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The Effect of Problem-Solving-Based Blood Glucose Management through Real-Time Self-Monitoring: A Case Study

Sumiko Kamoshita*[1], Misaki Kurawaka[2], Fumio Shimura[1]

[1]*Asian Nutrition and Food Culture Research Center, Jumonji University*
[2]*Food Science Department, Faculty of Human Life, Jumonji University*

**Corresponding author; sumiko-k@jumonji-u.ac.jp*

ABSTRACT *Background.* Understanding how daily habits affect blood glucose is challenging for many patients with type 2 DM, often leading to difficulties in sustaining self-management. This case study examined the impact of real-time glucose monitoring with the Free Style Libre on blood glucose control and behavioral change and introduced the concept of "problem-solving–based blood glucose self-management." *Methods.* A patient with type 2 DM and persistently poor blood glucose control was evaluated using continuous glucose data from the Free Style Libre, supported by lifestyle records and interview findings. *Results.* Use of the Libre enabled the patient to identify links between lifestyle behaviors and glucose fluctuations, prompting gradual lifestyle adjustments. HbA1c improved by 1.8% within three months, and glucose visualization enhanced motivation, self-efficacy, and active problem-solving. *Discussion.* The patient's process of identifying challenges and implementing solutions resembled a Project-Based Learning (PBL) approach, supporting the applicability of "problem-solving–based blood glucose self-management" as a patient-centered model. *Conclusion.* Real-time glucose monitoring facilitated significant short-term improvement in blood glucose control and promoted meaningful behavioral change. This approach may offer value for DM education and public health strategies, though further validation is needed.

Keywords: Self-management, Free Style Libre, HbA1c improvement, Problem-solving–based blood glucose management, public health significance

INTRODUCTION

Diabetes mellitus (DM) is classified into four main types: type 1 DM, type 2 DM, DM caused by specific diseases or conditions, and gestational DM (1). Both genetic and environmental factors play a role in its development. In Japan, most cases of DM are type 2, which is strongly influenced by lifestyle habits such as high-calorie diets, high-fat diets, and lack of exercise (1). When these unhealthy habits continue for a long time, the body produces less insulin, and insulin resistance increases, leading to DM (2). Patients with type 2 DM are required to control their blood glucose levels through dietary and exercise therapy to prevent severe complications. If blood glucose control is not sufficient, medications such as oral drugs or insulin injections may be necessary (2). Diet and exercise therapy usually start as soon as a person is diagnosed with DM or is suspected of having it. If these treatments are successful, blood glucose levels can be kept within a healthy range, and the need for medication may decrease (2). However, to achieve this, patients must make diet and exercise therapy a part of their daily routine. These are not a short-term effort but something that must continue for life. Since DM is a chronic disease with few noticeable symptoms, particularly in the early stages, patients often do not experience significant physical changes or disruptions to their daily activities. This makes it difficult for them to fully realize they have DM or feel a sense of urgency. It is often noted that, even

when individuals acquire knowledge and skills related to dietary and exercise therapy, they frequently struggle to maintain these practices in daily life, leading to poor blood glucose control and unsuccessful self-management of blood glucose (3). Schmitt et al. assessed the level of illness acceptance in a cohort of 320 patients with DM and found that those with lower acceptance demonstrated fewer self-management behaviors and had higher HbA1c levels. They reported that accepting one's condition and facing DM directly is closely linked to the continuation of effective blood glucose self-management, and that this factor plays a stronger role than psychological distress in influencing glycemic control. (4). This helps them stay motivated to learn about self-care, include treatment in their daily routines, and create a new lifestyle that supports better health (5,6).

Reports exist regarding the factors influencing the quality of blood glucose control and the support systems available for patients (5,7,8,9,10); however, there are few studies that detail specific methods for achieving good blood glucose control. Okui et al. conducted an intervention study involving ten employed patients with type 2 DM, using systematic self-monitoring of blood glucose (SMBG). Although participants experienced a shift in their awareness toward improving their lifestyle habits, the study also revealed the difficulties of conducting blood glucose monitoring in work environments. Consequently, the authors emphasized the need for a simpler and more practical approach (11). There is an urgent demand for methods that allow blood glucose fluctuations to be recorded without the need to consider specific times, places, or conditions for measurement.

In this study, we report a case of a type 2 DM patient who had been experiencing poor blood glucose control and a continuous rise in HbA1c levels, but who achieved significant improvement in blood glucose control over a relatively short period through self-management using the Free Style Libre Flash Glucose Monitoring System. Although personal experiences and self-collected data related to one’s own health or illness may hold significant academic value, such information is often underrepresented in scholarly literature and rarely reaches formal publication. This study presents data voluntarily contributed by an individual who sought to address this limitation. By documenting these insights in an academic format, the study aims to contribute to the literature and pursue publication in this journal.

