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ORIGINAL ARTICLE

Enhancing Diabetes Medication Adherence Clinics Service Delivery: A Pre-Delivery Framework based on the Double Diamond Model

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ABSTRAK

Klinik kepatuhan terapi ubat-ubatan diabetes (DMTAC) di Malaysia memainkan peranan penting dalam pengurusan penyakit diabetes jenis 2. Namun, ia berdepan dengan beberapa cabaran seperti kadar ketidakhadiran pesakit yang tinggi, keciciran daripada program dan ketidakseragaman dalam penyampaian perkhidmatan, yang secara keseluruhannya menjejaskan keberkesanan klinik ini. Berpandukan tiga fasa pertama model reka bentuk Berlian Berganda (Double Diamond) (penemuan, penerangan, pembangunan), kajian ini bertujuan untuk membangunkan kerangka pra-penyampaian berasaskan bukti untuk menangani jurang tersebut secara sistematik. Bukti disintesis daripada (i) kajian kohort retrospektif melibatkan 198 pesakit yang mengukur hasil klinikal dan faktor risiko keciciran; (ii) temu bual separa berstruktur dengan 32 pesakit yang mengenal pasti halangan, pemudah cara dan keutamaan perkhidmatan; serta (iii) tinjauan skop komprehensif melibatkan 61 ujian terkawal rawak mengenai intervensi diabetes yang dikendalikan ahli farmasi. Keperluan reka bentuk yang diperolehi telah dipadankan dengan Model Transteoretikal (TTM), "Health Action Process Approach" (HAPA), serta model komunikasi "Motivational Interviewing" (MI) dan "Shared Decision-Making" (SDM). Kerangka yang terhasil merangkumi tiga domain: (i) Pra-perkhidmatan: penilaian tahap kesediaan pesakit dan saringan halangan mengikut peringkat perubahan; (ii) Semasa perkhidmatan: intervensi modular berfokuskan pesakit yang disampaikan melalui MI atau SDM dengan perancangan tindakan dan penanganan berpaksikan HAPA; dan (iii) Pasca perkhidmatan: kaedah lawatan susulan yang fleksibel, bantuan pengurusan diri yang disesuaikan, serta peringatan janji temu automatik. Kerangka pra-penyampaian ini menawarkan panduan berasaskan teori yang boleh dilaksanakan oleh pakar klinikal dan pengurus perkhidmatan untuk meningkatkan penglibatan pesakit, kepatuhan ubat dan hasil klinikal di DMTAC seluruh Malaysia.

Kata kunci: *Intervensi ahli farmasi; kepatuhan ubat; pengurusan diabetes*

ABSTRACT

Diabetes medication therapy adherence clinics (DMTAC) in Malaysia are crucial for managing type 2 diabetes but encounter significant operational challenges, including high rates of patient non-attendance,

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program dropout and variability in service delivery, which collectively undermine their effectiveness. Guided by the first three phases of the Double Diamond design-thinking model (discover, define, develop), this study aimed to create an evidence-based pre-delivery framework to systematically address these gaps. Evidence was triangulated from (i) a retrospective cohort study of 198 patients that quantified clinical outcomes and attrition risk factors; (ii) semi-structured interviews with 32 patients that illuminated barriers, facilitators and service preferences; and (iii) a comprehensive scoping review of 61 randomised controlled trials on pharmacist-led diabetes interventions. Design requirements extracted from these sources were mapped to the Transtheoretical Model (TTM), Health Action Process Approach (HAPA) and the communication models of Motivational Interviewing (MI) and Shared Decision-Making (SDM). The resulting framework comprised three sequential domains: (i) Pre-Service: stage-matched assessment of patient readiness and barrier screening; (iii) Within-Service: modular, patient-centred interventions delivered via MI or SDM with explicit action- and coping-planning rooted in HAPA; and (iii) Post-Service: flexible follow-up modalities, tailored self-management aids and automated appointment reminders. This pre-delivery framework offers clinicians and service managers an actionable, theory-informed guide to enhance engagement, medication adherence and clinical outcomes across Malaysian DMTAC settings.
Keywords: Diabetes management; medication adherence; pharmacist-led intervention

INTRODUCTION

Diabetes medication therapy adherence clinic (DMTAC) plays a crucial role in managing diabetes and its complications. These specialised, pharmacist-led services aim to optimise medication adherence and improve clinical outcomes among patients with type 2 diabetes. The current DMTAC protocol in Malaysia follows a standardised approach, featuring scheduled sessions that focus on medication management, lifestyle modification and regular follow-ups (Lim et al. 2023). These sessions seek to enhance medication adherence, deepen patients' understanding of their treatment and empower them to effectively manage their condition.

Despite the recognised benefits of DMTAC, several significant challenges hinder the program's effectiveness. These challenges include patient non-attendance, high program dropout rates and variability in service delivery across different healthcare settings (Teng et al. 2022). The standardised nature of the DMTAC protocol often struggles with varying levels of patient engagement and inconsistencies in implementation across diverse healthcare facilities. To address these issues and enhance the delivery of DMTAC services, adopting a structured and comprehensive approach to the design and implementation of targeted interventions is essential to improving the program's effectiveness and reach.

The Double Diamond model, a widely recognised framework in design thinking, offers a systematic process for developing and implementing complex interventions (Design Council 2019). This model consists of four key phases: discover, define, develop and deliver. The discover phase involves a comprehensive assessment of the problem, understanding the needs and experiences of stakeholders, and identifying potential barriers and facilitators. The define phase synthesises the insights gained during the discover phase to clearly articulate the problem and its underlying factors. The develop phase involves the co-creation of potential solutions, while the deliver phase encompasses the implementation, evaluation and refinement of the intervention.

Applying the Double Diamond model provides a structured approach to enhancing DMTAC service delivery. While foundational research detailing the discover and define phases for this project has been previously published (Hassan & Hatah 2022; Hassan et al. 2024a; Hassan et al. 2024b). This paper details the crucial "develop" phase of the Double

Diamond model, presenting a novel, synthesised framework for DMTAC service pre-delivery. The novelty of this work lies in the integration and translation of diverse findings derived from clinical outcomes analysis (Hassan et al. 2024b), exploration of patient perspectives (Hassan et al. 2024a), and a comprehensive scoping review (Hassan & Hatah 2022) into a structured, theory-informed framework. This "pre-delivery framework" is conceptualised as a strategic guide for the design and planning of enhanced DMTAC services, aiming to proactively address identified challenges and optimise service effectiveness. By conducting a detailed needs assessment and contextual analysis, it ensures that the intervention is tailored to the specific needs and conditions of the target populations. Adapting the Double Diamond model can help to develop an effective solution to improve the efficiency and consistency of DMTAC services.

This study aims to present this comprehensive pre-delivery framework, built on the strengths of the existing DMTAC protocol while incorporating insights from diverse research methodologies. The ultimate goal is to provide a robust foundation for enhancing patient engagement, optimising care and improving clinical outcomes in diabetes management across Malaysia, preparing the way for more effective delivery of DMTAC services.

