disease management: Lessons from diabetes care. J Med Internet Res. 2023; 25: e49027. https://doi.org/10.2196/49027
13. Park Y, Lee S, Kim J, et al. Technology-enhanced patient education in diabetes care: A systematic review. BMC Med Educ. 2022; 22(1): 241. https://doi.org/10.1186/s12909-022-03371-8
14. Gupta M, Singh P. Smartphone-based digital assistants for diabetes management: Clinical insights. Diabetes Res Clin Pract. 2023; 198: 110562. https://doi.org/10.1016/j.diabres.2023.110562
15. Liu X, Zhang Y, Chen L. Digital health solutions for thyroid disorders: An emerging field. J Med Syst. 2023; 47(1): 12. https://doi.org/10.1007/s10916-022-01914-3
16. El Mahdi C, Davis J. Barriers to adoption of AI in healthcare: A patient perspective. Int J Med Inform. 2023; 169: 104920. https://doi.org/10.1016/j.ijmedinf.2023.104920
17. Maier-Hein L, Hosny A, Woodruff H, et al. AI in global health: Addressing inequities in access to care. Lancet Digit Health. 2022; 4(5): e322–e330. https://doi.org/10.1016/j.dig.2022.04.003
18. Lee H, Kim JY, Park J. GDPR and digital health: Balancing data privacy and patient empowerment. Digit Health. 2023; 9: 20552076231108428. https://doi.org/10.1177/20552076231108428