

**NEED FOR HUMAN-CENTERED DESIGN OF TYPE-2 DIABETES SELF-CARE
MANAGEMENT MOBILE APPS IN HOME SETTINGS**

**Dr. Abhijeet Prasad Sinha, DIT Ph.D. Fellow, Dr Manmohan Singhal, M Pharma, Ph.D.2*,
Dr Ashish Joshi, MD, MBBS, Ph.D.3 Dr Bhavna Kumar, PhD4 Dr Neeraj Kumar Sethiya,
PhD5**

1 DIT University Ph.D. fellow India

2*Associate Professor DIT University, Dehradun India

3Dean and distinguished professor, The University of Memphis, Tennessee, USA

4Associate Professor DIT University, Dehradun India

5Associate Professor DIT University, Dehradun India

***Primary author-** Abhijeet P Sinha

***Corresponding Author:** Dr. Manmohan Singhal, M Pharma, PhD

*Faculty of Pharmacy, School of Pharmaceutical and Population Health Informatics, DIT
University, Dehradun Uttarakhand 248009, Email: Manmohan.singh@dituniversity.edu.in

Abstract

Diabetes mellitus type 2 (T2DM) is one of the most common and widespread diseases in the world. It affects people in both rich and developing countries. Insulin resistance diabetes mellitus (T2DM), which affects about 95% of people with diabetes, is caused by many things, such as genes, lifestyle, and the surroundings. There is no cure, but the disease can be better controlled and managed with good management, monitoring of the physiological parameters, changes to the way of life, and nutritional management. With a growing population, it's getting harder and harder for healthcare services to provide good care. Given the nature of the disease and the setting of the healthcare system, it has become much more important to focus on self-care management to deal with the complications of T2DM. To reach the goal of self-care management, mobile can be leveraged and mostly accessible to the urban population.

The m-health apps that are built with users in mind can be much more important and have a hugely positive effect. Self-care management includes checking the blood glucose level, keeping the ideal weight, and focusing on a healthy diet, blood pressure, and other important physiological parameters. It is very important and would bring an integrated approach to self-care management to the Chronic Care Model (CCM). It would also help people who have two diseases at the same time, like people with high blood pressure and diabetes. m-Health interventions would help people stick to their self-care management plans, and in the future, this application could include a nutrition informatics module that focuses on the local/regional diet of India. So, it would give a person with diabetes a combined way to take care of themselves when they have diabetes. Patients are more likely to be ready for self-care management and to use m-Health for self-management of disease if they seem to have some control over their ailments. Most importantly the designed

mHealth app caters to the user's needs and follows human-centered, keeping people at the core for the usability and utility of the mHealth application.

Key Words: *Users centered mHealth, Self-care management, T2DM, Human-centered designs, self-care-oriented mobile apps, HCD design*

Introduction

Diabetes mellitus (DM), a metabolic disorder with long-term high blood sugar, is one of the biggest health problems of the 21st century. More than 537 million people have it, and that number is projected to grow to 783 million by 2045 [1, 3]. Around the world, 90% to 95% of people with diabetes have T2DM, which is the most common and fastest-growing type of disease [3]. Because the disease gets worse over time, it affects more and more organs and can lead to neuropathy, heart disease, and retinopathy if it isn't properly watched and treated [3,4]. Even though T2DM is more common in middle age, more and more people over the age of 20 are also getting it early. People younger than 40 years old are more likely to get the disease early. Environment and genes are the most important risk factors for T2DM, along with a few other things [5].

