ORIGINAL RESEARCH

Enablers and Barriers to Medication Self-Management in Patients With Type 2 Diabetes: A Qualitative Study Using the COM-B Model

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Introduction: Type 2 diabetes mellitus is a chronic disease of global concern. Medication self-management is the process by which an individual actively plans, monitors, evaluates, feeds back, controls, and regulates their medication through their behavior and awareness. Patients' medication self-management is key to glycemic control. A comprehensive understanding of the factors influencing medication self-management and the implementation of effective intervention programs is therefore paramount.

Objective: To examine the enablers and barriers to medication self-management in patients with type 2 diabetes mellitus and to propose a corresponding medication self-management program to improve medication self-management.

Methods: This qualitative study drew up the interview outline with reference to the COM-B model. Sampling was done using purposive sampling method and data collection was done using semi-structured interviews. The interviews mainly included patients' challenges and facilitators in the process of medication self-management. The data were analyzed using a framework analysis method, and themes were generated using the COM-B model.

Results: A total of 20 patients participated in this study. The enablers identified within the COM-B model were the policy support for medical insurance and higher medication self-efficacy. The barriers include low medication literacy, aging of body functions, changes in living habits, the impact of work, limited medical resources, misguided beliefs about medication, and emotional response. The online media applications and the impact of family and friends were mixed factors. Outside of the model, diet and exercise also have an impact. Finally, we propose targeted solutions to improve medication self-management based on the Behavior Change Wheel.

Conclusion: This study proposes targeted medication self-management programs, including education interventions to improve medication literacy and self-efficacy, leveraging mobile smart devices, and improving health insurance policies to promote patient medication management levels. Our findings will contribute to medication self-management for type 2 diabetes and many more chronic diseases.

Keywords: type 2 diabetes mellitus, medication self-management, enablers, barriers, qualitative study, framework analysis

Introduction

Currently, type 2 diabetes mellitus (T2DM) represents a significant public health concern on a global scale. T2DM is the most prevalent form of diabetes, accounting for over 90% of all diagnosed cases.[1] Some studies have indicated that the most effective approach to treatment is the implementation of effective and sustainable self-management strategies for diabetes.[2] Given the chronic nature of T2DM and the difficulties associated with its cure, medication management plays a pivotal role in the management of the disease. Medication self-management is a process through which an individual

engages in active and conscious planning, monitoring, evaluation, feedback, control, and regulation of medication through their behavior and awareness.[3] The self-management of medication in patients with diabetes mellitus encompasses the monitoring of blood glucose levels, the adjustment of insulin dosage, the adherence to oral hypoglycemic medications, and the management of associated adverse effects.[4]

It has been demonstrated[5] that in patients with T2DM, delayed drug intake, omission, and intermittent medication are prevalent. Furthermore, approximately half of the patients adhere to their prescribed medication regimen less than what is recommended by their physicians at the time of hospitalization. The proportion of patients who were unable to take oral medication or use insulin by medical advice due to various factors was 33% and 38%, respectively.[6] A domestic study revealed that only 27.5% of T2DM patients in China were able to regularly monitor their blood glucose levels according to medical recommendations,[7] and there was a lack of monitoring of medication efficacy. A related report by BALKHI[8] indicates that only 48.6% of T2DM patients demonstrated high medication adherence. Some studies have shown that compared with patients with high medication adherence, non-adherent patients have higher levels of glycosylated hemoglobin, systolic and diastolic blood pressure, and low-density lipoprotein cholesterol; and medication adherence in diabetic patients is significantly associated with hospitalization and mortality rates.[9] The current state of medication self-management among patients with T2DM is a cause for concern. The lack of effective self-management has led to adverse outcomes that demand immediate attention and intervention from medical professionals.

At present, there is an increasing number of studies on medication self-management interventions and the factors that influence T2DM patients. However, these studies are predominantly quantitative.[5] The theoretical foundation of these studies is imperfect and the analysis of how behavior is influenced is not yet clear. Furthermore, existing studies do not seem to examine behavior in terms of individual capability, opportunity, or motivation. Consequently, the efficacy of these studies in assessing behavioral change is limited. This shortcoming leads to a significant discrepancy between medical staff's efforts to provide medication self-management support to patients and their actual needs, so patients are often unable to obtain effective interventions that truly meet their needs. Consequently, this study used the COM-B model as the theoretical basis and qualitative research as the methodology to comprehensively analyze the influencing factors of medication self-management behaviors of T2DM patients in terms of capability, opportunity, and motivation, to provide a basis for the implementation of more effective medication self-management programs in the future.

