ORIGINAL ARTICLE

Factors Affecting Glycemic Control Behaviors Among Patients with Type 2 Diabetes in Rayong Province, Thailand

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Background: Diabetes is a major public health problem in Thailand and worldwide. Adults diagnosed with diabetes are at an increased risk of early death.

Objective: To determine factors affecting glycemic control behaviors among type 2 diabetic patients in Rayong Province, Thailand.

Materials and Methods: The data were collected from 400 subjects using a self-administered questionnaire and randomly selected by multistate random sampling technique. Data were analyzed by frequency, percentages, means, standard deviation, and stepwise multiple regression analysis.

Results: The results indicated that knowledge about glycemic control, attitudes towards glycemic control, perceived severity of type 2 diabetes, perceived susceptibility to diabetic complications, perceived self-efficacy towards glycemic control, perceived outcomes of behavior changes in glycemic control, and glycemic control behaviors of the participants were at a moderate level at 80.75%, 85.75%, 86.25%, 83.25%, 88.50%, 87.25%, and 89.00%, respectively. Factors affecting glycemic control behaviors significantly included perceiving outcomes of behavior changes in glycemic control (β=0.875), knowledge of glycemic control (β=0.135), completing a bachelor's degree or more (β=0.060), perceived susceptibility to diabetes complications (β=0.054), receiving knowledge from relatives and siblings frequently (β=0.044), and attending appointments consistently (β=0.037). These six factors could explain glycemic control behaviors at 87.50%.

Conclusion: The present study suggested that healthcare providers and related institutes can utilize these factors to educate diabetic patients in this area to control their blood sugar levels.

Keywords: Type 2 diabetic patients; Glycemic control behaviors; Behavioral change; Eastern Economic Corridor

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Diabetes is a non-communicable disease which causes a major public health problem worldwide. More than 537 million people were reported suffering from diabetes mellitus (DM) worldwide. The number of people with DM is expected to rise to 592 million by the year 2035 and 783 million by the year 2045[1-3]. Diabetes caused 4.2 million deaths and 79% of diabetic patients lived in low- and middle-income countries[4]. Diabetes costs at least 760 billion in health costs. A study of risk factors for diabetes indicated that 374 million people are at risk of developing diabetes. The situation of diabetes in the Western Pacific Region found that there are approximately 163 million people with diabetes aged between 20 and 79 years, accounting for 35% of the total number of diabetic patients in all age groups worldwide[2,5].

In Thailand, diabetes increases in the same direction as the world situation. In 2022, the prevalence of diabetes among the population aged 15 years and older was 9.51%[6-8]. The Ministry of Public Health reported that 2.9 million Thai people had diabetes, and the incidence cases was 515.52 per 100,000 population. The rate of admissions for diabetes in the past three years has increased approximately five times between 2020 and 2022. In 2021 alone, diabetic patients were admitted to hospitals under the Ministry of Public Health 941,226 times. One hundred seven diabetic patients are admitted to a hospital under the Ministry of Public Health every hour[9].

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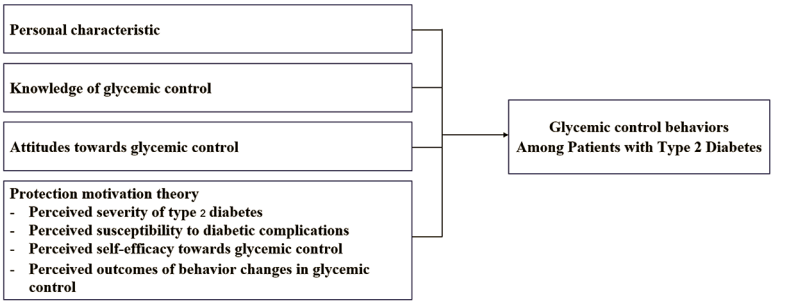

Figure 1. Conceptual framework.