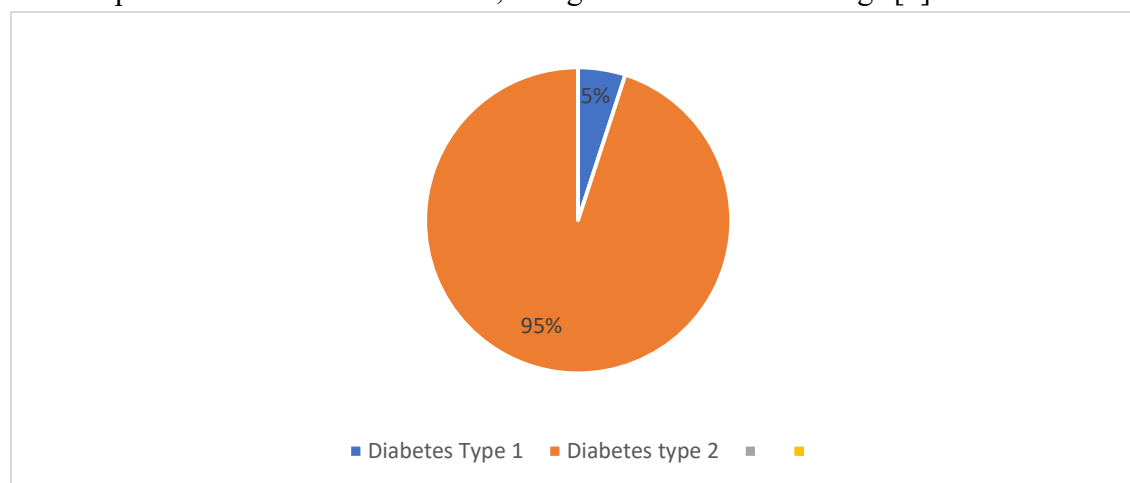


Figure 1 Prevalance of two types of diabetes

Source : [IDF Diabetes Atlas Tenth edition 2021](#)

One of the hardest things for healthcare workers to do today is to meet the ongoing needs and wants of people with chronic conditions like diabetes [6]. Follow-ups are much more important and significant for diabetic people who want to avoid long-term problems [6]. Many types of scientific studies show that diabetic complications can be slowed down or stopped with careful metabolic management [5]. As far as diabetic patients' needs go, they aren't just about keeping their blood sugar level stable; they also include therapy and limitations due to disability [4]. There is a lot of scientific proof that shows that the public's lack of knowledge about health and bad attitudes hurt the effectiveness of the treatment. Since there is no cure for DM, it is always important to take care of the disease in a scientific and practical way [5,6,7].

Patients with diabetes have to live with it for the rest of their lives, and since it's almost impossible for them to go to the doctor regularly, self-care control becomes very important [7]. Both the

European Association for Diabetes study and the American Diabetes Association support the self-centered care management method. This includes self-monitoring of glycemia level, physical activity, foot care, good nutrition, and taking medications regularly. People should have enough knowledge, courage, and skills to do this. The main goal of person-centered care for T2DM is to help people live healthier lives [5,6].

A healthy way of life includes doing physical activities daily, eating a balanced diet by managing nutrition, keeping a healthy weight, and not smoking. Self-care management and practises would not be possible without the help of technology, which has been used to track and improve the lives of diabetic patients and continues to do so. People with T2MD need health tracking tools to measure and keep an eye on their blood sugar levels and blood pressure. These tools have been shown to be important in both preventing and treating T2MD. The other main reason to use a person-centered method is to make it easier on a healthcare system that is already having to deal with the problems of a growing population [4,6].