MATERIALS AND METHODS

This study employed the Double Diamond model to guide the systematic development of an enhanced service delivery model for DMTAC. The Double Diamond model provided a structured process for developing complex interventions by alternating between divergent phases of exploration and divergent thinking, and convergent phases of synthesis and focused problem-solving (Design Council 2019). This approach was particularly well-suited for health services research, as it ensured that the resulting intervention was grounded in a deep understanding of the problem context, stakeholder needs and existing evidence (Feldman et al. 2020).

The research was organised into the first three of the model's four phases: discover, define and develop. The discover and define phases constituted the foundational research, which had been published previously. This paper detailed the crucial develop phase, which focused on synthesising the foundational evidence to create a novel, theory-informed pre-delivery framework for DMTAC services. The entire research process, including the methods and key outputs for each phase, was visually summarised in Figure 1. This diagram served as a roadmap, illustrating the logical progression from broad problem

	Discover	Define	Develop
Guiding Question	What is the current state and what are the problems with DMTAC services?	What are the core challenges to address and what does existing evidence suggest?	How can we design a comprehensive and targeted solution?
Methods	**Retrospective Cohort Study:** Analysis of clinical records (n=198) to assess clinical outcomes and identify risk factors for attrition. **Qualitative Study:** Thematic analysis of semi-structured interviews (n=32) to explore patient experiences, barriers, and needs.	**Scoping Review:** Systematic review and narrative synthesis of 61 randomized controlled trials on pharmacist-led diabetes interventions.	**Theoretical Integration:** Selection and integration of behavioral theories (TTM, HAPA) and communication approaches (MI, SDM) to address identified needs. **Framework Synthesis:** Inductive, multi-stage triangulation and mapping of findings from Discover and Define phases to theoretical constructs to build the framework components.

FIGURE 1: Methods for each research phases based on the Double Diamond Design Thinking processes

exploration to the development of a targeted, evidence-based solution.

The development of the proposed framework was predicated on a comprehensive body of foundational research conducted during the discover and define phases. The methods for these studies were summarised here to provide context for the current paper's focus on the develop phase.

Discover Phase

The discover phase utilised a mixed-methods approach to gain a deep and multifaceted understanding of the challenges within the existing DMTAC service model. A retrospective analysis of patient records was conducted at three health clinics and two hospitals in Selangor, Malaysia. The study population included 198 patients with type 2 diabetes who attended at least one DMTAC session between January 2018 and December 2020. Patients were categorised by attendance (complete versus incomplete). Clinical outcomes, including changes in glycated haemoglobin (HbA1c) and fasting blood sugar (FBS), were assessed using two-way repeated measures ANOVA. Binary logistic regression was employed to identify risk factors for incomplete attendance. This study had been published in full by Hassan et al. (2024b).

To explore patient perspectives, semi-structured interviews were conducted with 32 DMTAC attendees from five healthcare facilities between January and July 2022. Participants were recruited via convenience sampling. The interviews explored experiences with program content, communication, scheduling and barriers to attendance. Transcripts were analysed using Braun and Clarke's (2006) six-step thematic analysis approach to identify key themes. A full report of this study had been published by Hassan et al. (2024a).

Define Phase

The define phase aimed to synthesise existing evidence on effective interventions to identify gaps in current practice and potential solutions. A scoping review was conducted following the Joanna Briggs Institute guidelines, searching databases such as Ovid Medline, PubMed, Scopus and Web of Science for articles published between 1990 and 2020. The review focused on pharmacist-led diabetes management interventions. Data from 61 selected randomised controlled trials were extracted and evaluated through narrative synthesis, focusing on intervention content, delivery methods and outcomes. The complete findings of this review were published by Hassan and Hatah (2022).

Develop Phase

The develop phase, the primary focus of this manuscript, involved the systematic synthesis of evidence from the foundational phases and its integration with established behavioural theories to construct the proposed pre-delivery framework. The design of the framework was intentionally guided by established behavioural science theories and communication models to ensure it was equipped to address the complex challenges identified in the discover and define phases. Four theoretical components were selected which were the Transtheoretical Model (TTM) of Behaviour Change, Health Action Process Approach (HAPA), Motivational Interviewing (MI) and Shared Decision-Making (SDM). The selection of each theoretical component was justified by specific evidence from the foundational research.

The qualitative study revealed significant variability in patient readiness, with some feeling overly confident in their self-management abilities while others felt overwhelmed, leading to disengagement. The TTM, also known as the Stages of Change (SoC) model, directly addressed this by proposing that individuals progressed through distinct stages of readiness for change (precontemplation, contemplation, preparation, action and maintenance). Incorporating the TTM allowed pharmacists to first assess a patient's stage of readiness, enabling the tailoring of interventions to be more relevant and effective,

thereby avoiding the "one-size-fits-all" approach that patients found unhelpful.

While the TTM was effective for assessing motivation, the HAPA provided a crucial bridge between intention and action. HAPA divided behaviour change into a motivational phase (building intention through risk perception, outcome expectancies and self-efficacy) and a volitional phase (translating intention into action through planning). The qualitative data showed patients struggled with logistical barriers and translating knowledge into consistent behaviour. The scoping review identified various intervention components but lacked a structure for their application. HAPA provided this structure by emphasising concrete action planning (what, when, where) and coping planning (how to overcome anticipated barriers), which were essential for supporting patients in the volitional phase of change.

Patient interviews highlighted a perception of communication as "one-sided" and lacking empathy, which diminished engagement. MI was a collaborative, person-centred communication style designed to explore and resolve ambivalence and strengthen a person's own motivation for change. It was the ideal vehicle for engaging patients, particularly those in the TTM's pre-contemplation or contemplation stages. Instead of a didactic delivery of information, MI used empathy, open-ended questions and reflective listening to help patients articulated their own reasons for change, directly addressing the communication deficits identified.

For patients who were ready to act (preparation/action stages), SDM was the appropriate collaborative model. SDM was a process where clinicians and patients work together to make health decisions, integrating the best clinical evidence with the patient's values and preferences. This approach directly responded to patient desires for more involvement in their care and facilitates the collaborative goal-setting and action planning central to the HAPA model.

Framework Synthesis and Integration Process

The development of the framework was a systematic, multi-stage process designed to ensure that the final product was both evidence-based and theoretically sound. The first step was the process of evidence triangulation and thematic extraction. The process began with an inductive analysis of the key findings, themes and recommendations from the three foundational studies (retrospective cohort study, qualitative patient study and scoping review). These data points were collated and coded to create a comprehensive list of "design requirements" for an enhanced DMTAC service. Examples of these requirements included the need to "personalise content to avoid repetition", "address logistical and transportation barriers", "improve patient-provider communication style" and "incorporate evidence-based behavioural strategies".

