Original Article

Understanding Factors Influencing Blood Sugar Control in Working-age Patients with Type 2 Diabetes and Evaluating a Health Behavior Change Program: A Cross-sectional Study with a Quasi-experimental in Northern Thailand

Abstract

Introduction: Type 2 diabetes mellitus (T2DM) is a major health concern, especially among working-age groups. **Methods:** The study consisted of two main phases. In the first phase, 247 people with T2DM who were working age and took part in a survey in April 2023 were asked about factors that affected their blood sugar control. Participants aged 35–59 years were diagnosed with diabetes (fasting blood sugar [FBS] ≥126 mg/dl) and other chronic conditions using stratified random sampling. Phase two implemented a behavior change program for 44 uncontrolled T2DM working-age individuals (FBS >130 mg/dl), using a quasi-experimental design with two groups. Following Bernard's formula, the sample size included intervention and control groups of 22 individuals each, chosen from different villages by simple random sampling. This study conducted the group intervention in September 2023, with each session lasting 1 week. **Results:** In the blood sugar control factors analysis in working-age individuals, obesity increased the risk of impaired control by 1.22 times (95% confidence interval [CI] = 1.14–10.31). It was found that a higher perception of disease severity was conducive to improved management of blood sugar by 1.38 times (95% CI = 0.03–0.39). After the implementation of a behavior modification program, a notable improvement in the control of dietary sugar levels was found ($P < 0.01$), resulting in a statistically significant reduction in blood sugar levels ($P = 0.01$). **Conclusion:** The local public health center can customize the program to improve the health outcomes of individuals diagnosed with T2DM. This can be achieved by modified according to the community context.

Keywords: *Behavior modification program, type 2 diabetes mellitus, working-age group*

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Introduction

The working-age population, crucial for social development and the economy, faces higher health risks, including chronic conditions like diabetes.[1] In 2023, the WHO reported that noncommunicable diseases accounted for 74% of global deaths, with diabetes being a leading cause.[2] Uncontrolled type 2 diabetes mellitus (T2DM) among the working-age population is a critical health concern, linked to lifestyle-related risk factors.[3] Excess energy intake and sedentary lifestyles contribute to T2DM and behaviors like skipping breakfast and frequent dining out.[4-6] High-risk occupations correlate with higher odds of obesity and lower fitness levels.[7] Smoking, heavy drinking, poor stress management, and inadequate sleep are additional risk factors.[8,9]

In Thailand, diabetes is a leading cause of death, with uncontrolled T2DM prevalent among the working population.[10,11] Complications lead to significant costs, with disability-adjusted life years ranking diabetes high in morbidity.[12-15] Uncontrollet T2DM increases the risk of long-term consequences, affecting health and quality of life.[16] Diabetes management goals include maintaining HbA1c levels below 7%.[17] However, between 2021 and 2023, the Health Disease Control dashboard showed a controlled diabetes prevalence below 60%. Mae Tha Hospital in Lampang Province devised a plan to enhance diabetes care for its 519 cases, focusing on active engagement in self-care practices.[18] The Primary and Integral Work Group plays a central role in addressing prevalent health concerns, emphasizing the importance

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of consistent self-management practices in preventing complications.

Self-management for chronic illnesses involves knowledge and organizing activities, addressing lifestyle changes and emotional, mental, social, and environmental impacts. Implementing behavioral changes in diabetes care can utilize the Precede-Proceed model. This model, initially developed in 1970[19] and modified in 2005,[20] includes phases like assessments (social, epidemiological, behavioral, and environmental), evaluations (educational, ecological), and program implementation. Employing this model helped create a strategy promoting self-management and better blood sugar control. To address these challenges, the research aims to apply the Precede-Proceed model to design a health behavior change program for patients struggling to control their sugar levels at Mae Tha Hospital, Lampang Province.

Methods

Study design

The research had two phases: first, it studied factors affecting blood sugar control in 212 working-age individuals via a cross-sectional survey. Second, it implemented a behavior modification program for 44 uncontrolled T2DM, using a quasi-experimental design with two groups. The study lasted 4 weeks, collecting data before and after the intervention.