Conceptual Framework

The COM-B model was initially proposed by Michie[10] in 2011. The model posits that for an individual to engage in a specific behavior (B) at a given moment, they must possess the requisite physical and psychological capability (C) and have the necessary opportunity (O) to perform the behavior. Additionally, motivation (M) encompasses the fundamental drives and automatic processes,[11] as illustrated in Figure 1. The exterior of the model revolves around nine different kinds of intervention functions: education, persuasion, motivation, coercion, training, restriction, environmental reconstruction, modeling, and enablement. This is shown in Figure 2. The COM-B model has been employed extensively in
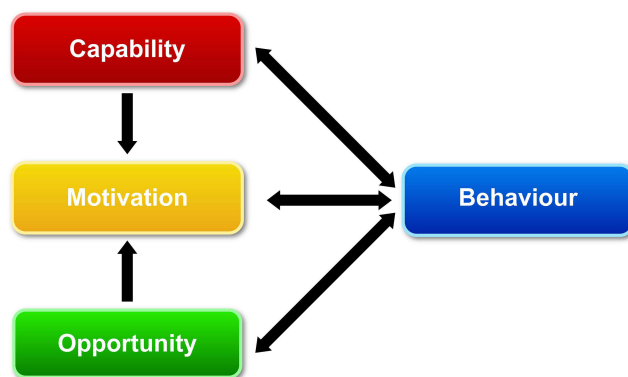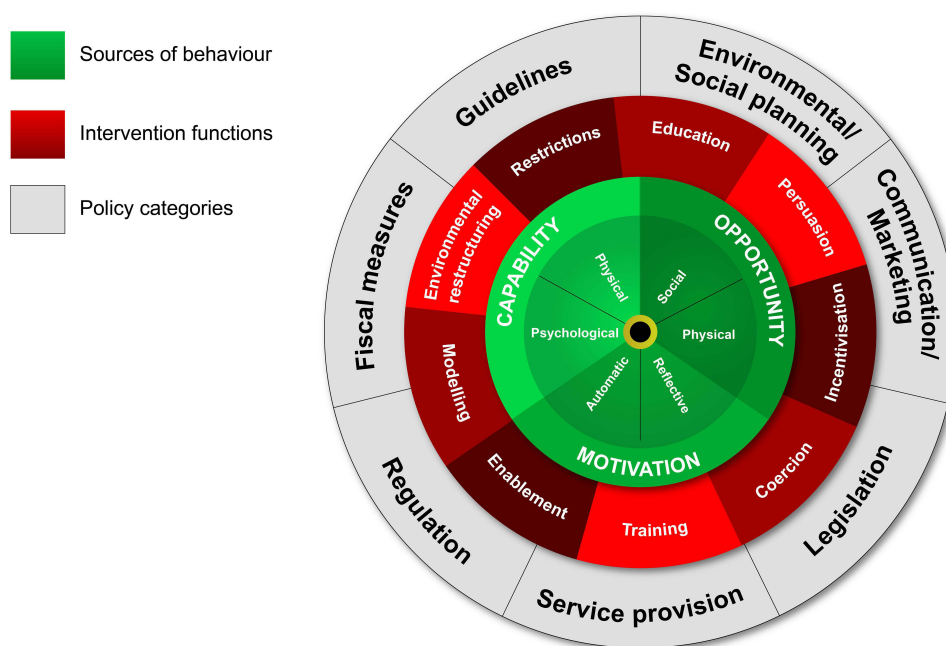

Figure 1 COM-B model.

Figure 2 Behavior Change Wheel.

a multitude of international contexts, including individual health promotion[12] and disease prevention.[13] In the context of qualitative research, Boyd,[14] a foreign researcher, employed the COM-B model to investigate the facilitators and impediments to maintaining a healthy postpartum lifestyle in patients with gestational diabetes mellitus. Moreover, the Behavior Change Wheel Application Guide[10] states that the six subcomponents of the COM-B model can be improved by corresponding intervention functions. It can be seen that the COM-B model integrates various aspects, and its application also helps to design interventions systematically and explicitly.

Objectives

In this study, data were obtained through semi-structured interviews and analyzed using the COM-B model, which identified the factors influencing medication self-management in patients with T2DM. Based on the nine intervention functions of the behavior change theory, targeted strategies were developed to overcome barriers and consolidate enablers.

Methods
Recruitment

This was a qualitative study that followed the Standards for Reporting Qualitative Research (SRQR). This study adopted the sampling principle of purposive sampling combined with maximum differentiation, aiming to select patients with type 2 diabetes mellitus (T2DM) with diverse experiences and backgrounds to ensure the richness and representativeness of the findings. A semi-structured interview was used for data collection, with the study participants coming from the First Affiliated Hospital of Anhui University of Chinese Medicine. Before conducting the formal interview, the interviewer introduced the purpose and method of the study in detail to the patients, and after obtaining verbal consent, an informed consent form for the interview was signed. We included study subjects who were: (1) aged $\geqq 18$ years; (2) diagnosed as T2DM patients; (3) taking glucose-lowering drugs or injecting insulin and other drugs; (4) conscious and able to communicate normally; (5) Informed consent and voluntary participation in the study. The study was approved by the Ethics Committee of the First Affiliated Hospital of Anhui University of Chinese Medicine (No. 2024AH-19).

Sample Size

This study employed a theory-based interview approach, and Francis[15] recommends conducting a minimum of 10 interviews and allowing for a maximum of 3 additional interviews or fewer if the data are saturated (ie, no new themes emerge) after the initial analysis. Initially, a minimum of 10 interviews were planned, with a decision to add up to three more interviews based on data saturation. However, during the actual interviews, it was found that the data were not saturated and that a larger sample size was needed to explore the facilitators and barriers to medication self-management fully. Consequently, upon reaching 17 cases, the data from the interviews in this study demonstrated no further emergence of new themes. To further confirm the attainment of saturation, an additional three interviews were conducted, and the interviews were terminated when no new themes were resolved. Thus, a total of 20 patients were interviewed in this study.

Interview Procedure

A semi-structured interview outline was developed on the basis of the COM-B model, through a process of literature review and group discussion. Which is presented in Table 1.

All interviews were conducted by two panelists who had undergone training in qualitative interviewing. Furthermore, two research participants were pre-interviewed using a preliminary version of the interview outline to test its operationalization before the interviews commenced in earnest. Through the pre-interview, the question "Do you feel that diabetes medication management is important? Why?" was changed to "What is your attitude toward diabetes medication management?". Before the start of the interview, study participants were asked to fill out a general information questionnaire, participants were allowed to withdraw from the interview at any time during the interview process, and all interview data were deleted after completing the analysis to protect the privacy of the interview participants. The recording tool utilized was a cellular telephone, and the location of the interview was selected to be a convenient setting for both parties to ensure that the environment was quiet, relaxed, and undisturbed and that the interview lasted for 30 to 40 minutes.