Second step was by mapping evidence to theoretical constructs. The extracted design requirements were then systematically mapped onto the constructs of the selected behavioural theories (TTM, HAPA) and communication models (MI, SDM). For instance, the requirement to "personalise content" was mapped to the TTM's stages of change, leading to the creation of the "assess patient readiness" component of the framework. The need to "address logistical barriers" was mapped to HAPA's "coping planning" construct. The need to "improve communication style" was mapped to the principles of MI and SDM. This step ensured that every component of the framework was justified by both empirical evidence and theoretical principles.

Step 3 involved structuring the framework workflow. The mapped themes and components were organised into a logical, chronological workflow that mirrored the natural progression of a patient consultation. This resulted in the three-stage structure: "Pre-Service" (assessment and planning), "Within-Service" (intervention delivery), and "Post-Service" (follow-up and support). This process-oriented structure was

chosen to enhance the framework's intuitive appeal and practical utility for clinicians and service managers.

Final step was iterative refinement and consensus. An initial draft of the framework was developed by one author (F.H.) and then subjected to an iterative review process by the entire research team. Multiple rounds of discussion were held to challenge assumptions, refine the categorisation of themes and sub-themes, and ensure the framework's structure and content were robust, coherent and accurately reflected the synthesised evidence from all foundational phases. This collaborative process minimised individual bias and ensured the final framework was a comprehensive and validated representation of the collective dataset.

RESULTS

This section summarised key findings from the discover and define phases that informed framework development, followed by a detailed presentation of the developed framework itself.

Key Findings from the Discover Phase: Impact of DMTAC on Clinical Outcomes and Identification of Risk Factors for Non-Completion

This section summarises the findings from our retrospective cohort study, which investigated how DMTAC attendance affects glycemic control and identified specific risk factors for patient attrition (Hassan et al. 2024b). An examination of the patient database for those receiving DMTAC services revealed that only 49% (n = 98) fully attended their appointments, while 50.5% (n=100) attended fewer than four sessions, in line with DMTAC protocol. The cohort had an average age of 56.52 years (SD = 12.91), with 49% (n = 97) being male. The majority identified as Malay, had an unspecified education level and were not employed. There were no significant baseline differences between the complete and partial attendance groups regarding sociodemographic and clinical characteristics, except for Malay ethnicity (p = 0.018). Baseline sociodemographic and clinical characteristics were analysed between the complete and incomplete attendance groups (Appendix Table S1).

No significant difference in HbA1c levels was found between the groups at the beginning and end of the study, with HbA1c values for the complete group decreasing from 10.83% (95% CI: 10.31, 11.34) to 9.61% (95% CI: 9.13, 10.09), $p < 0.001$, and for the incomplete group from 10.40% (95% CI: 9.84, 10.97) to 9.94% (95% CI: 9.42, 10.47), p = 0.029. FBS values significantly decreased in the complete attendance group, from 10.14 mmol/L (95% CI: 8.97, 11.31) to 7.73 mmol/L (95% CI: 6.67, 8.79), $p < 0.001$, while no significant change was observed in the missed attendance group (p = 0.996). The significant difference in FBS values between groups at the end of the study was p = 0.024 (Appendix Table S2).

Logistic regression identified gender, education level and duration since diabetes diagnosis as significant risk factors for DMTAC attrition. Male patients were 65.2% less likely to miss appointments compared to female patients (OR = 0.35; 95% CI = 0.14, 0.85, p = 0.021). Those with lower education levels also had a lower risk of attrition (OR = 0.28; 95% CI = 0.08, 0.99, p = 0.049). An increase in the duration since diabetes diagnosis slightly increased the risk of attrition (OR = 1.06; 95% CI = 1.01, 1.11, p = 0.023). No significant associations were found between age, employment status and the number of comorbid diagnoses with DMTAC attrition (Appendix Table S3). These findings highlighted specific patient groups at higher risk of non-completion, informing the need for targeted engagement strategies within the framework.

Key Findings from the Discover Phase: Patient Perspectives on DMTAC in Malaysia

To better understand the patient experience, semi-structured interviews were previously conducted to explore how individuals perceive the value and accessibility of DMTAC services

(Hassan et al. 2024a). The study interviewed 32 respondents aged 23 to 81 from the state of Selangor to explore their perceptions of the DMTAC services. Three primary themes emerged: (i) the role of the program in meeting patients' needs; (ii) the quality and effectiveness of information delivery; and (iii) the availability and accessibility of services. Patients generally appreciated the DMTAC program for enhancing their self-efficacy, helping them prioritise diabetes management amidst other chronic conditions and managing disease-related stress. However, some patients felt capable of managing their diabetes independently and perceived the information as repetitive, leading to reduced motivation to attend the sessions. This indicated a need for personalised approaches and assessment of patient readiness within the framework.

The quality and effectiveness of information delivery were influenced by several factors, including barriers to information delivery, patient-centered communication, the patient-pharmacist relationship and the content of the information provided. Patients reported varying experiences with hospital waiting times, privacy during consultations and language proficiency, which impacted their ability to benefit from the DMTAC sessions. Effective communication and a strong patient-pharmacist relationship were crucial for patients to feel understood and supported. However, some patients felt the communication was one-sided and lacked empathy, reducing their engagement with the program. These points underscored the framework's emphasis on communication strategies.

Availability and accessibility issues significantly impacted patients' attendance at DMTAC appointments. Logistical constraints such as transportation, parking difficulties and the need for frequent clinic visits posed challenges, especially for those relying on public transport or caregivers. Some patients suggested offering services via telephone or video calls to reduce the need for physical attendance. Additionally, forgetfulness and oversight led to missed appointments, with patients recommending reminder phone calls as a potential solution to improve attendance. Overall, the study highlighted the need for tailored DMTAC services that consider individual patient needs and circumstances to enhance their effectiveness and accessibility (Appendix Table S4). These logistical and accessibility concerns directly informed the framework's recommendations for flexible service delivery.

Key Findings from the Define Phase: Limitations of Current Practice and Potential Solutions from Scoping Review

As part of the define phase, a scoping review was conducted to synthesise existing global evidence on pharmacist-led diabetes interventions and identify gaps in current Malaysian practice (Hassan & Hatah 2022). The systematic search identified 4,370 articles on pharmacist-led diabetes management, with 140 articles included for full-text review after removing duplicates and unrelated titles/abstracts. Ultimately, 61 randomised controlled trials were selected for analysis. These studies spanned various regions, with the majority conducted in Asia (n = 27) and North America (n=16). The settings for these interventions included community health centers, community pharmacies, outpatient clinics and outpatient pharmacies. Interventions were often delivered by multidisciplinary teams, though 24 studies involved pharmacists working independently. Methods of service delivery primarily consisted of face-to-face sessions, with additional methods such as phone calls, group sessions and home visits were employed, highlighting options for the framework's service delivery strategies.

The interventions were categorised into eight strategy types: diabetes education, medication review, drug consultation/counseling, clinical intervention, lifestyle adjustment, self-care, peer support and behavioral intervention (Appendix Table S5). Most studies employed a combination of these strategies, with diabetes education being the most common. The follow-up periods for the interventions ranged from 1.5 to 24 months, with the most frequent duration being 12 months. The

frequency of follow-ups varied, with the mean number being six. The majority of studies reported significant improvements in glucose control and medication adherence, demonstrating the effectiveness of pharmacist-led interventions in managing diabetes. This evidence base provided a rich source of intervention components for the proposed framework.