Furthermore, the insights gained from this case extend beyond the management of a single individual and hold significant implications from a public health perspective. The demonstration of a simple and sustainable method of self-monitoring for blood glucose control not only contributes to improving the quality of life of patients with DM but also has the potential to strengthen DM prevention and management at the community and workplace levels. Importantly, in the current context where DM is becoming an urgent global public health challenge, the findings of this study may serve as practical evidence that can be shared across countries and regions. Such outcomes are expected to support the advancement of preventive interventions and health education both domestically and internationally, while also informing health policy development and contributing to global strategies for DM control. Thus, this case report transcends an individual success story, offering meaningful insights for broader societal health strategies and for the international public health framework.

METHODS

Participant (Self-initiated data provider) The patient is an elderly man who is currently working. He was diagnosed with non-insulin dependent DM (type 2 DM) in 2013. He has no complications and continues outpatient treatment at a hospital in Tokyo. He takes oral medication but does not use insulin injections. He lives with his wife. Since February 2024, he has been using the Free Style Libre flash glucose monitoring system, manufactured by Abbott, for self-monitoring of blood glucose levels.

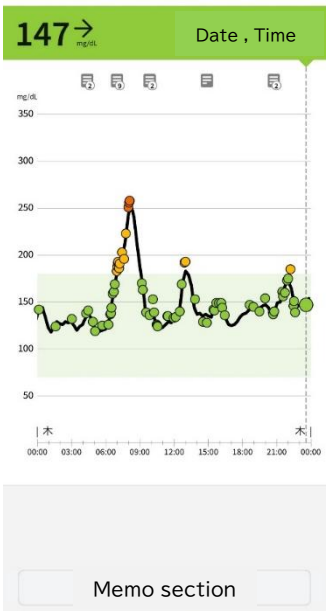
Following a diagnosis of type 2 DM, the patient had continuously adhered to dietary and exercise therapies; however, blood glucose control remained challenging, and HbA1c levels continued to rise. In response, the patient began using the Free Style Libre system to monitor blood glucose fluctuations in real time while reassessing lifestyle habits. This resulted in improved blood glucose control and a marked reduction in HbA1c levels. Believing that this personal experience could offer valuable insights into DM management, the patient expressed a strong desire for these findings to be published in the form of an academic paper. The research team deemed this request appropriate, carefully

reviewed the data provided by the patient to confirm its authenticity, and submitted the research protocol for ethical review to the Jumonji University Research Ethics Committee, as described below. Upon receiving approval, the study was compiled into a research manuscript. The patient was fully informed of the purpose and content of the study, as well as the intended use and handling of the provided data. After fully understanding and accepting these conditions, the patient voluntarily consented to provide personal data in support of this research. In this study, the patient is referred to as the “Self-initiated data provider.”

Blood Glucose Self-Monitoring Tool Used by the Self-initiated data provider The self-initiated data provider uses the Free Style Libre flash glucose monitoring system (hereinafter referred to as "Libre") as a tool for self-monitoring blood sugar levels. Libre is a flash glucose monitoring system that continuously measures glucose levels in the interstitial fluid under the skin. It has a disposable sensor attached to the upper arm, which is scanned using a dedicated Reader to display glucose readings. The system can also be used with a smartphone app called Free Style Libre Link instead of the Reader. This app can be easily downloaded from the Google Play Store or App Store, and the self-initiated data provider in this study uses the app. The sensor is a white, disk-shaped device measuring 35 mm in diameter and 5 mm in thickness, and it is capable of continuously measuring glucose levels for two weeks with a single sensor. During the monitoring period, the sensor remains attached to the body without removal, allowing the user to continue daily activities, including bathing. Even for individuals who are employed, glucose monitoring is not restricted by the time, location, or type of work performed. While strong pressure on the sensor may cause slight discomfort, under normal conditions, it does not produce pain or irritation to the skin.

When the sensor is scanned, the smartphone screen displays a diurnal variation graph. The light green area represents the target blood sugar range (70–180 mg/dL). Circular markers on the line graph indicate individual glucose measurements, with color variations depending on the glucose concentration: green if within the target range, yellow for 181–240 mg/dL, orange for above 240 mg/dL, and red for below 70 mg/dL. The graph also shows the daily average blood sugar level. Additionally, a memo section at the bottom of the screen allows users to record information such as meals, exercise, bathing, sleep, and commuting (Figure 1).

a. Sensor attached to the left upper arm



b. Example of a diurnal variation graph in blood glucose levels

Figure 1 Sensor and a diurnal variation graph

a: The sensor is a white, disk-shaped device that continuously measures glucose levels for up to two weeks while worn on the body, permitting normal daily activities. It generally causes no pain or skin irritation.

b: The screen displays the daily mean glucose level, date and time, and a glucose profile. The light green area indicates the target glucose range (70–180 mg/dL), and measured glucose values are shown as color-coded circles according to glucose level. A memo field below the graph allows users to record daily activities such as meals and exercise.

