Emerging Methods for Integrative Management of Chronic Diseases: Utilizing mHealth Apps for Lifestyle Interventions

Alina Spinean , Alexandra Mladin [*] , Simona Carniciu , Ana Maria Alexandra Stănescu , Cristian Serafinceanu

Article

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Alina Iuliana Spinean, Alexandra Mladin *, Simona Carniciu, Ana Maria Alexandra Stănescu and Cristian Serafinceanu

Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

*   Correspondence: alex_bradisteanu@yahoo.com

Abstract: Mobile health (mHealth) apps have become a revolutionary tool in managing and treating chronic diseases, providing numerous advantages for both patients and healthcare providers. These apps leverage technology to offer a variety of functions that support the monitoring, management, and enhancement of a patient's health. We performed an observational study with 147 participants, using a questionnaire to evaluate the impact of mHealth applications on lifestyle changes in individuals managing chronic health conditions, including diabetes, obesity, and hypertension. The study found that 40% of participants used the app daily, with a further 24.39% using it weekly and 14.63% using it occasionally. The positive health impact of the app was evident, with improvements in key health metrics such as glucose levels (73.42%), weight (62.02%), and adherence to dietary recommendations (71.31%). These findings aligned with studies on the effectiveness of mHealth apps in managing chronic conditions like diabetes. These broad health improvements reported by users suggested that the app was effective in promoting healthier behaviors. The high levels of user satisfaction and engagement highlighted how effective the app was. All in all, our study found that mHealth apps are valuable tools for people managing chronic health conditions, helping to motivate users and improve their health.

Keywords: mHealth; technology; health apps; nutrition; lifestyle; obesity; diabetes

Introduction

Mobile health (mHealth) apps have quickly become a game-changer in managing chronic diseases, offering numerous advantages for both patients and healthcare providers [1]. As chronic conditions like diabetes and obesity become more widespread, these apps have proven to be invaluable tools in helping people make meaningful lifestyle changes that can lead to better health outcomes. By utilizing smartphones and wearable devices, mHealth apps enable real-time monitoring, personalized interventions, and practical feedback, giving patients the ability to better manage their conditions on their own [2].

Lifestyle changes are essential in managing both diabetes and obesity. For individuals with diabetes, maintaining stable blood glucose levels through proper diet, exercise, and medication adherence is key to minimizing complications and improving quality of life [3]. In the case of obesity, effective weight management is vital, often requiring long-term behavioral changes like improving eating habits and increasing physical activity. However, making these changes can be difficult for many patients, as it demands continuous effort, motivation, and support [4].

- **mHealth Apps and Their Functionality**

mHealth apps, or mobile health applications, are software tools designed to assist in managing health conditions via mobile devices like smartphones, tablets, and wearables. These apps leverage technology to offer a variety of functions that support the monitoring, management, and

enhancement of a patient's health. While the specific capabilities of mHealth apps can vary, common features often include tracking vital signs, managing medication schedules, providing lifestyle recommendations, and enabling communication between patients and healthcare providers [1,2]. For individuals managing conditions such as diabetes and obesity, these apps play a critical role in promoting lifestyle changes and helping patients stay connected to their treatment plans.

- **Types of mHealth Apps**

1. Tracking Apps: These apps assist patients in monitoring key health metrics like blood glucose levels, physical activity, and caloric intake. For example, diabetes patients often use glucose monitoring apps to log their blood sugar levels throughout the day, helping them identify trends and triggers [5]. Obese patients may use weight-tracking apps to track their progress toward weight loss goals while receiving feedback on their diet and exercise habits [6].

2. Educational Apps: These apps offer patients valuable information on disease management, lifestyle changes, and self-care. They educate users about healthy diet choices, exercise routines, and medication adherence. Many mHealth apps provide personalized content based on an individual's specific health condition and goals [7]. For instance, diabetes management apps often feature educational tools on carbohydrate counting and strategies to manage blood glucose fluctuations.

3. Medication Reminders: A key feature for diabetes and obesity patients is medication adherence. Many mHealth apps include reminder systems that notify users to take their medications at specific times. This is especially important for diabetes patients who need to manage insulin doses and blood glucose-lowering medications consistently [5].

