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RESEARCH ARTICLE

Application of Telemonitoring to the Management of Type 2 Diabetes Mellitus in Southeast Asia: A Scoping Review

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ABSTRACT

This study aims to improve the quality of life of type 2 DM patients by increasing patient awareness of DM conditions and increasing patient participation in DM management. A scoping review of the study was conducted using the Arkey and O'malley framework, a literature search was conducted in 9 databases followed by a manual search of the reference lists of relevant papers from 2013-2023. Inclusion criteria included quantitative and qualitative primary data studies, focusing on Type 2 DM patient management, use of technology in patient monitoring, and conducted in a Southeast Asian country. Search results from 3,221 studies reviewed, only 11 research articles meeting the criteria included in this review. The results of the study showed that there were 4 web-based, 2 WhatsApp-based, 2 telephone-based interactive, 1 SMS-based, 1 video-based consultation, and 1 Bluetooth-based device-based. There are challenges and opportunities in research results that vary from each study discussed. The application of telemonitoring is an effective way in the management of Type 2 DM patients that can be well received by patients, taking into account the time, energy and cost efficiency in remote monitoring, but its use is adjusted to the conditions at the research site.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease characterized by elevated blood sugar levels that results in serious diseases such as heart disease, blood vessels, eyes, kidneys, and nerves (World Health Organization, 2021). DM is one of the degenerative diseases that is of important concern because it is a global public health challenge that is always increasing every year and is a world health threat in the current era (Ogurtsova et al., 2022). The prevalence of people with type 2 DM in 2021 was 536.6 million (10.5%) in the world and is expected to continue to increase to 783.2 million (12.2%) in 2045 (World Health Organization, 2021). Southeast Asia (SEA) has the third highest number of people with DM in the world, with 90.2 million people (International Diabetes Federation, 2021). The prevalence of type 2 DM cases in SEA continues to increase by 85–90%, along with changes in lifestyle and unhealthy diets (International Diabetes Federation, 2021). This causes a high health burden for countries in the SEA region.

Based on the prevalence trend of type 2 DM in SEA, it shows that DM is a significant health problem in the region, so more effective efforts need to be made to manage and monitor the condition of type 2 DM patients throughout SEA. Management of type 2 DM requires remote monitoring by health professionals in blood sugar level monitoring, lifestyle modification, and strict medication (Ramachandran, A., Snehalatha, C., & Shetty, 2017). Currently, various policy initiatives have been proposed for monitoring, education, and support of health workers in healthcare (Wen et al., 2017).

Self-management in DM patients is an important effort in controlling blood sugar levels and suppressing complications, both micro and macrovascular. Therefore, in this era of modernization, there is a need for efforts to assist people with type 2 DM in managing DM care, such as the use of technology in improving blood sugar control management [6,7].

SEA has a high internet penetration rate, with an average of 63% of the population connected to the internet by 2020 (Statista, 2021). The availability of technology infrastructure in SEA has seen increased access to digital technology adoption, including mobile phones and the internet. This allows for opportunities to implement telemonitoring solutions that utilize the available technology (Statista, 2021). Telemonitoring has a positive impact in reducing the number of hospitalizations and facilitating the monitoring of advanced stages of a patient's condition (Martín-lesende et al., 2017), but to date the effects of implementing telemonitoring are still debated, especially with variations in patient characteristics from background, self-management capabilities, medical conditions, and acceptance of empowering patients in telemonitoring (Andrès et al., 2019). Telemonitoring is a technology-based nursing care delivery method that is useful for improving health care remotely. This method is a communication method that depends on human, financial, and technological factors themselves (Syamsu et al., 2023). Telemonitoring can take the form of a telephone, mobile phone, the use of websites, social media, and interactive videos in the process of remote nursing care (Raafi et al., 2021).

Telemonitoring has been an effective strategy for managing and monitoring the condition of DM patients in SEA. In several studies, telemonitoring has shown significant benefits in reducing DM complications, such as improving the quality of life of DM patients by increasing patient awareness of DM conditions and increasing patient participation in DM management (Hanley et al., 2015). This suggests that while technology can be an effective tool in improving quality of life and reducing healthcare costs for DM patients in SEA, limited resources may pose a challenge in the implementation of telemonitoring in SEA. Therefore, more effective efforts need to be made to increase the accessibility of technology and improve the quality of life of DM patients in the SEA region. Although telemonitoring can improve the quality of life of patients with type 2 DM by increasing patient awareness of DM conditions and increasing patient participation in DM management, there is a need for increased support in sustainable DM disease management outside of healthcare facilities, as well as initiatives from the government to encourage digital transformation in the health sector.

