https://doi.org/10.48047/AFJBS.6.15.2024.12938-12947

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Digital Connectivity and Smartphone Utilization Among Urban Type 2 DiabetesPatients: Implications for Health Interventions

Rajesh Saxena[1], Dr. Anurupa B Singh[2] and Dr. N. P.Singh[3]

[1] PhD Scholar-Amity Business School, Amity University, India[2]Guide-Amity Business School (Amity University), India [3]Eternal University, India

Volume 6, Issue 15, Oct 2024

Received: 15 Aug 2024

Accepted: 25 Sep 2024

Published: 21 Oct 2024

doi: 10.48047/AFJBS.6.15.2024.12938-12947

Abstract:

Background- Diabetes is a major public health concern globally, and effective management is critical to improving patient outcomes and reducinghealthcare costs.

Methods-This cross-sectional observational study assesses the prevalence of smartphone ownership, internet access, and usage patterns among 530 urban type 2 diabetes patients.

Results-The findings reveal that 95.5% of participants own smartphones and 96.4% have internet access, indicating a high level of digital connectivity. The study also highlights significant daily engagement with digital platforms, with nearly half of the respondents spending over three hours online each day. These results suggest that digital health interventions, particularly those delivered via smartphones, have the potential to be highly effectivein this population.

Conclusion-The study underscores the feasibility of leveraging digital tools to enhance diabetes self- management and care, while also emphasizing the need to address potential disparities in digital literacy and access.

Keywords:

Type 2 Diabetes, Digital Connectivity, Digital Health Interventions, Diabetes Self-Management

Introduction:

Diabetes is one of the largest global public health concerns, imposing a heavy global burden on public health as well as socio-economic development. [1]

According to the WHO estimates (2016), there are 422 million patients with diabetes over 18 years old worldwide [2], which will increase to 552 million

patients by 2030 [3]. Diabetes has reached epidemic proportions in many developing economies, such as China and India. [4] India has the second greatest number of diabetes patients in the world. India is expected to have 74.9 million individuals with diabetes between the age range of 20-79 years in 2021.

This number is forecast to rise to 124.9 million by the year 2045. According to the International Diabetes Federation (IDF), India is home to one-seventh of all diabetic individuals globally, and one-third of households in India have at least one person with diabetes [5].

Today, in the era of information technology, diabetic patients have become more dependent on online sources to access health information ubiquitously, especially with the propagation of smartphones, tablets, and laptops. Health-related information on the Internet for diabetes encompasses thousands of websites, chat rooms, and support groups that can be accessed by health consumers [6,7] Technological advances have also been harnessed to support lifestyle and pharmacological interventions, as well as medical devices (blood glucose meters, continuous glucose monitoring [CGM] devices, insulin pumps, and smartpens) [8].

Digital health apps can be generally broken down into three categories: those used for tracking wellness, those that function as stand-alone medical devices (e.g., for titrating insulin), and those that display, download, and/or use data from medical devices that diagnose, prevent, monitor, or treat a condition (e.g., blood glucose monitoring, CGM, insulin pump or automated insulin delivery [AID] system [also known as "closed-loop" control system]) [9]. Among almost half a million health-related apps available for wireless devices (usually smartphones), apps designed to help manage diabetes are among those most commonly available [10]. These are intended to improve health outcomes and quality of life by coaching people with diabetes, supporting healthy nutrition and weight control, encouraging glucose monitoring and remote monitoring, assisting with the interpretation of results, maintaining lifestyle modifications, guiding medication dosing, and, ultimately, reducing complications [11]. Diabetes apps have enormous potential, given that more than 2.7 billion individuals in the world use smartphones and about 0.5 billion people already use mobile apps for diet, physical activity, and chronic disease management [12]. The widespread adoption of

smartphones among the general population has transformed them into powerful tools for accessing information, communication, and even health management. With the majority of urban residents owning smartphones, there is a unique opportunity to leverage these devices to deliver personalized healthcare interventions, improve disease management, and enhance patient outcomes [13].

