

Tailoring Educational Content for T2DM Patients: A Qualitative Study on Preferences for Interactive Multimedia Applications

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Abstract

Background. The development of interactive multimedia-based applications has become increasingly important in providing effective health education to Type 2 Diabetes Mellitus (T2DM) patients. Understanding the educational content required for such applications from local patients' perspectives is crucial for designing a user-friendly and impactful tool for T2DM management.

Objective. This study aims to investigate patients' views and preferences on the educational content and features of an interactive multimedia-based application for T2DM patients.

Methodology. Semi-structured qualitative interviews were carried out with a sample of T2DM outpatients (n = 16) at a tertiary referral university hospital in Kuala Lumpur between October 2022 and January 2023. The interviews were recorded, transcribed and subjected to thematic analysis.

Result. The majority of participants had been diagnosed with T2DM for less than ten years. The thematic analysis identified several key aspects related to the educational content required for development of a multimedia-based application. These include preference for educational materials, essential contents and interactive features. The participants also proposed a discussion area within such applications that would allow them to communicate and receive immediate advice from healthcare professionals, thus eliminating the need for frequent hospital visits.

Conclusion. The findings of this study highlight the significance of interactive multimedia-based applications in providing health education for T2DM patients. The identified essential content areas from the patients' perspectives can inform the development of effective tailored educational materials for patient's benefit.

Key words: educational material, diabetes mellitus, multimedia applications, health education, patient communication

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a metabolic disorder characterized by an increase in blood glucose level and other metabolic dysfunctions due to insufficient insulin or insulin resistance.¹ This chronic disease has affected more than 450 million people worldwide and is anticipated to reach approximately 650 million by the year 2040.¹ Malaysia has been listed as one with the highest prevalence rates of diabetes mellitus (DM) in the Western Pacific region and among the highest in the globe, with an estimated annual expenditure of USD 600 million.² With a 68.3% increase, the prevalence of DM rose from 11.2% in 2011 to 18.3% in 2019.³ This national survey also revealed that in 2019,

approximately 3.6 million adults (18 years and older) in Malaysia had DM, of which 49% (3.7 million) were undiagnosed. With a prevalence of 31.3%, DM is anticipated to affect 7 million Malaysian adults aged 18 and older by 2025, posing a significant public health risk.³ T2DM can result in a variety of microvascular and macrovascular complications, such as diabetic retinopathy, neuropathy, heart disease and stroke.

Patient health education for self-management is essential, particularly for those with chronic illness. An essential component of diabetes education should focus on the improvement of self-management and disease knowledge.⁴⁻⁶ T2DM self-management includes the following: main-

eISSN 2308-118x (Online)

Printed in the Philippines

Copyright © 2025 by Yasin et al.

Received: August 5, 2024. Accepted: September 25, 2024.

Published online first: April 25, 2025.

<https://doi.org/10.15605/jafes.040.01.18>

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taining a healthy weight, engaging in regular physical activity, monitoring blood sugar levels regularly, adhering to prescribed medication regimens, caring for diabetic feet, possessing effective problem-solving abilities, health coping strategies and engaging in risk-reduction behaviors.⁷ Inadequate patient health education is consistently associated with unfavorable results, including increased hospitalization, greater use of emergency care, decreased adherence to medication regimen and a diminished capacity to interpret labels and health resources.⁸ Furthermore, according to a report by the International Diabetes Federation, 80% of complication associated with diabetes are preventable through education in self-management behaviors, such as physical activity and dietary control.⁹

Traditional patient health education methods for T2DM, such as printed pamphlets and face-to-face counselling, often fail to meet the diverse needs of patients. Many patients face barriers such as low health literacy, limited access to healthcare resources and challenges in understanding medical terminology. These factors contribute to poor disease management and suboptimal health outcomes. Furthermore, static and text-heavy educational materials are often disengaging, particularly for patients with limited literacy or those who are not accustomed to reading complex health information.^{10,11}

Multimedia is an information transmission method that integrates multiple forms of communication, such as text, graphics, audio, video and animation.¹² Research has demonstrated that the utilization of multimedia in patient education, such as incorporating audio or video, can enhance the exchange of information, sustain audience engagement and facilitate effective communication regarding a patient with chronic illness.¹³ Previous research has found that individuals with T2DM who were receiving patient health education through multimedia platforms experiences a moderate improvement in their understanding of diabetes and the efficacy of self-management.^{14,15} Interactive multimedia presents numerous significant advantages in health education. For instance, interactive video media has been shown to improve motivation and retention of health information, especially in older adults.¹⁶ In the context of diabetes education, digital self-management education programs have shown efficacy in reducing HbA1c levels, indicating improved diabetes management.¹⁷ Additionally, apps such as myDiabetes have demonstrated significant user engagement, as patients have accessed educational videos, suggesting a strong preference for digital learning tools.¹⁸

