A mixed methods of qualitative and quantitative study of patients' understanding about carbohydrate portion in type 2 diabetic subjects

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การวิจัยแบบผสมผสานเชิงคุณภาพและเชิงปริมาณเกี่ยวกับความเข้าใจของผู้ป่วยในการประมาณสัดส่วนคาร์โบไฮเดรตในผู้ป่วยเบาหวานชนิดที่สอง

นางสาวพรสวรรค์ พฤทธิ์ธโนปจัย

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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พรสวรรค์ พฤทธิ์ธโนปจัย : การวิจัยแบบผสมผสานเชิงคุณภาพและเชิงปริมาณเกี่ยวกับความเข้าใจของผู้ป่วยในการประมาณสัดส่วนคาร์โบไฮเดรตในผู้ป่วยเบาหวานชนิดที่สอง (A mixed methods of qualitative and quantitative study of patients' understanding about carbohydrate portion in type 2 diabetic subjects) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร.จงจิตร อังคทะวานิช, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: ผศ. นพ.ธิติ สนับบุญ, 153 หน้า.

วัตถุประสงค์ของการศึกษาด้วยวิธีผสมผสาน เพื่อประเมินความเข้าใจเกี่ยวกับสัดส่วนคาร์โบไฮเดรตและหาปัจจัยต่างๆที่มีความเกี่ยวข้องกับความรู้เรื่องสัดส่วนคาร์โบไฮเดรตในผู้เป็นเบาหวานชนิดที่สอง กลุ่มตัวอย่างคือผู้เป็นเบาหวานชนิดที่สองจำนวน 135 คนที่มารับบริการที่คลีนิคเบาหวาน ของโรงพยาบาลจุฬาลงกรณ์ ความรู้เรื่องสัดส่วนคาร์โบไฮเดรตถูกประเมินโดยแบบทดสอบที่ถูกพัฒนาขึ้นในการศึกษานี้ มีการเก็บข้อมูลเกี่ยวกับลักษณะพื้นฐานทางสังคมประชากร ประวัติทางการแพทย์ ข้อมูลเกี่ยวกับการดูแลตนเอง ข้อมูลการได้รับความรู้เรื่องเบาหวานและความรู้ทั่วไปเกี่ยวกับเบาหวาน หลังจากนั้นจึงได้เลือกกลุ่มตัวอย่างแบบเจาะจงจำนวน 24 คน เพื่อทำการทดสอบทักษะในการประเมินปริมาณอาหารและสัมภาษณ์ การวิเคราะห์ข้อมูลใช้สถิติเชิงพรรณา การทดสอบทีแบบเป็นอิสระต่อกัน การวิเคราะห์ความแปรปรวน การทดสอบไคสแควร์และการวิเคราะห์พหุตัวแปรสำหรับข้อมูลเชิงปริมาณ และวิธีกรอบแนวคิดสำหรับข้อมูลเชิงคุณภาพ

ผลการทดลองแสดงให้เห็นว่าคะแนนเฉลี่ยของความรู้เรื่องสัดส่วนคาร์โบไฮเดรตเท่ากับ 16.24 คะแนนและมีความคลาดเคลื่อนมาตรฐานของค่าเฉลี่ยเท่ากับ 0.34 ผู้เข้าร่วมวิจัยส่วนใหญ่มีปัญหากับการแปลความหมายฉลากโภชนาการ ในการศึกษานี้พบความเข้าใจผิดเกี่ยวกับการจำแนกอาหารที่มีคาร์โบไฮเดรตและการประเมินปริมาณคาร์โบไฮเดรตในอาหาร นอกจากนี้ยังพบว่ามีความสัมพันธ์ระหว่างความรู้เรื่องสัดส่วนคาร์โบไฮเดรตกับการควบคุมระดับน้ำตาลในเลือด การวิเคราะห์ด้วยการทดสอบทีแบบเป็นอิสระต่อกัน และการวิเคราะห์ความแปรปรวนชี้ให้เห็นปัจจัยที่มีความเกี่ยวข้องกับความรู้เรื่องสัดส่วนคาร์โบไฮเดรต ได้แก่ อายุ ระดับการศึกษา อาชีพ รายได้ และการมีเครื่องตรวจวัดระดับน้ำตาลในเลือด ในทำนองเดียวกัน การวิเคราะห์ด้วยการทดสอบไคสแควร์และการวิเคราะห์พหุตัวแปรแสดงให้เห็นว่า ระดับความรู้ต่ำในเรื่องสัดส่วนคาร์โบไฮเดรต มีความสัมพันธ์กับ 5 ตัวแปร ได้แก่ อายุ ระดับการศึกษา รายได้ การได้รับข้อมูลเรื่องเบาหวานจากสื่อและคะแนนความรู้ทั่วไปเกี่ยวกับเบาหวาน

ดังนั้นจึงเป็นเรื่องสำคัญที่ควรระมัดระวังการสื่อสารที่ผิดพลาดและความเข้าใจผิดในการให้ความรู้เรื่องเบาหวาน โดยเฉพาะอย่างยิ่งกลุ่มที่มีระดับความรู้ต่ำในเรื่องสัดส่วนคาร์โบไฮเดรต

ภาควิชา โภชนาการและการกำหนดอาหาร	ลายมือชื่อนิสิต .....
สาขาวิชา อาหารและโภชนาการ	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....
ปีการศึกษา 2559	ลายมือชื่อ อ.ที่ปรึกษาร่วม .....

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KEYWORDS: TYPE 2 DIABETES / KNOWLEDGE / CARBOHYDRATE PORTION

PORNSAWAN PRUTANOPAJAI: A mixed methods of qualitative and quantitative study of patients' understanding about carbohydrate portion in type 2 diabetic subjects. ADVISOR: ASSOC. PROF.JONGJIT ANGKATAVANICH, Ph.D., CO-ADVISOR: ASST. PROF. THITI SNABBOON, M.D., 153 pp.

The purpose of this mixed methods study was to evaluate understanding about carbohydrate portion and determine factors which were associated to carbohydrate portion knowledge in adults with type 2 diabetes. The sample group was 135 adults with type 2 diabetes who attended the diabetic clinic of King Chulalongkorn Memorial Hospital. Knowledge of carbohydrate portion was evaluated by the test which developed in this study. The data about socio-demographic characteristics, medical history, self-management information, diabetes education information and general diabetes knowledge were collected. After that, 24 participants were selected by purposive sampling to attend food estimation skill test and interview. Data analysis were using descriptive statistics, independent t-test, ANOVA, Chi-squared test and Multivariable analysis for quantitative data and Framework method for qualitative data.

The results showed mean score of carbohydrate portion knowledge was 16.24 points with SEM of 0.34. Most of participants had problem with interpretation of nutrition facts label. This study found that some misconceptions about identifying foods that contain carbohydrate and estimating carbohydrate content in foods. In addition, the association between carbohydrate portion knowledge and glycemic control was found in this study. The analysis of independent t-test and ANOVA indicated the factors which were associated with carbohydrate portion knowledge. There were age, education level, occupation, income and having glucose meter. In the same way, analysis of chi-square test and binary logistical regression showed low level of carbohydrate portion knowledge was associated with 5 variables. There were age, education level, income, receiving diabetes information from media and score of general diabetes.

Therefore, it is important to be careful of miscommunication and misunderstanding in diabetes education, especially group of people with low level of carbohydrate portion knowledge.

Department:	Nutrition and Dietetics	Student's Signature .....
Field of Study:	Food and Nutrition	Advisor's Signature .....
Academic Year:	2016	Co-Advisor's Signature .....

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INTRODUCTION

1.1 Background

Diabetes mellitus is one of the fastest growing health problems in the world. It is a chronic disease which has a main problem with carbohydrate metabolism. The main characteristic is rising of glucose level, called hyperglycemia. The chronic hyperglycemia is associated with dysfunction of many organs which lead to serious health complications such as retinopathy, neuropathy, nephropathy and cardiovascular disease, etc. The complications can affect the quality of life and cause of disabilities or death[1].

Globally, 382 million people with diabetes in 2013 (8.3%) tend to 592 million in 2035[2]. Thailand is one of top 10 countries in the Western Pacific region regarding number of people was affected by diabetes[3]. Although the number of undiagnosed cases was reported as being reduced from 66.5% to 47.3% in men and from 51.4% to 23.4% in women between 2004 and 2009, the proportion of patients with poor glycemic control was still high. More than 70% of diabetic patients had HbA1c >7% in tertiary care hospitals and prevalence of diabetic complications were not lower (31.2% retinopathy, 43.8% nephropathy)[4]. The cost of diabetes depend on complications including disability.

The three major pillars of diabetes treatments are medication, physical activity and healthy eating. All of them need self-management in patients[5]. Self-management relates to many factors such as age, income, culture and attitude, etc.[6, 7] but the most important and apparent barrier of self-management is lack of knowledge[8]. Therefore, diabetes self-management education is recommended for all patients with diabetes.

Dietary intervention was an important treatment to prevent complications[1]. Nutrition therapy from registered dietitian was reported to decrease 0.5-2% of HbA1c for people with type 2 diabetes. Goal of dietary intervention is a healthful eating pattern in proper portion size[5]. Food portion size influences both the energy intake and meal composition. Diabetes educators often teach patients to use reference sizes (hand, household measurements)[9]. It is a common method for weight control, but it has also

been reported as being a major barrier for dietary adherence[10]. Most patients believe that it is hard to follow a healthy eating plan in real life. This why it is important to apply the knowledge to reality[11].

The results of Breen et al.'s study in Ireland demonstrated that people with type 2 diabetes confused about the relationship between types of foods and blood glucose level. One third of participants did not recognize that starchy food, fruit and fruit juice can increase blood glucose level. More than half of them misunderstood that protein and fat directly raise blood glucose level. This study showed even in Ireland, diabetes related nutrition knowledge still had a misconception, especially about carbohydrate foods [12].

Although many studies in western countries were conducted nutritional diabetes knowledge, they focused on protein and fat due to the composition of their food[13]. It is different from Thai cuisine. A main ingredient of Thai foods is rice and Thai people usually consume carbohydrate-rich foods[14]. This is a reason why most educators in Thailand are greatly concerned about carbohydrate portion during a diabetes education[15]. The studies in Thai people with type 2 diabetes were conducted only general knowledge of diabetes such as characteristic of diabetes, blood glucose monitoring, diabetic symptoms and complications[16]. Moreover, there have been few studies in Thailand which focus on the perceptions of people with diabetes, especially nutrition issue. Any research interest in this field involved contextual factors such as a belief in Buddhism[17, 18], the position of medical doctors in Thai society[19] and the interpretation of doctor's dietary suggestions[14]. There is little information about dietary management, rarely interested in carbohydrate portion. Therefore, this study aims to evaluate understanding of carbohydrate portion in type 2 diabetes patients. It may help to improve diabetes education program in the future.

1.2 Research question

- How do people with type 2 diabetes understand about carbohydrate portion?
- Which factors are associated with carbohydrate portion knowledge in people with type 2 diabetes?

1.3 Objective

- To evaluate understanding of carbohydrate portion in people with type 2 diabetes
    - Diabetes diet
    - Types of food that contain carbohydrate
    - Sugar-sweetened beverages
    - Amount of carbohydrate in foods
    - Reading the nutrition facts label
- To determine the association between general knowledge of diabetes and carbohydrate portion knowledge.
- To determine the association between carbohydrate portion knowledge and socio-demographic characteristics.
- To determine the association between carbohydrate portion knowledge and HbA1c.

1.4 Hypothesis

- There is a significant relationship between the general knowledge of diabetes and carbohydrate portion knowledge.
- The people with type 2 diabetes who had received diabetes education do higher scores compare to those who not.
- The socio-demographic characteristics that relate to carbohydrate portion knowledge are education level and economic status.
- The people with type 2 diabetes who achieved HbA1c goal have better score in the carbohydrate portion knowledge test.

1.5 Benefit

The results of this study could help healthcare staffs understand perception and viewpoints of people with type 2 diabetes about carbohydrate portion. It may have some misunderstandings of carbohydrate portion that can be solved in the future. The results could be applied to improve diabetes education program and make it easier to understand for people with type 2 diabetes. Moreover, it will explain the influence of factors to carbohydrate portion knowledge.

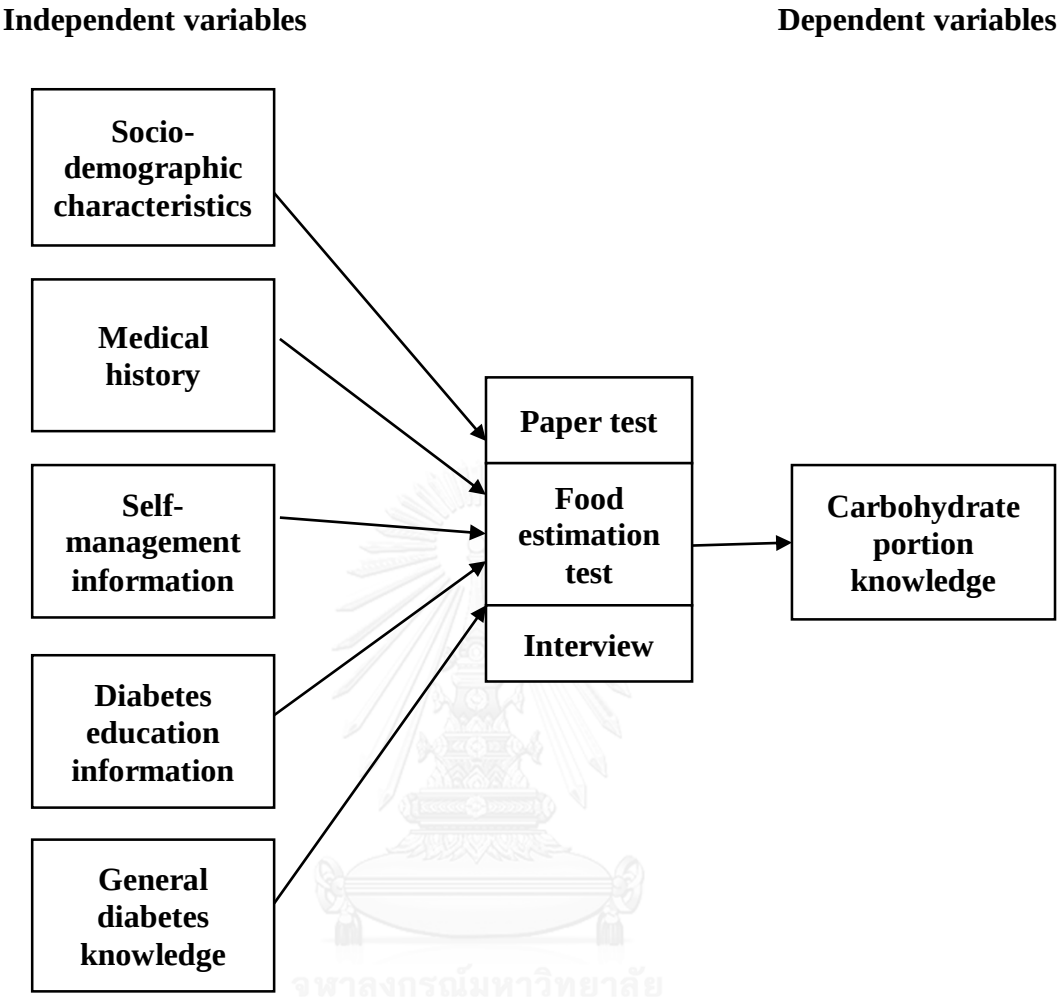

Figure 1-1 Conceptual framework

CHAPTER 2
LITERATURE REVIEW

2.1 Definition of diabetes from World Health Organization (WHO)

"The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both."[20]