Table 1 A Semi-Structured Interview Outline Based on the COM-B Model

COM-B Model Components	Definitions	Example Interview Outline
Capability	Capability is categorized into physical capability (physical skills, strength, endurance) and psychological capability (knowledge, mental skills required to engage in necessary thought processes. Eg comprehension, reasoning).	1. Can you talk about how you understand medication self-management?
		2. How do you approach medication self-management? For example, in terms of medication approach skills.
Opportunity	Refers to the external factors that contribute to the occurrence of an individual's behavior, divided into the physical opportunity (time, resources, geographic location, material, etc.) and the social opportunity (perceptions, policies, interpersonal influences, socio-cultural practices, etc.).	1. Does your family care about your medication? How are they involved in your medication management?
		2. What external factors do you think may affect your normal medication use (including family, society, work, etc.) and why?
		3. What advice would you give to healthcare professionals about your medication use? Why?
Motivation	Motivation refers to the process of brain activity that inspires and directs the behavior of the organism and is divided into reflexive motivation (including planning and evaluation) and Automatic motivation (including emotional reactions, desires, impulses, repression, and spontaneous processes of drive states and reflexive reactions).	1. What are your feelings about participating in medication self-management?
		2. What is your attitude towards diabetes medication management?
		3. What do you think is the biggest difficulty in the process of medication management? Why?

To control the quality of the interviews, a good trusting relationship was established with the interviewees before the interviews to ensure that the results were authentic and rigorous. The audio recordings were kept by the interviewer and the names of the interviewees were replaced with letters and numbers to protect the privacy of the interviewees. The accuracy and credibility of the findings were ensured through 20 rounds of interviews and data validation. Self-reflection was conducted throughout the interview process to reduce the influence of the researcher's subjective thinking on the analyzed results. The research team recorded the interview and analysis process in detail, and after the interview, the transcribed textual information was verified by the interviewee to ensure the authenticity and objectivity of the research data. Data were systematically analyzed using a framework analysis method to ensure the reproducibility of the research process.

Data Analysis

The researcher transcribed all the recorded interview data through WPS software within 24 hours to ensure that the transcription was error-free and then imported into NVivo software. The qualitative study was based on the COM-B model as the theoretical foundation, and the choice of framework analysis as the method of data analysis was to use the sub-themes in the model as a diagnostic framework for the factors influencing medication self-management behaviors and to provide a modeling framework for the next step of proposing interventions that would help patients with T2DM to better medication self-manage. Although the data analysis was based on the COM-B model, it allowed for the emergence of new themes outside the theoretical framework. Data analysis was divided into the following five steps:

Familiarization

The transcribed text was read several times before the data analysis to fully immerse the text and thus better understand the text and the interviewee's meaning. And by asking common questions (eg, What happened? Who said it? etc) to understand the feelings and experiences of the interviewees and to gain a general sense of the text.

Identify a Coding Framework

Two researchers undertook an independent coding of the transcribed text, based on the COM-B model and the textual content itself. Following this, they engaged in a discussion of their respective coding themes in person, consulting immediately with a third qualitative research expert if they encountered any disagreements. This process led to the development of a basic coding framework.

Coding

The two researchers then proceeded to apply the previously identified coding framework to the textual data, repeating this process until all data within the text that matched the coding framework had been captured and the coding process was complete.

Charting

Following the encoding of the text, the researcher placed the individual texts into a frame matrix for each corresponding topic.

Mapping and Interpretation

Finally, the individual themes and corresponding textual content were mapped and interpreted into the final research findings.

Results

Participant Characteristics

A total of 20 patients with T2DM were interviewed. The sample included eight female and twelve male patients. Seventeen of the patients were from inpatient settings, while three were from outpatient settings. Thirteen of the patients were from urban areas, while seven were from rural areas and towns. All of the patients were on hypoglycemic or other types of medication. Table 2 provides a summary of the characteristics of the participants.

Table 2 Participant Characteristics (n=20)

Variable	Values
Age (years), n (%)	
25–50	3(15)
51–60	6(30)
≧61	11(55)
Sex, n (%)	
Male	12(60)
Female	8(40)
Highest level of education completed, n (%)	
Middle school and lower	10(50)
High school	6(30)
College and higher	4(20)
Marital status, n (%)	
Married	15(75)
Never married	2(10)
Widowed	3(15)
Location, n (%)	
Rural	3(15)
Town	4(20)
City	13(65)
Employment, n (%)	
Employed	5(25)
Unemployed	11(55)
Self-employed	4(20)
Monthly income, n (%)	
≤3000	6(30)
3001–5000	7(35)
5001–6999	3(15)
7000–8999	1(5)
≥9000	3(15)
Source of patients, n (%)	
Residents' medical insurance	7(35)
Employee basic medical insurance	13(65)
Primary caregiver, n (%)	
Spouse	13(65)
Children	3(15)
Nursing staff	1(5)
None	3(15)
Types of medication, n (%)	
2–5	15(75)
6–9	4(20)
≧0	1(5)

Qualitative Findings

A total of 11 subthemes were derived from the framework analysis, based on the COM-B model, which analyzes the factors influencing medication self-management behaviors of T2DM patients in terms of ability, opportunity, and motivation. One subtheme was analyzed outside the model. For further details, please refer to Table 3.