Multimedia solutions can also be tailored to meet the cultural and linguistic requirements of diverse populations, thereby improving their effectiveness in patient health education.¹⁰ The effectiveness of interactive multimedia in other chronic conditions, including obesity interventions in Malaysia, highlights the potential for similar approaches to be effective in T2DM education.¹⁹ Although these multimedia solutions demonstrate significant potential, it is essential

to investigate the specific preferences and requirements of T2DM patients in Malaysia, ensuring that educational content is culturally relevant, specifically tailored to the local population's needs and effective in enhancing health outcomes. Despite several previous published studies which reported the views and perceptions of Malaysian patients regarding the potential use of multimedia-based applications in managing various health conditions,^{20,21} qualitative studies involving T2DM patients in Asian settings, particularly in Malaysia, are scarce.^{22,23}

This study aims to identify the preferences of T2DM patients regarding the educational content and features of an interactive multimedia-based application. By identifying specific local patients' preferences and requirements, this research hoped to provide valuable insights for healthcare providers and developers in adopting or developing more effective, user-friendly multimedia tools that cater to the unique needs of T2DM patients in Malaysia.

METHODOLOGY

Study design

This study employed a qualitative research design using semi-structured interviews to gather in-depth insights from participants. This study adhered to the Standard of Reporting Qualitative Research (SRQR) to ensure methodological rigour, transparency and comprehensive reporting throughout the research process. The SRQR framework was applied to provide consistency in reporting of the research process and outcomes.

Researcher characteristics and reflexivity

All interviews were conducted by the primary researcher (NS) to maintain consistency. Researcher reflexivity was maintained throughout the study to reduce biases arising from preconceptions or assumptions. The researcher's background in pharmacy and experience with diabetes management were acknowledged as factors influencing the researcher's approach and interpretation of data.

Context and setting

The study was conducted at Hospital Canselor Tuanku Muhriz (HCTM), a tertiary hospital in Kuala Lumpur, Malaysia, between October 2022 and January 2023. Participants were recruited from the pharmacy outpatient department, where they were receiving routine care and medications for T2DM.

Sampling strategy

A purposive sampling strategy was employed, targeting participants who met the study's inclusion criteria and able to provide rich and relevant data, such as vocal participants and both technologically and non-technologically savvy participants. The inclusion criteria were: 1) adult aged

18 years and above; 2) diagnosed with T2DM; and 3) able to speak and understand either Malaysia or English language. Exclusion criteria were: 1) pregnant woman; 2) individuals with neurodegenerative diseases that impair communication; and 3) those who were unable to give informed consent.

A total of 16 participants were included in the study, representing a diverse range of socio-demographic characteristics including age, ethnicity and educational backgrounds. Data saturation was achieved, with no new themes or insights emerged from the data following discussion and consensus within the research team.

Data collection

Data was collected through semi-structured interviews conducted by NS in the outpatient pharmacy’s counselling room during follow-up visits. Each interview lasted approximately 30 minutes. No follow-up interview occurred. The interview guide (Table 1) was developed based on research questions and pre-tested with two patients, leading to slight modifications for clarity. The interview covered participants’ views on and preference of educational materials and multimedia-based applications for managing their condition. Interviews were recorded, transcribed and stored securely in password-encrypted files.

Data analysis

The 6-step thematic analysis was conducted to identify patterns and themes within the data, as recommended by Braun and Clarke.²⁴ The steps involved were (1) familiarizing with data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and lastly (6) producing the report. An inductive coding was performed to develop codes and themes without trying to fit into an existing framework. Inter-rater reliability was achieved through discussion within the research team and coding discrepancies were resolved through series of discussion and iterative review until disagreements were resolved and consensus was achieved.

A number of themes were derived and classified under three domains namely: (1) patient preferences for educational materials; (2) views on important educational content; and (3) preferred features of a multimedia-based application.

Ethical consideration

Ethical approval for the study was obtained from the University Kebangsaan Malaysia Ethics Committee (UKM PPI/111/8/JEP-2022-508). All participants provided informed consent before participation and were assured of their right to withdraw from the study at any time without penalty. Participant confidentiality was maintained by anonymising the interview transcripts and all data were securely stored following ethical guidelines.

Table 1. Interview guide

Key questions	
1.	What kind of educational materials do you like the most? (Probe: Conventional type of materials e.g. pamphlets or multimedia-based materials?)
2.	Would you rather learn from materials on paper or on your computer? (Probe: Why do you think so?)
3.	What would you like to see in educational materials about diabetes that will help you take care of it? (Probe: Content of conventional type of materials or multimedia-based materials?)
4.	Do you have any ideas for what should be in multimedia-based educational materials? (Probe: What would be the important features to be included in a mobile application?)
5.	Before this, when people used multimedia to learn, did they run into any problems? (Probe: What kind of problem(s)? Why do you think so?)