Sample size

Phase 1

The prevalence and factors influencing sugar control among diabetic patients in the working-age group were investigated utilizing Taro Yamane's (1967) sample size calculation formula. The sample characteristics included individuals aged 35–59 years, comprising both males and females, diagnosed with diabetes (fasting blood sugar [FBS] ≥126 mg/dl) and/or chronic medical conditions. In addition, participants were required to be proficient in reading and writing Thai and demonstrate a willingness to participate in the study. Phase 2: The sample size was determined for a study aimed at developing health behavior modification programs for working-age individuals struggling with uncontrolled sugar levels. Bernard's formula (2000) was employed for calculating the sample size. This study randomly selected 44 patients registered at Mae Tha Hospital for inclusion in the study. The intervention and control groups were defined based on specific criteria. The inclusion criteria included individuals aged 35–59, of both genders, diagnosed with T2DM, and unable to maintain controlled sugar levels (FBS >130 mg/dl). Participants needed to demonstrate communication abilities in speaking, reading, and writing, as well as self-care skills, with normal cognitive functioning and the absence of dementia, speech, or hearing impairments. The willingness to participate in research endeavors was also essential. Exclusion criteria involved the presence of physical disabilities and diagnoses of psychiatric disorders. Notably, the control and experimental groups were geographically separated, with the intervention group residing in a village distinct from that of the control group, separated by 50 km.

Research instruments

Phase 1

The questionnaire for T2DM among the working-age group consisted of four sections: general information (18 items), severity knowledge (10 items), attitude (10 items) and behavior (10 items). Respondents were given three options per question, where correct answers earned 1 point and incorrect or unsure responses received 0 points. The interpretation of the diabetes health status perception score was categorized into three levels: 8–10 points reflected a high level of knowledge, 6–7 points indicated a moderate level, and 0–5 points denoted a low level of knowledge. Part 3 assessed attitudes toward diabetes with 10 questions, offering 5 options rated from 1 to 5. For positive items, scores ranged from 1 for "strongly disagree" to 5 for "totally agree," while for negative items, the rating was reversed. The average score indicated attitude levels: 3.67–5.00 reflected a good level, 2.34–3.66 moderate level, and below 2.34 indicated a low level. Part 4 evaluated self-care behaviors, also using 5 options. Positive behaviors were scored from 5 for "regularly" to 1 for "never practice," while negative behaviors reversed the scale. The average score indicated behavior levels: 3.67–5.00 signified good behavior, 2.34–3.66 moderate, and below 2.34 suggested a low behavior appropriateness level. Questionnaires for Parts 2–4 were developed based on the Precede-Proceed model and literature review.[21-24]

Phase 2

The questionnaire consisted of 5 parts. Part 1 provided 7 basic patient information items. Part 2 comprised a knowledge, understanding, and decision-making questionnaire with 12 items, scoring 1 point for correct answers and 0 points for wrong answers/unsure responses. Part 3 evaluated confidence in controlling blood sugar levels, ranging from 1 point for "not sure at all" to 10 points for "very confident." Part 4 assessed eating habits at high sugar levels with 10 questions. Scores were assigned based on daily practice (4 points), 4–6 days a week (3 points), 1–3 days a week (2 points), and never practice (1 point). Part 5 "evaluated medication-taking behavior for controlling blood sugar levels," included 10 questions scored similarly to Part 4.[25,26] Sections 2–5 presented mean and standard deviation scores for comparison and served as guidelines for entering the behavior modification program. In addition, a record form for blood pressure and blood sugar levels was included.

Statistical analysis

Phase 1

Independent variables encompassed various demographic and health-related factors including gender, age, body mass index (BMI), marital status, education level, occupation, family income, duration of disease, underlying conditions, family history of diabetes, exercise habits, smoking and alcohol consumption, history of COVID-19 infection, knowledge and perception of disease severity, attitudes, health-care promotion factors, health-care obstacles, food and medication consumption, and social and family support. Dependent variables focused on behavior modification programs. This study was analyzed using descriptive statistics and used logistic regression to study factors impacting blood sugar control.

Phase 2

The behavior modification program was served an independent variable, while knowledge and decision-making skills, self-efficacy, eating, and medication-related blood sugar control behavior, and FBS levels were constiituted dependent variables. The residence of the sample group remained a controlled variable across both the phases. In this step, one-way ANCOVA was used to compare scores between the intervention and control groups both before and after the intervention.

Intervention

In the intervention group, participants engaged in a series of activities are outlined in Table 1, with each session taking place weekly. They were provided with a comprehensive diabetes control action manual and were encouraged to keep a detailed record of their daily food intake. Conversely, the control group maintained their regular lifestyle without receiving any additional treatment.