METHODS

This review aims to determine an overview of telemonitoring implementation, identify challenges and opportunities for telemonitoring implementation in the management of type 2 DM.

Stage I: Research Question

The research question in this review is: What is the overview of telemonitoring implementation in the management of type 2 DM in SEA? SEA countries consist of Brunei, Malaysia, Indonesia, Thailand, Singapore, the Philippines, Vietnam, Laos, Cambodia, Myanmar, and Timor-Leste.

Stage II: Relevant Studies and Search Strategy

This review will summarize the application of teleminitoring in the management of type 2 diabetes in SEA. It will summarize how telemonitoring has been applied to people with DM in Southeast Asia and identify the challenges and impacts of telemonitoring on DM management in people with DM. To obtain relevant documents related to the topic of interest, searches were conducted on several databases, such as PubMed, ScienceDirect, Cochrane, Ebsco, Willey, DOAJ, Taylor & Francis, Google Scholar, and Garuda. The review also included an alternative manual search based on citations in the

reference lists of the articles used. The full list of databases and terms used in the article search is presented in Table.1.

The inclusion and exclusion criteria in this review were set based on the Population Concept Context (PCC) model and are listed in Table.2

The articles included in this review are those that have eligibility criteria such as qualitative or quantitative studies, research areas conducted in the SEA region, use of technology in conducting patient monitoring, and research conducted on people with DM. Article searches are limited to full articles published in English and Indonesian from 2013 to 2023.

Phase III: Study Selection

Extraction of Studies from the Database

Figure 1 in this review will illustrate the article screening process using the PRISMA list, which outlines the screening procedures and manuscript extraction criteria after the initial search based on eligibility criteria in research articles that match the research questions. The search results from the database were 3,318 articles to be filtered in the form of abstracts and 416 articles to be further filtered in full text. Of these, there are 94 articles that are relevant to the research question. Furthermore, to ensure that the article is in accordance with the research question, the author assesses the complete article, and the remaining nine articles are eligible. Further searches were conducted manually by the author through the selected articles, resulting in an additional 3 articles. The selection process was carried out based on the inclusion criteria of 11 articles for later analysis. Initially, titles and abstracts were examined, followed by a full-text review of the selected articles. If an article was deemed suitable, it was subjected to further evaluation.

Reliability of Study Extraction

All articles obtained from the search results were entered into the Mendeley tool used as a reference manager in the preparation of this study. Artiel included context and meaning according to the source document in the form of a title, abstract, and full text. To ensure that the articles were suitable for use, they were then re-screened by the reviewers using the inclusion and exclusion criteria set out in the guidelines.

Stage IV: Data Extraction

The author extracted data from articles relevant to the topic of the research, such as the time (year) of the research, the country where the research was conducted, the purpose of the research, the methods in the research, the population included in the research, as well as the relevance of the application of telemonitoring in the management of type 2 diabetes and the barriers, challenges, and opportunities for the application of telemonitoring. This is intended to facilitate the process of extracting the data needed in the preparation of the research.

Stage V: Summary of Findings and Reporting of Results

Literature findings were used to identify results based on keywords that appeared. In this review, all articles used were analyzed for title, abstract, and full article, then checked for discrepancies and duplication. All articles analyzed contained information on the application of telemonitoring in the management of patients with type 2 diabetes in SEA.

RESULTS

Characteristics Studi

Of the 11 articles discussed, the authors found articles from 5 countries, 3 studies were conducted in Indonesia, 3 studies were conducted in Malaysia, 2 studies were conducted in Singapore, 2 studies

were conducted in Thailand, and 1 study was conducted in Cambodia. The research design varies, there are 8 articles using Quantitative studies each 4 studies using Randomized Control Trial (RCT) [14,15,16,17], 1 study using Cluster-randomized Control Study (J. Y. Lee et al., 2012), 2 studies using Quasi-Randomized Control Study (J. Y. Lee et al., 2012), 2 studies used Quasi Experimental [18,19], and 1 study used Cross-Sectional Study (Wati et al., 2021) while 3 other studies used Exploratory Qualitative research design [21,22,23]. The smallest study sample size of 16 samples was conducted in Singapore (Tan et al., 2023), and the largest sample size was 330 samples conducted in Singapore (Tyagi et al., 2022). For quantitative study settings, there are 4 studies conducted in rural areas [5,1419,24], and 4 studies conducted in urban areas (Damayanti et al., 2021), while qualitative studies were 2 studies conducted in urban areas (Steinman et al., 2019) and 1 study conducted in rural areas (Tan et al., 2023). Overall, of the 11 included studies, the research population was in the age range of 18–65 years. All the included studies addressed the application of telemonitoring in DM patient management. A detailed discussion of the findings regarding the description of telemonitoring implementation for quantitative studies is presented in Table 3 and for qualitative studies in Table 4.