Table 3 Themes and Sub-Themes of the COM-B Model-Based Framework Analysis

COM-B Category- Themes	Subthemes Identified
CAPABILITY-The individual's physical and psychological capability to engage in the behavior	
Physical capability	Ageing of body functions(B)
Psychological capability	Low medication literacy in the early stages of diabetes(B)
OPPORTUNITY-Environmental factors influencing the behavior	
Social opportunity	Applications of online media(M)
	Impact of family and friends(M)
	Policy support for medical insurance(E)
Physical opportunity	Changes in living habits(B)
	Impact of the work(B)
	Limited medical resources(B)
MOTIVATION-Individual internal factors that direct the behavior	
Reflexive motivation	Higher medication self-efficacy(E)
	Misguided beliefs about medication(B)
Automatic motivation	Emotional response(B)
Beyond COM-B Model:	Effects of diet and exercise(M)

Notes: E: Enablers factor B: Barrier factor M: Mix factor.

Descriptions of Subthemes and Quotes From Interviews
Capability
Ageing of Body Functions
Many older people with type 2 diabetes say they get more diseases as they get older. They also forget things more easily, which means they often miss or take the wrong medication.

> As she gets older, her body develops a lot of new diseases, and in addition to diabetes I need to add some other medicines on a temporary basis, so the difficulty is that there are so many medicines that it's just impossible to remember them, and it's really easy to miss them (statement from the daughter of a female elderly patient) (P2)

Low Medication Literacy in the Early Stages of Diabetes
Some patients lack knowledge and skills related to medication. They believe that once they have used glucose-lowering drugs, they need to take them for life. They even think that there is no obvious discomfort in their bodies and try to control their blood glucose by adjusting their diets and exercises, and stop and reduce their medication privately. Some patients reflected that they had a low level of education, were completely ignorant of medication knowledge, could not acquire and understand medication knowledge, and did everything at the doctor's discretion.

> This blood sugar is different according to the person's weight, age, and other aspects of the situation, like my weight, blood sugar is usually around 8 is not high, you can not talk about the same as young people.(P9)

> I'm uneducated, I can't do my own internet research, and I can't read the instructions for my medication. (P3)

Opportunity
Applications of Online Media
With the rapid development of short videos, medical science videos are also becoming increasingly popular among the public. Respondents tend to watch medical science videos on their mobile phones to learn about relevant medications, as well as learn to use electronic blood glucose meters and so on through short video instruction.

> I don't know how to use an electronic blood glucose meter either, but my daughter sent me the learning video via WeChat, so we followed it and slowly got the hang of it. (P17)

However, some interviewees reflected that at present, the professional level of short video bloggers varies and the authenticity of the video content is doubtful. Patients are often unable to screen their professionalism, which makes it easy to mislead patients.

I searched on my phone and found lots of videos about diabetes. But I don't know which ones are right. (P16)

I read on the internet that medication for diabetes can damage your organs, and as I had already had a liver and gallbladder removal, I was worried about the effects on my health. (P16)

Impact of Family and Friends

From the interviews, we learned that family members can help patients take their medication regularly. Most diabetic patients were helped by their family members to finger-measure their blood glucose. Some older people said that going to the pharmacy to buy medication was difficult, so they relied on their children to help them.

My lover is very concerned about me, but I got annoyed after a while, and she tests my blood sugar every day. (P17)

After I got diabetes, I didn't care about taking my medication myself at first, but my daughter-in-law bought it for me and looked it up online for me anyway. (P5)

Sometimes, when my son comes back from work, he asks me if I have any medicine. If I don't have it, he buys it online. It's easy for him to buy it, and the delivery man delivers it in 10 minutes. (P9)

However, some interviewees reflected that their children are busy with work and family live under great pressure and do not have the time and energy to take charge of their medication management. Some elderly patients even need to take care of their grandchildren, thus often neglecting their health.

You see the kids are so busy, they go out in the morning and don't come home until seven or eight o'clock in the evening, and sometimes my son-in-law only comes back once a week, and I'm basically on my own for my medication. (long sigh) (P3)

Some interviewees often mentioned in the interviews that the remarks of their neighbors or friends of their patients had influenced them. Due to the lack of knowledge of hypoglycemic drugs, the attitude towards medication is highly susceptible to the influence of some erroneous remarks, which may mislead their medication management behaviors.

By the way, those people say that if you take glucose-lowering medication and you can't reduce it at the end, you can't stop, you have to take it all the time, so I stopped taking it, and that's the situation. (P16)

Some people say this, after you get complications from diabetes, let's say you're taking insulin now, if it gets worse later on, insulin won't even be able to cure it. (P1)

Policy Support for Medical Insurance

T2DM has a long course and requires lifelong medication, making long-term treatment expensive. Most of the interviewees said that the national health insurance policy reduces the financial burden of medication and strengthens patients' medication compliance. Especially for some patients with low-income levels, the chronic disease card can save them part of the drug treatment costs, greatly reducing the economic pressure and facilitating patients' self-management of medication.

It doesn't cost anything to buy medication, there's a chronic disease card, after reimbursement, it now costs 10 Yuan, the medication isn't expensive. (P10)

Changes in Living Habits

In the course of the interviews, it became evident that the medication management of some young patients with T2DM was influenced by their lifestyle habits. If they skipped breakfast or did not get out of bed, they would subsequently neglect to take their medication in the morning.