Table 2. Participants’ socio-demographic and clinical characteristics (n = 16)

Variable	Category	Frequency, N
Age	Years, Mean (± SD)	58.06 (± 11.11)
Gender	Male	7
	Female	9
Ethnicity	Malay	11
	Chinese	1
	Indian	4
Highest education qualification	Secondary school	5
	Diploma	4
	Degree	7
Duration of T2DM since diagnosis	1 - 10 years	13
	11 - 20 years	1
	21 - 30 years	1
	31 - 40 years	1
Type of anti-diabetic medication(s)	Oral hypoglycemic agent (OHA)	10
	Insulin therapy	2
	Mixed OHA + Insulin	4

RESULTS

Patients demographic

A total of 16 T2DM patients, consisting of 9 females (n = 9, 56%) and 7 males (n = 7, 44%), participated in this study. The participants’ age range was between 44 and 83 years old. The majority of the participants were Malay (n = 11, 69%) and the rest were Indian (n = 4, 25%) and Chinese (n = 1, 6%). Ten participants (n = 10, 63%) were taking oral antihyperglycemic medication, including metformin, gliclazide MR, and a metformin/sitagliptin combination tablet. The majority of the participants (n = 13, 81%) had been diagnosed with T2DM within the past 1 to 10 years. The study participants’ socio-demographic and clinical characteristics is summarised in Table 2.

Themes identified

Domain 1. Patients’ preference for educational materials

Theme 1. Convenience and accessibility of digital media

It is essential for patients to receive health education to increase their knowledge and awareness of illness manage-

ment and consequently enhance their health outcomes and quality of life. In the present study, participants rated an interactive multimedia-based application as a more effective health education resource than a paper-based educational resource. This is due to its accessibility and availability at all times. It was believed that delivering instructional content through multimedia-based applications would enable participants to read and refer to the information at their leisure, at any time and place. Moreover, with multimedia-based applications, participants can easily and quickly obtain information in audio and video format.

"I would choose digital because it's easy to store. With pamphlets, they are easily lost or thrown away because they are large and do take up space" (Participant 6, male, 48 years old).

"I can access the mobile apps at any time, and easier to understand because there are pictures, video and not a long text" (Participant 15, male, 63 years old).

Theme 2. Technological accessibility challenges for older adults

There were several participants who prefer hardcopy forms of educational materials over multimedia technology due to their lack of exposure to digital technology and compromised visual function. This is particularly relevant for older adult patients. A participant also addressed few technical issues with the use of a multimedia-based application as interactive health educational content. These include application consuming phone storage, reliance on a strong internet connection and absence of data backup if the app or mobile device crashes.

"I prefer pamphlets because apps are so troublesome for me. It is easier to see on paper than on a phone because the view of this phone is tiny for my eyes" (Participant 10, female, 83 years old).

"It is challenging for us to read from the phone. The writing fonts in the apps are too small to be read" (Participant 3, male, 74 years old).

"It might consume the phone data, and if there is no internet at that time, apps cannot be opened and used as usual" (Participant 8, male, 54 years old).

Domain 2. Views on important educational content

Theme 1. Personalized health monitoring

The results indicate that participants appear enthusiastic to learn about the normal range of monitoring parameters for T2DM prevention such as fasting blood sugar, blood pressure and BMI. Consequently, it will enable patients to modify their treatment, behaviour and lifestyle in order to achieve effective glucose control and avoid negative side effects. In addition, the patient would avoid hypoglycemic episodes and diabetes complications by understanding the normal monitoring parameter range.

"What is the best reading for sugar level and BMI based on my age? Moreover, what should I do if, let's say, my sugar level is too high or too low?" (Participant 16, female, 59 years old).

"I always have hypo problems when fasting, sometimes, I skip the insulin because I'm afraid of fainting, but when I check my sugar the next day, my sugar is still high. So I want to know the normal sugar level range based on my age" (Participant 14, male, 68 years old).

Theme 2. Cultural and practical considerations in dietary choices

Additionally, the patient was aware of dietary portions and food selection to control the disease but lacked adequate knowledge regarding food selection. Participants were concerned about the dietary requirements of patients with diabetes. They suggested an explanation of dietary information in educational materials, particularly regarding appropriate food selection, portion control and calorie counting. They prefer that the information regarding food selection be tailored to their dietary preferences, such as local cuisine. Additionally, they would like to know the total daily calorie requirement and calorie counting based on their daily food intake, without discouraging them from attaining a normal blood glucose level range.

"I'm from Kedah, and rice is our breakfast routine. I cannot eat a sandwich, and it does not suit my stomach. I would like to know more about the diet suitable for Malaysians" (Participant 8, male, 54 years old).

"What food can be eaten, the suitable portion of food, food that needs to be avoided, the timing of eating, the best time to finish the meal" (Participant 9, female, 58 years old).

"What are the appropriate types of food? How do you count your calories? How do you know if the food we eat exceeds the calorie requirement for the day" (Participant 15, male, 63 years old).