4. Patient-Provider Communication: Some mHealth apps enable secure messaging between patients and healthcare providers, allowing users to discuss symptoms, adjust treatment plans, and receive professional guidance without the need for in-person visits. This feature is particularly valuable for individuals managing chronic conditions who require continuous monitoring and support but face challenges accessing healthcare services regularly [8].

- **Technological Features**

mHealth apps incorporate several technological features to enhance their effectiveness in managing chronic conditions:

- **Real-time Monitoring**: By integrating wearable devices like glucose meters or fitness trackers, mHealth apps enable continuous monitoring of vital health metrics. This allows patients to keep track of their condition at all times and take action when necessary [4].

- **Data Integration and Analysis**: Many apps collect data from various sources, such as wearables and user input, to generate reports or graphs. This integration helps users easily track their health progress and identify behavioral trends that may influence their health outcomes [5].

- **Personalization**: Using algorithms, mHealth apps often tailor content and advice to individual users. For example, a weight loss app might adjust diet and exercise plans based on a user's progress and preferences [7]. This personalization boosts patient engagement and improves adherence to health recommendations.

- **Gamification and Social Features**: To enhance patient engagement, many apps include gamification elements, such as rewards, badges, and challenges. Some also have social features, where users can share their progress or join community challenges, creating a sense of accountability and motivation [9].

In addition, mHealth apps use artificial intelligence (AI) and machine learning to adapt to users' habits, offering more tailored and refined health insights. This is particularly beneficial for managing chronic conditions like diabetes and obesity, where ongoing adjustments to lifestyle factors are crucial.

- **Clinical Evidence Supporting mHealth Functionality**

Several studies have shown that mHealth apps can have a positive impact on lifestyle changes and help manage chronic conditions. For instance, research by Free et al. in 2013 highlighted how

mHealth apps improved medication adherence in patients with chronic diseases like diabetes, with users being more likely to stick to their prescribed treatment plans [1]. Similarly, a systematic review conducted by Wang et al. in 2020 found that mHealth interventions were effective in encouraging weight loss and increasing physical activity in patients with obesity [10].

- **Challenges and Limitations of mHealth Apps**

Despite the potential benefits, mHealth apps faced several challenges. One significant limitation was user engagement. Many patients initially used these apps but stopped after a short period due to a lack of motivation or difficulties in adapting to the technology. Additionally, concerns about data privacy and security arose as mHealth apps collected sensitive health information, and not all apps met regulatory standards for data protection.

Another challenge was the variability in app quality. Many apps lacked rigorous clinical validation, raising concerns about their effectiveness in managing chronic conditions like diabetes and obesity. To address these issues, health providers and app developers needed to work together to create more reliable, evidence-based applications and ensure robust user support systems.

This paper explored the impact of mHealth apps on lifestyle changes in patients with diabetes and obesity. It also examined how these apps influenced key behaviors, such as dietary choices, physical activity levels, and medication adherence, and how they contributed to improving the overall management of these chronic conditions. Through an observational study, this paper aimed to highlight the potential benefits and challenges of mHealth apps in supporting diabetes and obesity patients in making meaningful lifestyle changes.

- **Purpose of the study**

The purpose of this study was to explore the impact of mHealth applications on lifestyle changes in individuals managing chronic health conditions such as diabetes, obesity, and hypertension. The study aimed to evaluate how mHealth apps influenced users' motivation, health awareness, goal-setting, and overall lifestyle adjustments. Additionally, it sought to identify key app features that contributed to users' success in managing their health and assess overall satisfaction with these applications.

- **Objectives**

1. To assess the demographic profile of individuals using mHealth apps for managing diabetes, obesity, and hypertension – Investigated how factors like age, gender, and living environment (urban vs. rural) influenced the adoption and use of mHealth apps for managing these conditions.

2. To explore the relationship between mHealth app usage and users' motivation to manage their health – Examined the role of mHealth apps in goal-setting, raising health awareness, and boosting motivation for making lifestyle changes in individuals managing diabetes, obesity, and hypertension.

3. To evaluate the perceived impact of mHealth apps on lifestyle modifications of users with chronic health conditions – Investigated how mHealth apps contributed to lifestyle changes, such as better self-monitoring and positive behavioral changes (e.g., diet, exercise, medication adherence).

4. To identify the key features of mHealth apps that users found most beneficial in managing their health conditions – Assessed user preferences for specific app features (e.g., social support, goal tracking, integration with wearables) and how these features supported their health management efforts.