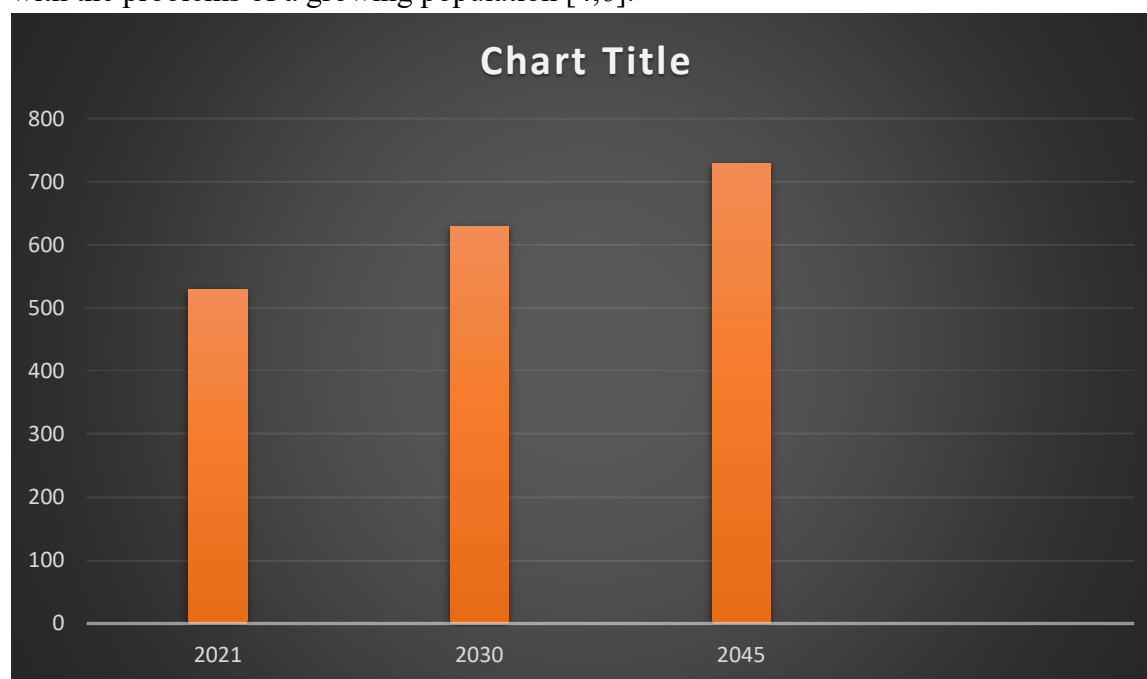


Figure 2 Trend of the diabetic patient throughout the words in millions

Source: IDF Diabetes Atlas Tenth edition 2021

Self-care and nutritional management

People who ate a balanced diet had a much lower chance of developing type 2 diabetes, which has been linked to better glucose metabolism and less diabetes in general [8]. Every day, you should eat fruits, low-fat dairy products, veggies, and whole grains. You should also eat less poultry, fish, legumes, red meat, and tree nuts [7]. In Chronic Care Management (CCM), self-care or management of self-care can improve health outcomes and may lower the chance of diabetic complications. M-health treatments, which use mobile phone technology, are used in a number of

global programs that focus on self-care management. A lot of research is being done to help people improve their self-efficacy, self-care, health-related quality of life, and clinical outcomes. But most of the m-health apps that have been made are clinical and don't focus on self-care things like nutrition, food, and exercise, nor do they test blood glucose levels. The m-health application healthcare has the potential to improve support for patients with type 2 diabetes mellitus. It is important to improve patient outcomes by improving self-care, comprehensive self-care management, and incorporating nutrition informatics, and psychological support can help patients deal with diabetes and stick to self-care activities. Most studies looked at good lifestyle habits like being active and checking your blood sugar. But for people with diabetes, taking care of their signs and symptoms and following a diet plan can be the hardest part of self-care and can improve their health. Mobile phone technology is very popular among people of all ages and income levels, and it opens up new possibilities in health care, such as preventing Type 2 diabetes and helping people take care of themselves. The future seems to be in mobile health applications (mHealth) that use existing technology to make better use of smartphones to help avoid and treat chronic diseases like diabetes type 2. Diabetes can be stopped and even cured with food [9]. Dietary tactics, on the other hand, have changed over time and science has learned more [8, 9]. In the past, nutritional control meant limiting foods that were high in sugar, like fruits, starches, bread, and refined carbohydrates [10]. Since the diet has less carbs, it may have too much protein and fat. But now, the major focus is still on a diet with few fats, especially saturated fats, which can raise cholesterol levels, and as little protein as possible for people with kidney problems [10]. The new method puts more focus on fat because people with diabetes have more trouble with fat [11]. When there is a lot of fat in the body, insulin doesn't work as well. This makes it hard for glucose to get into the cells, which causes diabetes. On the other hand, insulin can do its job better when body fat is smaller and fat intake is limited [12].