Diabetes is divided into 4 types

1. Type 1 diabetes is reported about 5-10% of the total cases of diabetes. The patients with type 1 diabetes are insulin dependent because the beta cells of the pancreas are destructed by autoimmune. This process rapidly happens in infants and children, but slowly in adults. The uncontrolled patients have high risk to present with ketoacidosis.
2. Type 2 diabetes is the most common. (90-95%) It is mainly caused by insulin resistance with decreased insulin secretion. The people with type 2 diabetes usually are overweight or obese with excess percentage of fat in the body. In the early stage, symptoms do not become apparent and the patients may not be aware until diabetes complications occur. The risks of type 2 diabetes depend on age, obesity and lack of physical activity. Moreover, people with hypertension or dyslipidemia have higher risk compared with normal people.
3. Other specific types of diabetes are unusual forms due to other causes such as genetic defects, diseases of the exocrine pancreas, endocrinopathies, drugs, infections, uncommon forms of immune-mediated diabetes.
4. Gestational diabetes mellitus is defined as glucose intolerance that is diagnosed first time during pregnancy. Even mostly the condition will be back to normal after delivery, the cases still have higher risk for type 2 diabetes than normal people[21].

2.2 Management of type 2 diabetes

The diabetes health care team should include physician, nurse, pharmacist, dietitian and psychologist. The assessment is important process to develop comprehensive care plan. The factor that should be assessed as follows:

- Medical history
    - Age and characteristics of onset of diabetes
    - Eating patterns, nutritional status, and weight history
    - Physical activity habits
    - Diabetes education history, barriers and readiness for behavior change
    - Review of previous treatment regimens and current treatment of diabetes
    - Glucose monitoring and presence of DKA (frequency, severity, and cause)
    - Hypoglycemia episode (awareness, frequency and cause)
    - History of diabetes-related complications
    - Psychosocial problems
- Physical examination e.g., height, weight, BMI
- Laboratory evaluation e.g., HbA1c, lipid profile, liver function tests
- Referrals
    - Annual dilated eye exam
    - Family planning for women of reproductive age
    - Medical Nutrition Therapy
    - Diabetic Self-management education
    - Periodontal exam
    - Mental health service, if needed

All staffs will help the patients manage their conditions and set glycemic treatment goals. The goal depends on many factors such as age, life expectancy, disease duration, presence of complication, comorbid condition, risk of hypoglycemia and psychological status[(1)]. American Diabetes Association (ADA) recommend that the treatment goal for outpatient, non-pregnant people with type 2 diabetes are HbA1c < 7.0 %, preprandial capillary plasma glucose 80-130 mg/dl and peak postprandial capillary plasma glucose 180 mg/dl. However, patient safety is the first priority, especially patients with history of severe hypoglycemia or have a limited expectancy. The target may be considered for HbA1c <8%. HbA1c is a reliable measure that

presents average glycemia over several months[5]. The study of Heisler et al. (2005) indicated that the patients who knew their updated HbA1c have a better skill to assess diabetes control and understand diabetic self-management knowledge more than those who did not know[22]. Although it is a routine test to assess glycemic control and strong predictive value for diabetes complication, it still has a limitation. The patients with hemoglobinopathy cannot use this marker because erythrocyte turnover and hemoglobin variants affect HbA1c value[5].

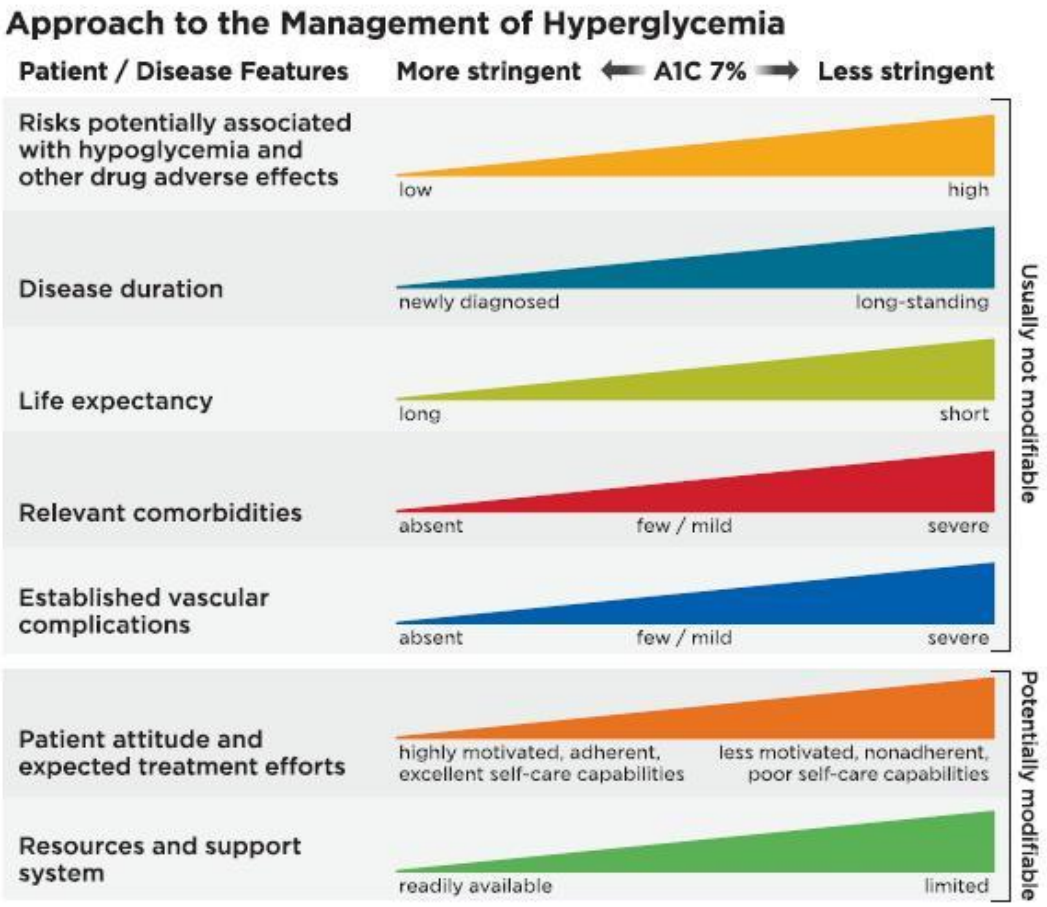

Figure 2-1 Factors that associated with glycemic treatment goal[5]

Due to HbA1c reflects the average blood glucose level over 3 months, actual blood glucose level is evaluated by Self-Monitoring of Blood Glucose or SMBG. It is helpful to immediately confirm hypoglycemic event and help people with diabetes monitor their glycemic status by themselves. The patients can learn to adjust their insulin dose, eating pattern and physical activity to prevent complications. It especially help to reduce frequency of hypoglycemic events in people with hypoglycemia

unawareness. The continuous glucose monitoring (CGM) is suggested by physicians in some cases to improve their glycemic control, but need to assess patients' knowledge and skill. It is not only using glucose meter properly, the patients need to understand how to interpret the values and adjust them with current treatment [1, 5, 23].

The 3 main factors that relate to achieving glycemic target without hypoglycemia are medication, physical activity and diet. All of them include in daily life and need patient cooperation. The people with type 2 diabetes need diabetes knowledge to develop self-care behavior and problem solving skill. The medical staffs will help to adjust from theory to reality, especially diet. It is good to tailor an individual plan for each patient depend on their lifestyle, such as shift work, eating habit, culture, etc.[1, 5].

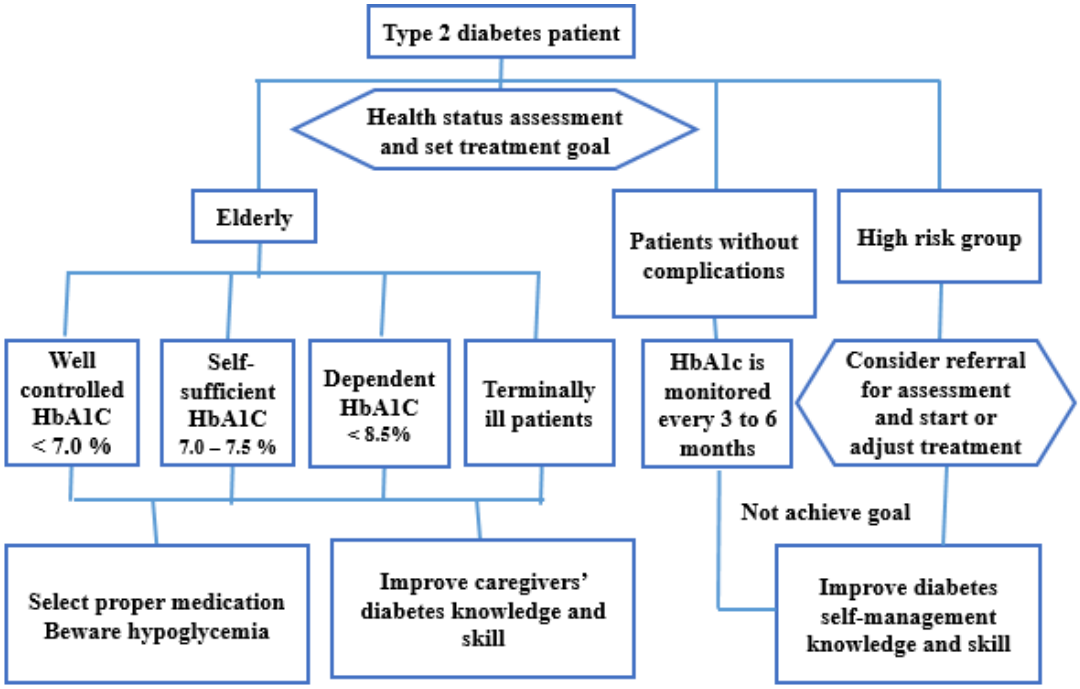

Figure 2-2 Diabetes care process in Thai Clinical Practice Guideline for Diabetes 2014. Adapted from Diabetes Association of Thailand[24]

According to Thai Clinical Practice Guideline for diabetes 2014, people with type 2 diabetes should be assessed health status and given self-management education. In elderly or dependent patients, the education should be given to caregivers or members of family[24].

2.3 Diabetes self-management education

The lifestyle change is very important to manage diabetes. Diabetes self-management education (DSME) is essential for type 2 diabetes patients. It is important to have enough necessary information to solve any problems by themselves and create a collaborative treatment plan. The best practice of DSME is skilled-based approach and patient-center to modify evidence-based standards with individual needs, goals, and life experiences. The education is not only given information, but it is also included empowerment to try the new things and go over barriers. In case of the patients with complications or comorbidities, diabetes self-care is more difficult. It makes more challenging to healthcare providers [5, 25, 26].

The American Association of Diabetes Educators (AADE) indicates AADE7 Self-Care Behaviors™. It contains 7 topics of education that diabetes patients should know for effective self-management as follows: Healthy Eating, Being Active, Monitoring, Taking Medications, Problem Solving, Healthy Coping, Reducing Risks.

Moreover, the vocabulary should be provided in diabetes education. The patients need to understand the words that associate with their disease, treatment and outcome. It is important to staff-patient communication and also abilities for finding information from different sources of knowledge. The effective DSME need to evaluate and monitor outcomes. The goal setting is important to create education plan. It is better to make a decision with the patients and select proper outcomes together [27].

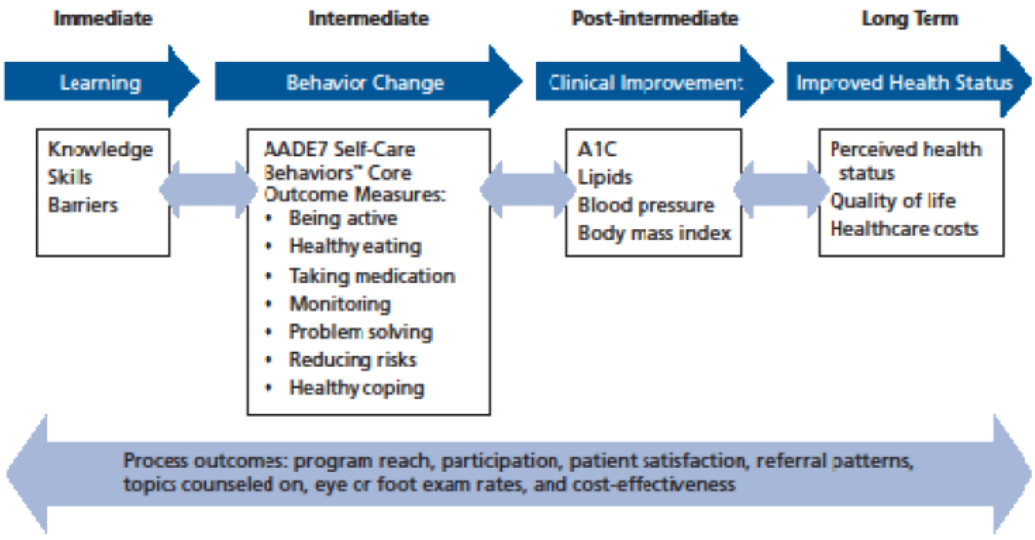

Figure 2-3 The goal of diabetes self-management education[27]

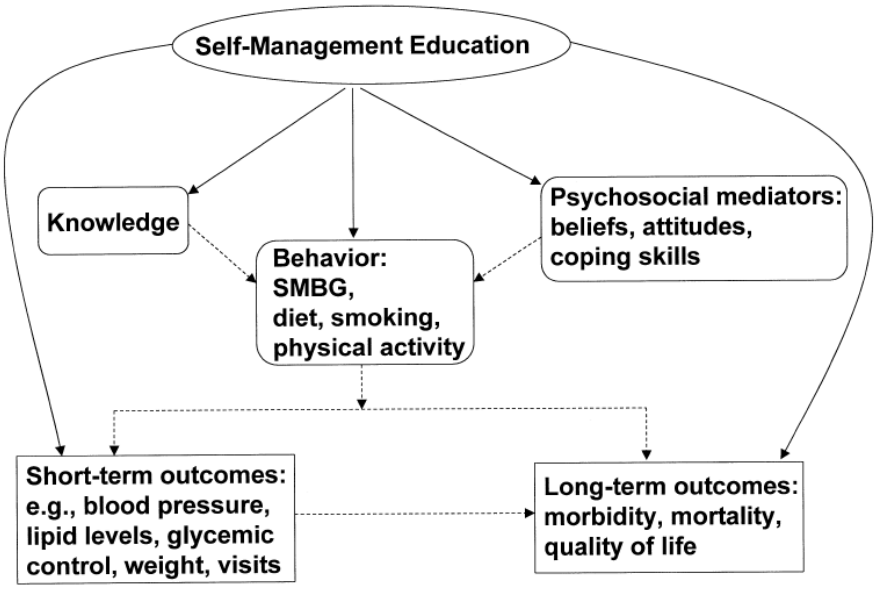

Figure 2-4 Relationship between DSME, associated factors and outcomes[28]

DSME helps to slow progression of complication. The risk of complication in patients who do not receive DSME is 4 times higher than people who received. This can improve quality of life, self-efficacy, empowerment and health coping. Additionally, DSME affect admission and readmission rate, therefore reducing healthcare costs. Although DSME has many benefits, the healthcare system does not fully support to refer the patients for DSME. Moreover, the patients may misunderstand about the necessity and effectiveness of the program. They do not concern about education [26, 28, 29].