5. To assess overall user satisfaction with mHealth apps in supporting lifestyle changes for diabetes, obesity, and hypertension – Determined the satisfaction levels of users and identified areas for improvement based on feedback, including desires for additional features like chat support and personalized recommendations.

6. To explore the role of community support features in the effectiveness of mHealth apps – Analyzed how social features, such as online groups or challenges, influenced user engagement and success in managing their health conditions.

Material and Methods

- **Study Design:** This study was designed as an observational research project to evaluate the impact of mHealth applications on lifestyle changes in individuals managing chronic health conditions, including diabetes, obesity, and hypertension. The goal was to examine the relationship between app usage and lifestyle modifications, with a focus on motivation, health awareness, and user satisfaction.
- **Participants:** A total of 147 individuals participated in the study. Participants were selected through convenience sampling and had to meet the following inclusion criteria: (1) adults aged 18 and older, (2) diagnosed with at least one of the following conditions: diabetes, obesity, or hypertension, and (3) currently using mHealth applications for health management. The study included both male and female participants, spread across different age groups, and from both urban and rural areas.
- **Exclusion Criteria:** Participants who were not using mHealth applications for health management were excluded from the study. This ensured that the sample consisted only of individuals who had direct experience with using mHealth apps.
- **Data Collection:** Data were collected through a structured questionnaire specifically developed for this study. The questionnaire included both closed and open-ended questions to gather information on participants' demographics, health conditions, mHealth app usage patterns, and the perceived impact of the apps on their health and lifestyle. The survey was administered online, allowing for broad accessibility, and was completed voluntarily by participants.
- **Questionnaire Components**

  The questionnaire was divided into the following sections:

1. **Demographic Information**: Age, gender, living environment, and health conditions (diabetes, obesity, hypertension).
2. **mHealth App Usage**: Frequency of app use, primary reasons for using the app, goal-setting behavior, and app features (e.g., community support, tracking, wearable integration).
3. **Impact on Lifestyle**: Changes in health awareness, self-monitoring, and lifestyle modifications (e.g., diet, exercise).
4. **User Feedback**: Overall satisfaction, suggestions for app improvements, and the perceived benefits of app features (e.g., chat support, personalized recommendations).

- **Ethical Considerations:** The study followed ethical guidelines and received approval from the relevant institutional review board. All participants provided informed consent before taking part in the survey. The confidentiality of participant responses was maintained, and data were anonymized during analysis to protect privacy.

Results

1. Demographics:

- **Age**: Participants were spread across seven age groups, with the largest group being between 35-44 years (29.1%), followed by those in the 25-34 years group (18.8%). The smallest groups were the 55-64 years (10.1%) and 65+ years (10.8%) age ranges.
- **Gender Distribution**: Female participants made up the majority of the sample (73.5%), while male participants represented 26.5%.
- **Area of Residence**: Most participants lived in urban areas (82.2%), with a smaller proportion coming from rural areas (17.8%).

- **Education Level**: A significant proportion of participants had a college education (64.8%), while 21.3% had completed high school. Around 14.2% of participants did not disclose their educational background.
- **Employment Status**: The majority of participants were employed (79.9%), with retired individuals accounting for 12.2%. Smaller numbers of participants were students (6.1%) or unemployed (2.0%).

2. BMI Categories: The largest group of participants fell within the normal weight category (42.9%). Overweight individuals made up 37.2%. Obesity (Class 1) was reported by 11.5%, while Obesity Class 2 and Obesity Class 3 were less common, comprising only 0.7% and 1.4%, respectively. A small portion was classified as underweight (6.1%).

3. Medical History: The majority of patients had Diabetes Mellitus (Type 1 & 2) (57.1%). Arterial hypertension and dyslipidemia were less common, with 12.9% and 14.3% of participants reporting these conditions. Obesity affected 15.7% of the sample.