Rayong Province is one of the Eastern Economic Corridor (EEC) that is a targeted area for economic development in Thailand. According to the EEC Development Plan, chronic non-communicable diseases remain a public health problem in this area. Rayong Provincial Public Health Office reported that diabetes between 2019 and 2022 tended to increase by 5.57, 5.87, and 6.09%, respectively. While in 2022, 36.07% of diabetic patients could control their blood sugar levels, this proportion did not meet the Ministry of Public Health's criteria, which was 40%. The authors found that the information to confirm the cause or factors that affect the behavior of controlling blood sugar levels in people in EEC provinces was limited. As a result, patients with type 2 diabetes in Rayong Province and the EEC increased the acute complication rate by 1.40%. The complication affected patients, families, and communities physically, mentally, and socio-economically.

The EEC Development Project is a strategic plan under Thailand 4.0 with spatial development. This builds on the success of the Eastern Seaboard (ESB) area of three provinces including Chonburi, Rayong, and Chachoengsao. The EEC serves as a model for operating the EEC[10]. The EEC causes more migration and urbanization that affects health, way of life, social conditions, and the economy. The changing dynamics of urbanization influence the health and lifestyle of people in this area. There is a rush, especially among the working-age population. There is a risk of health hazards[11]. In addition, health policy makers would like working age groups to change behaviors and lifestyle to prevent and control chronic diseases such diabetes and hypertension.

The previous studies found that the factors influencing blood sugar level control behaviors included gender[6], age[7], duration of diabetes[8,9], food consumption behavior, emotional and stress management[11], consistent medication adherence[12], continual medical consultations[13], taking medication as prescribed by a physician[7,8,14], complications arising from diabetes[15], and physical activities[12,16].

However, most of the previous studies conducted on factors affecting glycemic control behaviors among type 2 diabetic patients were done in other regions. There is little knowledge about this topic in Rayong Province. Further, the prevalence of diabetic patients with uncontrolled blood sugar levels increased over time in this province. Therefore, the present study applied the Protection Motivation Theory to determine factors influencing blood sugar control behaviors among type 2 diabetic patients in Rayong Province, Thailand. This theory suggests that if diabetic patients had perceived susceptibility, perceived severity of the disease, perceived self-efficacy, and perceived outcome of prevention, they will change behaviors to control their blood sugar levels. The present study was conducted on diabetic patients aged 35 to 59 years since they are the majority of the working aged group in the EEC. The results of the study can be utilized to develop policy, programs, or healthcare services for diabetic patients to change their behaviors for blood sugar control. These help to prevent complications and improve their quality of life.

The conceptual framework in the present study included personal characteristics, knowledge, and attitude about glycemic control. Additionally, Protection Motivation Theory was applied to glycemic control behaviors. This consisted of perceived susceptibility to diabetes complications, perceived severity of type 2 diabetes, perceived self-efficacy towards glycemic control, and perceived outcomes of behavior changes in glycemic control (Figure 1).

Materials and Methods

Study design, settings, and participants

An analytic cross-sectional study was conducted between March and July 2023. Data was collected

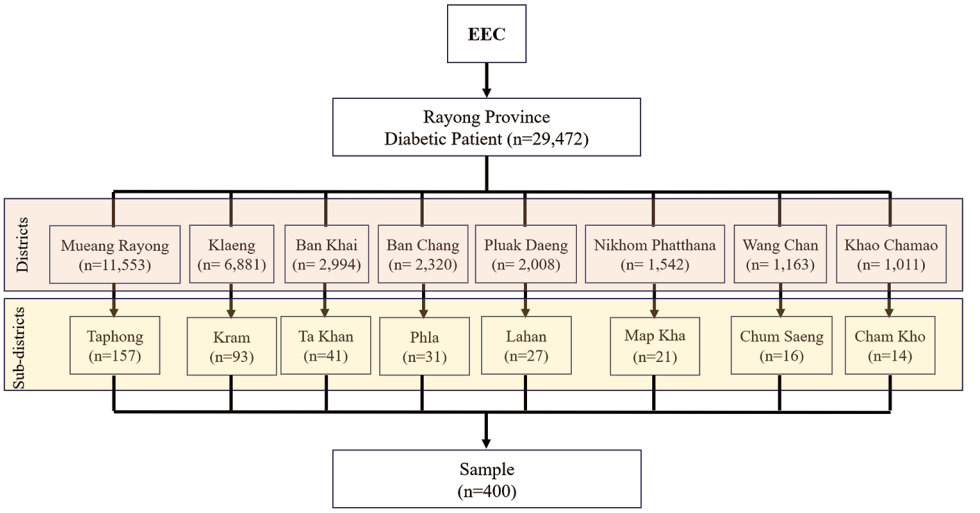

Figure 2. Sampling frame.