> Three capsules a day, taken before meals, but if I don't get up in the morning for breakfast, I don't take them in the morning, which makes it two capsules a day. (P11)

Also, changes in dining locations can affect patients' regular medication use. Some patients find it inconvenient to carry their glucose-lowering medication out to meals or work, so they choose to forgo their medication occasionally.

> Sometimes I go out at night and don't eat at home. Friends ask me to drink, so I don't take the medicine. (P8)

> I can't take the medicine on New Year's Day when I visit relatives. It's not convenient. Sometimes I don't take it, but it doesn't have much effect. (P9)

> Therefore, the formation of a regular routine is a facilitator for medication self-management in patients with T2DM, integrating medication behaviors into their lives as part of their daily routine.

Impact of the Work

The pace of life in modern times is fast, and the pressures of the workforce are considerable. Some of the T2DM patients who were still engaged in employment reported that they often had to forgo or neglect their medication as a consequence of their demanding schedules, which resulted in poor glycemic control and even the emergence of complications associated with diabetes.

> I came to the hospital once at the beginning of July and was prescribed insulin, which I went back to take myself. Then on the 20th I ran out of insulin and stopped taking it for a week because I was very busy with my project and didn't have time to come and buy the medicine. (P12)

> Especially for male patients, with more work-related socializing and the prevalence of the drinking culture in China, when drinking alcohol respondents indicated that they would consider forgoing the use of glucose-lowering drugs, etc., fearing that drinking alcohol and using medication would cause adverse drug reactions.

> You're like we're out on construction sites all year round, sometimes we eat very irregularly, sometimes we go out at night to drink and socialize and forget to take insulin with us. (P4)

Limited Medical Resources

Some interviewees identified the unequal distribution of healthcare resources and complexity of medical procedures as key factors influencing their inability to procure glucose-lowering medication promptly. For individuals residing in rural regions, the unavailability of certain pharmaceuticals in small local hospitals or pharmacies resulted in the necessity to alter their medication regimen or discontinue its use.

> Can't buy medicine, as our side is very remote, in Feidong Qiaotouji's side, a slightly better hospital is about seventeen or eighteen kilometers away. (P12)

> It's a hassle to go to the hospital to buy medicine. You need to make an appointment on your phone, which is difficult for older people. (P9)

> T2DM patients were more experienced in seeking medical care and therefore more demanding of their doctors. They trusted their doctors, and they refused to take medication prescribed by other doctors.

> I didn't take the medication I was prescribed by a doctor I didn't know. I didn't think it was necessary. (P18)

Motivation
Higher Medication Self-Efficacy

Higher confidence in managing medication was linked to better medication self-management in T2DM patients. Most respondents said they took their medication or monitored their blood sugar because they were afraid of getting complications from diabetes. They believed that taking their medication properly would help control their blood sugar.

Of course, I take medication management seriously because I don't want to get complications. (P18)

Why am I afraid to stop taking my medication, I've been diabetic for so many years and I've been relying on my medication to maintain my blood sugar levels. (P3)

During the interviews, we found that some of the patients had suffered from diabetes complications for a long time and passively accepted the treatment and care from their doctors and family members, which led to their negative attitudes towards the management of their medication and glycemic control.

I said that since I'm at this age and it's a chronic disease, I don't care, just let it go.(P17)

Misguided Beliefs About Medication

Medication beliefs are considered to be the main factor affecting medication adherence, and patients with false medication beliefs tend to have poor medication adherence. Some of the interviewees believed that taking glucose-lowering drugs for a long period or changing the type of medication suddenly might cause harm to their body, and thought that "every medicament has side-effect", hoping to reduce insulin or glucose-lowering drug dosage to reduce the side effects of medication.

People say that medicine affects the internal organs, so I stopped taking it. I took about 40 capsules, and I still have more than 20 left. (P16)

The doctor said to change my medication because one of them doesn't work long-term. I don't want, because my kidneys aren't good and I'm worried other meds will damage them. (P14)

Emotional Response

The most effective method for determining the efficacy of diabetes medications is through regular monitoring of blood glucose levels. However, most people say that finger-prick blood glucose testing is painful, especially for those who are sensitive to pain. This makes patients reluctant to monitor their blood glucose. They want a non-invasive blood glucose meter that does not hurt.

I don't test myself at home, sometimes I'm afraid that sticking my finger will hurt. (P7)

There is also a blood glucose meter for measuring nails, but I don't know if it's accurate, he said that you can know your blood glucose without sticking a needle and putting it on your hand. I bought one online, spent a few hundred yuan, bought it back to see a watch, and threw it away. (P4)

Beyond COM-B
Effects of Diet and Exercise

T2DM patients' blood glucose levels are affected by their drugs, diet, and exercise. Some respondents said that blood glucose control is related to drug dosage, food type and portion, and exercise. If diet and exercise are not controlled, the patient's blood glucose will fluctuate with the same medication dosage. This makes it difficult for inexperienced diabetic patients to adjust the dosage of insulin or oral hypoglycemic agents, which affects how well the patient manages their medication.

Diabetes has three legs. Diet, medication, and exercise. I haven't been able to exercise for three months. I broke my leg and had surgery. Now I'm in rehab and exercising a little. Eating more or something high in sugar might affect your blood sugar. (P18)

Integrating Findings

To the best of our knowledge, this is the inaugural qualitative study to analyze the factors influencing medication self-management behaviors in patients with T2DM based on the COM-B model. The objective is to propose an intervention strategy for patients' medication self-management.