Theme 3. Understanding and managing diabetes medications

In the interactive patient education materials, participants would also like to learn about medication management, including medication storage, particularly insulin and adverse effects such as hypoglycemia. A participant needs to understand how to adjust insulin dosage to prevent hypoglycemic episodes. They were curious about how the medication functions in the body, especially insulin. As mentioned by a patient in this study, overcoming the anticipation of insulin treatment requires this step. With knowledge of medication management, the patient would have a high level of self-efficacy to deal with disease-related tasks.

"I want to know why we have to take this diabetes medicine every day, how it affects our body and how

it works to reduce blood sugar. Furthermore, what happens if I skip the medication for one or two days and just control my diet" (Participant 16, female, 59 years old).

"Insulin-related facts, benefits and how to use. Because many people are frightened by insulin injections because of the perception that insulin injection is for severe cases of diabetes only. While with insulin injections, the sugar level is easy to control" (Participant 7, female, 52 years old).

"Video on how to store insulin because I cannot read it. If in the form of a video, it is easy to see and understand" (Participant 5, female, 49 years old).

Participants in this study also desire greater knowledge of T2DM and its management. Understanding the disease is crucial for preventing complications and enhancing quality of life. When asked about diabetes in general, the majority of participants were unable to provide adequate responses. Some were unaware of the complications of diabetes and the treatment objectives for T2DM. If the patient does not comprehend the disease, they may not be motivated to take the medication, making it difficult to achieve the therapeutic goal.

"What is diabetes, what happens in the body and why does the patient need to start the medication" (Participant 2, female, 47 years old).

"What is diabetes, and what are the complications if we do not control the sugar level? For me, this is important to create awareness of what happened and why the patient needs to start any medication." (Participant 11, female, 44 years old).

Domain 3. Preference features of multimedia-based application

Theme 1. User engagement and support in digital health applications

Participants agreed that patient education materials using multimedia-based applications should be user-friendly for people of all ages, with fewer buttons to select, clear instructions and engaging video and audio for each app topic. To increase therapy adherence, they favor applications that provide continuous motivation, support and medication reminder. Participants also suggested incorporating a communication function with the healthcare provider into the applications so that they could receive immediate feedback on urgent disease-related matters, such as insulin dose adjustments.

"Attractive video education, a reminder on taking the medication, not too many buttons to click with simple to understand instructions and maybe some motivational quote" (Participant 9, female, 58 years old).

"Room for a message with the pharmacy because sometimes I might have hypoglycaemia, but I am unsure whether to continue taking medicine the next time" (Participant 3, male, 74 years old).

Participants expressed a strong preference for features such as reminders for medication, motivational content and communication functions to interact with healthcare providers for immediate advice.

"Reminder push notifications, health records section inside apps, search features, video guide for counselling especially method of handling insulin pen" (Participant 13, female, 48 years old).

"Maybe a chat area for me to have immediate advice without having to go to the hospital too often" (Participant 11, female, 44 years old).

DISCUSSION

This study explored T2DM patients' preferences for educational content and features of a multimedia-based application for T2DM management. The findings in the present study indicate that multimedia applications are generally favoured in our local setting. However, individual preferences and needs vary depending on patients' factors such as age and digital literacy. This is consistent with another local recent study for diabetes²⁵ and other various health conditions.^{20,21} Previous studies have shown a strong correlation between multimedia application usage with improved diabetes management and adherence, diabetes awareness and self-management behaviors, such as blood glucose monitoring, insulin administration and a lower HbA1c level.²⁶⁻²⁹ Another study done in Iran also demonstrated that multimedia applications had a positive impact on improving health beliefs and increased physical activity leading to improved health outcomes.⁹ Therefore, it was suggested that T2DM patients use a multimedia-based application as an educational tool to improve clinical outcomes as well as health belief and behaviors.

In the present study, we have highlighted that older adult participants preferred using traditional hardcopy or paper-based educational material as compared to the digital educational material. Nonetheless, a technology survey indicates that the older adults must catch up with the general population in terms of technology adoption³⁰ despite the basic human abilities such as perception, cognition, motor control and functional anthropometry being altered by the aging process.³¹ Older adults may utilize some technologies less frequently because they do not meet their requirements for a particular purpose. Individuals' strengths, limitations and life experiences will have an impact on how they will interact with technology adoption. According to the National Diabetes Registry Report in 2020, 29.73% of Malaysians with T2DM were over 60 years old, making up the largest proportion of the population.³² Therefore, the employed technology should

enhance the lives of the older adults and contribute to an increase in the quality of life. It is necessary to conduct extensive research to ensure that technologies can be effectively utilized and are beneficial to older adults. The interactive mobile application must meet the requirements of older adults by accommodating their cognitive level, capitalizing on their intact talents, assisting them with performing daily tasks and safeguarding their privacy, independence and safety. In addition, the patients' views on important educational content of an interactive multimedia-based application for T2DM demonstrate that the patients expect personalized health monitoring. It may include FBS, BP, BMI and disease knowledge. This indicates that the patient is aware of the importance of self-management and prevention of disease complication. A previous study concluded that in order for educational materials to have an effect on patient behavior on self-management, they must include information on medication adherence, blood glucose monitoring, problem-solving, living with the disease, complication risk, dietary modification and physical activity.¹⁴ Most multimedia applications in the market are limited to dietary modification, physical activity and glucose monitoring.¹⁴ Additionally, the patient's educational materials should aid in the development of self-efficacy which is an individual's belief in their capacity to think, experience and act over time.^{33,34} Individuals with a high level of self-efficacy are therefore confident in their ability to execute, whether it be administering medications correctly, modifying their diet, preventing hypoglycemia episodes, or adhering to therapy.