By continuously tracking glucose levels in the interstitial fluid, Libre helps users understand how their daily habits affect blood sugar. This supports better self-management and helps prevent high and low blood sugar levels.

Interview Survey In June 2024, two face-to-face interviews were conducted. The self-initiated data provider was asked to share his thoughts about DM and self-management. The goal was to understand how his feelings and attitudes changed before and after using Libre.

Medical Record Review Medical data from the self-initiated data provider's hospital visits were used in this study. The basic data for this study were laboratory details, types of prescribed oral medications, daily average blood glucose levels recorded by Libre, and a blood glucose diurnal variation graph. The self-initiated data provider voluntarily provided these materials. It should be noted that no intervention was made by the research team toward the self-initiated data provider during the course of the study, including the process of preparing the manuscript for publication.

Ethical Considerations A detailed explanation of this study was provided to the self-initiated data provider, both in writing through the research protocol and verbally. Among the items described in the protocol, particular emphasis was placed on the following points.

- The data provided must be authentic, and the self-initiated data provider assumes full responsibility should any information prove otherwise.
- The data will be used solely for research purposes, and any information disclosed in publications will be processed to prevent the leakage of personal information.
- Any figures or tables created on the basis of the provided data must be authentic.
- Participation as a self-initiated data provider in this study is entirely voluntary, and refusal to participate carries no disadvantage or penalty.

Consent was considered established upon submission of a signed consent form. Through this process, the ethical soundness of the study—particularly with respect to the protection of personal information and the assurance of research quality—was confirmed, and ethical approval was subsequently obtained from the Jumonji University Research Ethics Committee (Approval No. JEC2024043).

RESULTS

Diabetes Mellitus Treatment Plan at Diagnosis Table 1 shows the dietary and exercise guidance the self-initiated data provider received from his doctor when he was diagnosed with type 2 DM (non-insulin-dependent DM). At first, his treatment only included dietary and exercise therapy, but because he had difficulty managing his blood glucose levels, oral medication was later added. He has never used insulin injections.

Table 1 Diabetes mellitus treatment plan

Treatment	Guidance Details
Dietary therapy	- Maintain a stable weight. - Avoid overeating and finish dinner at least two hours before bedtime. - Reduce high-carbohydrate foods and eat more fiber-rich vegetables. - Make sure to get enough protein.
Exercise therapy	- Walk for about one hour during weekday commutes. - Engage in alternative physical activities on non-working days.
Oral medication	- Oral hypoglycemic agents (Suglat 1 tablet/day, Metoana HD 2 tablets/day, Twymeeg 4 tablets/day, Metformin 1 tablet/day). - Lipid-lowering agent (Lotriga granules 1 packet/day). - Gout and hyperuricemia treatment (Allopurinol 2 tablets/day). - Vasodilator (Amlodipine OD 1 tablet/day). - Hypercholesterolemia treatment (Livalo 1 tablet/day).

Dietary and exercise guidance provided at the time of diagnosis with type 2 DM; oral medication agents were added later due to poor blood glucose self-management.

Even with these treatments, his HbA1c levels kept rising, making him increasingly worried about complications. In search of a way to lower HbA1c levels, he learned about Libre, a self-monitoring blood glucose tool, and decided to incorporate it into his management plan. Libre is covered by insurance for DM patients requiring insulin therapy; however, since the self-initiated data provider did not qualify, he bore the full cost (7,000 yen per two weeks).

Impact of Libre on Blood Glucose Levels The self-initiated data provider started using Libre in January 2024. At first, his blood glucose and HbA1c levels kept rising, but from March 2024 onward, both began to decrease. Notably, the self-initiated data provider's HbA1c level decreased by 1.8% within three months, demonstrating a significant improvement (Figure 2).