Technological advancement and self-care management

In the field of diabetes, changes in technology are becoming more unpredictable. By giving patients more power, they are giving patients the chance to take charge of their own care [13]. But they might be hard for both patients and doctors at the same time. So, to understand how to use diabetic technology and get the most out of it, one must be aware of the unmet needs in controlling diabetes right now. Human-centered design apps are working better because they take into account the needs and wants of both healthcare providers and patients [14].

Human-centered designs (HCD) have become a powerful way to make mobile health (mHealth) apps that are satisfying and easy to use [15]. For a specific plan, both quantitative and qualitative methods are changed to provide the best self-centered care [15]. Even though different mobile apps work in different ways, the main idea behind them all is the same: to use data from the patient to keep track of ongoing health problems. These tools can keep an eye on.

- ❖ Physical activity
- ❖ Blood glucose level
- ❖ Blood pressure

- ❖ Detecting the abnormalities or Complications at both physiological and psychological levels.

Mobile Health Apps and Self-management

The mHealth app can be used on personal mobile devices and is often geared towards the user. The number of people who use these apps keeps going up, and they are now the second most popular type of app [16], just behind apps for mental health. These apps do a lot of different things, such as keeping track of physical activities, measuring carbs and keeping a nutrition database, keeping track of weight, sharing data with peers or doctors, setting alerts, sending messages, and providing social support. The most important thing that makes it different from other monitoring devices is that it can connect a health care worker and a patient even when they are not in the same room [16].

Different apps use different ways to report, such as graphs, detailed reports, or text data that can show the daily amount of sugar or another important physiological parameter [18]. Because these apps keep the person up-to-date on their current physiological parameters, they make it easier for the person to stick to their exercise, food, management plans, and medications, which improves their diabetes over time. It's important to note that mobile apps aren't always made to do more than one thing. Patients can always choose whether they need an app with limited functions or one that can do more, based on how bad their condition is [18].

Human-centered design

The human-centered design of the m-health application is very important. It would bring an integrative approach to self-care management to the Chronic Care Model (CCM). It would also help patients with co-morbidities, such as those who have both high blood pressure and diabetes. m-Health interventions would help people stick to their self-care management plans. In the future, this application could include a nutrition informatics module that focuses on local foods. So, it would give a person with diabetes a combined way to take care of themselves when they have diabetes. Patients are more likely to be ready for self-management and to use m-Health for self-management of disease if they seem to have some control over their illness. Integrated self-care management of type 2 diabetes using an application with a human-centered design that was made with and for the patient. This will help patients handle their own care at home. The quality of the app needs to have several features, such as a self-diary where daily entries can be made about diet, exercise, and medicines. DBMS-integrated self-assessment questions with built-in features like awards, goal setting, chat with FAQs, and WhatsApp group- Keeping the user at the center.[21]