Patients also viewed the importance of dietary modification for T2DM patients. According to a study, the necessary non-pharmacological approach for T2DM is weight loss-promoting lifestyle changes.³⁵ Another study also indicates that the use of multimedia educational material in nutrition therapy has an impact in achieving metabolic control in T2DM patients.⁶ In particular, nutritional therapy enhances weight loss and metabolic outcomes, thereby decreasing insulin resistance associated with diabetes-related metabolic diseases.³⁶ The patient educational material should include the patient's daily nutritional needs tailored to local dietary practices. The Malaysian Ministry of Health outlines that effective diabetes management requires culturally relevant dietary education. This includes understanding local food selections, types and preparation methods, which differ from Western dietary practices.³⁷ Therefore, patients should have a sufficient nutritional intake based on Asian local dietary preferences. Using multimedia-based applications, the daily dietary needs should be able to recommend meal quantities, calories monitoring and appropriate food selections based on the local dietary intake.

In addition to effective and educational content, a multimedia-based application should also incorporate interactive features. The benefits of implementing interactive features in such applications include the ability to analyze personal health data and provide targeted education and

personalized feedback, which is the most effective strategy to improve patient understanding and self-management of diabetes.³⁸ T2DM patients must acquire new coping skills and adopt a healthier lifestyle, which requires ongoing information, care, therapy and a high level of commitment.⁷ In addition, a multimedia-based application should include a messaging feature with the healthcare professionals (HCPs) so that patients can receive personalized feedback or prompt advice on urgent matters requiring HCPs' attention, such as adjusting the insulin dose during hypoglycemic episodes. Previous research suggests that digital interventions that incorporate both educational content and communication with HCPs tend to have higher patient satisfaction and better health outcomes, based on the Health Promotion Model.⁹ Implementing such features in future multimedia applications could bridge gaps in care and reduce unnecessary hospital visits, ultimately improving patient adherence to treatment.

Nonetheless, implementing multimedia-based applications in healthcare settings faces several significant challenges and barriers. One of the primary concerns is the cost associated with developing, deploying and maintaining these technologies. Initial investments in software development, hardware procurement and ongoing updates can be substantial, posing a financial burden on healthcare institutions.^{39,40} Additionally, accessibility remains a critical issue, as not all patients have equal access to the necessary technology, such as smartphones or high-speed internet. This digital divide can limit the reach and effectiveness of multimedia applications, particularly in rural or underserved areas.^{41,42} Furthermore, patient literacy is a significant barrier. Those who have low health literacy may struggle to understand and use these applications effectively, reducing their potential benefits. They may also find it challenging to navigate these tools, leading to lower adoption rates.^{41,43,44} Addressing these challenges require various approaches, including investment in infrastructure, training for healthcare providers and efforts to improve patient literacy. Additionally, robust data, security measures and clear regulatory guidelines are essential to foster trust and compliance.

The findings from this study offer valuable insights for healthcare providers and developers of multimedia applications aimed at T2DM patients. Future mobile applications should focus on providing comprehensive, culturally relevant and easily accessible educational content tailored to individual patient needs. Moreover, features that enhance patient-provider communication should be prioritized to support real-time care and guidance.

Further research is needed to explore the long-term impact of multimedia applications on patient outcomes, including glycemic control, medication adherence and quality of life. Additionally, future studies should examine the cost-effectiveness and feasibility of implementing such tools in routine clinical practice, especially in resource-limited settings.

Limitations

This study has several limitations. The relatively small sample size, though sufficient for data saturation in qualitative research, limits the generalizability of the findings to the wider T2DM population. Furthermore, this study relied solely on qualitative data and future studies may benefit from triangulating qualitative findings with quantitative data to provide a more comprehensive understanding of patient needs and preferences. Therefore, future research should employ a mixed-method approach involving larger and diverse populations to confirm the study's findings and explore variations across different subgroups.