2.4 Medical nutrition therapy

Medical nutrition therapy (MNT) included nutrition assessment, nutrition diagnosis, nutrition intervention and evaluation. It is an effective and cost-saving method to reduce HbA1c in type 2 diabetes patients. MNT generally is provided by trained nutritionist, registered dietitian or physician who have good knowledge of nutrition[5]. The goal of MNT is eating a wide variety of foods in appropriate amount. It will help to control weight, blood glucose and blood pressure. The challenge of MNT is a meal planning. The medical staffs should design it individually. MNT is not only giving information, it is coaching. The patients need flexibility to buy, prepare and cook their meals, in addition eating out. It may take 3 to 6 months to modify their lifestyle depend on basic nutrition knowledge, motivation and barriers[29].

Table 2-1 Nutrition recommendation in diabetes patients[1, 5]

Topic	Recommendation
General	- Complete 3 main meals, may have snacks for hypoglycemia prevention. - Use nutrition label for portion control - Weight loss is recommended for overweight or obese patients by reducing only energy in food, but still follow a healthy eating plan. - The meal plan is modified to suit belief, culture and economics of the patients. It is better to use informal communication and discuss together. - Current evidences are not enough to indicate ideal percentage of energy for people with diabetes. Therefore, macronutrient distribution should be modified from current eating habits.
Carbohydrate	- Carbohydrate portion control is important for glycemic control. It can be managed by carbohydrate counting or experienced-based estimation. - Understand 3 different types of carbohydrate (sugar, starch and fiber) including their effects on health. - Good sources of carbohydrate are fruits and vegetables, whole grains, beans, dairy products. The healthy sources do not contain added sugar, saturated fat or high sodium. - Low glycemic foods (glycemic index < 55) can help to regulate blood sugar level such as multigrain bread, pumpernickel bread, whole oats, legumes, apple, lentils, chickpeas, brown rice, etc. - The recommended amount of fibers and whole grains in people with diabetes is the same recommendation for healthy people

Table 2-1 (cont.) Nutrition recommendation in diabetes patients[1, 5]

Topic	Recommendation
Carbohydrate	- Foods that contain sugar do not have different effect on blood glucose level compared with the foods that contain equal amount of energy and carbohydrate. However, nutrient-dense foods are much better for health. - Sugar-sweetened beverages should be avoided for reducing weigh gain and risk of metabolic complication.
Fat	- Quality of fat is more important than amount, but have to concern both. - Limit saturated fat and trans-fat, such as butter, fatty red meats, etc. and select good sources of fat such as nuts, avocado, fish, etc. - The recommended amount of fat is not different from healthy people. - Select fat-free or low-fat dairy products. - Mediterranean diet that contains high monounsaturated fatty acid may have benefit to control blood glucose level and decrease risk of cardiovascular disease. The prevention effect is similar to the diet that contains lower fat and higher carbohydrate. - Foods that contain long-chain n-3 fatty acids (EPA and DHA) and n-3 linolenic acid (ALA) can help to reduce cardiovascular disease risk.
Protein	- Choose low fat protein sources such as fishes, egg whites, beans, etc. - Plant sources of protein usually contain high fiber and phytochemicals with low glycemic index, but it is not necessary to intake only plant based protein. - Avoid processed meats

Table 2-1 (cont.) Nutrition recommendation in diabetes patients[1, 5]

Topic	Recommendation
Micronutrients	- Micronutrient supplementation is not necessary in people with normal eating. Healthy meal plan can provide enough micronutrients to meet requirements. - There is not a clear evidence about benefit of micronutrient supplementation in people without underlying deficiencies. - Routine supplementation of antioxidants such as vitamin C, vitamin E, beta carotene are still not shown evidence apparently. They should be aware of safety, especially long-term supplementation. - Chromium, vanadium, magnesium and CoQ10 supplementation are not provided enough evidences to prove glycemic control effect. - There are not enough evidences to support that any herbs can cure diabetes. - Supplementation is recommended in patients with micronutrient deficiencies or have risk of deficiencies.
Alcohol	- If the diabetes patients drink alcohol, limitations are 1 drink per day for female and 2 drinks per day for male. - Alcohol increases risk of delayed hypoglycemia, especially in patients on insulin treatment or insulin releasing drugs.
Sodium	- Recommended daily sodium is 2,300 mg/d as same as healthy people. - For patients with both diabetes and hypertension may be considered to decrease the number of daily sodium.

Table 2-2 Diabetes self-management about healthy diet[30]

Skill	Barrier	Measure	Methods of measurement
- Meal planning - Weighing and measuring food - Carb counting - Label reading	- Environment trigger - Emotional - Cultural - Financial	- Type of food choices - Amount of food eaten - Timing of meals - Alcohol intake - Effect of food on glucose - Special situations and problem solving	- Patient self-report - Observation - Food and BG records - 24 hr. recall, food frequency questionnaire

2.5 Self-management in people with diabetes

As lifestyle change is very important for diabetes control. The adherence to self-care measure by comparing patients' behavior with standard. It is difficult to identify because diabetes treatment is complex and specific to each individual patient. The treatment relates to meal plan, exercise and blood glucose monitoring[31]. Many studies were conducted about related factors and self-care behavior to help the patients overcome their barriers. Glasgow et al. (1997) investigated about belief, social and environmental barriers by 2,056 people with diabetes in USA. The participants were asked to complete 2 questionnaires. The first one was created by the researcher to assess personal models and barriers. The other one was Summary of Diabetes Self-Care Activities scale (SDSCA) to evaluate self-management activities. The results showed that taking medication was the most effective treatment in the patients' belief. Its score was 4.52 ± 1.01 points from 5 points. The second one was avoiding sweets with score 4.21 ± 0.89 points. For other self-management behavior, eating low fat and high fiber diet, eating low calorie diet, regular exercise, stop smoking, regularly testing glucose level scored 3.94, 3.85, 3.91, 3.89, 4.09 points respectively. On the other hand, the first barrier of diabetes patients was diet (2.55 ± 0. 49) while exercise and medication scored only 1.97 ± 0.62 and 1.45 ± 0.49 respectively[32]. Similarly, the study in Thailand by Attavorrarat et al. (2012) showed self-management score of the diet was 4.98 ± 0.93 points. It was lower than medication (6.69 ±

0.98), but higher than the exercise (2.87 ± 2.13)[33]. Furthermore, Sittikankaew et al. (2014)'s study indicated same results in 143 people with type 2 diabetes. The self-management score in diet section was 3.10 ± 0.63 points. It was lower than medication adherence (3.56 ± 0.6) and stress management (3.81 ± 0.86), but higher than the exercise (2.39 ± 1.15) and blood glucose monitoring (2.97 ± 0.92)[34]. When comparing 3 main components of diabetes management; diet, exercise and medication in previous studies, dietary self-management behavior was lower than medication, but still higher than exercise.

Qualitative studies help to fulfill comprehensive view about self-management in people with diabetes. Booth et al. (2013) explored type 2 diabetes patients' attitude to compare with health professionals' opinions on diet and exercise. The main concept was not different between 2 groups. One of the barriers was lack of understanding and knowledge about both type and amount of food. The patients felt confused with a lot of things to remember, including misunderstanding in communication. For other reasons, the patients could not modify the information to reality. For example, healthy foods were more expensive and harder to access them. The next one was motivation. They believed that diabetes can be controlled by only using medication. Some of them failed to achieve the goal and did not want to try again. An environment and social were one of the reasons. The patients felt separate from their family at mealtime, festivals and special events. The last one was negative thinking about new things, especially those older than 60 years. They refused to change usual habits and thought the suggestion was not based on a reality[35]. Similarly, study of Onwudiwe et al. (2011) indicated barriers of diabetes self-management in low income African American people. The most significant problem was knowledge. It affected understanding of treatment goal, medication management, and food portion control including follow-up compliance. Lack of knowledge made the patients confused about self-care, especially if they received incomplete information from several sources. The participants in this study said that they need more education for better self-care. This means self-care was hard to do correctly without knowledge, even the patients had motivation and awareness[36].

Although knowledge is important, the study of Abbott et al. (2010) presented other factors that relate to self-management. Even the participants received nutrition knowledge and cooking skill for diabetes, it still had many problems. Firstly, the participants were not responsible to cook, therefore they could not persuade members of family to eat a healthy

diet. The second was an economic problem. Family incomes were not enough to provide healthy foods, especially those that contain artificial sweeteners and low fat. The last one was acceptance of food preference. Each family had its own culture[37]. The results were supported by Fort et al. (2013)'s study in people with type 2 diabetes. The researchers pointed out that lack of knowledge was the problem only at the first stage. It could be fixed by good education and communication. The significant factor that has to be concerned was financial difficulty. It is similar to the results from study of the Abbott et al. The financial problem was important due to price of healthy diet. The next one was faith. The patients believed that the life was in control of God, even doctor treatment or self-care could not help. The third one was gender. A role of females in a family needed much time and she cannot have enough time to take care of herself. The last one was family support and how the family is affected. This factor was influential to dependent patients. From all studies, the ways to fix problems may need more than education depend on their barriers[38].

However, Kisokanth et al. (2013) explained that self-management started with education. Lack of knowledge is the most common reason of this problem. The patients need enough knowledge for lifestyle modification. They usually receive information from several sources and the data is not clear enough to do in a real life or too complicated to understand in case of people with low literacy. Although the knowledge has strongly effect to self-management, there are other related factors as follows: culture, belief, social support, motivation and other psychological factors. For example, Thai people believed that illness comes from Karma (effect from a previous life) and cannot be controlled, even self-care. The behavior modification will be achieved, the medical staffs should adjust patients' attitude together with diabetes education[8].

2.6 Relationship between glycemic control, knowledge and self-management

Savoca and Miller (2001) examined food selection, eating patterns and attitude about self-management in people with type 2 diabetes by interview. The dietary adherence is a challenge to avoid favorite foods and select healthful food choices. The knowledge reflects how people with type 2 diabetes interpret guideline to their practice. The problem solving skill is very important for dietary adjustment. Even people with type 2 diabetes attended diabetes education program, it is only give information about dietary guideline. They needed more coaching and support to increase self-efficacy in special situations. The

greater attention to meal plan helps the people with diabetes keep their blood sugar levels within the target goal[39].

Boondarick et al. (2007) determined about the association between factors in type 2 diabetes patients. The results were found that blood glucose level related to diabetes knowledge, calories burnt by exercise, gender, age, BMI, but did not have relationship with eating behavior score and compliance. The researchers explained the reason about eating behavior did not relate to blood glucose level because eating behavior score was determined by the frequency and amount of food. It could cause the participants' confusion and led to inaccurate answers[40]. The results were supported by Bains et al. (2011)'s study. It showed glycemic control associate with knowledge (β=0.12), but did not relate to dietary self-care behavior. The knowledge had relationship with health literacy only (β=0.55)[6]. In Thailand, the study of Chompusri et al. (2007) showed the same results. Even predisposing factors had a relationship with dietary self-care behavior, knowledge did not affect diet. It associated with belief (r = 0.15) and value (r = 0.17). For association between reinforcing factor and eating habit, it related to publish health team (r = 0.14), person in family (r = 0.16) and person in community (r = 0.23)[41].

The results of Thunnome et al. (2006)'s study argued that knowledge associate with self-management behavior (r=0.48), but in an analysis, the dietary section was not separated from other sections of self-management[42].

Lerdsrimongkol et al. (2007) evaluated the relationship between blood glucose level and eating habits in type 2 diabetes patients. The questionnaire was created by researchers to estimate the amount and frequency of food groups. The results showed eating habits did not associate with blood glucose level, but have a relationship with the food group that can eat in unlimited amount such as green leafy vegetables. The participants had a problem with the food group that should be selected type and controlled amount such as rice, fruit, etc. The best score of practice was in the food group that should be avoided. The researchers explained that the patients may not have enough knowledge for putting into good practice. It was easy to understand the term "avoid" and "unlimited". It did not need calculation skill[43].

The effects could be explained by Xu et al. (2008)'s study. The researchers found that knowledge did not affect directly to self-management, but through belief in treatment (β=0.27) and self-efficacy (β=0.11). The factors that directly affect self-management were

belief in treatment (β=0.15), self-efficacy (β=0.39) and duration of diabetes (β=0.17). Moreover, knowledge related to education (β=0.50) and affected to provider-patient communication (β=0.14) [44]. Similarly, Kueh et al. (2015) indicated that diabetes knowledge did not relate directly to dietary self-management, but via patient's attitude. This means attitude have a relationship with both knowledge (β=0.32) and dietary self-care (β=0.18). Same as Bains et al. (2011)'s study, only age showed relationship with eating habits[7].