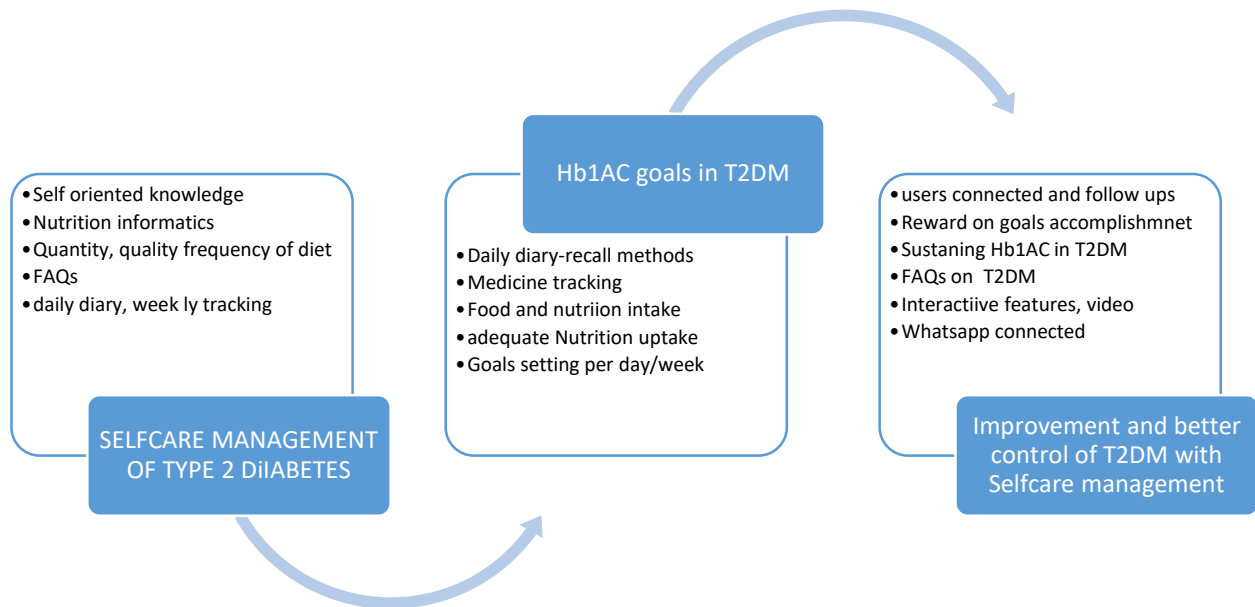


Figure 1. Swayam Diabetes care mhealth HCD design model for selfcare management

Complete Feedback Loop and its role in controlling T2DM.

The most important way apps give useful information to healthcare providers is through the ability to talk back and forth [19]. Important choices about the diabetic patient are made based on the information about their body. Recently, a full feedback loop between healthcare workers and participants has helped reduce HbA1c by a lot. Many studies have shown that contact that goes both ways is better. Also, the developer and the healthcare worker work together to make the app as useful as possible. For example, the medical or expert team's useful information is used in a good way to improve the design of the app and make it easier to use [19, 18].

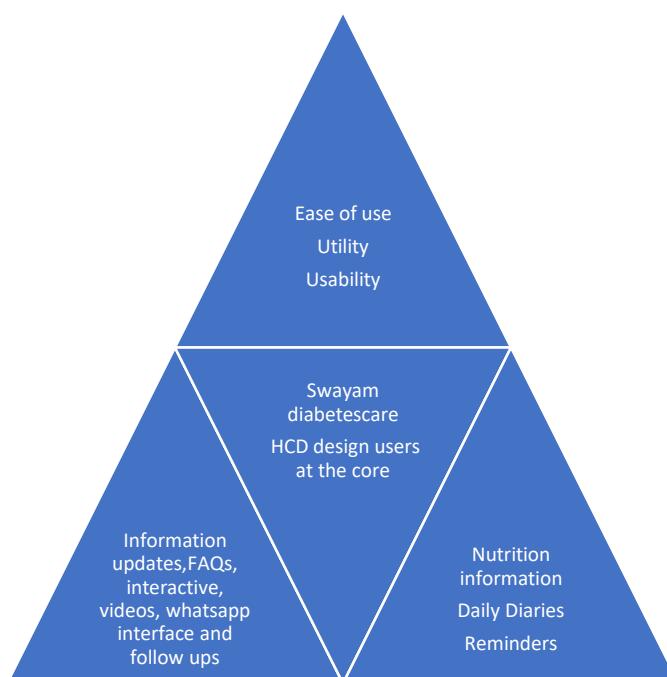


Figure 2. SWAYAM Diabetes care application, HCD design, and features

Based on the user-centered factors, the Swayam Diabetes health care apps was developed, and possible actions to be tested with users $n=18$ with qualitative In depth interviews are to be made with prototype application and taking inputs into the design of this mhealth application example, recent research showed that the patient's glycosylated hemoglobin level went down with the help of technology intervention and a full feedback loop. This result used all the users' physical activities information, such as blood pressure, blood glucose level, exercise, and daily diaries will also be evaluated by feedback from the users on its utility and usability. The old way of sharing information always leads to mistakes, called "artifacts," because environmental factors and personal circumstances affect physiological information.[21] However, these problems can be prevented by using the above important feature Figure 2 which is embedded into prototype design of Swayam diabetes care mhealth app. Currently, about 9–17% of apps have personal information, and daily monitoring and very few in local context and if this number goes up in the coming years, things could get better [19, 18, 17].