Firstly, in our interviews, we found that patients with T2DM have gradually aging body functions and memory loss with age, so they often have multiple complications or are combined with other chronic diseases, and the complexity and variety of medications are very likely to lead to delays, interruptions, and omissions in their medication intake. In developed countries, more than half of T2DM patients are over 65 years of age,[16] and about 40% of older diabetic patients have four or more diseases.[17] The aging of the organism in elderly patients causes cognitive and physiological function decline, which leads to their self-management ability at a low level.[18] Similar studies have shown that elderly patients with multimorbidity are prone to poor medication adherence, improper medication management, and low medication safety during medication self-management.[19]

We observed that low medication literacy in the early stages of the disease is detrimental to medication management in patients with type 2 diabetes. Pouliot[20] defined drug literacy as the ability to understand and use information about medications to make good decisions. Most patients said they lacked knowledge and skills related to disease medication at the early stage of diabetes. Those with lower literacy levels were especially susceptible to erroneous beliefs about medication. These beliefs led to erroneous medication behaviors. Many foreign studies[21–23] have shown that diabetic patients' knowledge, attitudes, and behaviors affect each other. Therefore, improving medication literacy is the best way to help diabetic patients access and use medication information, make reasonable decisions, and control their blood glucose levels.

In the era of rapid development of the Internet, with the wide application of smartphones and other digital products, short videos on medical science are rapidly becoming popular. Most of the respondents indicated that they could learn a lot of drug knowledge and medication skills and so on through the *Douyin* App and *WeChat* short video. However, some patients reflected that the quality of video content on the Internet currently varies, and it is often difficult for patients to screen the authenticity of the content, which can easily lead to misinformation. Although the development of the Internet has penetrated all aspects of healthcare, the popularity of modern electronic information channels, including smartphones, is still unsatisfactory for middle-aged and elderly patients with chronic diseases.[24] During the interviews, elderly T2DM patients generally reflected that they were not accustomed to using mobile phones for online registration, payment, and medication collection, and on the contrary, they were more willing to do it offline at the window.

Support from family and friends is a favorable social opportunity for medication self-management in T2DM patients. Most of the interviewees indicated that their spouses and children, as their core companions in the process of treatment and medication, not only cared for them psychologically but also provided practical help materially. During the interviews, it was found that since there are many obstacles for elderly patients in seeking medical treatment and purchasing medicines, they are often accompanied by their children in seeking medical treatment or purchasing medicines on their behalf. Especially for patients with low medication adherence, the reminder and supervision of medication by family members greatly reduce the risk of missing or incorrectly taking medication. Indeed, PAN et al have previously reported this finding,[25] so our findings reinforce this view. However, it is worth noting that two interviewees pointed out that their children were often busy with their work and did not have more time to supervise medication management in the elderly, and even some elderly diabetic patients were tasked with caring for their grandchildren, which resulted in the patients neglecting to manage their disease.

The support of health insurance policy is a facilitating factor that the interviewees were very willing to mention. T2DM has the characteristics of being difficult to cure, and the patients even need to carry out lifelong blood glucose monitoring and medication management, as well as have to face complications at any time, and need to bear a higher level of the burden of treatment and care expenditures. Through interviews, it was found that the chronic disease outpatient system introduced in China has largely alleviated the problem of people's difficulty in using medication, and patients with chronic diseases such as diabetes can be reimbursed for their medical expenses through chronic disease cards. This has the additional benefit of reducing the financial burden of long-term medication for patients, while also significantly enhancing their medication compliance.

During the interviews, we identified changes in lifestyle habits as a deterrent to medication self-management in patients with T2DM. Specifically, when a patient's regular daily routine is disrupted, it may affect the time, place, and dose of their medication. When there is a change in the place of dining, such as a gathering with family and friends, some patients find it inconvenient to carry their hypoglycemic drugs or insulin out of the house, or they believe that using

medication in a public place will cause embarrassment and affect their image. From the perspective of the COM-B model, this irregular lifestyle may be related to the lack of attention to medication self-management, and Piekarz et al[26] pointed out that making plans for special times (eg, when going on holiday) can effectively prevent the occurrence of missed doses and improve adherence. This is an influential factor not mentioned in previous quantitative studies.

Some of the male respondents in our study indicated that work would have some negative impact on their medication management. Specifically, frequent changes in their workplaces made it impossible for them to review and buy medication at regular intervals, and they repeatedly complained that they were forced to give up or forget to take their medication because of their busy work schedules. A foreign qualitative study showed that patients may miss medication when facing the interference of busy work.[26] In this interview, this phenomenon was mainly concentrated in male patients, which may be because men have heavier tasks at work and male workers are predominantly involved in workplace socializing and traveling for work. However, this is inconsistent with the findings of Shaha et al[27] that medication adherence is higher in males than females. Therefore, our findings show a new perspective that previous medication management for chronic disease patients mainly focuses on the elderly population and ignores the young and middle-aged patients,[28] who, as the main labor force of the family and society, often neglect their medication management due to the pressure of their work, even though they have high self-care ability.

However, it is worth noting that some T2DM patients living in rural areas reported that patients living in remote rural and mountainous areas were unable to enjoy medical resources promptly due to the unbalanced development of medical care, forcing them to choose to forgo medication. Previous studies have indicated that patients' medication adherence improves with increased ease of dispensing.[29] At the same time, the professionalism of the doctor can also have an impact on a patient's medication management, and some patients only trust the medication regimen of the bedside director, not the intern. There have been foreign studies showing that patients' mistrust of the dose and type of medication prescribed by doctors is closely related to poor medication compliance.[30] At the same time, it also reflects that the doctor's professional level is the key factor in maintaining medication adherence of diabetic patients indirectly.