Application of telemonitoring in DM Management

In this study review there are 8 quantitative studies (Damayanti et al., 2021) and 3 qualitative studies [21,22,23]. The study results show that the application of telemonitoring is mostly Web-based as many as 4 studies [6,21,22,24], 2 WhatsApp-based studies [14,20], 2 studies using interactive telephone [20,22], 1 study using SMS text messages (Damayanti et al., 2021), 1 study using video consultation (Tan et al., 2023) and 1 study using Bluetooth devices (Tyagi et al., 2022).

Challenges and Opportunities for Telemonitoring Implementation

In the included study, we identified challenges and opportunities for the successful implementation of telemonitoring in Southeast Asia, which we classified into both extrinsic and instrinsic factors. These factors are described in the text of the article, summarized based on the participants' statements found in the qualitative study, and presented in Table 5. Some of the statements described in the article, such as "possible suboptimal care due to the absence of in-person physical examination," "problems in network connectivity," and "telemedicine devices that are not user-friendly," were considered challenges based on extrinsic factors in the implementation of telemonitoring. For intrinsic factors that are considered challenges such as "lack of familiarity with digital health technology," "assumption that in-person meetings are more satisfying," "cost of care," and "concerns about medical data protection," Opportunities in the implementation of telemonitoring are based on extrinsic factors such as "making it easier for patients to receive consultations," "saving time," and "positive support from family," while opportunities come from intrinsic factors such as "desire to know how to use the device" and "comfort and convenience in data tracking".

DISCUSSION

A review was conducted to see how telemonitoring is implemented in DM management within the SEA region. Overall, the review provides a comprehensive overview of the application of telemonitoring in DM management. All included studies showed that telemonitoring is a promising way to improve DM management that is highly accepted by patients who volunteered to be included in the study and proven to be effective as a key strategy in improving the self-management of DM patients as it is considered cheap and efficient in remote monitoring, but its use is adapted to the conditions at the study site.

The results obtained from this review show that the most common application of telemonitoring from 11 studies in SEA is web-based telemonitoring with varying implementation. The form of web-

based implementation is through a web portal equipped with a mobile application device and email address of the participant to remind regular blood sugar measurements (J. Y. Lee et al., 2016), sending blood sugar data automatically to the online portal and visually displayed and getting automatic feedback from the research team to support diabetes management (J. J. N. Lee et al., 2023), sending blood sugar test results through telemedicine devices (Signaling & Rochelle, 2017), and telemonitoring is done through sending voice messages to the patient's cell phone periodically to educate and support the management of chronic diseases such as DM (Steinman et al., 2019). The application of interactive telephone-based telemonitoring is using the interactive voice response (IVR) method to monitor diabetic patients. Patients answer questions via mobile phone, including symptoms of hypoglycemia and hyperglycemia, medication adherence, carbohydrate intake, physical activity, sleep quality, and foot care (Pichayapinyo et al., 2019), and conduct telephone monitoring to assess behavior for 7 days, including carbohydrate consumption, physical activity, and symptoms of glycemia, and support patients to overcome obstacles (Jantraporn et al., 2019). The form of implementing WhatsApp-based telemonitoring is that researchers send individual messages to each patient containing education about diabetes management, reminders to monitor blood sugar and diet, and support to overcome the problems faced (Sukarno & Munthe, 2021), consultations with remote doctors via WhatsApp, and monitoring glycemia through laboratory reports such as HbA1c from patients to doctors (Wati et al., 2021). The form of telemonitoring through text messages is carried out by sending short messages automatically to the patient's cell phone, which contain education, reminders, and motivation to help patients manage their diabetes (Damayanti et al., 2021). A form of video consultation telemonitoring involves independently checking blood glucose and blood pressure and then consulting the results via VC-based (Tan et al., 2023). Another form of telemonitoring application found in this study is through bloetooth devices. By receiving video-based distance education in the application, the healthcare team can remotely monitor blood pressure, capillary glucose, and body weight through bloetooth devices and cell phones (Tyagi et al., 2022).