Furthermore, the internet has become an indispensable resource for health-related information, support, and services. Given the high levels of internet access observed among urban type 2 diabetes patients, there is immense potential to harness digital platforms for delivering health education, facilitating self-management, and providing remote healthcare services [14].

Failure to respond to therapy is linked to diminished treatment advantages and can impose a detrimental economic cost on both individual patients and society as a whole [15]. The cost of managing DM include intangible costs, direct costs, and indirect costs [16]. It is understood that the financial aspect of diabetes management is not covered by insurance, which means that higher out-of-pocket expenses can result in lower adherence to medication. This can lead to suboptimal treatment benefits and ultimately result in poor health outcomes [16]. Therefore, an Internet of Things (IoT) enabled platform for managing diabetes mellitus (DM) has the capability to enhance health results and has also demonstrated the ability to decrease healthcare expenditures and personal spending by minimizing the frequency of visits to the clinic [17,18].

Understanding the intersection of digital connectivity and smartphone utilization among urban type 2 diabetes patients is crucial for developing effective health interventions tailored to their needs. This research aims to shed light on the prevalence of smartphone ownership, internet access, and usage patterns among urban type 2 diabetes patients, as well as to explore the implications of these findings for health interventions.

Methodology:

Study Setting- This cross-sectional observational study was conducted from January 2022 to December 2022 in the Northern region of India, specifically targeting the tier 1 urban population of New Delhi. The study gathered data from a convenience sample of individuals diagnosed with type 2 diabetes, aiming to assess their use of digital applications for managing their health.

Study Population-

The target population for this study comprised adults aged 18 years or older who had received a diagnosis of type 2 diabetes in accordance with the stringent diagnostic criteria outlined in the American Diabetes Association's Standards of Medical Care in Diabetes guidelines [19]. These guidelines ensure uniformity and accuracy in the diagnosis of type 2 diabetes, thereby enhancing the reliability of the study findings.

To maintain the integrity of the study's objectives, healthcare professionals directly involved in the provision of care for diabetic patients, including physicians, nurses, and technicians, were excluded from participation. This exclusion criterion aimed to mitigate any potential bias stemming from professional familiarity with digital health tools and practices, thereby ensuring the validity and generalizability of the study results.

Participants who met the following criteria were deemed eligible for inclusion in the study: Participants must have confirmed diagnosis of type 2 diabetes from a qualified healthcare provider, as per established diagnostic criteria; Individuals who actively used digital health applications, including but not limited to mobile apps, wearable devices, and online platforms, to support their diabetes management were included in the study; and, Prospective participants were required to provide informed consent, indicating their voluntary willingness to take part in the study and contribute to its objectives.

Sample Size-

In order to ensure the statistical robustness and reliability of our study findings, careful consideration was given to determining an appropriate sample size that would adequately represent the target population of individuals with type 2 diabetes in the urban setting of New Delhi, India. With the aim of achieving a statistical power of 80% at a significance level of 5%, we employed the following formula to calculate the sample size:

$$n_A = k\, n_B$$

$$n_B \geq \left[\sigma_B^2 + \frac{\sigma_A^2}{k}\right]\left[\frac{z_{1-\alpha/2} + z_{1-\beta}}{\delta}\right]^2$$

$$n_A = k\, n_B$$

$$n_B \geq \left[\sigma_B^2 + \frac{\sigma_A^2}{k}\right]\left[\frac{z_{1-\alpha/2} + z_{1-\beta}}{\delta}\right]^2$$

where

,

$z_{1-\alpha/2}$ = 1.96 for 5% level of significance

$z_{1-\beta}$ = 0.84 for 80% power

k = nA/nB, where nA and nB are the group sizes

σ_A = anticipated standard deviation in group A

σ_B = anticipated standard deviation in group B (we can have σA = σB)

δ = minimum medically important difference between the means to be detected

Based on these parameters and considerations, we determined a sample size of 529+1, totalling 530 participants. This sample size was deemed sufficient to detect meaningful differences and associations within the study population, thereby ensuring the robustness and reliability of our statistical analyses. By adhering to rigorous sample size calculations and statistical principles, we aimed to enhance the validity and generalizability of our study findings, ultimately contributing to the advancement of knowledge in the field of digital health utilization among individuals with type 2 diabetes in urban settings.