through a self-administered questionnaire. The study population was 29,472 type 2 diabetic patients registered in the hospitals in Rayong Province. Four hundred study samples were type 2 diabetic patients who had blood sugar levels of 140 mg/dL or greater. The authors used blood sugar level of diabetic patients from the medical records in each study setting. They were diagnosed with diabetes for at least two years before the study began. The sample size was calculated based on the formula of population mean estimation based on 29,472 population, and the variance ($\sigma 2$) of diabetic prevention behaviors was 0.48[17]. The authors set the error of estimation (e) at 0.048, and the alpha (α) was 0.05. The sample estimated from the calculation was 400 subjects. Participants were randomly selected by multistage random sampling technique. Rayong Province was selected via simple random sampling from the EEC provinces. Then, eight districts were recruited into the study. One sub-district was randomly selected from each district by simple random sampling (Figure 2). Then, study subjects from each sub-district were selected by systematic random sampling. The inclusion criteria for the study subjects were 1) being aged between 35 and 59 years. 2) residing in the research area for at least one year, and 3) being able to read and write Thai. The exclusion criteria were 1) being pregnant, 2) having severe complications such as hypoglycemia or hyperglycemia since they might not complete the questionnaire on the date of data collection, 3) leaving the research area before the study started, 4) being unable to complete the questionnaires, and 5) withdrawal or unwilling to complete the questionnaire.

Research tool

The questionnaire was developed by the researchers based on the theoretical concepts and related studies which composed of eight parts, 1) sociodemographic characteristics, 2) knowledge of glycemic control, 3) attitudes towards glycemic control, 4) perceived susceptibility to diabetic complications, 5) perceived severity of type 2 diabetes, 6) perceived self-efficacy towards glycemic control, 7) perceived outcomes of behavior changes in glycemic control, and 8) glycemic control behaviors of type 2 diabetes. Sociodemographic characteristics included eight items regarding data on study subjects. Knowledge was assessed through 15 yes or no questions and grouped into three categories using a sum score for good with scores of 8 to 10, average with scores of 6 to 7, and low with scores of 0 to 5. Attitudes, perceived susceptibility to diabetic complications, perceived severity of type 2 diabetes, and perceived outcomes of behavior changes in glycemic control of 10 five-levels Likert scale questions starting from strongly agree to strongly disagree and classified into three groups using mean scores for high with 3.68 to 5.00, average with 2.34 to 3.67, and low with 1.00 to 2.33. Perceived self-efficacy towards glycemic control involved 15 five-rating scale questions ranging from strongly believe to strongly disbelieve and was categorized into three groups using mean scores for high with 3.68 to 5.00, average with 2.34 to 3.67, and low with 1.00 to 2.33. Glycemic control behaviors of type 2 diabetes

consisted of 15 five-levels rating scale questions starting from always to never and were classified into three groups using mean scores for high with 3.68 to 5.00, average with 2.34 to 3.67, and low with 1.00 to 2.33. Content validity of the questionnaire was evaluated by five experts in chronic diseases and health behaviors. It was assessed by calculating the item objective congruence index (IOC) for the individual item of the questionnaire. It was found that the IOC for the questions was between 0.6 and 1.0. The reliability of the questionnaire was determined by a pilot test among 30 subjects not included in the study. The Reliability of the questionnaire was measured using the KR-20 (Kuder Richardson) coefficient for knowledge and the other parts of the questionnaires were assessed by Cronbach's alpha coefficient. The reliability of part 3 to 8 was 0.709, 0.770, 0.704, 0.838, 0.704, and 0.721, respectively.

Data collection

After the present research was approved by the Provincial Health Officer of Rayong Province. Once, the researchers contacted the Director of the District Hospital and the Director of the Sub-district Health Promoting Hospital to explain the objectives and details of the research project and requested cooperation in the research. The authors then made an appointment with the study subjects in each sub-district to explain the objectives of the research, and data collecting process and requested participation in this research. The study subjects willing to participate in the present study and who met the inclusion criteria were requested to complete the questionnaires. Responding to the questionnaire took approximately 30 minutes. Then, all questionnaires were rechecked by the researchers for quality control. The completed questionnaires were used for data analyses.