CONCLUSION

This study highlights that T2DM patients are receptive to the use of a multimedia-based application for educational purposes, which could positively impact patient health education. Knowledge expansion among patients may influence their disease self-management and improve self-efficacy toward therapy. The most important aspects of this study are that educational materials should include essential topics in diabetes self-management, such as medication adherence, blood glucose monitoring, problem-solving, disease coping, risk of complications, diet modification and physical activity. A multimedia-based application for patient education must be engaging and interactive in order to enhance patients' ability to attain self-efficacy, improve their quality of life and prevent diabetes complications. The multimedia applications developers should also consider including doctors, pharmacists, nutritionists and psychologists who are experts in their fields to promote behavioral modification techniques among patients. Future research is needed in designing more user-friendly mobile applications, especially for elderly patients, with engaging content, interactive video or audio, comprehensible content, clear instructions, individualized diet recommendations and motivational content, tailored to this particular group of patients in order to maximize the impact on knowledge and self-efficacy among them.

Acknowledgments

We extend our heartfelt appreciation to the patients who participated in the semi-structured qualitative interviews. Their willingness to share their experience and insights has been invaluable in providing a deeper understanding of the educational content and features required for developing an interactive multimedia-based application for T2DM management.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

CRedit Author Statement (based on Author Form)

NS: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Visualization, Project administration; **TM:** Conceptualization, Methodology, Validation, Formal Analysis, Resources, Data Curation, Writing – review and editing, Visualization, Supervision, Project Administration; **EH:** Conceptualization, Methodology, Validation, Formal

Analysis, Resources, Data Curation, Writing – review and editing, Visualization, Supervision, Project Administration; **HA:** Methodology, Investigation, Resources; **NA:** Methodology, Investigation, Resources

Data Availability Statement

Datasets generated and analyzed are included in the published article.

Author Disclosure

The authors declared no conflict of interest.

Funding Source

None.

References

1. Sanaeinasab H, Saffari M, Yazdanparast D, et al. Effects of a health education program to promote healthy lifestyle and glycemic control in patients with type 2 diabetes: A randomized controlled trial. *Prim Care Diabetes*. 2021;15(2):275-82. PMID: 33055009 DOI: 10.1016/j.pcd.2020.09.007
2. Ganasegeran K, Hor CP, Jamil MFA, et al. A systematic review of the economic burden of type 2 diabetes in Malaysia. *Int J Environ Res Public Health*. 2020;17(16):5723. PMID: 32784771 PMID: PMC7460065 DOI: 10.3390/ijerph17165723
3. Institute for Public Health 2020. National Health and Morbidity Survey (NHMS) 2019. Non-communicable diseases, healthcare demand, and health literacy – Key findings. https://ipthk.moh.gov.my/images/technical_report/2020/4_Infographic_Booklet_NHMS_2019_-_English.pdf
4. Huang MC, Hung CH, Yu CY, Berry DC, Shin SJ, Hsu YY. The effectiveness of multimedia education for patients with type 2 diabetes mellitus. *J Adv Nurs*. 2017;73(4):943-54. PMID: 27779772 DOI: 10.1111/jan.13194
5. Collis B. Anticipating the impact of multimedia in education: Lessons from literature. In: *International journal of computers in adult education and training*. 1991;2(2):136-49.
6. Velázquez-López L, Muñoz-Torres AV, Medina-Bravo P, Vilchis-Gil J, Klünder-Klünder M, Escobedo-de la Peña J. Multimedia education program and nutrition therapy improves HbA1c, weight, and lipid profile of patients with type 2 diabetes: A randomized clinical trial. *Endocrine*. 2017;58(2):236-45. PMID: 28921414 DOI: 10.1007/s12020-017-1416-0
7. Kasar KS, Asiret GD, Yilmaz CK, Canlar S. The effect of model-based telephone counseling on HbA1c and self-management for individuals with type 2 diabetes: A randomized controlled trial. *Prim Care Diabetes*. 2022;16(1):41-8. PMID: 34518109 DOI: 10.1016/j.pcd.2021.09.005
8. Abed MA, Himmel W, Vormfelde S, Koschack J. Video-assisted patient education to modify behavior: A systematic review. *Patient Educ Couns*. 2014;97(1):16-22. PMID: 25043785 DOI: 10.1016/j.pec.2014.06.015
9. Lari H, Tahmadebi R, Noroozi A. Effect of electronic education based on health promotion model on physical activity in diabetic patients. *Diabetes Metab Syndr*. 2018;12(1):45-50. PMID: 28869152 DOI: 10.1016/j.dsx.2017.08.013
10. Georgieva-Tsaneva GN, Serbezova I. Research on the impact of innovative interactive technologies in the education of health care students. *Int J Emerg Technol Learn*. 2022;17(20):283-91. DOI: 10.3991/ijet.v17i20.32903
11. Heshmati H, Shakibazadeh E, Foroushani AR, Sadeghi R. A comprehensive model of health education barriers of health-care system in Iran. *J Educ Health Promot*. 2020;9:106. PMID: 32642462 PMID: PMC7325757 DOI: 10.4103/jehp.jehp_23_20
12. Huang JP, Chen HH, Yeh ML. A comparison of diabetes learning with and without interactive multimedia to improve knowledge, control, and self-care among people with diabetes in Taiwan. *Public Health Nurs*. 2009;26(4):317-28. PMID: 19573210 DOI: 10.1111/j.1525-1446.2009.00786.x
13. Kandula NR, Nsiyah-Kumi PA, Makoul G, et al. The relationship between health literacy and knowledge improvement after a multimedia type 2 diabetes education program. *Patient Educ Couns*. 2009;75(3):321-7. PMID: 19395223 DOI: 10.1016/j.pec.2009.04.001
14. Nkhoma DE, Soko CJ, Bowrin P, et al. Digital interventions self-management education for type 1 and 2 diabetes: A systematic review and meta-analysis. *Comput Methods Programs Biomed*. 2021;210:106370. PMID: 34492544 DOI: 10.1016/j.cmpb.2021.106370
15. Pai LW, Chiu SC, Liu HL, Chen LL, Peng T. Effects of a health education technology program on long-term glycemic control and self-management ability of adults with type 2 diabetes: A randomized