In the interviews, we found that the higher the patient's motivation for medication the higher the level of medication self-management. This motivation is mainly expressed in higher medication self-efficacy, which correlates with reflexive motivation in the COM-M model. T2DM patients with high self-efficacy are more motivated and confident in medication self-management. Quantitative studies have also indicated that patients who are aware of the necessity of medication to maintain their health and prevent disease recurrence, and who are confident in their medication management are more likely to adhere to their medication regimen.[31] Specifically, a higher sense of self-efficacy can arouse patients' motivation for medication self-management, making them actively learn about relevant medications and actively participate in the medication management process, so this positive and active psychological expectation will motivate patients to adhere to standardized medication behaviors. However, it was found in the interviews that some patients had serious complications and poor treatment results, and self-management was in a passive state. In the long run, this puts the patients in a negative state when facing the disease, and they do not actively cooperate with the treatment, this very low self-efficacy seriously affects the patients' medication management and treatment effect. It has been proved[32,33] that higher medication self-efficacy can promote the improvement of patients' medication self-management behaviors; followed by patients with higher self-efficacy for rational medication administration will observe the problems in medication administration in a more timely and effective manner.[34]

It is then of concern that erroneous medication beliefs were found to be an impediment to patients' medication self-management in this interview, with some patients believing that taking medication for a long period would be harmful to their bodies, and they attempted to blindly adjust the dose of their medication or discontinue the medication through dietary and exercise modifications. Alhewiti et al[35] showed that the stronger the patients' worry concerns about taking medication, the lower their medication adherence. In addition, elderly patients often mistakenly believe that medications are dangerous and toxic and that natural remedies such as dietary supplements or nutraceuticals are safer.[36,37] Therefore, our findings once again reinforce this view.

Blood glucose level is an important indicator for monitoring medication efficacy in patients with T2DM,[38] and it is also the key to medication management in patients with type 2 diabetes mellitus. Although non-invasive ambulatory glucose monitoring technology is available, it is expensive and limited by numerous factors compared to finger-prick

glucose measurement, and some data show that the discontinuation rate of ambulatory glucose monitoring within 1 year is as high as 27%.[39] In this study, the main emotional responses to monitoring blood glucose were found to be: fear of pain and desire. This spontaneous emotional response is the instinctive hair response of the body and mind during finger measurement of blood glucose. Multiple patients in the interviews indicated that prolonged finger-prick glucose measurement was painful, so they wished they could have a non-invasive glucose monitoring tool. Unable to overcome this instinctive fear, patients often choose to occasionally or forgo monitoring their blood glucose. Meanwhile, we found that previous studies on the influencing factors of adherence to blood glucose monitoring in diabetic patients mainly focused on quantitative aspects,[40,41] and seldom analyzed the intrinsic motivation of patients in terms of their psychological and emotional aspects, which is a new finding of this interview.

The reason why the effects of diet and exercise are independent of the COM-B model is that diet, exercise and medication management belong to the same self-management of T2DM patients, and the three are a parallel relationship that influences each other and cannot be separated from each other, and they work together to affect the blood glucose level. During the interviews, patients generally reflected that the control of blood glucose depends on standardized drug management, reasonable dietary structure, and appropriate exercise. They believed that all three were equally important and mutually reinforcing and that changes in diet and exercise could affect medication dosage adjustments, while self-adjustment of insulin or oral hypoglycemic drug dosage was challenging for some patients who lacked knowledge of medication in the early stages of diabetes. Therefore, medication self-management behaviors in patients with T2DM need to be based on capability, opportunity, and motivation, together with diabetic diet and exercise, to achieve effective control of blood glucose levels.

Practice Implications

Our findings demonstrate enablers and barriers to medication self-management in patients with T2DM in terms of capability, opportunity, and motivation, and many of the insights are supported by previous findings. New findings were also obtained by analyzing the factors of patients' medication self-management from some new perspectives using the COM-B model. Policy support from health insurance, greater access to medications, and higher medication self-efficacy enabled patients to effectively manage their treatment. In contrast, significant barriers include low medication literacy, functional decline associated with aging, lifestyle changes, work-related stress, limited medical resources, false beliefs about medications, and emotional responses such as fear and worry. In addition, online media applications and the influence of family members can be both facilitating and hindering, depending on the circumstances.

Based on these influencing factors, we proposed targeted solutions to improve medication self-management based on the behavior change wheel. These results have important implications for the development of targeted interventions to improve medication self-management in people with type 2 diabetes. Specifically, the barriers identified suggest the need for a comprehensive education program for healthcare professionals to improve medication literacy to reduce misconceptions about medication; particularly, to strengthen medication management training and guidance for elderly patients, to provide continuous monitoring and reminders of medication use, and to strengthen family support and continuity of care functions in community hospitals. For the patients themselves, they can be guided to establish regular work rest and dietary habits, and to formulate coping plans in advance is a key means to prevent missed doses. In addition, the facilitators identified suggest that appropriate use of mHealth apps can provide patients with ongoing support and reminders to improve adherence to their medication regimen. The use of incentives encourages patients to set glycemic control goals and set expected rewards to increase confidence in disease treatment. Finally, make full use of the support of health insurance policies to reduce the financial burden on patients and enable them to gain greater access to medication. Table 4 summarizes the optimization strategies corresponding to these influencing factors.