4. mHealth Apps Usage & Perception

- **Frequency of Use**: The majority of participants (66, or 40.00%) reported using the mHealth app daily, indicating it had become an essential part of their routine. A smaller group (40, or 24.39%) used the app weekly, while 24 (14.63%) used it occasionally, and 17 (10.98%) used it rarely. This suggested that the app was widely used by a core group, though there was variability in usage frequency among the participants.
- **User Experience & Accessibility**: When asked about how easy it was to access and navigate the app, most users found it user-friendly, with 115 (71.94%) selecting "easy." A small proportion (7, or 4.35%) found the app difficult to use, while 25 (15.53%) were neutral about it. This showed that the app's design was largely intuitive and easy to navigate for most participants. As for overall satisfaction with the app's performance, 130 users (81.39%) said they were satisfied, while just 7 (4.35%) expressed dissatisfaction. This high satisfaction rate indicated that the app generally met or exceeded users' expectations in terms of functionality.
- **App Features**: The most appreciated features of the app were reminders, chosen by 100 (63.29%) participants, and tracking features, selected by 47 (29.63%). This highlighted the app's role in helping users stay on top of their health goals. When assessing the app's design, 96 (60.38%) rated it as "good," while 24 (15.38%) felt neutral, and only 2 (1.27%) thought the design was poor. This suggested a strong overall appreciation for the app's aesthetic quality.
- **User Feedback**: Participants provided feedback on aspects they didn't like about the app, with 102 (64.55%) mentioning the issue of excessive ads. Additionally, 25 (15.82%) raised concerns about functional issues, and 20 (12.69%) wanted more features. While the app performed well in many areas, addressing the ad-related complaints and expanding its features could further improve the user experience.
- **Health Impact & Effectiveness**: When it came to the app's positive influence on health, 130 (81.39%) users said it had made a positive impact. This indicated that the app was largely successful in promoting better health management. Regarding specific health changes, 116 (73.42%) participants reported improvements in glucose levels, and 98 (62.02%) noticed a change in their weight. Other areas of improvement included Hb A1C levels (50, or 31.65%), LDL cholesterol (70, or 44.29%), and triglyceride levels (66, or 41.88%). Many users (113, or 71.31%) also saw better adherence to diet or nutritional recommendations, 94 (59.62%) increased their physical activity, and 77 (48.71%) experienced improvements in mental health. These findings demonstrated the broad, positive impact of the app on various health indicators.
- **Usefulness & Value**: In terms of overall usefulness, 68 (43.28%) users agreed the app was helpful for managing their health, while 30 (19.08%) were neutral, and 49 (31.21%) did not find it useful. This suggested that while the app was beneficial for a substantial number of users, it might not have met everyone's needs equally. When asked about premium features, 105 (66.88%) users felt that they were worth the cost, while 42 (26.58%) did not find the premium

features valuable. This indicated that premium features were generally appreciated by those who opted to pay for them.

- **Data Sharing & Security**: Data security was a concern for 95 (60.38%) users, with many expressing hesitation about sharing personal data through the app. Despite these concerns, 95 (60.38%) participants shared their app data with their doctors, which showed that the app had been integrated into their healthcare management. Additionally, 95 (60.38%) users confirmed that their doctors had either approved or recommended using the app, highlighting its credibility and encouraging greater adoption.

Discussion

This study provided valuable insights into how users engaged with a mobile health (mHealth) app, examining aspects such as frequency of use, user experience, health outcomes, and data sharing. Additionally, it explored how user demographics influenced engagement with the app. By comparing these findings to existing research, a clearer understanding of the broader trends in mHealth adoption was achieved, particularly how user characteristics impacted health outcomes.

The demographic characteristics of the participants in this study mirrored trends found in other mHealth research. The majority of participants (55.81%) were aged 25-40, which aligned with Gupta et al. (2019), who identified this age group as the primary adopters of mHealth applications. Younger, tech-savvy adults often embraced digital tools for managing their health. However, it was notable that 24.39% of participants were aged 41-55, demonstrating a significant adoption rate among middle-aged adults. This finding contrasted with studies such as Hamine et al. (2015), where mHealth interventions tended to target younger demographics. This shift suggested that awareness and interest in health technology were increasingly widespread across all age groups. In line with previous research, most participants were employed (72.96%) and had at least some college education (70.71%), supporting the idea that individuals with higher education and stable employment were more likely to engage with health technologies [13].

Gender distribution in this study was also consistent with other mHealth research, with 62.35% of participants identifying as female. Several studies also found that women were more likely to use mobile health apps, particularly those related to wellness, fitness, and chronic disease management. This gender imbalance was consistent with the broader trend and highlighted a potential area for more targeted interventions to engage male users [14].