Ethical consideration

This study was approved by the Human Research Ethics Committee of Boromarajonani College of Nursing Nakhon Lampang, reference number E2566-037. All participants in both the phases provided a written consent form before the questionnaire and intervention.

Results

Most participants were women (54.2%), mainly aged between 45 and 59 (95.3%) years. Most had a healthy BMI of 89.6%, with a small portion categorized as level 1 obese (10.4%). Occupationally, 50.9% were farmers, 35.8% were general employees, and 11.8% worked in personal businesses, as shown in Table 2.

Body mass index

Individuals with an obese BMI had a 1.22 times greater risk of being unable to control sugar levels compared to those with a normal BMI (95% confidence interval [CI] = 1.14–10.31). Duration of diabetes: Those with diabetes for 10 years or more faced a 1.05 times higher risk of inadequate sugar level control compared to patients with diabetes for <10 years (95% CI = 1.25–6.61). Comorbidities and knowledge and perception of disease severity: Having comorbidities showed a 0.98 times chance of affecting blood sugar levels (95% CI = 0.17–0.82), while knowledge and perception of disease severity showed a 1.38 times chance (95% CI = 0.03–0.39), as shown in Table 3. The information could be used to create programs for modification that focus mainly on knowledge enhancement.

Most participants were over 50 years old (82.98%), 55.32% had a direct relative with diabetes, and 57.44% had an illness duration of 1–5 years. A significant difference in education level between intervention and control groups was found using a Chi-square test ($P < 0.05$), as shown in Table 4.

Table 1: Program sessions and implementation

Activity	Objectives	Content
Unlocking the essentials: Understanding diabetes	To inform patients with chronic diseases about diabetes	Provide knowledge about diabetes to raise awareness about recognizing symptoms of hyperglycemia and potential side effects of blood sugar-lowering drugs, fostering an understanding of self-management
Selecting nutrient-rich foods	To educate patients with knowledge and raise awareness about the importance of nutrition	Provide information on healthy cooking techniques and practical experience, along with teaching about food sharing
	To educate patients and raise awareness about the importance of taking medications as prescribed	Diabetes medications and their potential side effects Demonstrate common medications, explain how to interpret drug labels, and detail proper storage methods
Work-life balance	To offer patients knowledge and raise awareness about the importance of exercise in preventing complications	To provide knowledge on time management for maintaining a balance between work and personal life, ensuring a healthy routine, incorporating exercise, or engaging in hobbies to prevent illness
Preventing complications through mental health	To encourage patients to maintain physical well-being, sleep, and emotional resilience to manage stress	Assess your mental state, gain self-understanding, and learn to manage stress, handle pressure, improve sleep quality, and regulate your emotions

Table 2: General characteristics of workers with diabetes (n=212)

Characteristics	n (%)	Blood sugar control		Crude	
		Yes, n (%)	No, n (%)	COR (95% CI)	P
Gender					
Male	97 (45.8)	76 (78.4)	21 (21.6)	1	
Female	115 (54.2)	96 (83.5)	19 (16.5)	0.72 (0.36–1.43)	0.34
Age (years)					
<45	10 (4.7)	6 (60.0)	4 (40.0)	1	
≥45	202 (95.3)	166 (82.2)	36 (17.8)	0.33 (0.09–1.21)	0.09
BMI (kg/m^2)					
Normal	190 (89.6)	158 (83.2)	32 (16.8)	1	
Overweight	22 (10.4)	14 (63.6)	8 (36.4)	2.82 (1.09–7.28)	0.03*
Duration of disease (years)					
<10	172 (81.1)	146 (84.8)	26 (15.2)	1	
≥10	40 (18.9	26 (65.0)	14 (35.0)	3.02 (1.40–6.64)	0.01*
Underlying disease/conditions					
No	67 (31.6)	49 (73.1)	18 (26.9)	1	
Yes	145 (68.4)	123 (84.8)	22 (15.2)	0.49 (0.24–0.98)	0.04*
Exercise					
Yes	127 (59.9)	111 (87.4)	16 (12.6)	1	
No	85 (40.1)	61 (71.8)	24 (28.2)	0.37 (0.18–0.742)	0.01*
Smoking status					
Never	190 (22.0)	151 (79.5)	39 (20.5)	1	
Regular smoker	22 (78.0)	21 (95.5)	1 (4.5)	0.18 (0.02–1.41)	0.10
Alcohol consumption					
Never	113 (53.3)	88 (77.9)	25 (22.1)	1	
Regular drinker	99 (46.7)	84 (84.8)	15 (15.2)	0.63 (0.31–1.27)	0.20
Knowledge and perception of disease severity level					
Low	25 (11.8)	14 (56.0)	11 (44.0)	1	
Medium	125 (59.0)	102 (81.6)	23 (18.4)	0.29 (0.12–0.71)	0.01*
High	62 (29.2)	56 (90.3)	6 (9.7)	0.14 (0.04–0.43)	<0.01*
Attitude level					
Low - medium	136 (64.2)	111 (81.6)	25 (18.4)	1	
High	76 (35.8)	61 (80.3)	15 (19.7)	1.09 (0.54–2.23)	0.81
Food consumption					
Low	8 (3.7)	7 (87.5)	1 (12.5)	1	
Medium	120 (56.6)	99 (82.5)	21 (17.5)	1.49 (0.17–12.72)	0.72
High	84 (39.7)	66 (78.6)	18 (21.4)	1.91 (0.22–16.54)	0.56