Framework Development

The proposed framework was not a theoretical construct developed in isolation. Each component was a direct response to specific evidence generated during the foundational research phases. Table 1 summarised the key findings from the retrospective cohort study, the qualitative study and the scoping review, and explicitly outlined their direct implications for the design of the new DMTAC service framework. This table provided a clear and transparent evidence base for the framework's structure and content.

Drawing upon the triangulated evidence presented above, the primary result of the develop phase was a comprehensive pre-delivery framework designed to guide the planning and tailoring of DMTAC services. The framework was conceptualised as a process-oriented workflow, visually represented in Figure 2. It was organised into three distinct, sequential stages; pre-service, within-service, and post-service, to provide a clear, intuitive and actionable guide for pharmacists and service managers. This structure transformed the service from a rigid protocol into a dynamic, patient-centred process.

The framework's workflow began with a crucial pre-service stage that fundamentally shifted the focus of the initial encounter from information delivery to deeper patient assessment. This stage was designed to create a comprehensive understanding of the patient's unique context before any intervention was planned. It directly addressed the qualitative findings that a "one-size-fits-all" approach was ineffective and that patients often felt information was repetitive.

The first step was to assess patient readiness for change, guided by the principles of TTM. This allowed the pharmacist to determine if the patient was in a pre-contemplation, contemplation or preparation stage, which dictated the most appropriate communication style and intervention focus. This was followed by a collaborative dialogue to identify patient priorities and concerns, ensuring the service addresses what mattered most to the patient, rather than adhering to a rigid protocol. Finally, this stage included a proactive screening for barriers, including the logistical issues identified in the qualitative study and the known attrition risk factors identified in the retrospective analysis. The output of this stage was a clear engagement strategy tailored to the individual.

The within-service stage represented the core therapeutic encounter. Guided by the insights from the pre-service assessment, the pharmacist moved from a standardised protocol to a highly tailored intervention. This stage had three interconnected components. First was intervention selection. Based on the patient's identified needs and priorities, the pharmacist selected from a modular set of interventions covering key areas such as medication adherence, pharmacotherapy, knowledge, lifestyle and self-care. This modularity supported by the diverse strategies found in the scoping review, ensured the session is focused and relevant.

Second was the communication approach. This component marked a deliberate shift away from the didactic style that patients found disengaging. For patients assessed as "Not Ready," the pharmacist employed MI to explore ambivalence and built intrinsic motivation. For patients assessed as "Ready," the pharmacist uses SDM to foster a collaborative partnership. This dual approach ensured the communication style matched to the patient's psychological state.

Third was action and coping planning. Informed by HAPA, this component focused on translating intention into behaviour. The pharmacist and patient engaged in collaborative goal-setting to establish specific and achievable objectives. Critically, they also developed

TABLE 1: Summary of key findings from foundational research and implications for framework design

Source of Evidence	Key Findings	Implication for Framework Design
Discover: Retrospective Study	High program attrition, with 50.5% of patients attending fewer than the four required sessions	Post-Service Stage: Framework must include strategies for proactive appointment reminders and flexible follow-up scheduling to mitigate non-attendance
	Risk factors for attrition include female gender, higher education and longer duration since diagnosis	Pre-Service Stage: Framework must include screening for these risk factors to identify patients needing more intensive engagement strategies from the outset
	Complete attendance was associated with significant improvements in FBS, while incomplete attendance was not	Reinforces the critical importance of improving attendance and completion rates, justifying the framework's focus on engagement and retention
Discover: Qualitative Study	Patients reported varying levels of motivation and readiness; some felt information was repetitive and unhelpful, leading to disengagement	Pre-Service Stage: Framework must begin with an assessment of patient readiness (using TTM) and existing knowledge to tailor content and avoid redundancy
	Communication was often perceived as one-sided, didactic, and lacking empathy	Within-Service Stage: Framework must incorporate collaborative communication strategies like MI and SDM to replace the traditional educational model
	Logistical constraints (transportation, parking, frequent visits) were significant barriers to attendance	Post-Service Stage: Framework must offer flexible, non-face-to-face follow-up options (e.g., telephone, video call) to reduce patient burden
	Patients suggested appointment reminders via phone calls would be helpful to combat forgetfulness	Post-Service Stage: Justifies the inclusion of a dedicated appointment reminder system as a standard component of service delivery
Define: Scoping Review	Pharmacist-led interventions are effective, but successful programs use a combination of strategies. Eight common types were identified, including education, medication review, and behavioral interventions	Within-Service Stage: Supports the framework's modular approach to intervention selection (e.g., knowledge, lifestyle, self-care) and validates the inclusion of behavioral change as a core component
	Interventions were delivered through diverse methods, including face-to-face, phone calls, group sessions, and home visits.	Post-Service Stage: Provides an evidence base for the framework's recommendation to diversify appointment methods beyond traditional in-person consultations.
	Interventions based on behavioral change theories were associated with positive outcomes	Methods & Overall Design: Justifies the explicit integration of TTM and HAPA as the theoretical foundation for the entire framework, enhancing its scientific rigor

FBS: Fasting blood sugar; HAPA: Health action process approach; MI: Motivational interviewing; SDM: Shared decision-making; TTM: Transtheoretical model

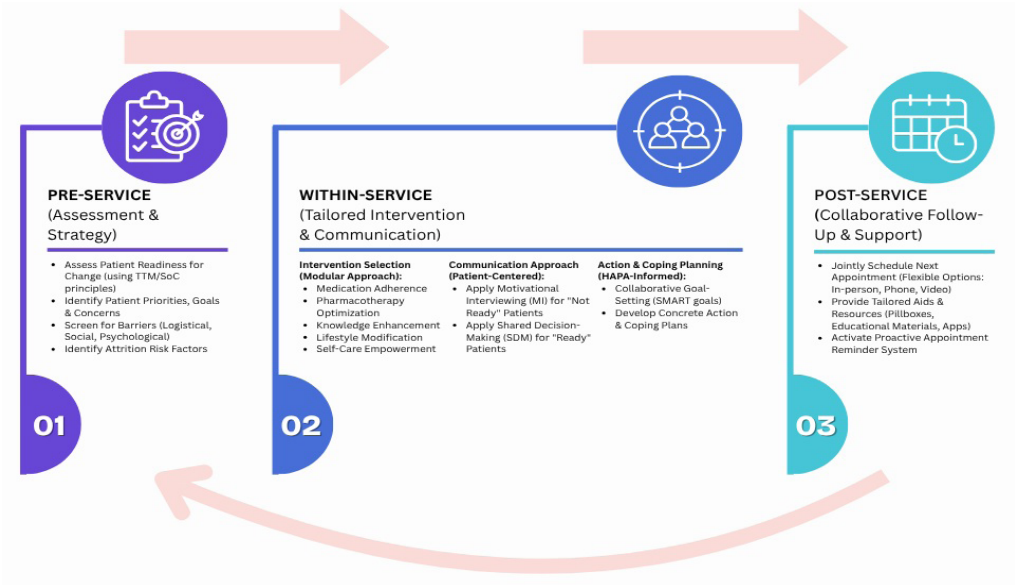

FIGURE 2: The comprehensive pre-delivery framework designed to guide the planning and tailoring of DMTAC services

concrete action plans (detailing what, when, and how) and coping plans (strategising how to overcome anticipated barriers), directly addressing the practical challenges that often derail self-management efforts.