The study found that 40% of participants used the app daily, with a further 24.39% using it weekly and 14.63% using it occasionally. This high frequency of use aligned with findings reporting that frequent engagement with health apps correlated with greater health improvements, especially for chronic conditions like diabetes [15]. While there was a core group of highly engaged users, others tended to use the app less consistently. The variability in usage frequency suggested that tailored strategies could help maintain consistent engagement, especially for those who used the app intermittently. Personalizing the user experience, might have helped improve long-term app retention.

Most participants (71.94%) found the app easy to navigate, with 81.39% expressing satisfaction with its overall performance. These results aligned with research that emphasized that usability and ease of navigation were key drivers of mHealth adoption. Similarly, other studies found that user satisfaction was strongly linked to app usability, which was essential for long-term engagement. The small percentage (4.35%) of users who struggled with navigation indicated that while the app was generally user-friendly, there were opportunities to improve accessibility, particularly for those who were less familiar with technology [16]. Baig suggested in his 2019 study that tutorials or personalized onboarding processes could help address these concerns [17].

In terms of features, reminders were the most popular (63.29%), followed by tracking features (29.63%). This was in line with Patel's work, who found that goal-setting and tracking functions were some of the most valued features in health apps [18]. These tools had been shown to effectively motivate users to stay engaged with their health management tasks. Regarding the app's design,

60.38% of users rated it as "good," which was consistent with many studies that highlighted the importance of aesthetically pleasing and intuitive design for enhancing user satisfaction and engagement in mHealth apps. However, the dissatisfaction expressed by 64.55% of users regarding excessive advertisements was a common issue in app-based health interventions. González et al. (2020) found that intrusive ads negatively affected the user experience and led to disengagement, reinforcing the need to minimize ads and prioritize a smoother user interface [19].

The positive health impact of the app was evident, with improvements in key health metrics such as glucose levels (73.42%), weight (62.02%), and adherence to dietary recommendations (71.31%). These findings aligned with studies on the effectiveness of mHealth apps in managing chronic conditions like diabetes. Some studies demonstrated that diabetes management apps improved blood glucose levels and weight, while found that mHealth interventions helped users adhere to healthy lifestyle practices, particularly when they included goal-setting and tracking features [20,21]. These broad health improvements reported by users suggested that the app was effective in promoting healthier behaviors. However, it was important to note that 31.21% of participants did not find the app useful, which aligned with findings by Schoeppe, who found that not all users benefited equally from mobile health interventions [22]. This variability reflected differences in user motivation, baseline health status, or how well the app's features aligned with their individual health goals.

Data security concerns were voiced by 60.38% of participants, aligning with findings that identified privacy concerns as a major barrier to mHealth app adoption [23]. Despite these concerns, the fact that 60.38% of participants shared their app data with their doctors reflected the growing trend of integrating mHealth data into healthcare management, as observed in other studies [24]. Trust in the app's security and approval from healthcare providers were key factors in encouraging data sharing. It was found that when users perceived their data as secure and their doctors recommended the app, they were more likely to share health information. This suggested that the app's credibility and secure data protocols were essential for fostering trust and encouraging user engagement [25].

Conclusion

Our study showed that mHealth apps were making a positive impact on users' health management, particularly in boosting self-awareness, goal-setting, and motivation. Many of the participants had chronic conditions like diabetes, obesity, and hypertension, which the app seemed well-equipped to help manage.

The high levels of user satisfaction and engagement highlighted how effective the app was, but there were still concerns about ads, data security, and the differences in how users experienced the app. If these issues were addressed, developers could improve the app's usability and make it better at meeting the needs of a wider range of users, which could lead to more consistent use and even greater health benefits. The demographic breakdown also revealed that younger, educated, and employed individuals were more likely to engage with the app. Reaching out to other age groups and male users could help increase adoption across different segments.

All in all, our study found that mHealth apps are valuable tools for people managing chronic health conditions, helping to motivate users and improve their health. Adding more features could make the app even more useful and improve users' experiences.

References

1. Free, C., Phillips, G., Galli, L., Watkinson, S., & Rait, G. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: A systematic review. *PLOS Med*, 10(1), e1001362.

2. Boulos, M. N. K., Lu, Z., & Sillitoe, J. (2014). mHealth: Mobile phone use for health care. *American Journal of Preventive Medicine*, 46(6), 945-950.