Apart from the effective application of telemonitoring from the 11 included studies, several studies conducted in developed countries also support the results of studies, including research conducted in Australia (Warren et al., 2017) and Brazil (Santos et al., 2022), which show that telemonitoring interventions significantly change diabetes patients blood glucose control, reduce health service costs, and increase patient satisfaction. Along with the rapid development of technology, many developed countries have implemented the use of telemonitoring in health care facilities and continue to strive for further development. As in European countries, there has been a rapid increase, which is evidence that the prospects for using telemedicine in European countries are very good (Muigg et al., 2019). If we reflect on the facts in developed countries, the use of telemedicine in developing countries will actually have a more significant impact. In addition to being able to overcome the uneven quality of health services, it can also be an alternative for patients in rural areas to still get health services like those in urban areas as long as they still reach internet access. The challenges of access to care in Southeast Asia face limited health resources and infrastructure, especially in rural areas, causing a high health burden for countries in the region, while the prevalence of type 2 DM in Southeast Asia continues to increase and requires self-management of DM patients through monitoring when patients cannot reach health care facilities.

In this review, there are interesting findings to discuss regarding the challenges in implementing telemonitoring in the management of patients with DM, such as generational differences. In this study, it was found that older patients prefer manual recording, while the younger ones are more open to technology. To overcome this challenge, education and training need to be evenly and widely distributed in order to demonstrate acceptance and effective use of telemonitoring among patients in general (J. Y. Lee et al., 2012). Another challenge found was the network connectivity, which was considered less user-friendly, thus preferring to consult in person. In this study, patients and health workers stated that it is currently very difficult because certain villages do not have internet lines.

This suggests that the implementation of telemonitoring technology needs to consider the quality of the network at the study site and conduct effective data security measures (Signaling & Rochelle, 2017).

In addition to the challenges that are interesting to discuss, opportunities in the application of telemonitoring were also found in this study, one of which is the convenience and ease of tracking data, because in addition to saving time not to visit health facilities, patients can also monitor their health via the internet wherever the patient is as long as they still reach the internet (Signaling & Rochelle, 2017). This shows the potential of telemonitoring to be extended to other health services to improve the quality of health services by increasing access to effective nursing for patients and health workers.

Overall, the government and healthcare professionals collaborate to ensure that telemonitoring systems are effective in supporting diabetes management. The government is responsible for encouraging and supporting the implementation of telemonitoring in health facilities in order to increase access to and adoption of digital technology in the community. Health workers play an important role in educating and guiding patients on how telemonitoring works and ensuring patients understand how to use telemonitoring devices properly. Patients need to be continuously educated about the benefits of this system so that management of their disease through telemonitoring can be guaranteed. The limitation of this review is that articles other than those in Indonesian and English were not included in it. In addition, only 5 countries in the SEA region were included, namely, Indonesia, Malaysia, Singapore, Thailand, and Cambodia. In the countries of Laos, Myanmar, the Philippines, Brunei, Vietnam, and Timor-Leste, we did not find any studies identifying the application of telemonitoring in DM patient management.

CONCLUSION

This review is the first to identify the application of telemonitoring in DM patient management in SEA. Most of the articles analyzed showed that the implementation of telemonitoring in both rural and urban areas is an effective strategy for creating a great need for effective diabetes management solutions through technological devices. Despite the effective implementation of telemonitoring, there are some challenges and opportunities where the implementation of telemonitoring in SEA still has technical problems such as poor internet network connectivity and difficulty using telemonitoring devices that are less user-friendly, so there is still an expansion of telemonitoring access by considering the potential availability of telemonitoring devices, familiarity with digital health technology, health care costs, internet connectivity, medical data security, and digital transformation in the health sector.