The final stage of the framework, post-service, was designed to ensure continuity of care and mitigate the high rates of attrition observed in the foundational research. This stage focused on collaboratively planning the next steps to support long-term engagement. The first step was to jointly schedule the next appointment. Critically, this included offering flexible options beyond traditional face-to-face visits, such as telephone or video consultations. This directly responded to patient feedback on logistical burdens and was supported by evidence from the scoping review on diverse delivery methods. Next, the patient was provided with tailored aids and resources, such as pillboxes, customised educational pamphlets or links to digital health apps, to support their self-management between visits. Finally, the framework mandated the activation of a proactive appointment reminder system, a simple yet effective strategy suggested by patients to combat forgetfulness and improve attendance rates. This stage closed the loop on the patient encounter, creating a supportive structure that extended beyond the clinic walls.

DISCUSSION

The primary objective of this study was to develop a comprehensive pre-delivery framework to enhance the DMTAC services in Malaysia, focusing on improving patient adherence, optimising service delivery and ensuring a more patient-centred approach. The results of the discover and define phases have been published previously (Hassan & Hatah 2022; Hassan et al. 2024a; Hassan et al. 2024b), detailing the analysis of clinical outcomes, identification of barriers and exploration of patient perspectives. Therefore, this discussion focuses solely on the development and components of the proposed framework. This discussion elaborates on the components of the proposed pre-delivery framework, demonstrating how its design is a direct response to the multifaceted challenges and opportunities identified in the prior foundational research.

Pre-Service Stage: Patient Assessment and Engagement Strategy

The discover phase highlighted that a 'one-size-fits-all' approach is suboptimal due to varying patient readiness, overconfidence in self-management, underestimation of disease significance, or stress from illness (Hassan et al. 2024a). Furthermore, quantitative data indicated that education level and time since diagnosis affect readiness and adherence (Hassan et al. 2024b). The current DMTAC protocol suggests that the initial consultation session should begin by explaining the objectives, benefits and goals, as well as assessing the patient's medication therapy (Teng et al. 2022). However, this process could be significantly enhanced by incorporating an assessment of the patient's readiness to change. This would enable the delivery of more individualised care. Sustained long-term lifestyle changes are crucial for managing chronic conditions like diabetes, ensuring effective control.

Categorising patients into "Ready" and "Not Ready" groups based on their willingness to engage in self-management activities can facilitate the delivery of appropriate interventions tailored to their specific needs and motivations (Hassan et al. 2023). For those categorised as "Ready", the interventions can focus on reinforcing positive behaviours and providing targeted education and support to enhance self-management skills. In contrast, for patients classified as "Not Ready," the approach should emphasise building trust, addressing barriers, and gradually increasing their readiness through MI and other behaviour change techniques. This approach aligns with the TTM or SOC Model, which emphasises the importance of meeting patients where they are in the stages of change and providing appropriate interventions accordingly (Oh et al. 2023). The TTM is particularly suitable here as it provides a clear pathway for addressing the varying levels of motivation observed in the DMTAC patient population (Hassan et al. 2024a).

The TTM proposes that behaviour modification progresses through five distinct stages: precontemplation, contemplation, preparation, action and maintenance. This framework empowers healthcare providers to recognise patients' current readiness and tailor their interventions accordingly. Research has shown that customising interventions to match an individual's stage of change can significantly enhance outcomes. For example, a systematic review of randomised controlled trials utilising the SoC model identified positive changes in lifestyle, treatment adherence and healthy habits when the provided interventions were specifically tailored and continually evaluated (Kwasnicka et al. 2016). Similarly, a study conducted in Malaysia demonstrated that a targeted intervention successfully advanced patients' behaviour stages and reduced their cholesterol levels (Ting et al. 2021).

Given the importance of assessing patient readiness before delivering behaviour-change interventions, it is recommended that the DMTAC framework include both the SoC and the Health Action Process Approach (Schwarzer & Hamilton 2020). HAPA, which views behaviour change in two phases; motivational and volitional, complements SoC well. The motivational phase focuses on risk perception, outcome expectancies and action self-efficacy, while the volitional phase includes action planning, coping planning and recovery self-efficacy. Tailoring interventions to patients' readiness stages can significantly enhance their effectiveness. For instance, patients in the motivational phase need discussions about health risks, benefits of change and their ability to take action. Meanwhile, those in the volitional phase may require support in setting specific, measurable, achievable, relevant, and time-bound goals and planning for potential obstacles. The integration of HAPA is justified by the need to not only motivate change but also to provide concrete action and coping plans, which is suggested by scoping review as an effective interventions (Hassan & Hatah 2022).

Within-Service Stage: Tailored Intervention and Communication

Findings from the discover phase indicated that some patients perceived the DMTAC service as impersonal and overly focused on medication, rather than their broader concerns. This necessitates a shift towards a more patient-centred approach. It is crucial to shift the focus towards a more patient-centred approach, where the interventions address the patients' specific needs and priorities. One strategy to enhance patient-centeredness is to encourage an open dialogue during the initial consultation, allowing patients to express their concerns, challenges and expectations regarding their condition and treatment (van der Heide et al. 2018). This can help healthcare providers to better understand the patients' perspectives and tailor the interventions accordingly. For instance, some patients may be primarily concerned about the cost of medications, while others may be more worried about potential side effects.

The existing DMTAC protocol in Malaysia focuses on various intervention modules aimed at increasing disease and medication knowledge, enhancing medication adherence, optimising pharmacotherapy and empowering self-care. Although these modules are comprehensive, findings from the discover phase indicate that the protocol could benefit from a more patient-centred approach. Specifically, interventions should be tailored to address the patient's current needs rather than following a sequential module. This approach would help to ensure that even if patients miss subsequent sessions, their immediate issues are addressed, thereby improving their overall satisfaction and likelihood of attending future sessions.

To enhance DMTAC service delivery, it is recommended that patient issues be clearly categorised to allow for more specific and organised interventions. The suggested categories include medication non-adherence, lack of disease and medication knowledge, suboptimal pharmacotherapy, unhealthy lifestyle and poor disease self-management (Martin et al. 2005). Addressing these issues with diversified intervention delivery methods and appropriate aids can improve patient outcomes. For instance, using aids like pillboxes, alarms and peer support can help to tailor interventions to the specific causes of medication non-adherence, making the services more effective and relevant. These categories and aids are derived from both patient-expressed needs and evidence of effective interventions from the scoping review.