Data collection:

Data collection for this study was conducted using a structured digital questionnaire, which was developed in both English and Hindi languages to cater to the diverse linguistic preferences of the study participants. The questionnaire was meticulously crafted based on validated items and scales from previous research studies, including the work by Rangraz Jeddi et al. [20] and Al-Nozha et al. [21]. These studies provided valuable insights into mobile phone usage patterns among patients with type II diabetes, which informed the design of our questionnaire. Prior to data collection, ethical approval was obtained from the relevant institutional review board, and informed consent was obtained from all participants. The consent process involved providing detailed information about the study objectives, procedures, potential risks, and benefits, ensuring that participants could make an informed decision about their participation. Participants were assured of the confidentiality and anonymity of their responses, and they were informed about their right to withdraw from the study at any time without consequences. Data collection was conducted electronically, with participants completing the questionnaire using their preferred digital devices, such as smartphones, tablets, or computers. The digital format allowed for efficient data collection and minimized errors associated with manual data entry. To maintain data integrity and consistency, standardized entry codes were assigned to each participant, facilitating the accurate recording and tracking of responses.

Data Analysis: Following data collection, the raw data were compiled and entered into a computerized database using SPSS software. The data entry process was checked by trained research personnel to ensure accuracy and reliability. Quality control measures, such as double-entry verification and error checks, were implemented to identify and rectify any discrepancies or inconsistencies in the data. Once the data were entered, they underwent rigorous statistical analysis to derive meaningful insights and draw valid conclusions. Descriptive statistics, including measures of central tendency, variability, and frequency distributions, were employed to summarize key variables and characteristics of the study population. Statistical significance was set at $p < 0.05$, indicating a threshold below which findings were considered to be unlikely due to chance alone. The use of statistical significance helped ensure the reliability and validity of the study findings. Finally, the results of the data analysis were interpreted in light of the study objectives and existing literature, providing valuable insights into the digital connectivity and smartphone utilization patterns among urban type 2 diabetes patients.

Results:

The survey results indicate a high level of cellphone and smartphone ownership among the participants. A staggering 95.3% of respondents reported owning a cellphone, with a similarly high percentage (95.5%) indicating they have a smartphone. This near-universal access to mobile technology suggests that interventions and health management solutions tailored for mobile devices could have broad reach within the type 2 diabetes community in urban areas.