- controlled trial. *Diabetes Res Clin Pract.* 2021;175:108785. PMID: 33781794 DOI: 10.1016/j.diabres.2021.108785
16. Fadhilah H, Subkhi MR. Penyuluhan Informasi Konseling Kesehatan Kepada Orang Tua Melalui Media Video Interaktif. 2024;3(2):204-8. DOI: 10.58184/mestaka.v3i2.336
 17. Salgueiro LJ, Pereyra-Bencosme K, Vargas-Martínez C, et al. Digital interventions in type 2 diabetes mellitus. *Principles and Practice of Clinical Research.* 2023;9(2). DOI: 10.21801/ppcrj.2023.92.5
 18. Blythin AM, Elkes J, van Lindholm T, et al. Can digital health apps provide patients with support to promote structured diabetes education and ongoing self-management? A real-world evaluation of myDiabetes usage. *Digit Health.* 2023;9:20552076221147109
 19. Yusoff H, Dali WPEW, Ruhaiyem NIR. Evidence-based of interactive multimedia-based nutrition education package efficacy on obesity outcomes through game and video intervention. In: Badioze Zaman H, et al., eds. *Advances in Visual Informatics. IVIC 2021. Lecture Notes in Computer Science*, vol. 13051. Springer, Cham; 2021: 1319
 20. Lee JW, Then YL, Lee SW. Health information seeking behaviour using mobile devices among people with diabetes: A comparison between Middle and high income country. *Digit Health.* 2020;6:2055207620956457. PMID: 32963802 PMCID: PMC7488880 DOI: 10.1177/2055207620956457
 21. Khan AI, Gill A, Cott C, Hans PK, Gray CS. mHealth tools for the self-management of patients with multimorbidity in primary care settings: Pilot study to explore user experience. *JMIR MHealth Uhealth.* 2018;6(8):e171. PMID: 30154073 PMCID: PMC6134226 DOI: 10.2196/mhealth.8593
 22. Vo V, Auroy L, Sarradon-Eck A. Patients' perceptions of mHealth apps: Meta-ethnographic review of qualitative studies. *JMIR Mhealth Uhealth.* 2019;7(7):e13817. PMID: 31293246 PMCID: PMC6652126 DOI: 10.2196/13817
 23. Kwan YH, Ong ZQ, Choo DYXC, Phang JK, Yoon S, Low LL. A mobile application to improve diabetes self-management using rapid prototyping: Iterative co-design approach in Asian settings. *Patient Prefer Adherence.* 2023;17:1-11. PMID: 36636285 PMCID: PMC9830050 DOI: 10.2147/PPA.S386456
 24. Braun V, Clarke V. Using thematic analysis in Psychology. *Qual Res Psychol.* 2006;3(2):77-101. DOI: 10.1191/1478088706qp063oa
 25. Sze WT, Know SG. Perspectives and needs of Malaysian patients with diabetes for a mobile health app support on self-management of diabetes: Qualitative study. *JMIR Diabetes.* 2023;8:e40968. PMID: 37870903 PMCID: PMC10628693 DOI: 10.2196/40968
 26. Ramchandani N. Virtual coaching to enhance diabetes care. *Diabetes Technol Ther.* 2019;21(S2):S248-51. PMID: 31169430 DOI: 10.1089/dia.2019.0016
 27. Greenwood DA, Gee PM, Fatkin KJ, Peeples M. A systematic review of reviews evaluating technology-enabled diabetes self-management education and support. *J Diabetes Sci Technol.* 2017;11(5):1015-27. PMID: 28560898 PMCID: PMC5951000 DOI: 10.1177/1932296817713506
 28. Lorig K, Ritter PL, Turner RM, English K, Laurent DD, Greenberg J. A diabetes self-management program: 12-month outcome sustainability from a nonreinforced pragmatic trial. *J Med Internet Res.* 2016;18(12):e322. PMID: 27979790 PMCID: PMC5200842 DOI: 10.2196/jmir.6484
 29. Represas-Carrera FJ, Martínez-Ques AA, Clavería A. Effectiveness of mobile applications in diabetic patients' healthy lifestyles: A review of systematic reviews. *Prim Care Diabetes.* 2021;15(5):751-60. PMID: 34275771 DOI: 10.1016/j.pcd.2021.07.004
 30. Rogers WA, Stronge AJ, Fisk AD. Technology and aging. *Rev Hum Factors Ergon.* 2005;9(1):130-71. DOI: 10.1518/155723405783703028