Importance of Physical Activity in self-care management

Mobile apps are made to track physical activity and measure how the body changes as a result of exercise. For example, they can measure the level of oxygen saturation, record the activity, and rate it as slow, average, or high. Based on the information given, these can also set goals for the patient and send messages based on the goals set. Exercise is the best way to keep diabetes under control [20]. When you work out, especially if you have T2DM, insulin becomes more sensitive. Importantly, the exercise works right away and lowers the amount of glucose in the blood. Also, many studies have shown that blood glucose levels stay the same after exercise when a person is fasting, but they go down when a person exercises after eating [20].

Self-oriented Knowledge

International clinical standards [15] say that learning about diabetes is an important part of taking care of yourself. It is an important part of treating diabetes, but most programs that try to help people with diabetes take care of themselves don't have any educational material. Many studies have shown that knowledge about diabetes is strongly linked to good self-management by people with T2DM, which helps them reach the HbA1c goal. The T2DM self-care mobile apps also help the person learn what they need to know, such as about diet, how to care for diabetes, and answers to questions from experts. Apps with more features [15, 19] can make these things better.

Conclusion

The best way to deal with the problems of T2DM is to take care of yourself with the help of apps that are designed with people in mind. The best way to avoid problems from T2MD is to live a healthy life, both physically and by eating well. As science grew, so did people's ideas about how to get a good mix of nutrients and nutrition informatics is a very important area. Most important are local diet recommendations and intake daily to control sugar, daily diaries, reminders, and reminders of medications, and information on self-care management. Human-centered apps make it easy and effective to control the biochemical and physical parameters. When there are a lot of problems when it comes to using the apps, we can expect more advanced and user-friendly places as technology moves forward. So, it would give a person with diabetes a combined way to take care of themselves when they have diabetes and comorbidities. Patients are more likely to be ready for self-care management and to use m-Health for self-management of disease if they seem to have some control over their ailments. Most importantly the designed mHealth app caters to the user's needs and follows a human-centered approach, keeping people at the core of the usability and utility of the mHealth application.

Acknowledgments

The only people who worked on this manuscript were the writers, who were given credit for their work.

Authors' Contributions

All of the authors worked on the planning of the study, the creation of the questionnaire, and the writing of the manuscript. They have also all given their permission for the manuscript to be published.

Conflicts of Interest

References

[1] A. P. Sapra and P. "Diabetes Mellitus," by Bhandari, in PubMed on September 18, 2021. The link is: <http://www.ncbi.nlm.nih.gov/books/NBK551501/>