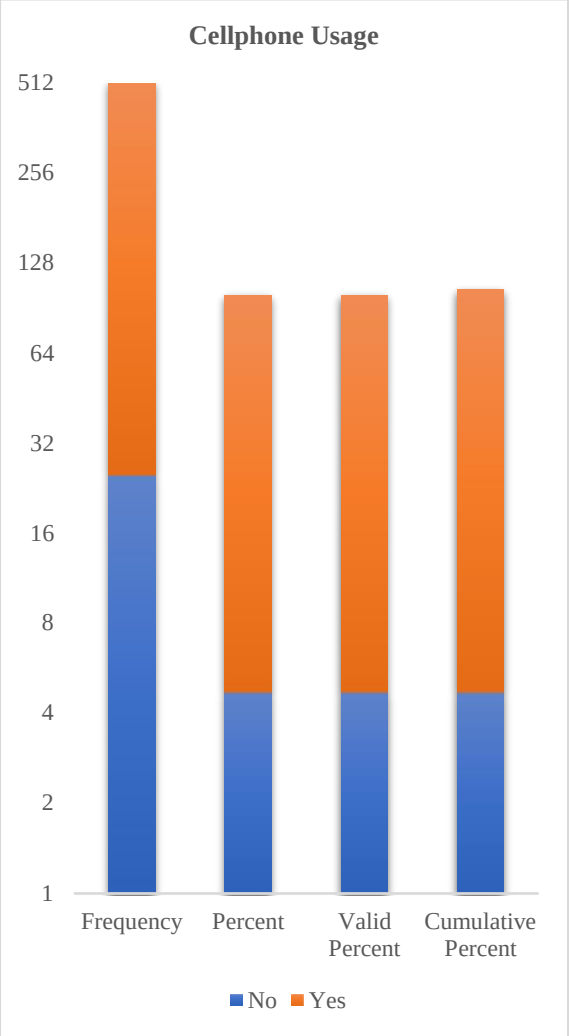

Figure 1: Cell-phone Usage

Access to the internet was also notably high, with 96.4% of participants confirming they have internet access. This highlights the potential for online health resources, telehealth services, and digital health management applications to play a significant role in supporting the healthcare needs of people with type 2 diabetes in urban settings.

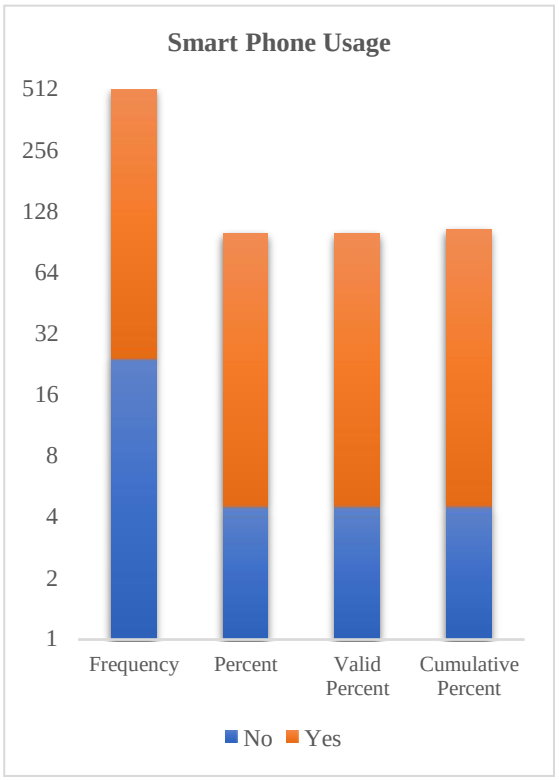

Figure 2: Smart Phone Usage

Access to the internet was also notably high, with 96.4% of participants confirming they have internet access. This highlights the potential for online health resources, telehealth services, and digital health management applications to play a significant role in supporting the healthcare needs of people with type 2 diabetes in urban settings.

The survey explored how much time respondents spent on the internet daily, revealing a significant tilt towards heavy usage. Nearly half of the respondents (48.5%) reported spending over 3 hours on the internet each day. Additionally, 22.3% indicated they use the internet for 2 to 3 hours, and 18.1% for 1 to 2 hours. Only a small fraction (8.1%) spent less than one hour online. This pattern suggests that the internet is a central part of daily life for most participants, underscoring its potential as a medium for delivering diabetes-related health information and services.