Strengths and Limitations

To the best of our knowledge, this is the inaugural qualitative study to utilize the COM-B model as an analytical framework for investigating enablers and barriers to medication self-management in patients with T2DM. A further strength of this study is that, by analyzing the influencing factors, we have proposed a targeted intervention program to overcome the hindering factors and consolidate the facilitating factors. This has been done based on the nine major

Table 4 Practice Implications Based on Identified Enablers and Barriers

COM-B	Identified Barrier and Enabler	Intervention Functions	Corresponding System Optimization Strategy
Physical capability	Ageing of body functions	Training, enablement	Enhancement of medication management training guidance for elderly patients, supervision and reminder of medication, family support role, and continuity of care in community hospitals.
Psychological capability	Low medication literacy in the early stages of diabetes	Education	Healthcare personnel to improve the ability to educate; patients to strengthen their knowledge of diabetes medication education, especially when patients use a new drug, the education should be comprehensive and detailed.
Social opportunity	Applications of online media	Enablement	Intelligent management of medicines; making full use of mobile devices such as mobile phones and computers; raising the requirements for the release of medical science videos and promoting high-quality science videos.
	Impact of family and friends	Enablement	Strengthen the level of support from family members and establish a medical and nursing-led model of family support.
	Policy support for medical insurance	Environmental restructuring	The State has continued to improve health insurance policies, increase reimbursement rates, increase the types of chronic diseases covered by health insurance other than diabetes, improve the drug catalog, and lower the application requirements for outpatient chronic diseases.
Physical opportunity	Changes in living habits	Coercion	Guiding patients to establish regular work, rest, and dietary habits, reinforcing the role of family supervision and reminders, informing them of the serious consequences of poor medication management; and formulating a response plan in advance is a key means of preventing missed doses.
	Impact of the work	Enablement	Rationalize your work and life, set up a schedule planner in advance, set up medication reminders, and a disease diary to form good habits.
	Limited medical resources	Environmental restructuring	The State should focus on the development of primary health-care institutions, achieve all-round linkages between upper and lower-level hospitals, share medical resources, and strengthen the level of primary health-care institutions.
Reflexive motivation	Higher medication self-efficacy	Incentivisation	Setting goals for glycaemic control, setting expected rewards and increasing confidence in disease treatment.
	Misguided beliefs about medication	Education, Persuasion	Help patients develop correct medication beliefs through tactful communication and professional health education.
Automatic motivation	Emotional response	Incentivisation, Persuasion	It refers to the psychological assessment of the patient before blood glucose measurement, understanding the patient's psychological state through listening and communication, and actively encouraging the patient to overcome psychological barriers and improve psychological resilience.
Beyond COM-B:	Effects of diet and exercise	Education	Healthcare professionals can strengthen the health promotion of diabetes self-management, stressing the importance of diet and exercise for drug management; patients themselves follow the medication prescribed by the doctor while adhering to a diabetic diet, along with appropriate exercise.

interventional functions of the Behavioral Change Wheel. This will be beneficial for our next research project. Nonetheless, several limitations remain. Firstly, while the sample size of 20 participants was sufficient for a qualitative study, the participants were from a single tertiary care hospital and did not include people with type 2 diabetes at home, which may not be representative of the wider population of people with type 2 diabetes mellitus (T2DM). Future studies should consider larger and more diverse samples to enhance the external validity of the findings. Second, data collection relied on patient self-reported data, which may be subject to recall bias and social desirability bias. In addition, a structured theory-based study may limit the content of participants' responses. Finally, this study was conducted in a specific cultural context and healthcare setting, which may affect the applicability of the findings to other

regions or healthcare systems. Future research should examine the impact of cultural and systemic differences on self-management of medication taking in patients with type 2 diabetes.

Conclusions

Based on the COM-B model, our qualitative findings indicated that low medication literacy and aging of body functions are barriers in medication self-management capability. We further found that the development of online media promotes medication self-management, but it does not apply as well to older adults. In terms of medication self-management opportunities, policy support for medical insurance is an enabler for respondents' medication self-management, however, limited medical resources is a barrier for T2DM patients to participate in medication management. Although most of the interviewees reported that family concern was beneficial to medication behavior, some elderly patients reported that their children were busy with work and family and often neglected their medication management. Changes in living habits are an impediment to regular medication use by patients, which has not been mentioned in previous studies. Unlike previous studies,[27] this study found that some male respondents considered the influence of work as a barrier factor to their medication use. In terms of motivation for medication self-management, we found that positive medication self-efficacy was an enabler, false beliefs about medication were a barrier, and fear of pain was the reason for poor adherence to blood glucose monitoring in patients. At the same time, we briefly present a framework of strategies that can be used to address barriers and exploit facilitators.

In future studies, we will use the behavior change wheel, a formal analytical framework, to delve into aspects of medication self-management in patients with type 2 diabetes. Specifically, we will analyze patients' medication capability, opportunity, and motivation, as well as the underlying mechanisms and interactions between these factors. In addition, we will design and test multiple interventions to assess their effectiveness in improving medication self-management. These interventions will include a variety of aspects such as educational interventions, technical support, social support, and policy improvement. Through randomized controlled trials (RCTs) and long-term follow-up studies, we will assess the impact of these interventions on patients' medication management, glycemic control, and overall health outcomes. Finally, we will collect feedback from patients and healthcare providers through qualitative and quantitative research methods to further optimize the design and implementation of the interventions.

Ethics Approval

The study involving human participants was conducted following the Declaration of Helsinki and approved by the Ethics Committee of the First Affiliated Hospital of Anhui University of Chinese Medicine (No. 2024AH-19).

Consent to Participate and for Data Publication

Informed consent was obtained from each participant before enrollment in the study, including permission to publish anonymized responses and direct quotes.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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