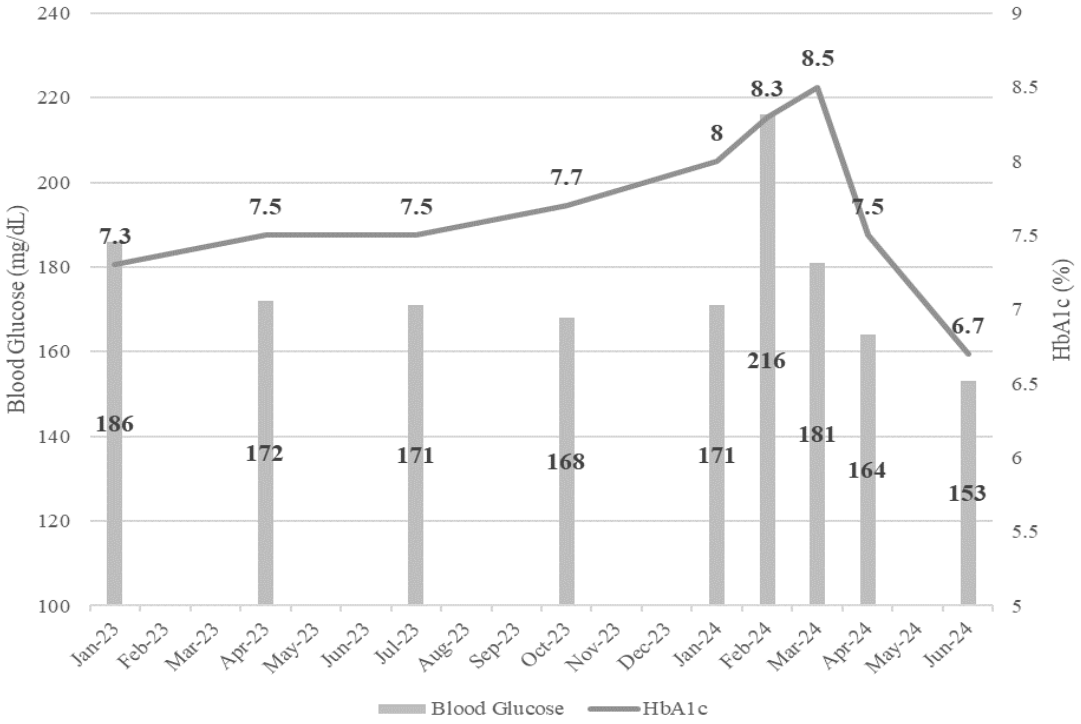


Figure 2 Changes in blood glucose levels and HbA1c during routine hospital visits
Left y-axis: blood glucose (mg/dL); right y-axis: HbA1c (%).
The x-axis shows measurements from routine checkups between January 2023 and June 2024. Use of the Free Style Libre began in January 2024.
Bars represent blood glucose levels, and the line represents HbA1c.

Key Observations from Libre Data Five days between March and May 2024, blood glucose monitoring data obtained via Libre were analyzed, including average daily blood glucose levels and diurnal variation graph (Figure 3). Details for the five days example are provided below:

a: workday (business event) On this day, the self-initiated data provider attended a work-related event where dining was unavoidable. After consuming a bento meal provided at the event, his blood glucose levels rose sharply. He realized that white rice and traditional Japanese sweets (which contain sugar) caused a big spike.

b: hospital checkup day (no work) On this day, the self-initiated data provider did not go to work because he had a hospital checkup. He had a fasting blood test in the morning and ate a late lunch. His blood glucose spiked sharply after eating. He discovered that blood glucose could rise even without eating and that having a full meal after fasting caused an even bigger spike than usual.

c: weekend (at home) While at home on a weekend, the self-initiated data provider ate half a pizza for lunch, which caused a sharp blood glucose increase. Worried about this, he tried exercise bike, which effectively lowered his blood glucose. Through this experience, he discovered that exercise bike was beneficial for blood glucose control. This realization provided him with reassurance that even foods typically considered unfavorable for DM management, such as pizza, could occasionally be enjoyed if paired with appropriate physical activity. He also noticed that oatmeal, which is usually considered good for blood glucose control, actually increased his levels. On the other hand, after dinner, his blood glucose remained stable, which made him feel relieved and happy. This experience helped him gain confidence in managing his blood glucose.

d: workday (usually) The self-initiated data provider spent most of the day sitting at work. Despite this, he was able to keep his blood glucose within the target range using only dietary therapy and oral medication. This success boosted his confidence in self-management. He also found that Shochu (a type of alcohol) helped lower his blood glucose. This discovery made him happy, as he realized he could still enjoy alcohol if he chose the right type.
e: workday (usually) On another workday, the self-initiated data provider noticed his blood glucose increased after lunch. To keep it within the target range, he did squat at work. This exercise successfully lowered his blood glucose. He learned that squat was an effective way to reduce post-meal spikes and that his blood glucose tended to rise more after lunch than other meals.

By observing these blood glucose changes, the self-initiated data provider gained a better understanding of how diet and exercise affected his body. Through repeated trial and error, the self-initiated data provider developed an optimized diet and exercise routine tailored to his lifestyle (Table 2).