*P<0.05. BMI: Body mass index, COR: Crude odd ratio, CI: Confidence interval

After the intervention, it was found that the intervention group displayed a significantly higher average score in knowledge and decision-making skills than the control group (P < 0.01). Moreover, concerning dietary habits, the intervention group exhibited a lower average score than the control group (P < 0.01), indicating a tendency for the intervention group to consume fewer sweet foods. In addition, upon controlling the influence of blood sugar levels (FBS), it was discovered that the in-group maintained a lower mean sugar level than the control group (P = 0.01), as shown in Table 5.

Discussion

The research identified a significant correlation between BMI and blood sugar control. It also found that managing blood sugar levels is 1.22 times more challenging for obese individuals, highlighting the connection between obesity and diabetes, where excess fat can lead to decreased insulin responsiveness.[27] The link between obesity and T2DM involves complex cellular and physiological mechanisms, as well as the development of multiorgan insulin resistance.[28] Inadequate blood sugar control in diabetes can result in various chronic complications, categorized as microvascular (nerve, kidney, and eye damage) and macrovascular (cardiovascular disease, stroke, and peripheral vascular disease).[29] Reducing body fat through a negative energy balance without surgery can stabilize or improve metabolic dysfunction caused by obesity, potentially leading to diabetes remission if β-cell activity is adequately restored.[28]

The duration of diabetes is a critical factor, with individuals who have had the condition for 10 years or more being 1.05 times more likely to struggle with proper blood sugar

Table 3: Factors related to controlling blood sugar levels

	P	OR	95% CI	
			Lower	Upper
BMI	0.02	1.22	1.14	10.13
Duration of disease	0.01	1.05	1.25	6.61
Underlying disease	0.01	−0.98	0.17	0.82
Knowledge and perception of disease severity	0.01	−1.38	0.03	0.39
Constant	0.87	0.09		

BMI: Body mass index, OR: Odds ratio, CI: Confidence interval

Table 4: Comparison of intervention and control groups differences (*n*=44)

Characteristics	Intervention group (*n*=22), *n* (%)	Control group (*n*=22), *n* (%)	*P*
Gender			
Male	7 (35.0)	13 (65.0)	0.13
Female	15 (62.5)	9 (37.5)	
Age (years)			
<50	3 (42.9)	4 (57.1)	0.68
≥50	19 (51.4)	18 (48.6)	
Waistline			
Normal	5 (31.2)	11 (68.8)	0.12
Overweight	17 (60.7)	11 (39.3)	
Blood pressure			
Normal	5 (35.7)	9 (64.3)	0.11
Elevated	8 (44.4)	10 (55.6)	
High blood pressure	9 (75.0)	3 (25.0)	
Education level			
Primary school	10 (37.0)	17 (63.0)	0.03*
Secondary school	11 (91.7)	1 (8.3)	
Bachelor's degree	1 (20.0)	4 (80.0)	
Occupation			
Agriculturist	10 (41.7)	14 (58.3)	0.45
General employee	8 (57.1)	6 (42.9)	
Government official	4 (66.7)	2 (33.3)	
Duration of disease (years)			
1–5	9 (40.9)	13 (59.1)	0.13
6–10	9 (75.0)	3 (25.0)	
>10	4 (40.0)	6 (60.0)	
Underlying disease			
No	10 (55.6)	8 (44.4)	0.76
Yes	12 (46.2)	14 (53.8)	
Treatment			
Tablets	16 (51.6)	15 (48.4)	1.00
Tablets and injections	6 (46.2)	7 (53.8)	