Additionally, it is important to prioritise and evaluate the main issues to be addressed in each DMTAC session. This prioritisation should involve a collaborative discussion with the patient to ensure that the interventions are relevant and manageable within the session's duration. By focusing on one or two major issues per session, the risk of information overload is reduced, making the sessions more effective (Grant et al. 2013). This also aligns with the qualitative findings that patients often experience information overload and redundancy, which can diminish their engagement and understanding.

Overall, the proposed framework suggests a more flexible and patient-centred approach to DMTAC services. By categorising patient issues and tailoring interventions accordingly, the framework aims to enhance the effectiveness of the DMTAC program. This includes offering more flexible delivery methods, such as telehealth services, and using various aids to support patients. The ultimate goal is to improve patient adherence, knowledge and self-management by delivering more relevant and timely interventions, thereby enhancing the overall quality of care provided by the DMTAC services in Malaysia.

The existing DMTAC protocol lacks clear guidance on intervention delivery, often resulting in a traditional didactic model (Hassan et al. 2024a). The qualitative findings and the scoping review both underscored the critical need for high-quality and patient-centred communication. The existing DMTAC protocol does not provide clear guidance on how interventions should be delivered during sessions. As a result, many sessions tend to follow a traditional educational model, where pharmacists primarily act as

information providers, delivering content to patients. The qualitative findings from the patient perspectives study highlighted the need for healthcare providers to engage in high-quality, effective communication with patients. Similarly, the scoping review carried out during the define phase emphasised the importance of adopting a patient-centred approach to service delivery and communication strategies. Effective communication processes are crucial as they enable patients to openly discuss their concerns and challenges with their healthcare providers, ultimately fostering better understanding and collaboration between the two parties (Hossny et al. 2022).

To address this gap, the proposed framework recommends the adoption of MI as a core communication strategy for DMTAC service delivery. MI is a collaborative, person-centred form of communication that aims to elicit and strengthen an individual's motivation for change (McNeil et al. 2014). It has been widely used in various healthcare settings, including diabetes management, to help patients explore and resolve ambivalence towards behavioural changes. The key principles of MI include expressing empathy, developing discrepancy, rolling with resistance and supporting self-efficacy. Incorporating MI into DMTAC service delivery can help healthcare providers build stronger therapeutic relationships with patients, enhance patient engagement, and facilitate the exploration of patient-specific barriers and facilitators to self-management. The choice of MI is justified by its proven effectiveness in addressing ambivalence and enhancing intrinsic motivation, which were identified as key challenges in patient engagement (Hassan et al. 2024a).

By adopting a more patient-centred approach to service delivery, the DMTAC program can better address the diverse needs and preferences of patients. A systematic review of reviews showed that MI positively impacts patient outcomes across various healthcare contexts, including smoking cessation, medication adherence, gynaecology and risky behaviour changes among adolescents (Frost et al. 2018). However, it is important to understand that the effectiveness of MI can vary depending on the context and target population. Factors such as the pharmacist's skill in using MI, the duration and frequency of sessions and the specific behaviours targeted can influence the outcomes (Gable & Hunziker 2023). Therefore, while the application of MI is recommended, continuous support and training for pharmacists are essential for its successful implementation.

In addition to MI, the framework suggests the incorporation of other evidence-based communication strategies, such as SDM and goal setting. SDM involves actively engaging patients in the decision-making process, ensuring that their preferences and values are taken into account (O'Brien et al. 2018). Goal setting, on the other hand, is a collaborative process where patients and healthcare providers work together to establish specific, measurable, achievable, relevant and time-bound goals. These strategies can help to foster a sense of partnership and shared responsibility between patients and healthcare providers, ultimately leading to better self-management outcomes. SDM and collaborative goal setting directly address patient desires for more involvement and less one-sided communication, and are supported by evidence of improved outcomes (O'Brien et al. 2018).

SDM is a communication process where healthcare providers collaborate with patients in making decisions about their health issues. This includes treatment options, intervention strategies and appointment scheduling. In SDM, healthcare professionals should provide information about the disease, discuss the risks and benefits of treatments through individualised, two-way communication based on the patient's preferences, values and circumstances. A key component of SDM is the use of patient decision aids (PDA), which are tools designed to help patients engage in informed decision-making about their treatment (Ankolekar et al. 2018).

Although SDM can occur without PDAs, their use is encouraged as they make the process clearer and more transparent. PDAs can be developed by healthcare providers or adopted from various sources. In Malaysia, a study

highlighted the successful use of an online PDA to help patients decide on initiating insulin therapy (Tong et al. 2017). This tool was well-received by patients for providing comprehensive information and facilitating meaningful discussions. These findings suggest that valuable resources are available, and the application of PDAs in the local Malaysian context is feasible.

Post-Service Stage: Collaborative Planning and Follow-Up

The define phase revealed diverse appointment schedules, while the discovery phase and clinical data highlighted high non-attendance and patient reluctance for frequent or multiple visits. This indicates a need for flexible, patient-centred scheduling. The current DMTAC protocol recommends appointment scheduling every one to three months, tailored to the patient's condition, other clinic appointments and medication refill needs. This aligns with international service delivery practices and accommodates existing patient requirements (Hassan et al. 2023). The framework proposes maintaining the flexible appointment scheduling approach, allowing pharmacists to plan follow-up visits based on patient needs and preferences.

The define phase revealed the diverse appointment scheduling approaches used in the existing DMTAC program. The current protocol mandates a minimum of four appointments, subject to patients demonstrating adequate medication adherence and achieving a 100% score on medication knowledge assessments. However, the discovery phase highlighted that many patients fail to attend their subsequent appointments, citing burdensome travel requirements and an inability to accommodate multiple hospital visits. To address this, the framework proposes maintaining the flexible appointment scheduling approach, allowing pharmacists to plan follow-up visits based on individual patient needs and preferences. International guidelines on diabetes management recommend appointment intervals ranging from one to three months, depending on the patient's condition and the need for medication titration or lifestyle changes (American Diabetes Association 2018). While one study found no link between the number of appointments and program success (Morrison et al. 2011), a more recent larger study indicated that frequent appointments positively impact HbA1c control among DMTAC patients (Alvarez et al. 2018). However, this needs to be balanced against patients' perceptions, as repetitive appointments may be viewed unfavourably (Salameh et al. 2012). The framework underscores the importance of jointly planning subsequent appointments with patients, taking into account their preferences, medication refill needs and other clinic visits.

In addition to appointment scheduling, the framework emphasises the importance of appointment reminders and follow-up strategies to enhance patient engagement. Effective reminders, such as phone calls, text messages or automated notifications, can help to reduce missed appointments and improve patient adherence (McLean et al. 2016). Furthermore, a proactive follow-up approach, where pharmacists reach out to patients who miss their appointments, can foster a sense of accountability and demonstrate the healthcare team's commitment to the patient's well-being. Consequently, the proposed framework suggests tailoring appointment schedules to the complexity of patients' needs and the time required to achieve target outcomes.