- [2] A. "Insulin resistance in the pathogenesis of type 2 diabetes mellitus," by Y. Mayorov, published in *Diabetes mellitus*, vol. DOI: 10.14341/2072-0351-6248. 14, no. 1, page 35, March 2011.
- [3] International Diabetes Federation, "International Diabetes Federation - Facts & Figures," If.org, December 9, 2021. Diabetes facts and figures can be found at idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html.
- [4]R. We are both. "Diabetes Mellitus Type 2," by Jialal, from NCBI on June 19, 2022. Find this book at www.ncbi.nlm.nih.gov/books/NBK513253
- [5]A. T. Kharroubi and H.M. "Diabetes Mellitus: The Epidemic of the Century," by M. Darwish, published in the *World Journal of Diabetes*, vol. 2015, DOI: 10.4239/wjd.v6.i6.850, page 850.
- [6] C. Solis-Herrera, R. A. DeFronzo, C. Triplitt, C. Reasner, and E. "Classification of Diabetes Mellitus," by Cersosimo, published on Nih.gov on February 24, 2018. Find the book at www.ncbi.nlm.nih.gov/books/NBK279119
- [7] M. Asif, "The prevention and control of type-2 diabetes by changing lifestyle and dietary pattern," *Journal of Education and Health Promotion*, vol. DOI: 10.4103/2277-9531.127541, Vol. 3, No. 1, Page 1, February 2014.
- [8] A. Brown, "Intensive dietary lifestyle interventions in type 2 diabetes," *Endocrine Abstracts*, January 2019, DOI: 10.1530/endoabs.61.ou6.
- "Primary Prevention of Type 2 Diabetes Mellitus by Lifestyle Intervention: Implications for Health Policy," in *Annals of Internal Medicine*, vol. 140, no. 11, page 951, June 2004, doi: 10.7326/0003-4819-140-11-200406010-00036.
- [10]J. B. Marks, "Lifestyle Modification and Weight Control in Diabetes Prevention and Treatment," in *Clinical Diabetes*, vol. July 2005, Vol. 23, No. 3, Pages 129–129, DOI: 10.2337/diaclin.23.3.129.
- [11]V. Naik, "Evidence-Based Prevention of Type 2 Diabetes: Role of Lifestyle Intervention Compared to Pharmacological Agents," *International Journal of Diabetes and Clinical Research*, vol. DOI: 10.23937/2377-3634/1410049. Vol. 2, No. 6, December 2015.
- [12]W. Sami, "Effect of diet on type 2 diabetes mellitus: A review," in *International journal of health sciences*, vol. 2017, Vol. 11, No. 2, pp. 65–71, [Online]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426415>
- [13]H. B. Santoso, M. L. Hakim, P. K. Nursalamah, and P. O. H. Putra, "Development of Mobile Self-Monitoring Tool Prototype Based on User-Centered Design," in *International Journal of Emerging Technologies in Learning (iJET)*, vol. December 2019, page 42, doi: 10.3991/ijet.v14i24.12043.
- [14]P. Athilingam, "A Mobile Application to Improve Self-Care of Patients with Heart Failure," *Journal of Cardiac Failure*, vol. 22, no. 8, pp. DOI: 10.1016/j.cardfail.2016.06.327, August 2016, pages S102–S103.

- [15]Z. S. Boonviriyaya, P. Nimmanterdwong, and P. Tangkijvanich, "Human-Centered Design of Mobile Health Applications for Older Adults: Systematic Review and Narrative Synthesis (Preprint)," JMIR mHealth and uHealth, April 2021, DOI: 10.2196/29512.
- [16]C. M. Lohnert, S. Eberle, and S. Stichling, "EFFECTIVENESS OF SPECIFIC MOBILE HEALTH APPLICATIONS (mHEALTH-APPS) IN DIABETES MELLITUS: A SCOPING REVIEW (Preprint)," JMIR mHealth and uHealth, vol. DOI: 10.2196/23477, Vol. 9, No. 2, August 2020.
- [17]K. S. Capra, and J. Hale. Bauer, "A Framework to Assist Health Professionals in Recommending High-Quality Apps for Supporting Chronic Disease Self-Management: An Illustrative Assessment of Type 2 Diabetes Apps," JMIR mHealth and uHealth, vol. September 2015, volume 3, number 3, page e87, DOI: 10.2196/mhealth.4532.
- [18] B. "Mobile phone applications and their use in the self-management of Type 2 Diabetes Mellitus: a qualitative study among app users and non-app users," by Jeffrey et al., was published in *Diabetology & Metabolic Syndrome*, vol. October 2019, Vol. 11, No. 1, pp. 1–17, DOI: 10.1186/s13098-019-0480-4.
- [19] S. W. Abbas, R. Joshua, and J.-H. Lee, "M-Healthcare Model: An Architecture for a Type 2 Diabetes Mellitus Mobile Application," in *Applied Sciences*, vol. 13, no. 1, page 8, December 2022, DOI: 10.3390/app13010008.
- [20] M. Borhade and S. "Diabetes Mellitus and Exercise," by Singh, published in PubMed in 2022. Type 1 and Type 2:
- [21]. **Abhijeet Prasad Sinha BSc, MPH, MBA, Manmohan Singhal M Pharma , Ph.D., Mansi Gupta BPT, MSW , Ashish Joshi, MD, MBBS, PhD**, *Development And Utility Of M-Health Enabled Nutrition Informatics Intervention For Self-Care Management Of Type 2 Diabetes In Home Settings*, journal of Positive School Psychology <http://journalppw.com>, 2022 Vol. 6, No. 12, 1261-1279