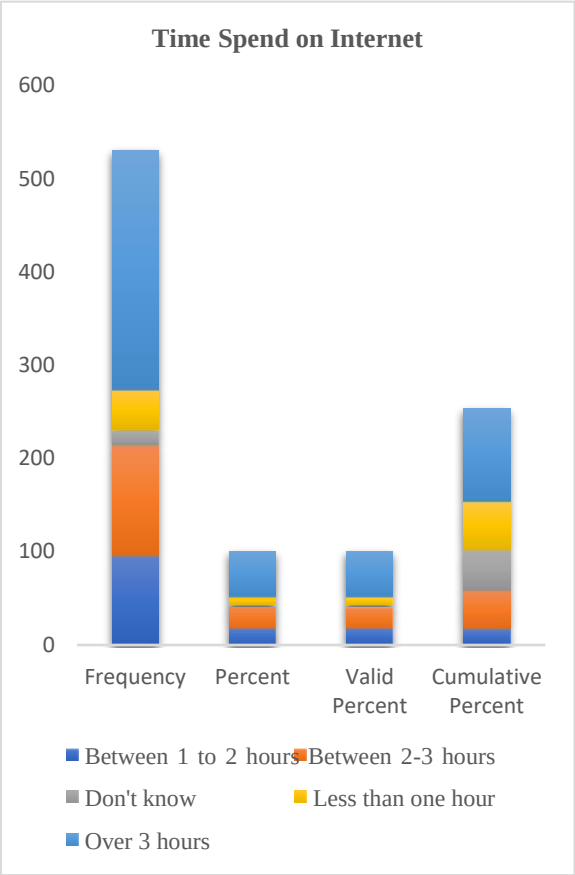

Figure 3: Time Spend on Internet

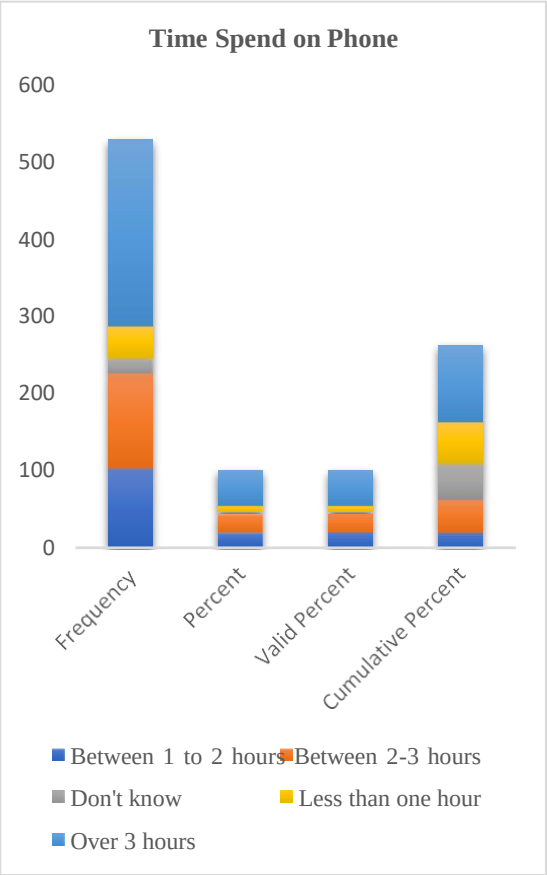

Figure 4: Time Spend on Phone

Similar patterns were observed regarding the time spent on their phones, with 45.8% of the participants spending over 3 hours on their phones daily. Another 23.2% used their phones for 2 to 3 hours, and 19.4% for 1 to 2 hours. The data mirrors the internet usage patterns, emphasizing the role of smartphones in the participants' daily routines and their potential as platforms for health management interventions.

The high levels of digital tool ownership and usage among individuals with type 2 diabetes in Tier 1 urban areas underscore the feasibility and potential efficacy of digital health interventions in this population. The substantial time spent online and on phones suggests that digital platforms can be effective channels for delivering health education, self-management tools, and support for this demographic.