The framework also proposes expanding the range of appointment methods. Evidence from the literature review indicates that the program can be delivered through online consultations, telephone calls, video calls, group sessions and home visits. Patient feedback suggests they are receptive to alternative, non-face-to-face approaches if they make attendance more convenient. However, these alternative methods require further investigation and the development of specific patient selection criteria to ensure their effectiveness. Online, video and telephone appointments may suit patients facing logistical or work-related barriers to attendance (Bedford et al. 2020). Group sessions could be more beneficial for patients needing social

support and motivation, while home visits may be appropriate for those with significant attendance issues or major logistical obstacles (Davis et al. 2021). These alternative approaches aim to reduce patient dropout and address the key factors behind non-attendance identified in patient perspectives. Additionally, the framework recommends providing flexible appointment options and written resources for patients deemed at high risk of non-attendance, based on the retrospective data analysis (Hassan et al. 2024b).

Limitations

This study acknowledged several limitations. Firstly, the proposed service delivery improvement framework was not tested or validated for user consensus. Nevertheless, the framework provides a foundation to develop a more sustainable service module. Some components require further elaboration and validation, which exceeds the study's scope. The overall validation process can commence once these components are finalised.

Secondly, while pharmacists' perspectives are integral to DMTAC success and have been explored in other research (including elements within our scoping review which covered pharmacist roles and interventions), this initial framework development phase prioritised the synthesis of patient-reported needs, clinical outcome data and broader evidence-based strategies to form a foundational structure. The critical input of practicing pharmacists is envisioned as a key component of the subsequent validation and refinement stages of this framework, ensuring its practical applicability and alignment with on-the-ground realities.

Lastly, detailed recommendations requiring input from experienced pharmacists and ministry-level service managers were also beyond the study's remit and are suggested for the framework's refinement in future stages. Despite these limitations, this study has contributed to the existing body of knowledge on improving medication adherence and appointment attendance in chronic disease management programs by proposing a structured pre-delivery framework.

CONCLUSION

In conclusion, the development of a patient-centred, flexible and evidence-based pre-delivery framework for DMTAC service delivery holds significant potential for enhancing diabetes management in Malaysia. By incorporating readiness-based interventions, personalised communication strategies and flexible appointment scheduling, the framework addresses key barriers identified in the discover and define phases, such as non-attendance, disengagement and inconsistent service implementation. This pre-delivery framework is designed to guide the planning and design of services before full implementation, thereby preparing for more effective delivery. Tailored interventions based on the patient's readiness to change are expected to improve adherence and foster sustained behaviour change, ultimately leading to better glycaemic control and overall health outcomes. Personalised communication strategies, including MI and shared decision-making, can empower patients to take an active role in their care, while flexible appointment scheduling can accommodate individual patient needs, thereby improving adherence and satisfaction.

Although the proposed framework has yet to be validated, it lays a solid foundation for future enhancements in DMTAC services. Future research should focus on the practical implementation and evaluation of this framework, utilising pilot studies to assess its impact on patient outcomes and refining it based on feedback from both patients and pharmacists. Such collaborative efforts will ensure that the interventions are feasible, acceptable and effective across diverse healthcare settings. By addressing both the initial implementation challenges and promoting long-term sustainability, the proposed framework has the potential to transform DMTAC service delivery, ultimately improving quality of care,

enhancing patient outcomes and setting a new standard for diabetes management in Malaysia.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT® (GPT-4o, OpenAI, San Francisco, USA) in order to improve the language and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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TABLE S1: Patient demographics and characteristics (Hassan et al. 2024b)

Characteristics	All patients (n = 198)	Complete (n = 98)	Incomplete (n = 100)	p-values
Baseline characteristics				
Age, years, mean (SD)	56.5 (12.9)	58.0 (12.9)	55.0 (12.8)	0.103
Male	97 (49.0)	59 (54.6)	38 (42.2)	0.063
Race				
Malay	99 (50.0)	43 (43.8)	56 (56.0)	0.018
Chinese	37 (18.7)	26 (26.5)	11 (11.0)	
Indian	62 (31.3)	29 (29.6)	33 (33.0)	
Years diagnosed, mean (SD)	10.43 (8.0)	9.3 (7.4)	11.6 (8.5)	0.051
Numbers of medications	5.86 (2.1)	5.8 (2.0)	5.9 (2.3)	0.701
Concurrent diagnosis	2.6 (0.1)	2.7 (0.9)	2.5 (1.0)	0.200
DFIT Score, mean (SD)	93.3 (9.6)	93.6 (9.3)	93.0 (9.9)	0.668
HbA1c, %, mean (SD)	10.6 (2.2)	10.7 (2.3)	10.5 (2.2)	0.747
FBS, mmol/l, mean (SD)	20.9 (4.2)	9.6 (3.3)	11.6 (4.6)	0.055
Education				
Primary	34 (17.2)	19 (19.4)	15 (15.0)	0.417
Secondary	57 (28.8)	29 (29.6)	28 (28.0)	
Tertiary	35 (7.7)	13 (13.3)	22 (22.0)	
Unknown	72 (36.4)	37 (37.8)	35 (35.0)	
Working status				
Working	82 (41.4)	38 (38.8)	44 (44.0)	0.066
Not working	111 (56.1)	55 (56.1)	56 (56.0)	
Unknown	5 (2.5)	5 (5.1)	0 (0.0)	
Adherence				
Poor	70 (35.4)	37 (39.4)	33 (33.0)	0.368
Moderate	104 (52.5)	50 (53.2)	54 (54.0)	
Good	20 (10.1)	7 (7.4)	13 (13.0)	
Unknown	4 (2)	4 (0.0)		

All values are reported as no.(%) unless otherwise noted.
DFIT: Medication dosage, frequency, indication, and timing; FBS: Fasting blood sugar level; HbA1c: Target glycated haemoglobin level; SD: Standard deviation

TABLE S2: Clinical measures for mean scores and adjusted mean scores for clinical outcome measures among adult diabetic patients (Hassan et al. 2024b)

		Descriptive Statistics Mean (SD		Adjusted Mean Mean (SD		
	N	First Measurement	Final Measurement	First Measurement	Final Measurement	p-value
a) HbA1C (n = 156)						
Complete group	85	10.83 (2.52)	9.61 (2.24)	10.83 (10.31, 11.34)	9.61 (9.13, 10.09)	<0.001
Incomplete group	71	10.40 (2.28)	9.94 (2.22)	10.40 (9.84, 10.97)	9.94 (9.42, 10.47)	0.029
Between group differences, p value		-	-	0.273	0.360	
b) FBS (n = 63)						
Complete group	42	10.14 (3.86)	7.73 (3.06)	10.14 (8.97, 11.31)	7.73 (6.67, 8.79)	<0.001
Incomplete group	21	9.85 (3.61)	9.84 (4.08)	9.85 (8.20, 11.50)	9.84 (8.35, 11.34)	0.996
Between group differences, p value		-	-	0.775	0.024	

CI: Confidence interval; FBS: Fasting blood sugar level; HbA1c: target glycated haemoglobin level; SD: standard deviation.