The study of Fenwick et al. (2013) used diabetes knowledge test that was developed by Fitzgerald et al. The researcher examined factors that related to diabetes knowledge in 181 people with type 2 diabetes. The patients with low level of education (β=1.14), had not visited ophthalmologist (β=1.78), had not attended diabetes education program (β=0.82) and spoke a language other than English (β=1.24) scored less than patients with higher level of education, had visited an ophthalmologist, had attended diabetes education program and spoke English. The people with type 2 diabetes who were member of National Diabetes Service Scheme (NDSS) had better knowledge score than those who not (β=1.21). The results were not shown relationship between diabetes knowledge and age, income, duration of diabetes that reported in some previous studies[45].

More factors that related to knowledge, Kim et al. (2015) investigated 3,606 Korean people with diabetes by questionnaires. They found only 15.5% of those that received diabetes education. The factors that associated with diabetes education are gender, marital status, family history, awareness and education. Women received the education more than men (OR = 1.33). Married people were given diabetes education more than those who were single (OR = 1.39). People who had family history of diabetes were concerned with diabetes education more than people who did not have (OR = 1.37). The diabetes education rate in people with awareness was higher than those who not (OR = 5.49). The last factor was education level. People with elementary school graduation or less did not receive diabetes education when compare with people with middle school graduation (OR = 1.57), high school graduation (OR = 2.36), university graduation or more (OR = 4.19)[46]. Similarly, the results of Pongmesa et al. (2009)'s study indicated that knowledge of diabetes have relationship with age, education level, having family member with diabetes[16].

Table 2-3 Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
1.	Diabetes Patient Knowledge Test	Hess et al. (1983)	950 people with type 1 and type 2 diabetes	38 items (from pilot study 150 items)	Multiple choices questions	1. Carbohydrate 2. Blood sugar 3. Basics 4. Food exchange 5. Insulin administration	Reliability Tested by Cronbach's coefficient alpha Content validity Experts (physicians, nurses and dietitians) selected questions from 150 items to match with objective necessary to manage diabetes and it was filled into test. Construct validity Association between knowledge score and clinical measurements Concurrent validity Compared knowledge score between 2 groups that were divided by age of diagnosis and type of diabetes
2.	Diabetes Knowledge Scales (DKN)	Dunn et al. (1984)	300 people with diabetes	15 items (from pilot study 89 items)	Multiple choices question	1. Goal of blood glucose level 2. Diet 3. Diabetes complication 4. Hypoglycemia management	Reliability Tested by Cronbach's coefficient alpha Face validity Asked open-ended questions and listed the answers to be the choices

Table 2-3 (cont.) Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
3.	Short Diabetes Knowledge Instrument (SDKI)	Bloomgarden et al. (1987)	593 elderly (age more than 60 years) with diabetes	13 items (from original 16 items)	Multiple choices question	1. Goal of blood glucose level 2. Diet 3. Exercise 4. Hypoglycemia management 5. Foot care	Reliability Tested by Test-retest reliability and Cronbach's coefficient alpha Construct validity Knowledge score related to formal education and incom
4.	A brief diabetes knowledge test	Fitzgerald et al. (1998)	811 adults with type 1 and type 2 diabetes	23 items (14-item general test and a 9-item insulin-use subscale)	Multiple choices questions	1. Diet 2. Blood glucose testing 3. Hypoglycemia management 4. Exercise 5. Diabetes complication 6. Medication and insulin	Reliability Tested by Cronbach's coefficient alpha Construct validity Association between knowledge score and socio-demographic characteristics (diabetes type, treatment, educational level, diabetes education received)
5.	Diabetes Knowledge Questionnaire (DKQ)	Garcia et al. (2001)	502 adult Mexican-Americans with type 2 diabetes	24-item (from original 60 items)	True-False questions with Unknown option	1.Cause of diabetes 2. Goal of blood glucose level 3. Diet 4. Diabetes complication 5. Hypoglycemia symptom 6. Foot care	Reliability Tested by Cronbach's coefficient alpha Construct validity Tested differentiation between control group and education group at baseline and 3 months follow up

Table 2-3 (cont.) Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
6.	Adknowl	Speight J & Bradley C (2001)	789 adults with type 1 and type 2 diabetes	33 item-sets or 137 items (Last revised 2009)	True-False questions with Unknown option	1. Diabetes treatment & testing 2. Management of diabetes when ill – separate item-sets for respondents using 3. General management of insulin and insulin use 4. The causes of, symptoms of and action to be taken during hypoglycemia 5. Effects of physical activity 6. Diet & food 7. Effects of alcohol 8. Reducing the risk of developing diabetes complications 9. Effects of smoking 10. Foot care 11. Blood glucose levels & HbA1c	Reliability Not Available Construct validity Association between knowledge score and predictive values

Table 2-3 (cont.) Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
7.	Instrument to Assess the General Knowledge of Patients with Diabetes	Wongwiwat-thananukit et al. (2004)	811 Thai people with diabetes from 21 hospitals	21 items (from pilot study 40 items)	True-False questions with Unknown option	1. General characteristics of diabetes 2. Diet control 3. Exercise 4. Medication 5. Sick-day management	Reliability Tested by Kuder-Richardson 20 formula Content validity 8 Experts reviewed the panel
8.	Spoken Knowledge in Low Literacy patients with Diabetes (SKILLD)	Rothman et al. (2005)	217 people with type 2 diabetes, poor glycemic control (HbA1c ≥ 8%) and low literacy	10 items (from pilot study 11 items)	Ask and answer questions orally	1. Hypoglycemia management 2. Eye check-up 3. Foot care 4. Goal of blood glucose level 5. Exercise 6. Diabetes complication	Reliability Tested by Kuder-Richardson 20 formula Construct validity Knowledge score related to income, education level, literacy status and clinical outcomes
9.	Diabetes Numeracy Test (DNT)	Huizinga et al. (2008)	398 people with type 1 and type 2 diabetes	43 items (full version) 15 items (short version)	Fill in short answer questions	1. nutrition 2. exercise 3. glucose monitoring 4. oral medication 5. insulin use	Reliability Tested by Kuder-Richardson 20 formula Construct validity Knowledge score related to education level, income, literacy and math skills

Table 2-3 (cont.) Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
10.	Diabetes knowledge questionnaire	Eigenmann et al. (2011)	129 Australian people with type 1 and type 2 diabetes	15 items	Multiple choices question	1. Ideal blood glucose levels 2. HbA1c 3. Chronic nature 4. Dietary guidelines 5. Benefits of physical activity 6. Frequency of physical activity 7. General diabetes long-term complications 8. Diabetes foot complications 9. SMBG 10. Sick-day management 11. Annual check-ups 12. Support services – National Diabetes Services Scheme 13. Diabetes medication 14. Hypoglycemia 15. Sick-day management	Reliability Tested by Test-retest reliability and Cronbach's coefficient alpha Content and face validity Discussed with participants in small groups during a national diabetes conference in 2007. The 20 items draft-questions were developed by Delphi survey. 52 diabetes experts were asked about their opinion on the most important question to be filled in the questionnaire.

Table 2-3 (cont.) Summarized study about diabetes knowledge tool development

No	Instrument	Author	Group	Number of items	Question type	Knowledge topics	Reliability-Validity
11.	AdultCarb Quiz	Watts et al. (2011)	132 people with type 1 and type 2 diabetes for patients participants and 15 registered dietitian-participants	43 items	True False Questions and multiple choices questions	1. Recognition of carbohydrate in commonly eaten foods 2. Ability to count the carbohydrate content in typical portions of simple foods 3. Ability to interpret a nutrition label for carbohydrate content 4. Knowledge of glycemic targets 5. Knowledge about preventing and treating hypoglycemia using carbohydrate foods 6. Ability to sum up the carbohydrate content of a meal.	Reliability Tested by Kuder-Richardson 20 formula and split-half reliability Content validity Correlation between total quiz score and updated HbA1c were evaluated by linear regression Construct validity 1. Compared between registered dietitian groups and patients group by Kruskal-Wallis test 2. Compared between group of patients who had education and group without education 3. Rate overall knowledge by experts

Table 2-4 Sample nutrition questions from diabetes knowledge instruments

No	Instrument	Author	Sample nutrition questions
1.	Diabetes Knowledge Scales (DKN)	Dunn et al. (1984)	1. Butter is mainly: A. Protein. B. Carbohydrate. C. Fat D. Mineral and vitamin. E. I don't know. 2. Rice is mainly: A. Protein. B. Carbohydrate. C. Fat D. Mineral and vitamin. E. I don't know. 3. You can eat as much as you like of which one of the following foods: A. Apples. B. Celery. C. Meat. D. Honey. E. I don't know. 4. A kilogram is: (circle at least two) A. A metric unit of weight. B. Equal to 10 pounds. C. A metric unit of energy. D. A little more than 2 pounds. E. I don't know. 5. If I don't feel like the egg allowed on my diet for breakfast I can: (circle at least two) A. Have extra toast. B. Substitute one small chop. C. Have an ounce of cheese instead. D. Forget about it. E. I don't know.
2.	Short Diabetes Knowledge Instrument (SDKI)	Bloomgarden et al. (1987)	1. Is cholesterol found in beans, *steak*, or olives? 2. Is starch found in bacon, lima *bearxs*, or chicken?

Table 2-4 (cont.) Sample nutrition questions from diabetes knowledge instruments

No	Instrument	Author	Sample nutrition questions
3.	A brief diabetes knowledge test	Fitzgerald et al. (1998)	1. The diabetes diet is: a. the way most American people eat b. a healthy diet for most people* c. too high in carbohydrate for most people d. too high in protein for most people 2. Which of the following is highest in carbohydrate? a. Baked chicken b. Swiss cheese c. Baked potato* d. Peanut butter 3. Which of the following is highest in fat? a. Low fat milk* b. Orange juice c. Corn d. Honey 4. Which of the following is a "free food"? a. Any unsweetened food b. Any food that says "sugar free" on the label c. Any dietetic food d. Any food that has less than 20 calories per serving*
4.	Adknowl	Speight J & Bradley C (2001)	1. People with diabetes can eat foods containing sugar as part of a high fibre diet 2. Sugary foods will have no effect on blood glucose levels 3. High-fibre foods help to keep blood glucose levels steady 4. High-fat foods can increase the risk of complication 5. Special diabetic products can be eaten freely without leading to weight gain 6. The same sized portion of fish and white meat such as chicken contain less fat than red meat such as beef or pork 7. It is not possible to eat too much protein 8. Fried foods are usually high in fat 9. Pastry and cakes are high in fat 10. Cheese and biscuits are usually less fattening than puddings 11. All margarines and spreads have fewer calories than butter 12. Restricting use of salt can help to reduce high blood pressure 13. Fresh fruit can be eaten freely with little effect on blood glucose levels 14. Fresh, unsweetened fruit juice can be drunk freely with little effect on blood glucose level

Table 2-4 (cont.) Sample nutrition questions from diabetes knowledge instruments

No	Instrument	Author	Sample nutrition questions
5.	Diabetes Knowledge Questionnaire (DKQ)	Garcia et al. (2001)	1. The way I prepare my food is as important as the foods I eat. 2. A diabetes diet consists mostly of special foods.
6.	Instrument to Assess the General Knowledge of Patients with Diabetes	Wongwiwat-thananukit et al. (2004)	1. Even the patients take diabetes medication, the blood glucose level is high if they still eat too many sweets.
7.	AdultCarbQuiz	Watts et al. (2011)	Recognition of carbohydrate 1. Bread 2. Breakfast sausages 3. Baked potato 4. Regular maple syrup 5. American cheese 6. Low-fat milk 7. Apple juice 8. Soda pop (not diet) 9. Cooked dried beans (e.g., navy beans, lentils) 10. Apple 11. Sugar 12. Butter 13. Cooked rice 14. Plain grilled chicken 15. Blackberry jam 16. Cooked spaghetti noodles (no sauce)

Table 2-4 (cont.) Sample nutrition questions from diabetes knowledge instruments

No	Instrument	Author	Sample nutrition questions
8.	Diabetes knowledge questionnaire	Eigenmann et al. (2011)	1. Which of the following statements about diabetes and diet is true? a. People with diabetes should eat a sugar free diet b. It is OK to eat fried take away food three times a week c. Red meat is a carbohydrate food d. A diet which is low in fat, high in fibre, low in added sugar is recommended for everyone with diabetes e. Unsure

2.7 Problem about diabetes knowledge

The study of Mann et al. (2009) in diabetes patients with low-income indicated misunderstanding about diabetes. More than half of participants thought "Glucose is high only when > 200 mg/dl" and 36% of the patients misunderstood that "Can feel when glucose is high". Moreover, some patients thought "their doctor will cure them of diabetes" (29%) and "there is no need to take diabetes medications when glucose levels are normal" (23%). However, the researcher did not evaluate self-management behavior and glycemic control[47].

Pongmesa et al. (2009) evaluated diabetes knowledge in Thai people by 42-item pre-tested questionnaire. It was divided into 7 parts as follows: socio-demographics (9 items), general knowledge of diabetes (8 items), risk factors (4 items), symptoms and complications (11 items), treatment and management (11 items), monitoring (5 items), and diabetes in women (3 items). The researchers indicated 3 levels of score (poor was less than 50%, fair was 50-80%, good was more than 80%). The results showed total score was 25.02 points from 42 points or 59.6 % that was classified as fair. The participants did the best score in risk factor part and the worst in diabetes in women part. For general knowledge of diabetes part, the patients got 47.5% that were classified as poor. Treatment and management part and monitoring part were in fair level. All parts of the test were not reached good level, only fair and poor level [16].

Breen et al. (2015) examined nutrition knowledge in 124 people with type 2 diabetes. The researcher selected ADKnowl questionnaire to evaluate nutrition knowledge and compared with 4 days semi-weigh food diary. The patients had 62.3% overall score and 59.2% dietary part score. More than 90% of participants can answer correctly is sugar increased blood glucose levels while only 66.9% recognized starchy food also increased blood glucose level. The participants who determined fruit and fruit juice raised blood glucose level were 62.9% and 59.3% respectively. Over 80% understood relationship between salt and blood pressure and high fat foods. More than half of participants confused that protein and fat directly affect blood glucose level. Only 36.3% for protein and 16.1% for fat identified them correctly. The most misunderstood question was about starchy foods and sugar. Only 12.1% answered correctly that sugar and starch need insulin in the same level depend on amount of carbohydrate. Over 66% misunderstood that they should avoid all sugar containing

foods. The results demonstrated that a lot of people with type 2 diabetes misunderstood about carbohydrate. The problem of nutrition knowledge influenced sugar, fruit and vegetable consumption [12].