Table 2 Adjustments to suit the self-initiated data provider's lifestyle

Category	Key Insights
Diet	- Split meals into two parts: consume protein food first, take medication, then eat the second portion. Prevents sudden spikes in blood glucose levels. - During the day, blood glucose levels rise most dramatically after lunch and remain relatively stable after dinner. - To reduce the consumption of staple foods (such as rice, bread, or noodles). - Shochu does not raise blood glucose. - Oatmeal, despite its reputation, raises blood glucose for this self-initiated data provider.
Exercise	[Workdays] - Walk quickly between home and the station, use stairs when changing trains (~1 hour total). - Squat at work to lower blood glucose. Number of times: 60 reps × 3 sets [Weekends] - Exercise bike effectively lowers blood glucose. Model used: ALINCO ALFITS, AFBX462 Load strength: 8 (maximum) Time: 1 cycle (approximately 1.5 to 2 minutes) × 5
Others	- Blood glucose rises in the morning even before eating, and medication alone does not lower it. Best to eat breakfast only after observing a natural glucose decline. -Blood glucose spikes post-bath but decreases as body temperature normalizes.

Visualization of daily blood glucose fluctuations clarified specific lifestyle prescriptions, including dietary patterns and types of physical activity.

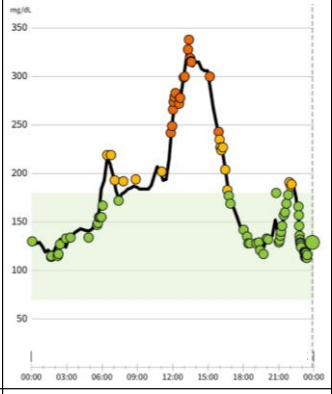
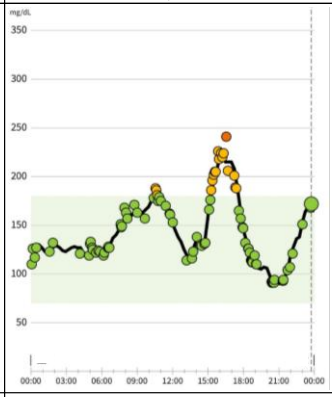
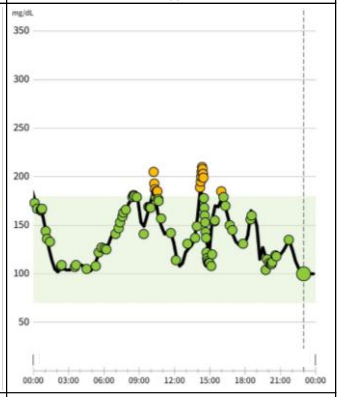
Psychological Changes Before and After Using Libre Table 3 shows how the self-initiated data provider's attitude toward DM management changed. Before Libre, he could only check HbA1c levels during medical checkups, making it difficult to understand the reasons behind fluctuations. As his HbA1c kept rising, he became more anxious about complications. However, with Libre, he could monitor his blood glucose at any time, gaining clarity on how his lifestyle affected his levels. He began to explore the relationship between lifestyle and blood glucose fluctuations. This led to increased motivation, confidence, and a willingness to actively manage his blood glucose levels.

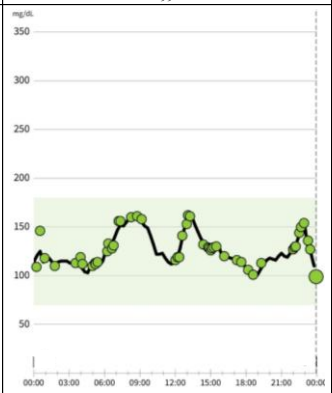
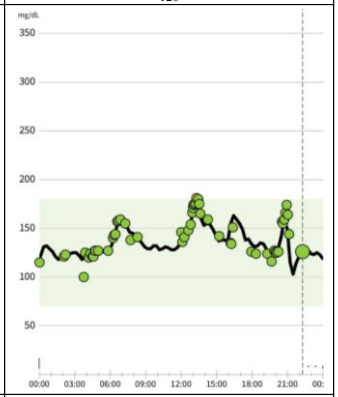
Table 3 Psychological Changes Before and After Using Libre

Before Using Libre	After Using Libre
- Struggled to fully recognize his DM. - Felt strong anxiety about complications. - Thought self-management of blood glucose was impossible. - Had no idea what affected his blood glucose levels. - Lost confidence due to poor blood glucose control.	- Accepted his DM and committed to managing it. - Developed a more positive attitude toward living with DM. - Gained confidence in self-management of blood glucose. - Became motivated to actively control his blood glucose. - Developed curiosity about how lifestyle impact glucose fluctuations. - Felt encouraged by praise from his physician.

A shift from negative to positive thinking was observed before and after the use of Libre.