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APPENDIX

Table. 1: Keyword search strategy in each database

No	Database	Keyword	Article Obtained	Date of Access
1.	Pubmed	*((((((((((((((Telemonitoring[Title/Abstract]) OR (Telehealth monitoring[Title/Abstract])) AND (Diabetes Mellitus[Title/Abstract])) OR (Diabetic Condition[MeSH Terms])) AND (southeast asia[MeSH Terms])) OR (southeastern asia[MeSH Terms])) OR (indonesia[MeSH Terms])) OR (malaysia[MeSH Terms])) OR (Singapura[MeSH Terms])) OR (thailand[MeSH Terms])) OR (Filipina[MeSH Terms])) OR (brunei[MeSH Terms])) OR (Vietnam[MeSH Terms])) OR (laos[MeSH Terms])) OR (myanmar[MeSH Terms])) OR (Kamboja[MeSH Terms])) OR (democratic republic of timor leste[MeSH Terms])*	1.354	1.
2.	*Science Direct*	*Telehealth monitoring OR implementation of telemonitoring AND Diabetes Mellitus OR Diabetic Condition AND Southeast Asia*	716	13 April 2024
3.	*Cochrane*	*telehealth monitoring AND Diabetes Mellitus OR Diabetic condition) AND southeast asia OR Southeastern Asia*	100	15 April 2024
4.	*Ebsco*	*(telehealth monitoring) AND (Diabetetes Mellitus management) AND Southeast Asia OR Southeastern Asia*	122	15 April 2024
5.	*Wiley*	*"telehealth monitoring" AND "Diabetes management OR Diabetes condition" AND "southeast asia OR southeastern asia" OR "Indonesia" OR "Malaysia" OR "Philippines" OR "Singapore" OR "Kamboja" OR "Vietnam"*	89	13 April 2024
6	*DOAJ*	'*Telemonitoring AND Diabetes AND Southeast Asia*'	224	15 April 2024
7	*Taylor & Francis*	*Telemonitoring application AND Diabetes management AND Southeast Asia*	137	16 April 2024
8	*Google Schoolar*	*Aplication of Telemonitoring in the management of Diabetes Mellitus Condition in Southeast Asia*	525	17 April 2024
9	*Garuda*	*Penerapan Telemonitoring AND Manajemen DM*	51	17 April 2024

Table 2: Population Concept and Context (PCC)

Criteria	
Popultion	It focuses on people with type 2 DM according to the country where the study was conducted.
Concept	Telemonitoring implementation
Context	studies were conducted in Southeast Asian countries consisting of Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Vietnam, Laos, Cambodia, Myanmar, and Timor-Leste.

Table 3: Application of Telemonitoring in Type 2 DM Management (Quantitative Study)

Author, Year Country	Aims	Sample (n, Age Range) and Setting	Application of Telemonitoring	Findings
(Pichayapinyo et al., 2019) 2019, Thailand	Knowing the improvement of glycemic control in patients with type 2 DM through an automated interactive voice response (IVR) phone call system	n = 36 age ≥ 20 years Rural	Interactive phone calls from health workers to patients	- There was a mean decrease in HbA1c levels of 0.9% (equivalent to a 9% decrease from the baseline mean HbA1c value - more than half of the patients (50%) had a decrease in HbA1c of more than 1.0% - about 23% of the patients had a decrease in HbA1c between 0.5% and 0.9% - there was a mean decrease in fasting blood glucose levels of 14.9 mg/dL (equivalent to a decrease of about 10% from the baseline mean value).
(Damayanti et al., 2021) 2021, Indonesia	To determine the effect of a 10-week short message system (SMS)-based intervention on the self-management of patients with type 2 diabetes.	n = 60 age ± 61 years Urban	Reporting by patients via automated text messages (SMS)	- There was an improvement in self-management practices in the intervention group. Statistical improvement was seen in the domains of general diet (0.42 ± 1.08); p=0.034), special diet (1.75 ± 1.42; p=0.0001), exercise (1.02 ± 1.85; p=0.005), blood glucose testing (0.53 ± 1.67; p=0.009), and foot care (4.75 ± 2.51; p=0.001) - There was no significant change in the control group (p>0.05).
(JY et al., 2020) 2019, Malaysia	Knowing the effectiveness of telemedicine and	n= 240 age ± 56 years Rural	Use of web-based devices by patients	- There was a mean reduction in HbA1c from baseline of 0.31% (95% C1 -0.51 to -0.10;