Table no. 1: Digital Connectivity and Smartphone Utilization among Urban type 2 Diabetes Patients

		Frequency	Percent	Valid Percent	Cumulative Percent
Cell-phone Usage					
	No	25	4.7	4.7	4.7
	Yes	505	95.3	95.3	100.0
	Total	530	100.0	100.0	

Smart Phone Usage				
No	24	4.5	4.5	4.5
Yes	506	95.5	95.5	100.0
Total	530	100.0	100.0	
Internet Usage				
No	19	3.6	3.6	3.6
Yes	511	96.4	96.4	100.0
Total	530	100.0	100.0	
Time Spend on Internet				
Between 1 to 2 hours	103	19.4	19.4	19.4
Between 2-3 hours	123	23.2	23.2	42.6
Don't know	19	3.6	3.6	46.2
Less than one hour	42	7.9	7.9	54.2
Over 3 hours	243	45.8	45.8	100.0
Total	530	100.0	100.0	
Time Spend on Phone				
Between 1 to 2 hours	103	19.4	19.4	19.4
Between 2-3 hours	123	23.2	23.2	42.6
Don't know	19	3.6	3.6	46.2
Less than one hour	42	7.9	7.9	54.2
Over 3 hours	243	45.8	45.8	100.0
Total	530	100.0	100.0	

Discussion:

According to the findings from few studies, the use of mobile phone technology results in a considerable improvement in glycemic control all over the world [20,22]. As a paradigm for translational and implementation research, the development of mobile technologies and smartphone applications for the prevention of diabetes may be leveraged.

The findings from our study reveal a remarkably high prevalence of smartphone ownership and internet access among urban type 2 diabetes patients, indicating a ripe landscape for the deployment of digital health interventions. With 95.5% of participants owning a smartphone and 96.4% accessing the internet, these tools are evidently integral to their daily lives and present a promising avenue for enhancing diabetes self-management and care.

Our findings are not isolated but resonate with corroborating evidence from the broader scientific literature. Mehbodniya et al. (2021) [23] similarly observed a high prevalence of mobile phone ownership (97.5%) and smartphone usage (87%) among their study participants, with a substantial majority accessing the internet on a daily basis (83.5%). These parallels reinforce the ubiquity of digital technology adoption among individuals with chronic health conditions, emphasizing its role as a cornerstone of modern healthcare delivery.

Moreover, international studies conducted by Boyle et al. [24] in New Zealand (2017), Humble et al. [25] in the UK (2015), and Dobson et al. [26] in Canada (2015) have reported analogous trends. These investigations elucidated a significant proportion of diabetes patients with access to mobile phones and smartphones, corroborating the global trend of digital technology integration into healthcare practices.

The substantial daily engagement with digital platforms, as evidenced by nearly half of the respondents spending over three hours online each day, underscores the potential of these mediums to serve as effective channels for health education and intervention. This extensive digital engagement can be leveraged to deliver personalized health information, facilitate self-management practices, and provide remote monitoring and support, which are critical in managing chronic conditions such as type 2 diabetes. A recent analysis analyzed the data on the efficacy of telehealth solutions. The research specifically focused on digital self-management treatments that used mHealth and included lifestyle change management. The findings revealed that, on average, there was a decrease of -0.52% in HbA1c levels [27].

Moreover, the high level of digital connectivity among the study population supports the feasibility of implementing technologically driven health interventions that could lead to improved health outcomes. Interventions might include mobile applications that assist with blood glucose monitoring, diet and physical activity guidance, medication adherence, and even direct communication with healthcare providers. These tools can empower patients with type 2 diabetes to take an active role in managing their health, potentially leading to better clinical outcomes and reduced healthcare costs.

The research presents several strengths that bolster the credibility and significance of its findings. Notably, the study addresses a pressing contemporary issue by investigating the prevalence of smartphone ownership and internet access among urban type 2 diabetes patients, shedding light on the potential for digital health interventions in diabetes management. A key strength lies in the robust sample size of 530 participants, which enhances the statistical power and generalizability of the findings to the broader urban type 2 diabetes population in New Delhi, India. Additionally, the adoption of a multilingual approach with questionnaires available in both English and Hindi languages promotes inclusivity and accessibility for participants from diverse linguistic backgrounds. Methodologically, the research follows a rigorous cross-sectional observational design and employs standardized entry codes for data entry, contributing to the methodological soundness of the study. Furthermore, the discussion section effectively integrates findings from previous studies conducted globally, reinforcing the robustness of the conclusions by aligning them with existing evidence and trends in digital health adoption among diabetes populations.