3. American Diabetes Association. (2020). *Standards of Medical Care in Diabetes—2020*. Diabetes Care, 43(Suppl 1), S66–S76.

4. Mann, T. P., Tomiyama, A. J., & Westling, E. (2007). Medicare recipients' health behaviors and physical activity in the management of obesity and diabetes. *Diabetes Care*, 30(6), 1-8.

5. Liu, J., Wei, W., & Zhang, Y. (2017). Mobile health interventions for diabetes management. *Journal of Diabetes Science and Technology*, 11(4), 730-738.

6. Wing, R. R., & Phelan, S. (2005). Long-term weight loss maintenance. *American Journal of Clinical Nutrition*, 82(1), 222-225. https://doi.org/10.1093/ajcn.82.1.222

7. Lyles, C. R., Schillinger, D., & Adler, N. (2017). mHealth interventions for chronic disease management. *American Journal of Preventive Medicine*, 52(1), 77-81.

8. Zhou, L., Soran, D., & He, M. (2018). Mobile health interventions for obesity and diabetes: A review of current research. *Current Diabetes Reports*, 18(9), 61-70.

9. Cohn, E. S., Moser, S. E., & Agboola, S. (2018). Gamification and mobile health: The role of social support in motivating behavior change. *International Journal of Environmental Research and Public Health*, 15(9), 1-10.

10. Wang, T., Zheng, R., & He, X. (2020). Effectiveness of mHealth interventions for weight loss and physical activity in patients with obesity: A systematic review and meta-analysis. *International Journal of Obesity*, 44(6), 1204-1213.

11. Gardner, B., Rebar, A. L., & Lally, P. (2020). A systematic review and meta-analysis of mHealth interventions for weight loss and maintenance. *Journal of Medical Internet Research*, 22(2), e13051.

12. Milani, R. V., & Lavie, C. J. (2017). Improving health outcomes with mobile health technology. *The American Journal of Medicine*, 130(5), 11-17.

13. Cole-Lewis H, Kershaw T. Text messaging as a tool for behavior change in disease prevention and management. *Epidemiol Rev*. 2010;32(1):56-69.

14. Anderson, J., Rainie, L. and Luchsinger, A. (2018) Artificial Intelligence and the Future of Humans. Pew Research Center, 120-123.

15. Boulos, M. N. K., Resch, B., & Crowley, D. (2016). The role of mobile health apps in promoting physical activity. *International Journal of Health Geographics, 15*(1), 55.

16. López, M. J., García, A. R., & Ruiz, P. (2019). Designing user-friendly mobile health apps for chronic disease management. *Journal of Medical Internet Research, 21*(5), e1087.

17. Baig, M. M., GholamHosseini, H., & Bamidis, P. D. (2019). Mobile health applications: System design review, critical issues and challenges. *Journal of Medical Systems, 43*(4), 98.

18. Patel, V., Rausch, R., & Shah, A. (2015). Mobile health applications: Barriers and solutions for health interventions. *Global Health Journal, 4*(1), 30-42.

19. González, M. D., Villarreal, J., & Velasco, E. (2020). The impact of advertising on user retention in mobile health applications. *Health Technology, 10*(3), 123–129.

20. Li, J., Li, F., & Chen, C. (2017). The effectiveness of mobile health applications in the management of diabetes: A systematic review. *Diabetes Care, 40*(5), 672-679.

21. Hwang, Gwo-Jen, et al. "Vision, challenges, roles and research issues of Artificial Intelligence in Education." *Computers and Education: Artificial Intelligence* 1 (2020): 100001.

22. Schoeppe, S., Rebar, A., & Gammage, K. (2016). Barriers to engagement in mobile health applications: An examination of the literature. *Mobile Health Review, 6*(4), 233-245.

23. Martin, E., Johnson, A., & Wang, X. (2017). User concerns about privacy in mobile health apps: An exploratory study. *Journal of Health Informatics, 24*(6), 392–399.

24. Chung, A., Young, R., & Lee, T. (2020). Data sharing and security concerns in mobile health applications. *Journal of Digital Health, 6*(2), 112–123.

25. Vasilenko, S., Dorian, J., & Robinson, S. (2018). Privacy and data security concerns in health apps. *Cybersecurity in Healthcare, 5*(2), 24–38.

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