TABLE S3: Multivariate analysis of factors associated with for not completing DMTAC session (Hassan et al. 2024b)

Variables	B(SE)	Adjusted OR (95% CI)	Wald (df)	p-value
Female		Ref.		
Male	-1.06(0.46)	0.35(0.14,0.85)	5.31(1)	0.021
Race				
Indian		Ref.		
Malay	0.55(0.42)	1.73(0.76,3.91)	1.73(1)	0.189
Chinese	-0.66(0.53)	0.52(0.18,1.47)	1.53(1)	0.216
Age	0.00(0.02)	1.00(0.96,1.03)	0.04(1)	0.850
Education Level				
Tertiary		Ref.		
Unknown	-0.80(0.57)	0.45(0.15,1.35)	2.03(1)	0.154
Primary	-1.28(0.65)	0.28(0.08,0.99)	3.89(1)	0.049
Secondary	-0.98(0.58)	0.38(0.12,1.17)	2.86(1)	0.091
Working status				
No		Ref.		
Yes	0.33(0.49)	1.39(0.53,3.61)	0.45(1)	0.504
Unknown	NE	NE	NE	NE
Years diagnosed with diabetes	0.06(0.03)	1.06(1.01,1.11)	5.18(1)	0.023
Concurrent diagnosis	-0.01(0.19)	0.99(0.68,1.45)	0.00(1)	0.973
HbA1C level at DMTAC first session	-0.05(0.08)	0.95(0.80,1.12)	0.41(1)	0.523

B: Logistic regression coefficient; CI: Confidence interval; df: Degree of freedom; DMTAC: diabetes medication therapy adherence clinic; HbA1c: Target glycated haemoglobin level; NE: Not estimable; OD: Odds ratio; Ref.: Reference group; SD: Standard deviation; SE: Standard error

TABLE S4: Categories of themes and sub-themes according to ABM constructs (Hassan et al. 2024a)

Themes	Sub-themes	ABM Constructs
The role of the program in meeting the patients' needs	Perceived self-efficacy	Predisposing
	Perceived priority of disease issues	Needs
	Perceived disease-related stress	Needs
The quality and effectiveness of information delivery	Optimisation of information delivery	Enabling
	Patient-centered communication	Predisposing, Needs, Enabling
	Patient-pharmacist relationship	Predisposing, Needs, Enabling
	Information content	Needs
The availability and accessibility to services	Logistic and time constrains	Enabling
	Appointment reminder support	Enabling

TABLE S5. Characteristics of included studies (Hassan & Hatah 2022)

Author & Year	Design	Setting	Providers	Intervention strategies	Duration/ Sessions	Outcomes Measured
Lim & Lim (2010)	Cross sectional	Outpatient clinic	Pharmacists	Adherence support Diabetes education	8 sessions	Glycaemic control, lipid profile
Tan et al. (2011)	Randomised controlled trial	Outpatient clinic	Physicians	Patient empowerment	12 weeks	Glycaemic control, diabetes knowledge, medication adherence, physical activity
Wong et al. (2012)	Randomised controlled trial	Outpatient clinic	Not mentioned	Patient empowerment	6 months	Glycaemic control, diabetes knowledge
Ismail et al. (2013)	Randomised controlled trial	Outpatient clinic	Multiple HCW	Patient empowerment	6 months	Glycaemic control, blood pressure, lipid profile, body weight
Ahmad et al. (2014)	Pre & post intervention	Community	Not mentioned	Diabetes education Patient empowerment	1 session	Perceived benefit
Alvani et al. (2015)	Non-randomised controlled trial	Outpatient clinic	Therapists	Psychological intervention	12 weeks	Glycaemic control, psychological wellbeing
Chow et al. (2015)	Randomised controlled trial	Outpatient clinic	Pharmacists	Adherence support Diabetes education Lifestyle adjustment Patient empowerment	2 sessions	Diabetes knowledge, medication adherence
Sazlina et al. (2015)	Randomised controlled trial	Outpatient clinic	Physicians	Lifestyle adjustment Psychological intervention	12 weeks	Physical activity
Bakar et al. (2016)	Cross sectional	Outpatient clinic	Pharmacists	Adherence support Diabetes education Patient empowerment	8 sessions	Medication adherence, patient's satisfaction
Butt et al. (2016)	Randomised controlled trial	Outpatient clinic	Pharmacists	Adherence support Diabetes education Lifestyle adjustment Patient empowerment	6 months	Glycaemic control, lipid profile, quality of life, body weight, medication adherence
Ibrahim et al. (2016)	Quasi-experimental	Community	Multiple HCW	Diabetes education Lifestyle adjustment Patient empowerment Psychological intervention	1 year	Glycaemic control, blood pressure, lipid profile, quality of life, body weight, physical activity

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Author & Year	Design	Setting	Providers	Intervention strategies	Duration/ Sessions	Outcomes Measured
Lee et al. (2016)	Randomised controlled trial	Outpatient clinic	Physicians	Patient empowerment Diabetes education Psychological intervention	1 year	Glycaemic control, blood pressure, lipid profile, quality of life, self-efficacy, cost analysis
Lim et al. (2016)	Randomised controlled trial	Outpatient clinic	Pharmacists	Adherence support Diabetes education	8 sessions	Glycaemic control, lipid profile
Ramli et al. (2016)	Randomised controlled trial	Outpatient clinic	Multiple HCW	Diabetes education Patient empowerment	1 year	Glycaemic control, blood pressure, lipid profile, body weight
Gillani & Gillani (2016)	Longitudinal interventional study	Outpatient clinic	Pharmacists	Diabetes education Patient empowerment	6 months	Glycaemic control
Ahmad et al. (2017)	Randomised controlled trial	Outpatient clinic	Physicians	Patient empowerment Diabetes education	18 months	Glycaemic control, diabetes knowledge, retention rate
Sharoni et al. (2017)	Quasi-experimental	Long-term care institution	Nurses	Diabetes education Patient empowerment	12 weeks	Glycaemic control, diabetes knowledge, quality of life, self-efficacy, foot condition
Ayadurai et al. (2018)	Randomised controlled trial	Outpatient clinic	Pharmacists	Adherence support Diabetes education Lifestyle adjustment	6 months	Glycaemic control, blood pressure, lipid profile
Ramadas et al. (2018)	Randomised controlled trial		Not mentioned	Lifestyle adjustment Psychological intervention	6 months	Glycaemic control, dietary knowledge
Lee et al. (2018)	Qualitative		Not mentioned	Shared decision making Diabetes education	1 session	Usability and utility
Chew et al. (2019)	Randomised controlled trial		Multiple HCW	Psychological intervention Diabetes education	18 weeks	Glycaemic control, blood pressure, lipid profile, quality of life, self-efficacy, diabetes distress
Lee et al. (2020)	Randomised controlled trial		Multiple HCW	Adherence support Patient empowerment	1 year	Glycaemic control, blood pressure, lipid profile, quality of life, self-efficacy