Figure3　Key Observations from Libre Data (Five days between March and May 2024)

		a. Mid-March 2024（workday : business event）	b. Mid-April 2024（hospital checkup day）	c. Early May 2024（weekend :at home）
MBG (mg/dL)		129	172	100
diurnal variation graph (day)				
Meal details	Breakfast	Yogurt, Salad chicken, Miso soup (onion), Vegetables (tomato/cucumber/cabbage), Sausage 【Take medication】	After the test: Chicken bar 【Take medication】	5:18 Boiled egg, Cheese 【Take medication】 7:15 Lettuce, Pickled bean sprouts, Salad chicken, Vegetable juice, Oatmeal, Yogurt
	Lunch	Lunch for a business meeting (bento) Traditional Japanese sweets	13:30 Beef stew, Coleslaw salad, Danish pastry, Black coffee	13:00 Lettuce, Pickled bean sprouts, Half a pizza
	Dinner	No special notes 【Take medication】	No special notes 【Take medication】	17:49 Boiled egg, Cheese 【Take medication】 18:30 Shochu, Stir-fried mushrooms, Pickled bean sprouts, Tosa-zukuri bonito, Avocado, Cucumber, Tomato, Herring roe
Exercise therapy		None (could not)	None (could not)	Rapid increase after lunch → Exercise bike
Things to notice		White rice and traditional Japanese sweets (which contain sugar) cause blood glucose levels to rise rapidly.	Blood glucose level may rise even without eating. Eating after fasting may increase blood glucose levels more than usual.	Oatmeal may raise blood glucose levels. Exercise bike is beneficial for blood glucose control. Blood glucose levels do not rise much after dinner.

		d. Mid-May 2024（workday :usually）	e. Late May 2024（workday :usually）
MBG (mg/dL)		99	126
diurnal variation graph (day)			
Meal details	Breakfast	5:00 Boiled egg, Cheese 【Take medication】 6:45 Stir-fried mushrooms, Pickled bean sprouts, Boiled cabbage, Pickled plum	5:00 Boiled egg, Cheese 【Take medication】 6:13 Pickled cabbage, Stir-fried mushrooms, Sausage, Yogurt, Natto, Mozuku seaweed
	Lunch	11:59 Boiled egg, Cucumber, Tomato, Pickled plum, Stir-fried mushrooms, Salad chicken, Boiled freeze-dried tofu	12:36 Konjac somen noodles, Cucumber, Seaweed, Salad chicken
	Dinner	21:59 Boiled egg, Cheese 【Take medication】 22:10 Shochu, Stir-fried mushrooms, Grilled duck, Half a block of tofu (topped with salted fish)	18:19 Boiled egg, Cheese 【Take medication】 18:30 Stir-fried mushrooms, Grilled duck, Half a block of tofu (topped with salted fish), Pickled cabbage
Exercise therapy		None	Rapid increase after lunch → Squat
Things to notice		Shochu may lower blood glucose levels.	Squat is beneficial for blood glucose control. Blood glucose levels tend to rise after lunch.

Five days exhibiting characteristic changes in blood glucose levels during the Libre use period are presented.
a: workday (business event)　Due to work-related constraints, dietary choices were limited and blood glucose levels rose rapidly; however, appropriate management was achieved.
b: hospital checkup day (no work)　A greater increase in blood glucose levels was observed after food intake following a fasting state compared with usual conditions.
c: weekend (at home)　Reassurance and enjoyment regarding meal consumption were observed.
d: workday (usually)　Confidence was gained in the ability to manage blood glucose levels through diet and medication alone.
e: workday (usually)　Blood glucose levels were found to rise more easily after lunch compared with after breakfast and dinner.

DISCUSSION

Patients diagnosed with DM often experience shock and anxiety about possible complications. To prevent complications and manage DM effectively, it is essential to continuously monitor blood glucose levels and maintain good control. Therefore, newly diagnosed patients are usually highly motivated to follow recommended dietary and exercise habits strictly. However, integrating DM management into long-standing lifestyle habits without stress is not easy. In particular, working

individuals, like the self-initiated data provider in this study, tend to prioritize work over their health. Additionally, since early-stage DM often has no clear symptoms, patients may gradually lose their sense of urgency about complications, making it easier for them to develop poor blood glucose control.

The self-initiated data provider in this study had extensive knowledge of DM, which suggested that blood glucose self-management might be easier for him compared to the general patient population. However, his HbA1c levels continued to rise, and during routine hospital checkups, he could not determine how his diet, exercise, and other lifestyle habits influenced his blood glucose levels. As a result, he lost confidence in his ability to manage his DM and became increasingly anxious about complications, feeling that self-management was beyond his control.

During these times, he learned about Free Style Libre, a tool that enables real-time blood glucose monitoring. Libre is covered by insurance for type 1 DM patients who require insulin therapy. However, it is also available for purchase online, making it accessible to type 2 DM patients and those concerned about their blood glucose levels. Because of this, Libre is considered a useful tool for self-monitoring blood glucose. After reviewing various usage examples, the self-initiated data provider decided to use Libre for his self-management.