Statistical analysis

Data analysis used the Jamovi, version 2.6.17 (https://www.jamovi.org). Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to describe sociodemographic characteristics, knowledge of glycemic control, attitudes towards glycemic control, perceived susceptibility to diabetic complications, perceived severity of type 2 diabetes, perceived self-efficacy towards glycemic control, perceived outcomes of behavior changes in glycemic control, and glycemic control behaviors. Stepwise multiple regression analysis was employed to determine factors affecting glycemic control behaviors among type 2 diabetic patients. All significance levels were set at 0.05.

Ethical approval

The information obtained from the present research was encoded for confidential information not disclosed individually, and no damage will be disclosed to the research subjects. The informed consent to participate was obtained from all of the participants and from the legal guardian(s) of illiterate participants. The present study was approved by the Human Research Ethics Committee, Naresuan University Institutional Review Board, Thailand (COA No. 032/2021) approved, dated 21 January 2021.

Results

Sociodemographic characteristics of participants

One hundred percent of estimated participants completed the questionnaire. Of 400 subjects, 65.25% were female, 29.75% aged between 51 and 55 years, with a mean of 50.02 and SD of 6.63. Most of them were married (68.75%), 42.75% were educated from junior high school, and 40.30% were employees. Their average monthly income was between 5,001 and 10,000 Baht for 44.25% (mean 12,212.16, SD 5,103.47). Thirty-three percent of the subjects had body mass index (BMI) between 25.00 and 29.90 kg/m^2, which mean overweight/obese level 2, and 59.25% were diagnosed with diabetes between 1 and 5 years (mean 5.10, SD 3.42) (Table 1).

Knowledge of glycemic control, attitudes towards glycemic control, perceived severity of type 2 diabetes, perceived susceptibility to diabetic complications, perceived self-efficacy towards glycemic control, perceived outcomes of behavior changes in glycemic control, and glycemic control behaviors

The results showed that knowledge about glycemic control, attitudes towards glycemic control, perceived severity of type 2 diabetes, perceived susceptibility to diabetic complications, perceived self-efficacy towards glycemic control, perceived outcomes of behavior changes in glycemic control, and glycemic control behaviors of type 2 diabetes of participants were at a moderate level of 80.75%, 85.75%, 86.25%, 83.25%, 88.50%, 87.25%, and 89.00%, respectively, with the mean of 10.35 (SD 1.22), 3.76 (SD 0.11), 3.59 (SD 0.11), 3.57 (SD 1.16), 3.51 (SD 1.18), 3.64 (SD 1.09), and 3.49 (SD 1.20), respectively (Table 2).

Table 1. Sociodemographic characteristics of participants (n=400)

Variables	n (%)
Sex	
Female	261 (65.25)
Age (year)	
Mean, SD	50.02, 6.63
Marital status	
Single	106 (26.50)
Married	275 (68.75)
Widow/divorced/separated	19 (4.75)
Education level	
Illiterate	9 (2.25)
Primary school	117 (29.25)
Junior high school	171 (42.75)
High school/equivalent	79 (19.75)
Diploma/equivalent	7 (1.75)
Bachelor degree/higher	17 (4.25)
Current occupation	
Government officer	72 (18.00)
Housework	127 (31.75)
Employment career	160 (40.30)
Agriculturalist	21 (5.25)
Business	20 (5.00)
Average monthly income (Thai Baht)	
Mean, SD	12,212.16, 5,103.47
Body mass index (kg/m^2)	
<18.50	17 (4.25)
18.50 to 22.90	114 (28.50)
23 to 24.90	77 (19.25)
25 to 29.90	132 (33.00)
≥30	60 (15.00)
Mean, SD	25.35, 4.64
Duration of diabetes (year)	
1 to 5	197 (49.25)
6 to 10	156 (39.00)
>10	47 (11.75)
Mean, SD	5.10, 3.42