Despite its strengths, the research is subject to several limitations that warrant consideration. Firstly, the cross-sectional design of the study restricts its ability to establish causal relationships between digital technology usage and diabetes management outcomes. Moreover, the reliance on convenience sampling may introduce selection bias, limiting the generalizability of the findings to the entire urban type 2 diabetes population in New Delhi. Self-reported data collected through structured digital questionnaires may also be susceptible to response bias, as participants may provide socially desirable responses or inaccurately recall their digital technology usage patterns. Furthermore, the regional specificity of the study, focusing exclusively on the urban population of New Delhi, restricts its applicability to rural or non-urban settings and other geographical regions with differing sociodemographic characteristics. Finally, while the research highlights the high prevalence of

smartphone ownership and internet access among urban type 2 diabetes patients, it may overlook disparities related to socioeconomic status, education level, and digital literacy, which could influence access to and utilization of digital health interventions. Addressing these limitations in future research endeavors is essential for ensuring the validity and equity of healthcare access in digital health interventions for diabetes management.

However, the implementation of such digital health strategies requires careful consideration of the design and accessibility of interventions to ensure they are user-friendly and cater to the specific needs and preferences of the target population. It also calls for ongoing evaluation to assess the effectiveness of these interventions in improving health outcomes.

Furthermore, while the high rates of technology adoption and utilization are promising, it is critical to acknowledge and address the digital divide that may exist among different subgroups within the urban population, such as varying levels of literacy and health literacy, which could affect the usage and effectiveness of digital health tools.

Conclusion:

The study underscores the significant potential of digital health interventions to improve the management of type 2 diabetes among urban patients in New Delhi, India. The high prevalence of smartphone ownership and internet access among the study participants indicates a robust foundation for implementing digital health strategies. These tools can empower patients by providing easy access to health information, self-management resources, and direct communication with healthcare providers.

The findings highlight the importance of leveraging digital connectivity to deliver personalized healthcare interventions that can enhance disease management and improve patient outcomes. Given the substantial daily engagement with digital platforms, smartphones can serve as effective mediums for delivering diabetes-related education, monitoring tools, and support systems.

References:

1. Lin X, Xu Y, Pan X, et al. Global, regional, and national burden and trend of diabetes in 195 countries and territories: an analysis from 1990 to 2025. Sci Rep. 2020;10:14790. doi:10.1038/s41598-020-71908-9
2. World Health Organization. Global report on diabetes. 2016;88
3. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011;94(3):311-321.
4. International Diabetes Federation. IDF Diabetes Atlas. 9th ed. Brussels, Belgium: International Diabetes Federation; 2019.
5. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Preprint. 2021.
6. AlGhamdi KM, Moussa NA. Internet use by the public to search for health-related information. Int J Med Inform. 2012 Jun;81(6):363-373. doi: 10.1016/j.ijmedinf.2011.12.004
7. Eng T. The eHealth Landscape: A Terrain Map of Emerging Information and Communication Technologies in Health and Health Care. Princeton, NJ: The Robert Wood Johnson Foundation; 2001
8. Gillies CL, Abrams KR, Lambert PC, et al. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. BMJ. 2007;334:299
9. Elenko E, Speier A, Zohar D. A regulatory framework emerges for digital medicine. Nat Biotechnol. 2015;33:697-702.
10. Martínez-Pérez B, de la Torre-Díez I, López-Coronado M. Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. J Med Internet Res. 2013;15
11. AADE. AADE7 self-care behaviours. Diabetes Educ. 2008;34:445-449.
12. Hood M, Wilson R, Corsica J, Bradley L, Chirinos D, Vivo A. What do we know about mobile applications for diabetes self-management? A review of reviews. J Behav Med. 2016;39:981-994.
13. Elsevier. A review of IoT applications in healthcare. Neurocomputing. 2023;443:127017. doi: 10.1016/j.neucom.2023.127017
14. Muñoz-Flórez A, Cortés O. Impacto de la Entrevista Motivacional en la Adherencia de Pacientes Diabéticos Inactivos a la Actividad Física: Estudio Piloto de un Ensayo Clínico EMOACTIF—DM [The motivational interview's impact on inactive diabetic patients' adherence to physical activity: A pilot study of a clinical trial]. Rev Colomb Psicol. 2017;26(2):263-281. doi: 10.15446/rcp.v26n2.59963.