2.8 Carbohydrate knowledge in type 2 diabetes

Although, diabetes diet is a healthy diet that is not much different from normal people, people with diabetes are often concerned about carbohydrate more than other nutrients. Due to carbohydrate directly affects blood glucose level, especially postprandial blood glucose [48]. From study of Breen et al. in Ireland, the people with type 2 diabetes understood definition of carbohydrate and could tell example of carbohydrate foods. They classified good carbohydrate from color. The brown one was better than white one. In their opinion, the most important thing was table sugar or sucrose. They believed it become toxic in their bodies. Sweet fruits and foods were also avoided while tasteless fruits and food were not their concern. People with type 2 diabetes were careful about food choices, but were not really interested in food portions. The patients with high level awareness tried to follow healthy guideline. They reduced fat intake and eat more vegetables, but it still was secondary concern. The first one was a low sugar diet [49].

Thai and Western cultures are different that make composition of foods are different as well. The most important food in Thai culture is rice. The rice is usually served at every meal, except replaced by noodle. There are 2 main kinds of rice in Thailand: long grain rice and sticky rice. The sticky rice is more common in the northern and north-eastern regions. It generally is used in Thai desserts. The long grain rice is commonly white color, but the brown one contains more fiber. Thai people with diabetes try to reduce their amount of rice in their meals. They think it will help to manage diabetes, but a problem is they still eat other kinds of carbohydrate foods, especially fruits. The diabetes patients divide fruit into 2 groups: sweet and non-sweet fruits. The examples of non-sweet fruits are guava, rose apple and unripe mango. They usually are tasteless or sour that the patients eat them with sugar [14]. Similarly, the study of Sansingchai et al. (2006) in uncontrolled people with type 2 diabetes. It showed misunderstanding of self-care in type 2 diabetes patients. Almost 80% of patients thought “People with diabetes can eat sour fruits in unlimited amount.” and “People with diabetes can replace sweetened milk with soy milk, drinking yogurt or yogurt.”

This means uncontrolled type 2 diabetes patients may related to lack of self-care knowledge, especially in dietary topics [50].

The amount and type of carbohydrate are very important for diabetes management. Carbohydrate counting is a method that generally is used for carbohydrate portion control, especially in type 1 diabetes patients. For people with type 2 diabetes, the carbohydrate counting is still in doubt for benefit. The method is quietly complex and needs calculation skill. It is suitable for people with good literacy or those who are ready to learn new things [51]. However, the principle of carbohydrate counting is not much different from diabetes knowledge in type 2 diabetes patients [52].

The basic carbohydrate counting started with carbohydrate identification. The patients need to know what foods and beverages contain carbohydrate. The next one is type of carbohydrate. There are 3 types: starch, sugar and fiber. Their glycemic responses are different. The patients should learn to determine type of carbohydrate in any food sources. The last one is amount of carbohydrate in foods. People with type 2 diabetes improve estimation skills from experience. The common way to estimate portion size is comparing with other items such as spoon, ladle, hand, etc. Moreover, food labels on packages are very useful to calculate amount of carbohydrate. As advanced carbohydrate counting is adjustment of insulin depend on the portion size of carbohydrate in each meal. It is very flexible, but need to monitor blood glucose level. For advance level, it may be excessively detailed for type 2 diabetes patients, especially those who do not use insulin [53-55].

CHAPTER 3
METHODOLOGY

3.1 Development of carbohydrate portion knowledge test

3.1.1 Drafting

The test was developed based on literature review. The content was identified by nutrition recommendation, basic carbohydrate counting and misunderstanding about nutrition from previous studies. The food items were created based on information from food diaries which were kept in counseling room over the past year. The draft was evaluated via google forms by 5 nurse educators, 5 dietitians and 5 committees of diabetes club at King Chulalongkorn Memorial Hospital. This team has worked for diabetes camp together. The questionnaire was a 5 points Likert scales to evaluate important of the items. (1 = Unimportant, 2 = Little important, 3 = Moderately important, 4 = Important, 5 = Highly important) The selected items were responded important more than 70%.

3.1.2 Pre-pilot study

The content validity was tested by Index of Item-Objective Congruence (IOC). The items were evaluated congruent with the objective by 4 experts. The experts were as follows: an endocrinology doctor, registered dietitian, chief of nutrition department in tertiary care hospital and nurse who works about diabetes education more than 10 years. The evaluation criteria were +1 this item is congruent with the objective, 0 this item may be congruent with the objectives and -1 this item is not congruent with the objective. The score for each item was calculated by the sum of scores from experts and divided by number of experts. The items with score ≥ 0.5 were accepted and unclear words were fixed and revised according to experts' suggestion.

The questions in the test were asked and ensured clarity again by 10 adults with type 2 diabetes. The participants read all the questions and restated them with their own word. They were asked to explain their ideas after answered each question.

3.1.3 Pilot study

The discrimination index of instrument was tested in 30 adults with type 2 diabetes. It was calculated by the number of people who answered this item correctly in the upper group minus the number of people who answered this item correctly in the lower group, divided by the number of all people. The lower group was people who had total score in the 25th percentile and people in the upper group had total score in the 75th percentile. The criteria were as follows: ≥ 0.40 is interpreted as very good items, 0.30-0.39 is good, 0.20-0.29 is fair and < 0.2 is poor items. The discrimination index of each item was at least 0.2. After that the test was calculated reliability coefficient by Kuder-Richardson (KR20) in other 30 people with type 2 diabetes[56].

3.1.4 Data analysis

The data was analyzed by SPSS version 22 for windows. The answers were coded into number one and zero depend on correct or incorrect (number one for correct and zero for incorrect). "Unknown" response was interpreted to incorrect.

Reliability was determined by Kuder-Richardson (KR20) and the discrimination index was calculated for each item.

3.2 Determining factors related to carbohydrate portion knowledge

3.2.1 Study design

The design was a cross-sectional study. Socio-demographic characteristics, medical information, self-management information and diabetes education of participants were obtained. All data including answers of the questions in the knowledge test were asked and filled in the data collection forms by the researcher.

3.2.2 Study population

The sample group was adults with type 2 diabetes who attended the diabetic clinic at Phor Por Ror Building, King Chulalongkorn Memorial Hospital.

Inclusion criteria

- Type 2 diabetes
- Age > 20 years
- Able to read and communicate in Thai

Exclusion criteria

- Hemolytic anemia
- Blood loss or blood transfusion in the prior 3 months
- Hospitalized in the prior 3 months
- Pregnancy
- Steroid therapy
- Cancer
- HIV infection
- Stage 4-5 of chronic kidney disease
- Cognitive problem

3.2.3 Participant recruitment and approach

The medical records were reviewed to find the patients who meet the inclusion and exclusion criteria. The criteria matched patients were approached by medical staffs at diabetic clinic on third floor, Phor Por Ror Building, King Chulalongkorn Memorial Hospital. The patients who were interested in the study met the researcher in a private room on the same floor. They were explained about detail of the study including risk and benefit. The researcher willingly answered any questions about the study. The patients could make decision independently after received all information. The patients who volunteered to participate the study, were provided consent form for reading and signing the name.

3.2.4 Sample size

Previous study (Howteerakul et al, 2007) conducted in adults with type 2 diabetes who attended tertiary hospitals in Bangkok. The results showed 76.1% of the participants had good overall knowledge of diabetes [57]. The number of participants was calculated by using Cochran (1963:75) equation. The significance level was 0.05 and the margin of error was 10%.

Cochran (1963:75) equation

$$n = \frac{Z^2_{\alpha/2} P(1- P)}{d^2}$$

n = sample size

P = the estimated proportion of good overall knowledge of diabetes was 0.76

d = the acceptable margin of error was 10% of estimated proportion = 0.1 x0.76 = 0.076

α = 0.05 and it was two-sided test; $Z_{\alpha/2}$ = 1.96

$$n = \frac{Z^2_{\alpha/2} P(1- P)}{d^2}$$

$$= \frac{(1.96)^2 0.76(1-0.76)}{(0.076)^2}$$

= 121.31

The calculated number of participants was 122. After adjusting for 10% dropout rate (10%), sample size was 135.

3.2.5 Data collection

The data collection forms consisted of 5 parts as follow: (APPENDIX A)

Part 1 Socio-demographic characteristics included gender, age, education, marital status, people who you live with, occupation, income.

Part 2 Medical history, self-management and diabetes education information included diabetes duration, other underlying disease, current treatment, self-monitoring of blood glucose, exercise, diabetes education, source of knowledge.

Part 3 General diabetes knowledge test consisted of 21 items. This instrument was developed by Wongwiwatthananukit et al. (2004). The content validity was tested by 8 diabetic experts and the reliability was tested with a sample of 811 patients from 21 hospitals [58].

Part 4 Carbohydrate portion knowledge test was divided into 2 sections as follow:

Section 1 General knowledge of diabetes diet (6 items)

Section 2 Carbohydrate portion control (23 items)

- Types of food that contain carbohydrate (12 items)
- Sugar-sweetened beverages (5 items)
- Amount of carbohydrate in foods (4 items)
- Reading the nutrition facts label (2 items)

Part 5 Information from medical record consisted of most recent documented HbA1c, hypoglycemia events, weight history, antidiabetic prescriptions within 6 months and records about diabetes education.

The data was collected from participants by asking face to face. It was scheduled for 45 minutes and required information from medical record was obtained after completing 4 first parts.

3.2.6 Data analysis

The data was analyzed by SPSS version 22 for windows.

Descriptive statistics were expressed as mean ± standard error of the mean (SEM) and percentage.

Analytical statistics were described relationship between variables. Spearman's rank correlation was used to test association between score of general diabetes knowledge and score of carbohydrate portion knowledge. Factors that related to poor glycemic control and factors that related to low level of carbohydrate portion knowledge were analyzed by Chi-squared test, Binomial regression and Multivariable analysis. Strength of association was also assessed. Relationship between score of carbohydrate portion knowledge and variables was assessed by Independent t-test and ANOVA.

Statistical significance was set at $\alpha < 0.05$. If p-value is less than 0.05, it will be accepted as statistically significant.

3.3 Determining food estimation skills and an in-depth interview

3.3.1 Study design

The design was a mixed methods study. It was designed to collect both qualitative and quantitative data. The qualitative and quantitative data were compared to see more comprehensive picture[59].

3.3.2 Study population

The sample group was participants who voluntary to provide information and complete the data collection forms in the second part of the study.

3.3.3 Sample size

For qualitative study, the size was determined by data saturation[60, 61] and the participants were selected by a non-random basis. A recruitment technique was Maximum variation sampling [62, 63]. The criteria were level of carbohydrate portion knowledge and glycemic control.

3.3.4 Data collection

A) Foods estimation skill test was scheduled for 30 minutes. (APPENDIX B)

First step

The participants answered number of ladle (tap-phi) for steamed rice that they should eat in a meal. Then, they were asked to estimate amount of steamed rice in the number that they answered. The scooped rice was weighed and was calculated percentage of error. The reference of rice weight was Thai food exchange list [64].

$$\% \text{ error of estimation} = \frac{\text{Patients' estimation weight} - \text{Reference weight}}{\text{Reference weight}} \times 100$$

Patients' estimation weight = weight of steamed rice that patients estimate

Reference weight = weight of steamed rice in the same number of ladle from reference (1 ladle = 55 grams).

Second step

The participants were asked to estimate portion of steamed rice on the plate sample and answered in ladle (tap-phi) unit. The correct answer was 3 ladles weight 165 g (3 exchanges of carbohydrate) and the score was calculated as follow:

Table 3-1 Estimation score for steamed rice on the plate sample

	Less than correct answer (Ladle)	**Score**	**More than correct answer (Ladle)**
Correct answer	3	5	3
Incorrect answer	2.5	4	3.5
	2	3	4
	1.5	2	4.5
	1	1	5
The answer less than 1 ladle and more than 5 ladles were scored as 0.			

Third step

The participants were asked to compare amount of carbohydrate between two food samples and answered "Less than" or "Equal" or "More than" the one that was reference.

Table 3-2 List of food in estimation skill test

No.	**Name**	**Weight (g)**	**Exchange of carbohydrate**	**Correct answer**
Unit 1 Starchy foods; Reference : 165 g of steamed rice (3 exchanges)				
1.1	Steamed glutinous rice	90	3 exchanges	Equal
1.2	Boiled wide rice noodles (Senyai)	180	2 exchanges	Less than
1.3	Boiled glass vermicelli (Woonsen)	240	3 exchanges	Equal
1.4	Porridge	110	1 exchanges	Less than
1.5	Boiled sweet potato	200	4 exchanges	More than
1.6	Boiled corn	130	3 exchanges	Equal

No.	Name	Weight (g)	Exchange of carbohydrate	Correct answer
Unit 2 Fruits; Reference : 45 g of banana (1 exchange)				
2.1	Tangerine	150	1 exchanges	Equal
2.2	Guava	240	2 exchanges	More than
2.3	Papaya	150	1 exchanges	Equal
Unit 3 Desserts; Reference : 165 g of steamed rice (3 exchanges)				
3.1	Mock fruits (Look Choup)	90	3 exchanges	Equal
3.2	Rice noodles with coconut cream (Lod Chong)	120	2 exchanges	Less than
Unit 4 Beverage; Reference : 15 g table sugar (1 exchange)				
4.1	Orange juice	200	2 exchanges	More than
4.2	Soymilk	250	2 exchanges	More than
4.3	Green tea original flavored	500	2 exchanges	More than

B) In-depth interview

Interview questions were semi-structured according to interview guide that was tested content validity by IOC (APPENDIX C). It consisted of general introduction about diabetes, diabetes education, diabetes food choices, understanding type of carbohydrate, amount of carbohydrate in foods and food label use. The interview was one by one interview and was conducted in a private room. It was scheduled for 60 minutes.

3.3.5 Data analysis

For quantitative data, the scores were expressed as mean ± standard error of the mean (SEM) and percentage of correct answer for each item.

For qualitative data was managed and analyzed by the Framework method. It was used for a inductive thematic analysis [65]. All interviews were audio recorded with consent from participants. Firstly, the interviews were transcribed verbatim and the audio recordings were double checked to ensure accuracy. Secondly, a note was made during reading transcript and listening audio-recorded interview for familiarization with interview. Thirdly, the data was classified and labeled with a code. The code was

developed. Fourthly, the data was organized into a framework matrix. Fifthly, the set of data was reviewed and find connection to create themes. The quotes were selected to be representative for findings support. Data gathering and analysis started in sets of three participants until a new theme was not found. The processes of coding, charting and mapping was in Microsoft Office Excel 365 Education E1[66].