SD=standard deviation

Table 2. Knowledge of glycemic control, attitudes towards glycemic control, perceived severity of type 2 diabetes, perceived susceptibility of diabetic complications, perceived self-efficacy towards glycemic control, perceived outcomes of behavior changes in glycemic control, and glycemic control behaviors (n=400)

Variables	n (%)
Knowledge of glycemic control	
Low (0 to 7 scores)	47 (11.75)
Average (8 to 11 scores)	323 (80.75)
High (12 to 15 scores)	30 (7.50)
Mean, SD	10.35, 1.22
Attitudes towards glycemic control	
Low (1.00 to 2.33)	18 (4.50)
Average (2.34 to 3.67)	343 (85.75)
High (3.68 to 5.00)	39 (9.75)
Mean, SD	3.76, 0.11
Perceived severity of type 2 diabetes	
Low (1.00 to 2.33)	19 (4.75)
Average (2.34 to 3.67)	345 (86.25)
High (3.68 to 5.00)	36 (9.00)
Mean, SD	3.59, 0.11
Perceived susceptibility to diabetic complications	
Low (1.00 to 2.33)	28 (7.00)
Average (2.34 to 3.67)	333 (83.25)
High (3.68 to 5.00)	39 (9.75)
Mean, SD	3.57, 1.16
Perceived self to efficacy towards glycemic control	
Low (1.00 to 2.33)	16 (4.00)
Average (2.34 to 3.67)	354 (88.50)
High (3.68 to 5.00)	30 (7.50)
Mean, SD	3.51, 1.18
Perceived outcomes of behavior changes in glycemic control	
Low (1.00 to 2.33)	18 (4.50)
Average (2.34 to 3.67)	349 (87.25)
High (3.68 to 5.00)	33 (8.25)
Mean, SD	3.64, 1.09
Glycemic control behaviors	
Low (1.00 to 2.33)	21 (5.25)
Average (2.34 to 3.67)	356 (89.00)
High (3.68 to 5.00)	23 (5.75)
Mean, SD	3.49, 1.20

SD=standard deviation

Factors affecting glycemic control behaviors

The results revealed that participants who had higher mean scores of perceived outcomes of behavior changes in glycemic control, knowledge of glycemic control, and perceived susceptibility to diabetes complications tended to have better glycemic control behaviors than those with lower mean scores (β=0.875, 0.0.135, and 0.054, respectively). Participants who finished a bachelor's degree or higher were more likely to have better glycemic control behaviors than those who were illiterate (β=0.060). Participants who received knowledge from relatives and siblings frequently seemed to have better glycemic control behaviors than those who did not (β=0.054). Lastly, participants who attended appointments consistently tended to have better glycemic control behaviors than those who did not attend as appointed (β=0.037). Those six significant factors can explain 87.50% of glycemic

Table 3. Factors influencing the glycemic control behaviors of participants (n=400)

Independent variables	b	Beta (β)	p-value
Perceived outcomes of behavior changes in glycemic control	0.916	0.875	<0.001
Knowledge of glycemic control	0.508	0.135	<0.001
Bachelor's degree or higher (Ref.=illiterate)	1.379	0.060	0.003
Perceived susceptibility to diabetic complications	0.082	0.054	0.008
Receiving knowledge from relatives, and siblings frequently (Ref.=never received knowledge from relatives, siblings)	0.661	0.044	0.015
Attending appointments consistently (Ref.=never attended appointments)	0.904	0.037	0.038

Constant (a)=1.529, adjusted R square=0.875, p<0.05, Ref.=reference group

control behaviors of diabetic patients (adjusted R square=0.875) (Table 3).

Discussion

The present study found that six factors influenced glycemic control behaviors among type 2 diabetic patients. These composed of perceived outcomes of behavior changes in glycemic control, knowledge of glycemic control, completing a bachelor's degree or more, perceived susceptibility to diabetic complications, receiving knowledge from relatives and siblings frequently, and attending appointments consistently.

The present study found that participants with higher mean scores for perceived outcomes of glycemic control behaviors seemed to have better glycemic control behaviors than those with lower mean scores. This finding is aligned with the conclusions of the study of Waebuesa (2008)[18] that showed that perceived outcome influenced glycemic control behaviors among diabetic patients. Thus, if participants had a good perception of behavior changes, they would modify their behaviors to lower their blood sugar levels. This helps them to control their blood sugar continuously.