The self-initiated data provider started using Libre in January 2024. At first, he struggled to determine how to use it effectively for managing his lifestyle habits. As a results, his blood glucose and HbA1c levels showed no immediate improvement during routine hospital checkups. However, by continuously monitoring his blood glucose fluctuations and comparing them with activities such as waking up, going to bed, bathing, excretion, exercise, meals, and work attendance, he gradually identified patterns. After about three months, he could gradually see how his lifestyle affected his blood glucose. These findings, shown in Tables 2 and 3, were not obtained easily. Instead, they were the result of repeated testing and trial and error, as he actively experimented to determine what affected his blood glucose. The intake of staple foods—especially rice, bread, and noodles—was identified as a major factor influencing blood glucose variability, and rigorous management of their consumption was strictly implemented. As a result of these efforts, his blood glucose decreased from 181 mg/dL to 153 mg/dL, and his HbA1c dropped from 8.5% to 6.7% between March and June 2024 (Figure 3). The fact that he was able to reduce his HbA1c by more than 1.5% in just three months is a significant achievement with academic importance for DM management.

Dietary therapy, which is essential for DM management, requires patients to carefully select ingredients and consider cooking methods for every meal. This places a major burden on them (12,13,14). Additionally, working individuals often have business meals and social events that take priority over their blood glucose management. Exercise therapy is also difficult to incorporate into daily routines due to time constraints (8). Despite these obstacles, the self-initiated data provider has established dietary and exercise therapy that fits into his lifestyle (Table 3). The real-time monitoring capability of Libre likely contributed to these discoveries by making it easier to identify the relationship between diet, exercise, and blood glucose fluctuations, which helped improve his lifestyle. Furthermore, the sensor can remain attached throughout daily life without removal. As it continuously monitors blood glucose levels while in place, there is no need for the user to remain consciously aware of the need to perform individual measurements. When confirmation of blood glucose levels is required, a simple scan of the sensor suffices. As such, even working individuals, regardless of the nature of their occupation, can monitor their glucose levels without being constrained by time, location, or environmental conditions. This ease of use provided by the Libre system is considered to have been a contributing factor in the marked reduction of HbA1c levels over a relatively short period.

Observing improvements in his blood glucose and HbA1c levels led to major changes in the self-initiated data provider's attitude toward DM and self-management. As summarized in Table 4, before using Libre, he struggled with self-management, feeling discouraged and pessimistic. However, after integrating Libre into his routine and seeing improvements in his HbA1c, combined with praise from his doctor, he gained confidence and motivation to continue self-management. His self-esteem improved, and he developed a positive mindset, fully accepting his condition. Notably, when he spoke about his DM, he appeared to be enjoying the process rather than feeling burdened by it. Confronting DM has been reported to serve as a foundation for learning and implementing self-management (5). For this self-initiated data provider, adhering to dietary and exercise therapy was not just about preventing complications—it also reinforced a sense of accomplishment: "I am improving my

lifestyle" and "I am successfully managing my blood glucose." This increased his confidence and helped him develop a more positive self-image.

To understand the factors contributing to such a dramatic improvement in HbA1c, it is useful to consider the concept of Project-Based Learning (PBL). PBL is a learning approach that focuses on solving problems, where the process of finding a solution is more important than the solution itself. The self-initiated data provider continuously worked to keep his blood glucose within the target range by identifying which lifestyle factors influenced his glucose levels. His curiosity about why and when his blood glucose spiked led him to explore different problem-solving approaches, which ultimately helped lower his HbA1c. The visualization of blood glucose levels on the smartphone display upon scanning the sensor, along with the use of color changes to indicate the magnitude of the values, is considered to have been a significant factor contributing to the improvement in HbA1c levels. It may be concluded that the outcomes achieved by the self-initiated data provider in this study were the result of an approach closely aligned with the principles of Project-Based Learning (PBL).

Similar to this study, previous research has also reported that approaches based on the learning theory of Project-Based Learning (PBL) are effective in supporting self-management of blood glucose levels. Anderson et al. have suggested that a problem-solving–based empowerment education program designed for African American patients with type 2 DM may contribute to improved DM management (15). Funnell et al. stated that a Diabetes Self-Management Support (DSMS) program grounded in empowerment is effective not only in enhancing patients' self-management abilities but also in improving long-term blood glucose control. They emphasized that the key to sustaining behavioral change lies in the process by which patients identify their own problems and goals and develop solutions accordingly (16). Minamimura indicated that a self-management intervention utilizing a problem-solving approach for patients with type 2 DM could be effective in improving blood glucose control (17).