	telemonitoring in managing type 2 DM			p=0.003) in the telemonitoring intervention group compared to the usual care group of 0.10% (95% C1 -0.29 to 0.09; p=0.31).
(Sukarno & Munthe, 2021) 2021, Indonesia	Identifying the effectiveness of Dia-Care telemonitoring using whatssApp on diabetes outcomes in type 2 DM patients	n=72 age 18-65 years Rural	Use of the Dia-Care application via WhatsApp by patients	- Both groups (control and intervention) had a significant improvement in knowledge about diabetes after 1 month of intervention (p=0.001) - Both groups had a significant improvement in fasting blood sugar levels after 1 month of intervention (p=0.03) - For depression levels, only the intervention group showed a significant decrease in depression levels with a mean decrease of 2.47 (SD= 1.59; p=0.04).
(Jantraporn et al., 2019) 2019, Thailand	To determine the effect of carbohydrate reduction combined with telemonitoring on HbA1c levels in patients with poorly controlled type 2 diabetes.	n = 53 aged 35-59 years Urban	Phone calls from health workers to patients	- A carbohydrate reduction program combined with telemonitoring is effective in reducing HbA1c levels in patients with poorly controlled type 2 diabetes - The experimental group showed significant improvement in HbA1c levels compared to the control group (p < 0.05).
(J. Y. Lee et al., 2017) 2017, Malaysia	To assess the effectiveness of telemonitoring in managing diabetes	n = 85 age ± 53 years Rural	Use of the website: patients submit their blood glucose level results.	- The telemonitoring group showed significant improvement in glycemic control with a decrease in mean HbA1c (1.07%) compared to the usual care group (0.24%).
(Wati et al., 2021)	Determining telemedicine	n = 264	Telemonitoring through a	- Out of 264 type 2 DM patients, only

2021, Indonesia	use and factors contributing to glycemic control in patients with type 2 DM	age 25-54 years Urban	telemedicine platform that includes health and non-health applications (WhatsApp)	19.2% used telemedicine and 60.2% of them had poor glycemic control - Telemedicine was found to be effective in Diabetes care (p=0.001)
(Tyagi et al., 2022) 2022, Singapore	Determine the clinical outcomes of patients using the new telemonitoring system compared to standard care.	n = 330 aged 26-65 years Urban	Remote monitoring of capillary glucose and BB via a Bluetooth device and mobile phone on the Outcomes of Patients Using a Novel Tele-monitoring System (OPTIMUM) app.	- The intervention group showed a significantly lower HbA1c of 0.34% (95% C1 = -0.57 to -0.11; p=0.0004) compared to the control group - No significant weight change was noted between groups

Table 4: Application of Telemonitoring in Type 2 DM Management (Qualitative Study)

Author, Year Country	Aims	Sample (n, Age Range) and Setting	Application of Telemonitoring	Findings
(Tan et al., 2023) 2023, Singapore	Understanding non-communicable disease patients' perceptions of the benefits and barriers to video consultation (VC) adoption and the potential challenges they may face	n = 16 age 38-65 years Rural	- Telemonitoring melalui Video Consultation	There were three main themes to this research: - Perceived benefits: Participants found the implementation of monitoring with video consultation (VC) to manage their illness to be safe and convenient. - Perceived barriers: • Concerns about the possibility of suboptimal care due to the absence of direct physical examination • Network connectivity barriers • Security of personal medical data - Potential challenges: • Availability of personally owned mobile and telemonitoring devices • healthcare cost considerations • Familiarity with digital health technologies
(Jantraporn et al., 2019) 2019, Malaysia	To understand the acceptance and effectiveness of telemedicine among patients	n = 48 mean age 51 years Urban	- Using digital telemedicine devices and patients sending their blood glucose results regularly	- Telemedicine has significant potential benefits in diabetes management. - Some of the key findings in this study are: • Generational differences: ✓ Older participants tended to prefer to record their blood glucose manually, while younger ones were open to the use of technology. ✓ Independence and convenience Participants were more comfortable using telemedicine, especially with a mobile device connected to a glucometer, which helped them manage their diabetes without

				having to frequent clinics. • Health data sharing and privacy There are concerns regarding data security and privacy. • Technical Challenges Poor internet connectivity and difficulty using telemedicine devices that are not user-friendly • Economic limitations and access to technology in active telemedicine implementation • role of family DM management through telemedicine is recognized as an important factor in providing support and supervision.
(Steinman et al., 2019) 2019, Kamboja	To identify factors that support and hinder chronic disease management	n = 70 age ± 55 years Urban	- Using the M-Health app to report complaints	- Barriers and facilitators of chronic disease management: • Barriers: access to medications and clinical support • Facilitators: family support and peer education are critical in helping patients manage their disease. - Participants' preferences for M-Health messages • Participants prefer M-Health messages to be simple and engaging. • Voice messages are preferred over text messages as they are more accessible. - Acceptability and feasibility of M-Healh messages • M-health messages are a useful addition to their disease management strategy - Implications for improved chronic disease management • M-Health has the potential to improve self-care behaviors.