15. Rout S, Swain S, Samal S, Sahu K. Out-of-pocket expenditure and drug adherence of patients with diabetes in Odisha. J Family Med Prim Care. 2018;7(6):1229-1235. doi: 10.4103/jfmpc.jfmpc_24_18
16. Basu S, Garg S, Sharma N, Singh M, Garg S, Asaria M. The determinants of out-of-pocket health-care expenses for diabetes mellitus patients in India: an examination of a tertiary care government hospital in Delhi. Perspect Clin Res. 2020;11(2):86-91. doi: 10.4103/picr.picr_169_18
17. Muralidharan S, Ranjani H, Anjana RM, Allender S, Mohan V. Mobile health technology in the prevention and management of type 2 diabetes. Indian J Endocrinol Metab. 2017;21(2):334-340. doi: 10.4103/ijem.IJEM_407_16.
18. Williams JLS, Walker RJ, Smalls BL, Campbell JA, Egede LE. Effective interventions to improve medication adherence in type 2 diabetes: a systematic review. Diabetes Manag. 2014;4(1):29-48. doi: 10.2217/dmt.13.62
19. American Diabetes Association. Standards of medical care in diabetes—2022 abridged for primary care providers. Diabetes Care. 2022;45(Suppl 1)
20. Rangraz Jeddi F, Nabovati E, Hamidi R, Sharif R. Mobile phone usage in patients with type II diabetes and their intention to use it for self-management: A cross-sectional study in Iran. BMC Med Inform Decis Mak. 2020;20(1).
21. Al-Nozha OM, Alshareef EK, Aljawi AF, et al. Diabetic patients' perspective about new technologies used in managing diabetes mellitus in Saudi Arabia: A cross-sectional study. Cureus. 2022 May 16;14(5) . doi: 10.7759/cureus.25038.
22. Doupis J, Festas G, Tsilivigos C, Efthymiou V, Kokkinos A. Smartphone-based technology in diabetes management. Diabetes Ther. 2020;11(3):607-619. doi: 10.1007/s13300-020-00768-3.
23. Mehbodniya A, Suresh Kumar A, Rane KP, Bhatia KK, Singh BK. Smartphone-based mHealth and Internet of Things for diabetes control and self-management. J Healthc Eng. 2021 Oct 16;2021:2116647. doi: 10.1155/2021/2116647
24. Boyle L, Grainger R, Hall RM, Krebs JD. Use of and beliefs about mobile phone apps for diabetes self-management: surveys of people in a hospital diabetes clinic and diabetes health professionals in New Zealand. JMIR Mhealth Uhealth. 2017;5(6)
25. Humble JR, Tolley EA, Krukowski RA, Womack CR, Motley TS, Bailey JE. Use of and interest in mobile health for diabetes self-care in vulnerable populations. J Telemed Telecare. 2016;22(1):32-38.
26. Dobson KG, Hall P. A pilot study examining patient attitudes and intentions to adopt assistive technologies into type 2 diabetes self-management. J Diabetes Sci Technol. 2014;9(2):309-315
27. Timpel P, Oswald S, Schwarz PEH, Harst L. Mapping the evidence on the effectiveness of telemedicine interventions in diabetes, dyslipidemia, and hypertension: an umbrella review of systematic reviews and meta-analyses. J Med Internet Res. 2020;22