3.4 Ethical consideration

All procedures in this study had been approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (IRB No.265/59, COA No.602/2016). The participants were informed about study entirely and ensured that their decision to participate or withdraw from the project would not affect their medical care in any way. Their name and the obtained information were kept confidential. The results were identified participants by number. The participants had the right to ask the questions about the study and could contact the researcher all the time during study.

For interview, they had the right to refuse to answer any questions and terminated the interview any time without any hindrance. The participants could withdraw from the study and not necessary to explain the reasons. Audio recordings and interview notes will be destroyed after the study is complete.

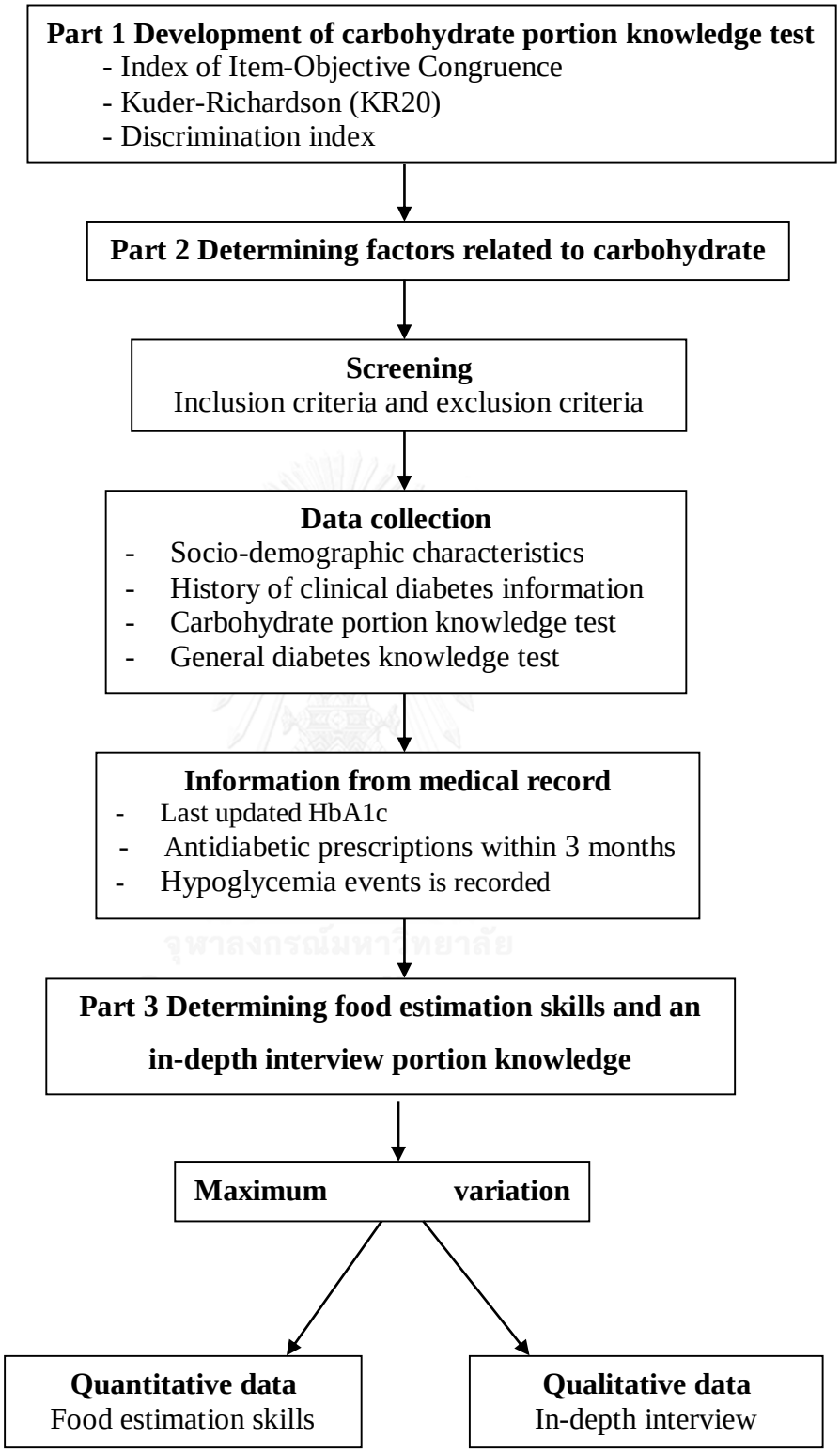

Figure 3-1 Diagram of the study design

CHAPTER 4
RESULTS

4.1 Development of carbohydrate portion knowledge test

The test was developed based on 4 domains of carb-counting knowledge in AdultCarbQuiz. The domains included ability to identify foods that contain carbohydrates, ability to estimate carbohydrate content in foods, ability to interpret nutrition information on labels, and ability to calculate amount of carbohydrate in a meal. The questions of knowledge test were divided into 4 topics. 1) Does this food that contain carbohydrate? 2) How many gram of this food contains 1 carb serving? (15 g carbohydrate) 3) From this label, if you consume this food for (number of serving size), how many gram of carbohydrate do you received? 4) From this meal plan, how many gram of carbohydrate in it? There were 40 items, 10 items for 1 question topic. As selecting items, the researcher reviewed food diaries which were kept in counseling room over the past year. The types of food that were eaten the most, were selected as items.

After the first draft was completed, the researcher invited the diabetes camp team (5 nurse educators, 5 dietitians and 5 committees of diabetes club) at King Chulalongkorn Memorial Hospital to participate in this project. The researcher asked them to evaluate the first draft via google forms. The questionnaire was a 5 points Likert scales to evaluate important of the items. (1 = Unimportant, 2 = Little important, 3 = Moderately important, 4 = Important, 5 = Highly important) The selected items were responded important more than 70%.

In the first round, the researcher received opinions about format of the test. It should start from basic nutrition knowledge about diabetes. As the number of items, 10 items in the question about food that contain carbohydrate may not sufficient while the most items about reading nutrition label had a similar pattern. For calculation of gram of carbohydrate in a meal, it was commented as too difficult question and diabetes education at King Chulalongkorn Memorial Hospital do not teach advanced carb-counting in every case. In addition, the test should include some questions about beverages and fiber.

In second draft, 25 new items for basic nutrition knowledge were created based on ADA nutrition recommendation and misunderstanding about nutrition from previous

studies. The number of items about identification of foods that contain carbohydrates increased to 30 and the number of items about nutrition label were reduced to 5. The question about calculation of carbohydrate content in a meal was changed to comparing amount of carbohydrate between 2 different types of food. For the beverages and fiber, they were added into the test as new questions "Which one is recommended beverage for diabetes?" and "Which fruit contains more fiber?". Therefore, the second draft consisted of 100 items including 25 items of basic nutrition knowledge, 30 items of foods contained carbohydrate, 20 items of recommended beverages, 10 items about fiber in fruits, 20 items of comparing carbohydrate content between 2 types of food and 5 items of nutrition label. In the second round, the 50 items was evaluated as highly important more than 70%. This draft became the first version of the test and was determine validity and reliability in the next step.

The first version of the test contained 50 items on the following topics: basic knowledge of diabetes diet (10 items), types of food that contain carbohydrate (15 items), sugar-sweetened beverages (15 items), amount of carbohydrate in foods (5 items), amount of fiber in fruits (3 items) and reading the nutrition facts label (2 items). The content validity was tested by Index of Item-Objective Congruence (IOC). The items were evaluated by 4 experts. The 4 items were rejected in this part due to the IOC score less than 0.5. The process of checking clarity of questions did not found a problem. 10 adults with diabetes could explain and restate the questions with their own word.

The second version contained 46 items. It was tested the discrimination index in 30 adults with type 2 diabetes. The 17 items were deleted due to poor discrimination power (discrimination index < 0.2).

The final edition contained 29 items with reliability coefficient of 0.827. It was calculated by Kuder-Richardson (KR20) in other 30 people with diabetes. (APPENDIX D)

4.2 Determining factors related to carbohydrate portion knowledge

The study investigated knowledge of carbohydrate portion in 135 adults with type 2 diabetes who attended the diabetic clinic at Phor Por Ror Building, King Chulalongkorn Memorial Hospital. Carbohydrate portion knowledge was evaluated by the test that was developed in the first part of the study. The data was presented association between factors and knowledge of carbohydrate portion.

4.2.1 Description of socio-demographic characteristics, medical information, self-management information and diabetes education

A total of 135 participants completed all data collection forms. Demographic characteristics of participants was as explained in Table 4-1. There were more women than men (68.89% and 31.11% respectively). Participants aged 60 years and older were 65.19% while younger than 60 years were 34.18%. As education level, 57.78% were diploma and higher whereas 42.22% were lower than diploma. Among these participants, the majority (66.67%) were married, 16.30% were single, 14.07% were widowed and 2.96% were divorced. It was found that 6.67% of participants lived with parents, spouse and children, 47.41% lived with spouse and children, 22.22% lived only with children, 13.33% lived with sibling and 10.37% lived alone. More than half of participants were unemployed, retired or housewives (59.26%), 20.74% were merchants, business owners or freelancers, 14.81% were government officers or state enterprise employees and 7 participants (5.19%) were business employees. For income per month, 35.55 % of participants did not receive any income, 21.48% earned less than 15,000 baht, 25.19% received 15,000 to 25,000 baht and 17.78% earned more than 25,000 baht

As shown in Table 4-2, the majority of participants (66.67%) had diabetes for more than 10 years and the rest of them had 5 to 10 years, 1 to 5 years and less than 1 years (19.26%, 12.59%, and 1.48% respectively). It was found that only 20 participants (14.81%) did not have other underlying disease. As other underlying diseases, 63.70% had hypertension and dyslipidemia, 9.63% had dyslipidemia only, 6.67% had chronic kidney disease stage 3 with hypertension and dyslipidemia, 5.19% had cardiovascular disease with hypertension and dyslipidemia. For treatment, almost 60 percent of the sample (59.26%) used oral medication only, 36.30% had insulin injection with or without oral medication and few (4.44%) used only diet control. Around half of participants (47.41%) had good glycemic control while 52.59% still had HbA1c more than 7.0. Moreover, the majority (93.34%) had no weight change within 6 months and the rest of them had weight gain and weight loss more than 5% (2.96%, 3.70%, respectively). As medication change within 6 months, more than eighty percent of participants (83.70%) received the same medication, 8.89% received higher medication dose and 7.41% received lower medication dose. Only 17 participants (6.67%) had hypoglycemia whereas most of them did not (93.33%).

Table 4-1 Socio-demographic characteristics of participants (n=135)

Characteristics		N	Percentage
Gender	Male	42	31.11
	Female	93	68.89
Age (years)	Younger than 60 years	47	34.81
	60 years and older	88	65.19
Education level	Lower than diploma	57	42.22
	Diploma and higher	78	57.78
Marital status	Single	22	16.30
	Married	90	66.67
	Divorced	4	2.96
	Widowed	19	14.07
People living with	Living with parents, spouse and children	9	6.67
	Living with spouse and children	64	47.41
	Living with children	30	22.22
	Living with sibling	18	13.33
	Living alone	14	10.37
Occupation	Government officer/State enterprise employee	20	14.81
	Merchant/Business owner/Freelancer	28	20.74
	Business employee	7	5.19
	Housewife/Retiree/No occupation	80	59.26
Income per month	No income	48	35.55
	Less than 15,000 baht	29	21.48
	15,000 to 25,000 baht	34	25.19
	More than 25,000 baht	24	17.78

Table 4-2 Medical information of participants (n=135)

Characteristics		N	Percentage
Diabetes duration	Less than 1 year	2	1.48
	1 to 5 years	17	12.59
	5 to 10 years	26	19.26
	More than 10 years	90	66.67
Other underlying diseases	No	20	14.81
	DLP only	13	9.63
	HTN and DLP	86	63.70
	CKD stage 3 with HTN and DLP	9	6.67
	CVD with HTN and DLP	7	5.19
Treatment	Diet control	6	4.44
	Oral medication only	80	59.26
	Insulin injection	49	36.30
HbA1c (%)	< 7.0	64	47.41
	≥ 7.0	71	52.59
Weight change within 6 months	No	126	93.34
	Increase ≥ 5%	4	2.96
	Decrease ≥ 5%	5	3.70
Medication change within 6 months	No	113	83.70
	Higher medication dose	12	8.89
	Lower medication dose	10	7.41
Hypoglycemia	No	126	93.33
	Yes	9	6.67

DLP: Dyslipidemia HTN: Hypertension CKD: Chronic kidney disease
CVD: Cardiovascular disease

More than half of participants (57.78%) had glucose meter while 42.44% did not. As frequency of using, 21.48% rarely used, 16.30% used 1 to 3 times per week, 4.44% used 4-6 times per week, 3.70% used once a day, 5.93% used more than once a day and 5.93% used only when they feel like they have hypoglycemia. Only 39 participants (28.89%) exercised more than 150 minutes per week whereas 71.85% did not. (Table 4-3)

Table 4-3 Self-management information of participants (n=135)

Characteristics		N	Percentage
Self-Monitoring of Blood Glucose	Do not have glucose meter	57	42.22
	Having glucose meter	78	57.78
Frequency of Self-Monitoring of Blood Glucose	Rarely use	29	37.18
	1-3 times per week	22	28.20
	4-6 times per week	6	7.69
	Once a day	5	6.41
	More than once a day	8	10.26
	Measured only hypoglycemia	8	10.26
Exercise more than 150 min/wk	No	97	71.85
	Yes	38	28.15

All participants received diabetes education about healthy diet. The percentage of participants who received diabetes education about general diabetes, diabetes complication, diabetes medication, self-monitoring of blood glucose, exercise and foot care were 55.56, 52.59, 47.41, 33.33, and 74.07, respectively. For frequency of diabetes education in 5 years ago, 17.04 % did not receive any diabetes education, 23.70% received 1 times, 36.30% received 2-4 times, 10.37% received 5-10 times and 12.59% received more than 10 times. In addition, some participants got more information about diabetes from family members, friends and media. Among participants, only 20 participants (14.81%) heard some information from family while the majority (85.19%) did not. 20.74% got diabetes information from friends whereas 79.26% did not. Media was the major other source of knowledge. Two-Third of participants (66.67%) received information about diabetes via media and the rest of them (33.33%) did not. (Table 4-4)

Table 4-4 Diabetes education that participants received (n=135)

Characteristics			N	Percentage
Diabetes education from healthcare staffs+	General diabetes	No	60	44.44
		Yes	75	55.56
	Diabetes complication	No	62	45.93
		Yes	73	54.07
	Diabetes medication	No	64	47.41
		Yes	71	52.59
	Self-Monitoring of Blood Glucose	No	72	53.33
		Yes	63	46.67
	Healthy diet	No	0	0.00
		Yes	135	100.00
	Exercise	No	90	66.67
		Yes	45	33.33
	Foot care	No	37	27.41
		Yes	98	72.59
Frequency of diabetes education in past 5 years	Did not receive		23	17.04
	Once		31	22.96
	2-4 times		50	37.04
	5-10 times		14	10.37
	>10 times		17	12.59
Other source of diabetes knowledge	Family	No	115	85.19
		Yes	20	14.81
	Friend	No	107	79.26
		Yes	28	20.74
	Media	No	45	33.33
		Yes	90	66.67

+ identified only education by diabetes nurse educator or dietitian which documented in medical record

4.2.3 Score of general diabetes knowledge and carbohydrate portion knowledge

The study evaluated both knowledge of general diabetes and carbohydrate portion as shown in Table 4-5. Mean score with SEM of general diabetes knowledge was 16.32 ± 0.28 points (77.71%). The minimum was 3 points and the maximum was full score (21 points). For test of carbohydrate portion knowledge, mean with SEM was 16.24 ± 0.34 points (56.00%). The minimum and maximum score were 4, 25 points respectively. As each section of carbohydrate portion knowledge test, the participants did higher score on section of general knowledge of diabetes diet (66.83%) than section of carbohydrate portion control (53.22%). The participants scored less than 50% on 2 units. Reading the nutrition facts label and amount of carbohydrate in foods were scored 23.50%, 42.00% respectively while types of food that contain carbohydrate and sugar-sweetened beverages were scored 53.22% and 58.83% respectively.