A common feature among these studies, including the present one, is the process through which patients independently recognize, understand, and resolve their own challenges related to blood glucose control. Therefore, this study proposes the term "Problem-solving-based blood glucose self-management" to describe this shared process. This concept is defined as: "A patient-centered approach whereby individuals recognize, understand, and analyze specific blood glucose control challenges arising from their own lifestyle habits, and, through the application of problem-solving techniques, identify solutions to achieve sustainable and optimal blood glucose management." DM, as a chronic condition, requires that patients take an active role in improving their own lifestyle habits as part of treatment. By establishing the concept of "Problem-solving-based blood glucose self-management", we believe it may be possible to promote sustainable, patient-led behavioral change and contribute to more effective DM care.

This study reports on a single case. The outcomes may have been influenced by the participant's unique background, lifestyle, and motivational factors. Thus, the generalizability and reproducibility of the findings, including the proposed concept of "Problem-solving-based blood glucose self-management," remain uncertain. Further studies with additional cases and larger populations are needed to evaluate this concept more rigorously. Key factors such as age, medical history, treatment history, social background, and patients' understanding and attitudes toward DM may shape the process of behavior change. Clarifying these influences will help define the applicability and limits of the proposed approach. This study provides preliminary evidence in this direction. It shows, in an exploratory manner, how the use of Free Style Libre in routine practice may affect patients' cognition and behavior. Future research should test whether these findings can be replicated and whether similar effects occur in broader patient groups. Such evidence would offer practical implications for the design of DM education and self-management support programs.

In Southeast Asian countries, DM prevention and control have become an urgent public health priority. The Lancet Regional Health – Southeast Asia reviewed the current status and challenges of the DM epidemic across 11 Southeast Asian nations, highlighting the rising prevalence in rural areas, dietary transitions, limited health literacy, and difficulties in accessing medical care (18). Nguyen TPL et al. examined the cost-effectiveness of interventions for the prevention of non-communicable diseases, particularly DM, in Southeast Asia. They proposed strategies such as expanding screening programs centered on primary care, improving access to health services, and ensuring the availability

of low-cost medications (19). Lim PC et al. investigated the knowledge level of patients with DM in 11 Southeast Asian countries and found that knowledge was particularly low among older adults, those with lower educational attainment, and patients with poor blood glucose control. As a policy recommendation, they emphasized the importance of identifying knowledge gaps, developing individualized educational plans, and promoting patient-centered communication and education through structured self-management programs (20). Phoosuwan N et al. reported that many patients with type 2 DM in Thailand lack sufficient knowledge about insulin use and overall DM management. They recommended strengthening DM self-management education—particularly in relation to nutrition and diet—and expanding support through community health facilities and educational programs, with special attention to individuals from lower educational and socioeconomic backgrounds (21).

The wider adoption of the Free Style Libre system has the potential to greatly contribute to behavioral change and improved treatment outcomes among people with DM. However, in Southeast Asia, several barriers remain, including high cost, insufficient insurance coverage and policy support, limited knowledge and health literacy among both patients and healthcare providers, and disparities in infrastructure and technology. Addressing these challenges will require multifaceted approaches that combine price subsidies, educational support, and the implementation of enabling policies.

CONCLUSION

This study reports a case of a patient with type 2 DM who utilized the Free Style Libre, a glucose self-monitoring tool, to explore the relationship between lifestyle habits and blood glucose fluctuations. Through this process, the patient achieved behavioral change and a marked improvement in HbA1c within a relatively short period. From these findings, several implications can be drawn.

First, in addition to conventional methods of blood glucose control, the introduction of a real-time glucose monitoring system was shown to enhance patients' self-efficacy and motivation, thereby encouraging active engagement in lifestyle modification. Its practicality and sustainability, even among individuals in employment, highlight its usefulness as a flexible self-management approach.

Second, the visualization of blood glucose fluctuations enabled by the Libre allowed the patient to recognize associations between lifestyle factors—such as diet and physical activity—and changes in blood glucose. This led to the proposal of a new concept termed "Problem-solving-based blood glucose self-management," in which patients identify, understand, and address their own challenges. This concept holds potential for application in DM education and support programs, contributing to the development of sustainable, patient-centered approaches to blood glucose control.

Third**, t**he documentation and analysis of a successful outcome in a single case, as presented in this study, may serve not only as a foundation for future collective and empirical research but also as an important contribution from a public health perspective. DM is a chronic disease of global prevalence, associated with substantial social and economic burdens. The insights gained from this case suggest that flexible, patient-centered approaches to self-management, tailored to individual lifestyles and values, may also contribute to DM prevention and control at the community and population levels. Furthermore, the demonstrated effectiveness of technology-assisted self-management has implications for healthcare systems and policy, particularly in low- and middle-income countries where the prevalence of DM is rapidly increasing. Thus, this study extends beyond the scope of a single case and carries meaningful significance from public health, policy, and international perspectives.

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