 31. National Research Council (US) Steering Committee for the Workshop on Technology for Adaptive Aging. *Pew RW, Van Hemel SB, eds. Washington (DC): National Academies Press (US); 2004.*
 32. Ministry of Health Malaysia. National Diabetes Registry Report 2020. Disease Control Division; 2021. https://www.moh.gov.my/moh/resources/Penerbitan/Rujukan/NCD/Diabetes/National_Diabetes_Registry_Report_2020.pdf
 33. Fleming GA, Petrie JR, Bergenstal RM, Holl RW, Peters AL, Heinemann L. Diabetes digital app technology: Benefits, challenges, and recommendations. A Consensus Report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) Diabetes Technology Working Group. *Diabetes Care.* 2020;43(1):250-60. PMID: 31806649 DOI: 10.2337/dci19-0062
 34. Tildesley HD, Mazanderani AB, Ross SA. Efficacy of A1C reduction using internet intervention in patients with type 2 diabetes treated with insulin. *Diabetes Care.* 2010;33(8):1738-40. PMID: 20668152 PMCID: PMC2909052 DOI: 10.2337/dc09-2256
 35. Beckerle CM, Lavin MA. Association of self-efficacy and self-care with glycemic. *Diabetes Spectr.* 2013;26(3):172-8. DOI: 10.2337/diaspect.26.3.172
 36. Hermanns N, Ehrmann D, Shapira A, Kulzer B, Schmitt A, Laffel L. Coordination of glucose monitoring, self-care behaviour and mental health: Achieving precision monitoring in diabetes. *Diabetologia.* 2022;65(11):1883-94. PMID: 35380233 PMCID: PMC9522821 DOI: 10.1007/s00125-022-05685-7
 37. Lim SL, Ong KW, Johal J, et al. Effect of a smartphone app on weight change and metabolic outcomes in Asian adults with type 2 diabetes: Randomized control trial. *JAMA Netw Open.* 2021;4(6):e2112417. PMID: 34081137 PMCID: PMC8176331 DOI: 10.1001/jamanetworkopen.2021.12417
 38. Malaysia Ministry of Health. Clinical Practice Guidelines on Management of Type 2 Diabetes Mellitus, 6th ed. 2020. <https://mems.my/cpg-management-of-type-2-diabetes-mellitus-6th-edition/>
 39. Boels AM, Rutten G, Zuithoff N, de Wit A, Vos R. Effectiveness of diabetes self-management education via a smartphone application in insulin treated type 2 diabetes patients—design of a randomised controlled trial ('TRIGGER study'). *BMC Endocr Disord.* 2018;18(1):74. PMID: 30348142 PMCID: PMC6196442 DOI: 10.1186/s12902-018-0304-9
 40. Knudsen LR, Lomborg K, Hauge EM, de Thurah A. Facilitators and challenges of implementing a digital patient education programme for rheumatoid arthritis into clinical practice. *BMC Health Serv Res.* 2024;24(1):1104. PMID: 39304859 PMCID: PMC11414131 DOI: 10.1186/s12913-024-11597-6
 41. Nair M, Svedberg P, Larsson I, Nygren JM. A comprehensive overview of barriers and strategies for AI implementation in healthcare: Mixed-method design. *Plos One.* 2024;19(8):e0305949. PMID: 39121051 PMCID: PMC11315296 DOI: 10.1371/journal.pone.0305949
 42. Ross J, Stevenson F, Lau R, Murray E. Exploring the challenges of implementing e-health: A protocol for an update of a systematic review of reviews. *BMJ Open.* 2015;5(4):e006773. PMID: 25869685 PMCID: PMC4401858 DOI: 10.1136/bmjopen-2014-006773
 43. Abell B, Naicker S, Rodwell D, et al. Identifying barriers and facilitators to successful implementation of computerized clinical decision support systems in hospitals: A NASSS framework-informed scoping review. *Implement Sci* 2023;18(1):32. PMID: 37495997 PMCID: PMC10373265 DOI: 10.1186/s13012-023-01287-y
 44. Berardi C, Antonini M, Jordan Z, Wechtler H, Palucci F, Hinwood M. Barriers and facilitators to the implementation of digital technologies in mental health systems: A qualitative systematic review to inform a policy framework. *BMC Health Serv Res.* 2024;24(1):243. PMID: 38408938 PMCID: PMC10898174 DOI: 10.1186/s12913-023-10536-1

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