Table 5. Challenges and Opportunities for Telemonitoring Implementation

Thema	Factors		Source	Excerpt
Challenge	Extrinsic	Possible suboptimal treatment due to a lack of direct physical examination	(Tan et al., 2023)	"I understand leg pain, back pain, all this I can't mention in the video... my leg is swollen, the doctor can't see it either. My blood test should come.... "(Tan et al., 2023) (p.5)
		Network connectivity	(Tan et al., 2023)	"My internet connection and some families may not be good." (Tan et al., 2023) (p.5) "At the moment, it is also very difficult because certain villages do not have internet lines." (Signaling & Rochelle, 2017) (p.14)
		Availability of mobile devices and telemonitoring	(Tan et al., 2023)	"I have no problem because I have all this (the BP machine and glucometer). But some low-income patients can't monitor themselves at home because they don't have the equipment; they have to go to the clinic." (Tan et al., 2023) (p. 5)
		Telemedicine devices that are not user-friendly	(Steinman et al., 2019)	"I'm worried that I won't be able to understand and practice if the content isn't simple or if it uses too many technical terms" (Steinman et al., 2019) (p. 9).
	Intrinsich	Lack of familiarity with digital health technology	(Tan et al., 2023)	"I have to study and catch up. All the advanced technology... I don't understand... My computer is not familiar." (Tan et al., 2023) (p. 5). "I record manually... I don't understand if it's through a phone device." (Signaling & Rochelle, 2017) (p. 11) "My husband has, my son has, but I don't have... I don't know how to use it." (Steinman et al., 2019) (p. 10). "It's okay, but what I'm afraid of is sometimes conflict, because it feels like I'm being watched by other people." (Signaling & Rochelle, 2017) (p. 14)
		Concerns over medical data protection	(Signaling & Rochelle, 2017)	"I have to study and catch up. All the advanced technology... I don't understand... My computer is not familiar." (Tan et al., 2023) (p. 5). "I record manually... I don't understand if it's through a phone device." (Signaling & Rochelle, 2017) (p. 11) "My husband has, my son has, but I don't have... I don't know how to use it." (Steinman et al., 2019) (p. 10).

				"It's okay, but what I'm afraid of is sometimes conflict, because it feels like I'm being watched by other people." (Signaling & Rochelle, 2017) (p. 14)
		Presumption that face-to-face encounters are more satisfying healthcare costs	(Signaling & Rochelle, 2017)	"Face-to-face (consultation) is more important and better. With face-to-face, information is clearer and more satisfying" (Signaling & Rochelle, 2017) (p. 15).
		Presumption that face-to-face encounters are more satisfying healthcare costs	(Tan et al., 2023)	"It doesn't make sense that it's more expensive... I should just see a doctor." (Tan et al., 2023) (p. 6)
Opportunities	Extrinsic	Make it easy for patients to receive consultations.	(Tan et al., 2023)	"I think it is a very good practice. There is no need to have direct contact with other people." (Tan et al., 2023) (p. 4)
		Save time	(Tan et al., 2023) (Signaling & Rochelle, 2017)	"Even if it rains, I still have to come to the clinic, whereas for video consultation (VC), rain or shine, the doctor is still there. It's a very beneficial thing for patients." (Tan et al., 2023) (p.4) "It's good to use, especially through the internet. It's much easier; we don't need to come to the clinic and can stay at home." (Signaling & Rochelle, 2017) (p. 13)
		Positive support from family	(Steinman et al., 2019)	"The difficulty is that the person holding the phone is not near the patient; it is the children who will relay the content of the message." I asked a grandchild or child to press the number button (Steinman et al., 2019) (p. 10).
	Intrinsisch	Desire to know how to use the device	(Signaling & Rochelle, 2017)	"for me it is not difficult, just need to teach it... the first time may be difficult to understand..." (Signaling & Rochelle, 2017) (p.11)
		Convenience and ease of data tracking	(Signaling & Rochelle, 2017)	"I like this, because you can transfer directly to your phone... This is the best tool because you can monitor your health through the internet wherever you go" (Signaling & Rochelle, 2017) (p.12). "It's even more convenient because we don't have time to come to the doctor in person" (Signaling & Rochelle, 2017) (p.12).