Table 4-5 Descriptive statistics of score of general diabetes knowledge and carbohydrate portion knowledge

Characteristics	Score				
	Total score	Mean ± SEM	%[a]	Min	Max
1. Knowledge of general diabetes	21	16.32 ± 0.28	77.71	3	21
2. Knowledge of carbohydrate portion	29	16.24 ± 0.34	56.00	4	25
2.1 General knowledge of diabetes diet	6	4.01 ± 0.09	66.83	0	6
2.2 Carbohydrate portion control	23	12.24 ± 0.30	53.22	0	19
2.2.1 Types of foods that contain carbohydrate	12	7.06 ± 0.18	58.83	0	12
2.2.2 Sugar-sweetened beverages	5	3.03 ± 0.11	60.60	0	5
2.2.3 Amount of carbohydrate in foods	4	1.68 ± 0.08	42.00	0	4
2.2.4 Reading the nutrition facts label	2	0.47 ± 0.05	23.50	0	2

[a] mean scores were converted to percentages

Moreover, test of general diabetes knowledge significantly related to test of carbohydrate portion knowledge (R = 0.351, p-value <0.001). In addition, both sections of carbohydrate portion knowledge statistically associated with knowledge of general diabetes. The correlation coefficient for general knowledge of diabetes diet and carbohydrate portion control were 0.329 and 0.292 respectively with p-value <0.001 (Table 4-6).

Table 4-6 Correlations between score of general diabetes knowledge and carbohydrate portion knowledge

Characteristics	Knowledge of general diabetes	P-value
1. Knowledge of carbohydrate portion	0.351	<0.001*
1.1 General knowledge of diabetes diet	0.329	<0.001*
1.2 Carbohydrate portion control	0.292	<0.001*

*significant correlations at P-value <0.05, Spearman's rank correlation

4.2.4 Participants' response in the test of carbohydrate portion knowledge

Carbohydrate portion knowledge test consisted of 29 questions in 2 sections. As shown in Table 4-7, the first section was general knowledge of diabetes diet. This section was asked participants to response "Is this sentence correct ? ". Most participants selected incorrect answer of question 1 (9.63%). Question 1 was "people with type 2 diabetes should eat carbohydrate foods as few as they can". The correct answer was "No", but 88.15% of participants misunderstood the sentence is correct. The rest of questions seem to be good understanding among these participants. Percentages of correct answer were more than 70 percent except question 2 (65.19%).

In section of carbohydrate portion control, the types of food which contain carbohydrate, was presented on Table 4-8. In this unit, the questions were names of food and participants were asked "Is this food source of carbohydrate?" The question with lowest percentage of correct answer was question 11 (25.19%). It was guava. In addition, question 12 was also fruit and only 37.78% of participants answered question 12 correctly. The question 12 was watermelon. Therefore, participants seem to be have misconceptions about fruit. The results were found 2 more questions with less than 50%

of correct. There were question 8 and 9 (36.30%, 49.63% respectively). Question 8 was cow milk and question 9 was glass vermicelli. On the other hand, more than 70% of participants understood first 4 questions (89.63%, 77.78%, 79.26%, and 88.15% respectively). There were taro, pumpkin, sweet potato and corn.

Table 4-7 Participants' answer in general knowledge of diabetes diet section (n=135)

Questions Is this sentence correct?	**Response**						**% Correct answer**
	Yes		**No**		**Do not know**		
	n	**%**	**n**	**%**	**n**	**%**	
1. People with diabetes should eat carbohydrate foods as few as they can	119	88.15	13	9.63	3	2.22	9.63
2. Everyone with diabetes needs an equal amount of cabohydrate	32	23.70	88	65.19	15	11.11	65.19
3. People with diabetes should eat low fat meat	117	86.67	8	5.93	10	7.41	86.67
4. Natural sugar in fruits does not need to limit.	32	23.70	100	74.07	3	2.22	74.07
5. People with diabetes should eat vegetables 5-6 serving per day	102	75.56	14	10.37	19	14.07	75.56
6. Good source of carbohydrate is fruits, whole grains, beans	124	91.85	5	3.70	6	4.44	91.85

Table 4-8 Participants' answer in types of foods that contain carbohydrate unit (n=135)

Questions Is this food source of carbohydrate?	**Response**						**% Correct answer**
	Yes		**No**		**Do not know**		
	n	**%**	**n**	**%**	**n**	**%**	
1. Taro	121	89.63	11	8.15	3	2.22	89.63
2. Pumpkin	105	77.78	25	18.52	5	3.70	77.78
3. Sweet potato	119	88.15	10	7.41	6	4.44	79.26
4. Corn	107	79.26	23	17.04	5	3.70	88.15
5. Chicken breast	42	31.11	80	59.26	13	9.63	59.26
6. Pork	55	40.74	72	53.33	8	5.93	53.33
7. Soy milk	83	61.48	50	37.04	2	1.48	61.48
8. Whole milk	49	36.30	77	57.04	9	6.67	36.30
9. Glass vermicilli	67	49.63	66	48.89	2	1.48	49.63
10.Soybean oil	57	42.22	69	51.11	9	6.67	51.11
11. Guava	34	25.19	98	72.59	3	2.22	25.19
12. Watermelon	51	37.78	81	60.00	3	2.22	37.78

Table 4-9 was demonstrated participants' response in unit of sugar-sweetened beverages**.** This unit consisted of 5 types of beverage and it asked "Is it not a sugar-sweetened beverages?". Participants selected correct answer less than 50% in question 3 (46.67%) and question 4 (31.85%). There were low fat drinking yogurt and vegetarian soymilk. While, question 2 and question 5 were more than 80% of participants who correctly answered. Question 2 was low fat milk and question 5 was soymilk with no added sugar.

Table 4-9 Participants' answer in sugar-sweetened beverages unit (n=135)

Questions Is it not a sugar-sweetened beverages?	**Response**						**% Correct answer**
	Yes		**No**		**Do not know**		
	n	**%**	**n**	**%**	**n**	**%**	
1. Whole milk	76	56.30	45	33.33	14	10.37	56.30
2. Low fat milk	115	85.19	9	6.67	11	8.15	85.19
3. Low fat drinking yogurt	61	45.19	63	46.67	11	8.15	46.67
4. Vegetarian soymilk	79	58.52	43	31.85	13	9.63	31.85
5. soymilk with no added sugar	115	85.19	10	7.41	10	7.41	85.19

As shown in Table 4-10, unit of amount of carbohydrate in foods asked participants to compare 2 different types of food. The question is "Which one contains more amount of carbohydrate or both equal?" There were question 1 (14.81%) and question 3 (12.59%) with less than 50% of correct. Question 1 was comparing between 1 ladle of white rice and 1 ladle of brown rice. The correct answer was equal, but 84.44% of participants misunderstood that white rice contains more amount of carbohydrate. Similarly, white rice and glass vermicelli which were in question 3 and most participants misunderstood that amount of carbohydrate in white rice was more than glass vermicelli (87.41%). On the other hand, percentage of correct answer in question 2 (77.78%) was more than 70%. The majority of participants knew that glutinous rice contains more carbohydrate than white rice.

Table 4-10 Participants' answer in amount of carbohydrate in foods unit (n=135)

Questions Which one contains more amount of carbohydrate or both equal?	**Response**								**% Correct answer**
	Answer 1		**Answer 2**		**Equal**		**Do not know**		
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
1. White rice and brown rice	114	84.44	1	0.74	20	14.81	0	0.00	14.81
2. White rice and glutanious rice	4	2.96	105	77.78	23	17.04	3	2.22	77.78
3. White rice and glass vermicilli	118	87.41	0	0.00	17	12.59	0	0.00	12.59
4. Cream stuffed steamed buns and bread	79	58.52	21	15.56	33	24.44	2	1.48	58.52

Table 4-11 Participants' answer in reading the nutrition facts label unit (n=135)

Questions	**Response**										**% Correct answer**
	Answer 1		**Answer 2**		**Answer 3**		**Answer 4**		**Do not know**		
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
Question 1	25	18.52	55	40.74	2	1.48	2	1.48	51	37.78	40.74
Question 2	74	54.81	8	5.93	1	0.74	1	0.74	51	37.78	5.93

Table 4-11 presented participants' response in the unit of reading the nutrition facts label**.** The participants were asked to read sample labels and answered grams of carbohydrate if they consume one cup for question 1 and one can for question 2. The first question could be answered by finding grams of carbohydrate on the nutrition facts label, but the second question needed to multiply serving size to get the correct answer. Both questions in this unit were selected correct answer less than 50%. Question 2

(5.93%) had percentage of participants' correct response lower than question 1 (40.74%). Most participants forgot to check serving size and multiply it to grams of carbohydrate. Moreover, this unit had the highest "do not know" response. Percentage of do not know answer was 37.78 in both questions while questions in other units were not more than 10%, except question 5 in section of general knowledge of diabetes (14.07%) and question 1 in unit of sugar-sweetened beverages (10.37%).

4.2.5 Questions in test of carbohydrate portion knowledge related to glycemic control

Table 4-12 was explained about relationship between correct answers and glycemic control. As section of general knowledge of diabetes diet, question 1 related with glycemic control (p-value=0.038) while the rest of questions in this section did not (p-value=0.121, 0.787, 0.308, 0.887, 0.163 respectively). Question 1 was "Should people with type 2 diabetes eat carbohydrate foods as few as they can?". Around fifteen percent of participants (15.63%) who had good glycemic control selected correct answer while 4.23% of who had poor glycemic control answer correctly. Among questions in unit of types of food that contain carbohydrate, only question 4 was statistically related to glycemic control (p-value=0.031). This question was "Is corn a source of carbohydrate". The results were unexpected because 81.25% of well glycemic control participants had correct answer whereas 94.37% of poor control could do it correctly. The other questions in this unit did not show relationship with glycemic control (p-value=0.837, 0.612, 0.334, 0.054, 0.322, 0.406, 0.536, 0.264, 0.257, 0.962, 0.259 respectively). All questions in unit of sugar-sweetened beverages did not associate with glycemic control. These p-value were 0.992, 0.472, 0.279, 0.550, 0.815 respectively. Unit of amount of carbohydrate in foods had question 3 that related to glycemic control (p-value=0.041). It was comparing amount of carbohydrate between white rice and glass vermicelli. Percentage of correct answer in participants with good glycemic control (18.75%) was more than participants with poor glycemic control (7.04%). Question 1, question 2 and question 4 of this unit did not related with glycemic control (p-value=0.815, 0.927, 0.391 respectively). The last unit in section of carbohydrate portion control was reading the nutrition facts label. Question 2 associated with glycemic control (p-value=0.027) while question 1 did not show association (p-

value=0.979). Question 2 was more difficult than question 1 because the number of serving size in nutrition fact label was not 1 of whole package. It was half a can. The correct answer can be found by multiplying serving size to grams of carbohydrate. 10.94% of participants who had good glycemic control understood how to calculate it, while 1 participant who had poor glycemic control also understood (1.41%).