The present study indicated that participants with higher mean scores of knowledge about glycemic control tended to have better glycemic control behaviors than those with lower mean scores. The result is in line with the study of Kerdonfag et al. (2010)[19] that showed that knowledge about glycemic control was significantly associated with behavior modification. It might be because when diabetic patients gained knowledge about diabetic control, they would adjust behaviors to control their blood sugar level.

Participants who finished a bachelor's degree or higher were more likely to have better glycemic control behaviors than those who were illiterate. This result is consistent with the study of Kanglee (2014)[20]. It might be that participants who finished a bachelor's degree or higher had more chances to gain knowledge about diabetes and health behaviors. As a result, this knowledge encourages them to change behaviors to control their blood sugar levels.

The present study revealed that participants who had higher mean scores of perceived susceptibilities to diabetic complications had better glycemic control behaviors than those with lower mean scores. The result is similar to the previous study[18] that indicated that susceptibility to diabetes complications is based on individual health perceptions. This means that when participants perceive that the diabetic complications are severe, they will take action to change their behaviors in preventing the complications and their consequences.

The current study showed that participants who received knowledge from relatives, or siblings frequently were more likely to have better glycemic control behaviors than those who never received it. This finding is the same as the previous study[21]. This might be due to the information the participants received from those people related to glycemic control such as food consumption, physical activities, stress management, and medication adherence. All of these factors enhanced them to modify their behaviors to control blood sugar levels better.

Lastly, participants who attended the appointments consistently tended to have better mean scores of glycemic control behaviors than those who never attended the appointments. The finding is similar to the study of Sreriphap (2021)[22] and Chaiyata et al. (2018)[23] that indicated that regular follow-up appointments influenced glycemic control among type 2 diabetic patients. This might be because participants received advice from healthcare providers to control blood sugar levels when visiting the hospitals. Consequently, participants who regularly attended the appointments had better glycemic control than those who did not.

Limitation and recommendation

The limitations that might have affected the

results were the other factors that the authors did not explore, such as social support from village health volunteers and healthcare providers. This factor might affect the outcomes. Further study should include social support to observe whether it would influence glycemic control behaviors among type 2 diabetic patients. The potential bias that might occur in the present study is information biases since the exposure and outcome are measured simultaneously. Prior knowledge of the condition might influence the ascertainment of the exposure or the outcome, which results in recall bias.

Conclusion

The factors influencing the blood sugar control behaviors among type 2 diabetes patients found in the present study can be used as a guideline to create policy, programs, or activities to control blood sugar levels for diabetic patients in the EEC, especially in Rayong Province, Thailand. The intervention program should focus on giving health education to increase knowledge and change behaviors on glycemic control, perception of susceptibility to diabetic complications, and perception of the outcome in glycemic control.

What is already known on this topic?

Diabetes affects the quality of life of diabetic patients, their families, communities, society, as well as economic development through loss of income, dependency, and the burden of long-term care costs. Factors that influence glycemic control behaviors among type 2 diabetic patients including knowledge about glycemic control, attitudes towards glycemic control, perceived severity of type 2 diabetes, perceived susceptibility to diabetic complications, perceived self-efficacy towards glycemic control, and perceived outcomes of behavior changes in glycemic control.

What does this study add?

This study revealed that glycemic control behaviors among type 2 diabetic patients involved perceived outcomes of behavior changes in glycemic control, knowledge of glycemic control, completing a bachelor's degree or more, perceived susceptibility to diabetes complications, receiving knowledge from relatives and siblings frequently, and attending appointments consistently. These findings can be utilized as a guideline to develop the model or program for glycemic control behaviors among type 2 diabetic patients in the study area.

Acknowledgement

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Available data and materials

The dataset of the present study is strictly protected under the terms of the Naresuan University Ethical Committee for Dissemination. Furthermore, Thailand's Official Information Act 1997 prohibits the release of identifiable data relating to public bodies. Due to these limitations, interested parties may contact the secretary of the Naresuan University Research Ethics Committee.

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Conflicts of interest

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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