*$P<0.05$

control. Prolonged diabetes duration complicates control due to a combination of insulin resistance and a continuing decrease in relative insulin deficiency production. As the illness progresses, achieving the necessary balance for blood sugar control becomes more challenging, consistent with research by Lin *et al.*,[30] who found that the duration of the disease was related to the control of blood sugar levels. Studies from Malaysia[31] and Myanmar[32] revealed similar trends, indicating a higher risk of glycemic control issues in individuals with diabetes diagnosed for more than 10 years compared to those with a shorter diagnosis period. A study in Thailand[33] further confirmed these results, emphasizing that individuals diagnosed with prolonged diabetes are more likely to have insufficient glycemic control than those diagnosed in the previous 10 years. Comorbidities and diabetes knowledge have a strong impact on blood sugar control. Those with comorbidities have a 0.98 times chance of better control, and deep diabetes knowledge increases the likelihood to 1.38 times. This underscores the importance of improving patient knowledge for effective behavior modification. Various comorbidities, such as hypertension and obesity, contribute to blood sugar level control, aligning with prior studies on comorbidities and glycemic control.[34]

Understanding the severity of diabetes and having health information are critical for blood sugar control.[35] Shareef *et al*. found increased knowledge in the intervention group, leading to improved self-care and decreased glucose levels. Ghazanfari *et al.* reported enhancements in healthy behaviors.[36] A Navi Mumbai study found that regular self-care and strict dietary management improved glycemic control, highlighting effective glucose management and diet adherence.[37]

The results of the health behavior change program for working-age groups unable to control sugar levels revealed a significant reduction in sweet food consumption in the intervention group compared to the control group. The intervention group, which received both group and individual advice along with continuous access to health-related content, focused on food and dietary habits. The approach of recording daily food intake allowed researchers to identify eating patterns and provide immediate advice, resulting in a statistically significant decrease in sugar levels for the intervention group. The control group, engaged in comprehensive physical examinations, did not show the same level of improvement in reducing sweet food consumption.[38,39]

Limitation

The limitations of the study include the likelihood that our findings are not generalizable to a larger population due to demographic and geographic variations. In addition, recall bias may influence participants' ability to respond accurately to the questionnaire, as we relied solely on self-reports. Therefore, there may be information bias in our data. Furthermore, FBS alone may not be sufficient; HbA1c measurement is still lacking.

Conclusion

The study highlights the effectiveness of health behavior modification programs for diabetics in primary care, even in rural areas, despite its single-center design and small

Table 5: Effectiveness of behavior modification programs in working-age individuals with uncontrolled blood sugar levels

Subscale	Mean (SD)				
	Intervention group		Control group		ANCOVA test, *F* (*P*)
	Baseline (*n*=22)	Follow up (*n*=22)	Baseline (*n*=25)	Follow-up (*n*=25)	
Knowledge and decision-making skills	7.86 (1.12)	9.18 (0.73)	7.91 (1.72)	9.14 (1.21)	<0.01*
Self-efficacy	68.81 (5.47)	70.68 (6.36)	60.52 (11.93)	63.86 (13.39)	0.84
Eating-related blood sugar control behavior	17.18 (1.82)	15.09 (2.31)	17.77 (3.18)	17.18 (2.86)	<0.01*
Medication-related blood sugar control behavior	35.41 (1.97)	37.27 (2.19)	36.04 (3.23)	36.82 (2.11)	0.29
Blood sugar level	204.11 (62.41)	139.32 (53.84)	130.17 (28.04)	155.94 (41.48)	0.01*

**P*<0.05. SD: Standard deviation

sample size. Recommendations include implementing similar programs for working-age groups and emphasizing tailored media content aligned with the intended audience and context.

Authors' contributions

Chatsuda Mata: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Discussion, Writing – original draft, Funding acquisition, Writing – review & editing. Pattaranai Chaiprom: Conceptualization, Methodology, Formal analysis, Discussion. Aumpun Chailangka: Conceptualization, Methodology, Investigation. Suwimon Singkhamkul: Data curation, Formal analysis, Investigation.

Data availability statement

The data that support the findings of this study are available upon request.

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Conflicts of interest

There are no conflicts of interest.

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