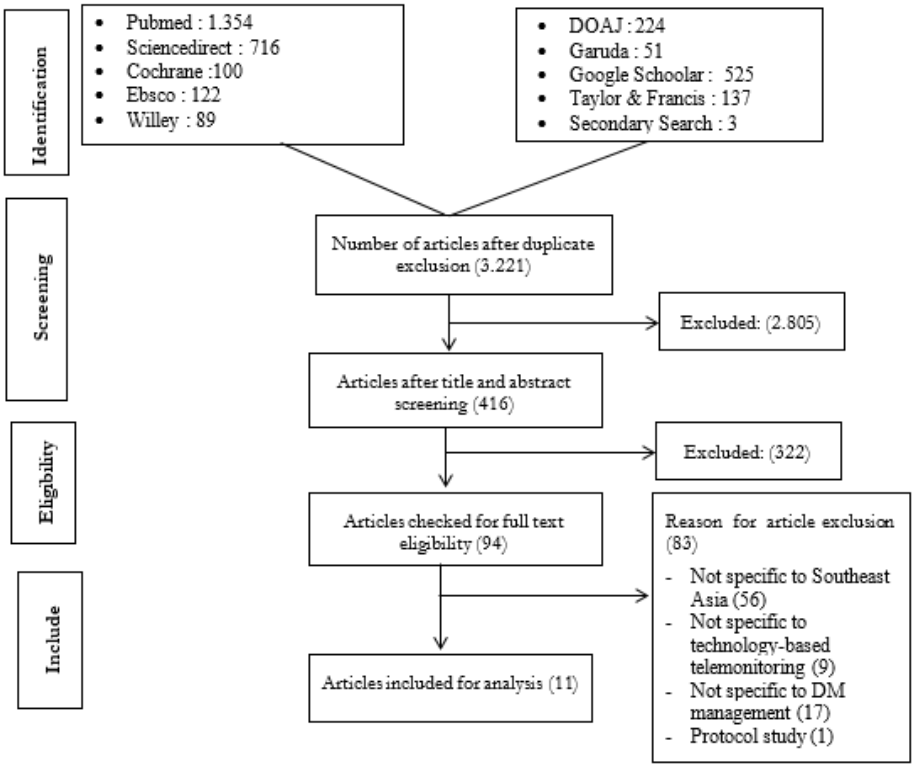

Figure 1. PRISMA Flowchart

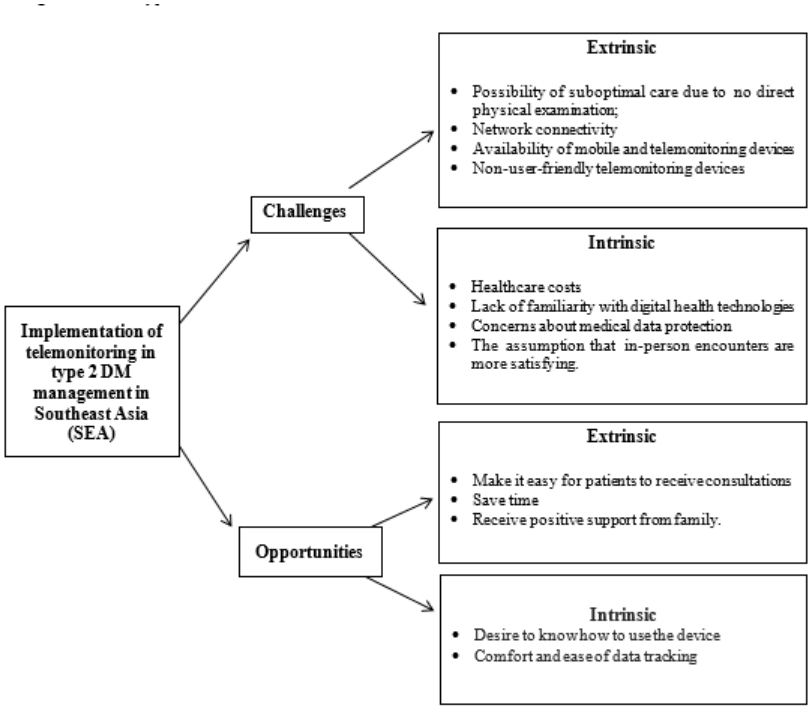

Figure 2. Framework of Challenges and Opportunities for Implementing Telemonitoring in the Management of Type 2 DM in Southeast Asia