Table 4-12 Relationship between questions in carbohydrate portion knowledge test and glycemic control (n=135)

Questions	HbA1c ≤ 7.0 (n=64)				HbA1c > 7.0 (n=71)				P-value
	correct		incorrect		correct		incorrect		
	n	%	n	%	n	%	n	%	
General knowledge of diabetes diet									
1. People with diabetes should eat carbohydrate foods as few as they can	10	15.63	54	84.38	3	4.23	68	95.77	0.038*
2. Everyone with diabetes needs an equal amount of cabohydrate	46	71.88	18	28.13	42	59.15	29	40.85	0.121
3. People with diabetes should eat low fat meat	56	87.50	8	12.50	61	85.92	10	14.08	0.787
4. Natural sugar in fruits does not need to limit.	50	78.13	14	21.88	50	70.42	21	29.58	0.308
5. People with diabetes should eat vegetables 5-6 serving per day	48	75.00	16	25.00	54	76.06	17	23.94	0.887
6. Good source of carbohydrate is fruits, whole grains, beans	61	95.31	3	4.69	63	88.73	8	11.27	0.163

*statistically significant as P-value <0.05, Chi-square test

Table 4-12 (cont.) Relationship between questions in carbohydrate portion knowledge test and glycemic control (n=135)

Questions	HbA1c ≤ 7.0 (n=64)				HbA1c > 7.0 (n=71)				P-value
	correct		incorrect		correct		incorrect		
	n	%	n	%	n	%	n	%	
Types of foods that contain carbohydrate									
1. Taro	57	89.06	7	10.94	64	90.14	7	9.86	0.837
2. Pumpkin	51	79.69	13	20.31	54	76.06	17	23.94	0.612
3. Sweet potato	53	82.81	11	17.19	54	76.06	17	23.94	0.334
4. Corn	52	81.25	12	18.75	67	94.37	4	5.63	0.031*
5. Chicken breast	43	67.19	21	32.81	37	52.11	34	47.89	0.054
6. Pork	37	57.81	27	42.19	35	49.30	36	50.70	0.322
7. Soy milk	37	57.81	27	42.19	46	64.79	25	35.21	0.406
8. Whole milk	25	39.06	39	60.94	24	33.80	47	66.20	0.526
9. Glass vermicilli	35	54.69	29	45.31	32	45.07	39	54.93	0.264
10.Soybean oil	36	56.25	28	43.75	33	46.48	38	53.52	0.257
11. Guava	16	25.00	48	75.00	18	25.35	53	74.65	0.962
12. Watermelon	21	32.81	43	67.19	30	42.25	41	57.75	0.259
Sugar-sweetened beverages									
1. Whole milk	36	56.25	28	43.75	40	56.34	31	43.66	0.992
2. Low fat milk	56	87.50	8	12.50	59	83.10	12	16.90	0.472
3. Low fat drinking yogurt	33	51.56	31	48.44	30	42.25	41	57.75	0.279
4. Vegetarian soymilk	22	34.38	42	65.63	21	29.58	50	70.42	0.550
5. soymilk with no added sugar	55	85.94	9	14.06	60	84.51	11	15.49	0.815

*statistically significant as P-value <0.05, Chi-square test

Table 4-12 (cont.) Relationship between questions in carbohydrate portion knowledge test and glycemic control (n=135)

Questions	HbA1c ≤ 7.0 (n=64)				HbA1c > 7.0 (n=71)				P-value
	correct		incorrect		correct		incorrect		
	n	%	n	%	n	%	n	%	
Amount of carbohydrate in foods									
1. White rice and brown rice	9	14.06	55	85.94	11	15.49	60	84.51	0.815
2. White rice and glutanious rice	50	78.13	14	21.88	55	77.46	16	22.54	0.927
3. White rice and glass vermicilli	12	18.75	52	81.25	5	7.04	66	92.96	0.041*
4. Cream stuffed steamed buns and bread	35	54.69	29	45.31	44	61.97	27	38.03	0.391
Reading the nutrition facts label									
Question 1	26	40.63	38	59.38	29	40.85	42	59.15	0.979
Question 2	7	10.94	57	89.06	1	1.41	70	98.59	0.027*

*statistically significant as P-value <0.05, Chi-square test

4.2.6 Factors related to poor glycemic control in this study

As shown in Table 4-13, there were many factors that related to glycemic control. In this study, the factors that show relationship with glycemic control were income (p-value=0.013), treatment (p-value=0.013), having glucose meter (p-value=0.039) and score of carbohydrate portion knowledge (p-value=0.009).

Table 4-13 Relationship between factors and poor glycemic control

Variable	χ^2	P-value
Gender	1.175	0.278
Age	1.810	0.178
Education level	0.000	0.994
Status	0.289	0.962
People who you live with	3.853	0.426
Occupation	6.333	0.097
Income	10.843	0.013*
Duration of diabetes	7.343	0.062
Secondary disease	1.387	0.846
Treatment	8.675	0.013*
Weight change within 6 months		
Weight gain ≥ 5%	1.259	0.345
Weight loss ≥ 5%	0.257	0.612
Medication change within 6 months		
Increase dose	2.652	0.134
Decrease dose	0.238	0.748
Hypoglycemia	2.526	0.127
Having glucose meter	1.927	0.039*
Frequency of SMBG	13.294	0.165
Exercise >150 min/week	0.000	0.995
Diabetes education from healthcare staffs		
General diabetes	0.101	0.750
Diabetes complication	0.018	0.892
Medication	1.596	0.207
SMBG	0.981	0.322
Exercise	0.059	0.807
Diabetic foot	1.787	0.181
Frequency of diabetes education in 5 years	2.929	0.570
Diabetes knowledge from other sources		
Family members	1.450	0.229
Friends	0.014	0.907
Media	1.485	0.223
Score of carbohydrate portion knowledge	9.479	0.009*
Score of general diabetes knowledge	0.093	0.954

*statistically significant as P-value <0.05, Chi-square test

Table 4-14 was explained relationship between poor glycemic control and selected factors that was determined by chi-square test. It was evaluated strength of association by binary logistical regression. Income of more than 25,000 baht per month (p-value=0.002), oral medication (p-value=0.021), diet control (p-value=0.040) and carbohydrate portion knowledge (p-value=0.001) were shown association with poor glycemic control. Among these participants, the group which earned income more than 25,000 baht per month were shown negative association (OR=0.183). Similarly, diet control and oral medication negatively associated with poor glycemic control (OR=0.097, 0.417 respectively). In addition, those who did more score of carbohydrate portion knowledge was negatively associated with poor glycemic control (OR=0.851).

Table 4-14 Binary Logistical Regression of poor glycemic control and selected factors

Variables	OR	95% CI		P-value
		Lower	Upper	
Income per month				
No income	1			
Less than 15,000 baht	0.512	0.200	1.308	0.162
15,000 – 25,000 baht	0.783	0.317	1.934	0.596
More than 25,000 baht	0.183	0.061	0.548	0.002*
Treatment				
Diet control only	0.097	0.010	0.900	0.040*
Oral medication only	0.417	0.199	0.876	0.021*
Insulin ± oral medication	1			
SMBG				
Do not have glucose meter	1			
Have glucose meter	1.626	0.817	3.235	0.166
CP score[+]	0.851	0.772	0.939	0.001*

[+]CP score: Score of carbohydrate portion knowledge

*statistically significant as P-value <0.05

The variables that p-value less than 0.2 were included in multivariable analysis. According to binary logistic regression, all variables were selected into this analysis. The results showed only carbohydrate portion knowledge was associated with poor glycemic control. Knowledge of carbohydrate portion was shown negative association with poor glycemic control (OR=0.849). Among these participants income, treatment and having glucose meter did not relate to poor glycemic control. (Table 4-15)

Table 4-15 Multivariate analysis

Characteristics	β	OR	95% CI		P-value
			Lower	Upper	
Income per month					
No income		1			
Less than 15,000 baht	-0.524	0.592	0.217	1.615	0.306
15,000 – 25,000 baht	0.460	1.584	0.554	4.531	0.391
More than 25,000 baht	-0.991	0.371	0.107	1.289	0.119
Treatment					
Diet only	-1.867	0.155	0.014	1.655	0.123
Oral medication only	-0.546	0.579	0.245	1.370	0.214
Insulin ± oral medication		1			
Having glucose meter	0.837	2.310	0.981	5.437	0.055
CP score[+]	-0.164	0.849	0.758	0.950	0.004*

[+]CP score: Score of carbohydrate portion knowledge

*statistically significant as P-value <0.05

4.2.7 Factors related to knowledge of carbohydrate portion

As shown in Table 4.16, the demographic characteristics that related to knowledge of carbohydrate portion were age, educational level, occupation and income. The participants who aged less than 60 years statistically had the higher score (p-value=0.004). The older group did 15.53 ± 0.43 points while the younger group earned 17.57 ± 0.49 points. The lower educational level significantly associated with less knowledge of carbohydrate portion (p-value<0.001). The participants with education up to high school graduation scored 14.88 ± 0.48 points whereas the higher education level group scored 17.24 ± 0.44 points. Occupation statistically related to knowledge of carbohydrate portion (p-value=0.002). Government officer or state enterprise employee did the best score (19.20 ± 0.70 points) when compare to other jobs. Business owner, business employee, retiree scored 16.07 ± 0.81, 16.57 ± 1.04, 15.53 ± 0.42 points respectively. Income per month was statistically significant to knowledge of carbohydrate portion (p-value<0.001). The group that received income more than 25,000 baht (19.13 ± 0.66 points) and the group which earned income 15,000 to 25,000 baht scored better in knowledge of carbohydrate portion than the group that did not receive any income (17.50 ± 0.59 points) and the group which earned income less than 15,000 baht (14.52 ± 0.51 points).

As demographic characteristics that were not statistically significant to knowledge of carbohydrate portion were gender, marital status, people whom participants live with (p-value= 0.898, 0.924, 0.305 respectively). The carbohydrate portion score of men was 16.30 ± 0.62 points and score of women was 16.22 ± 0.41 points. As marital status, the participants who were single, married, divorced, widowed scored 15.91 ± 0.65, 16.41 ± 0.43, 16.00 ± 2.04, 15.89 ± 1.05 points respectively. The participants who lived with parents, spouse and children, who lived with spouse and children, who lived with children, who lived with sibling, who lived alone scored 18.44 ± 1.51, 16.52 ± 0.49, 15.36 ± 0.62, 15.83 ± 0.67, 16.00 ± 1.50 points respectively.

Table 4-16 Relationship between demographic characteristics and score of carbohydrate portion knowledge

Characteristics		CP score[3]	P-value
Gender[1]	Male	16.30 ± 0.62	0.898
	Female	16.22 ± 0.41	
Age (years) [1]	Younger than 60 years	17.57 ± 0.49	0.004*
	60 years and older	15.53 ± 0.43	
Education level[1]	Lower than diploma	14.88 ± 0.48	<0.001*
	Diploma and higher	17.24 ± 0.44	
Marital status[2]	Single	15.91 ± 0.65	0.924
	Married	16.41 ± 0.43	
	Divorced	16.00 ± 2.04	
	Widowed	15.89 ± 1.05	
People whom you live with[2]	Living with parents, spouse and children	18.44 ± 1.51	0.305
	Living with spouse and children	16.52 ± 0.49	
	Living with children	15.36 ± 0.62	
	Living with sibling	15.83 ± 0.67	
	Living alone	16.00 ± 1.50	
Occupation[2]	Government officer/State enterprise employee	19.20 ± 0.70[a]	0.002*
	Merchant/Business owner/Freelancer	16.07 ± 0.81[b]	
	Business employee	16.57 ± 1.04[b]	
	Housewife/Retiree/No occupation	15.53 ± 0.42[b]	
Income per month[2]	No income	14.52 ± 0.51[a]	<0.001*
	Less than 15,000 baht	15.24 ± 0.72[a]	
	15,000 to 25,000 baht	17.50 ± 0.59[b]	
	More than 25,000 baht	19.13 ± 0.66 [b]	

*statistically significant as P-value <0.05

[1]Independent t-test, [2]One-way ANOVA with post-hoc Tukey test

[3]CP score: Score of carbohydrate portion knowledge expressed as mean ± SEM

Table 4.17 presented relationship between medical information and score of carbohydrate portion knowledge. The only factor which related to score of carbohydrate portion knowledge was HbA1c (p-value=0.001). The participants with good glycemic control had the better score of carbohydrate portion knowledge (17.44 ± 0.46, 15.17 ± 0.46 points). Diabetes duration was not statistically significant to knowledge of carbohydrate portion (p-value=0.076). The participants who had diabetes less than 1 year, 1 to 5 years, 5 to 10 years, more than 10 years earned score of 18.00 ± 2.00, 15.00 ± 0.74, 17.85 ± 0.78, 15.98 ± 0.42 points respectively. Other underlying diseases did not statistically relate to knowledge of carbohydrate portion (p-value=0.226). The participants who did not have any other underlying disease scored 17.85 ± 1.01 points. The score of the group which had dyslipidemia only, had hypertension and dyslipidemia, had chronic kidney disease stage 3 with hypertension and dyslipidemia, had cardiovascular disease with hypertension and dyslipidemia were 15.23 ± 0.54, 16.24 ± 0.43, 14.89 ± 1.59, 15.29 ± 1.06 points respectively. The participants who controlled blood glucose level by diet control only did the better score than group which used oral medication and group with insulin injection. However there was not significant relationship between treatment and knowledge of carbohydrate portion (p-value=0.380). Weight change within 6 months, medication change within 6 months and hypoglycemia did not also associate with score of carbohydrate portion knowledge (p-value=0.069, 0.105, 0.496 respectively). The participants who had no weight change scored 16.27 ± 0.34 points, who had more than 5% weight gain scored 19.25 ± 2.29 points and who had more than 5% weight loss scored 13.20 ± 1.88 points. The group that received higher medication dose scored 18.33 ± 1.08 points, another group that received lower medication dose scored 17.10 ± 1.04 points and the last group that their medication were not changed scored 15.95 ± 0.37 points. The group who had hypoglycemia events scored 17.11 ± 0.87 points while who did not scored 16.84 ± 0.36 points.

Table 4-17 Relationship between medical information and score of carbohydrate portion knowledge

Characteristics		CP score+	P-value
Diabetes duration[2]	Less than 1 year	18.00 ± 2.00	0.076
	1 to 5 years	15.00 ± 0.74	
	5 to 10 years	17.85 ± 0.78	
	More than 10 years	15.98 ± 0.42	
Other underlying diseases[2]	No	17.85 ± 1.01	0.226
	DLP only	15.23 ± 0.54	
	HTN and DLP	16.24 ± 0.43	
	CKD stage 3 with HTN and DLP	14.89 ± 1.59	
	CVD with HTN and DLP	15.29 ± 1.06	
Treatment[2]	Diet control	18.17 ± 1.25	0.380
	Oral medication only	16.34 ± 0.47	
	Insulin injection	15.86 ± 0.51	
HbA1c (%)[1]	≤ 7.0	17.44 ± 0.46	0.001*
	> 7.0	15.17 ± 0.46	
Weight change within 6 months[2]	No	16.27 ± 0.34	0.069
	Increase ≥ 5%	19.25 ± 2.29	
	Decrease ≥ 5%	13.20 ± 1.88	
Medication change within 6 months[2]	No	15.95 ± 0.37	0.105
	Higher medication dose	18.33 ± 1.08	
	Lower medication dose	17.10 ± 1.04	
Hypoglycemia[1]	No	16.84 ± 0.36	0.496
	Yes	17.11 ± 0.87	

*statistically significant as P-value <0.05

[1]Independent t-test, [2]One-way ANOVA with post-hoc Tukey test

+CP score: Score of carbohydrate portion knowledge expressed as mean ± SEM

DLP: Dyslipidemia HTN: Hypertension CKD: Chronic kidney disease

CVD: Cardiovascular disease

Table 4-18 Relationship between self-management information and score of carbohydrate portion knowledge

Characteristics		CP score[3]	P-value
Self-Monitoring of Blood Glucose[1]	Do not have glucose meter	15.44 ± 0.57	0.042*
	Having glucose meter	16.83 ± 0.41	
Frequency of Self-Monitoring of Blood Glucose[2]	Do not have glucose meter	15.44 ± 0.57	0.178
	Having glucose meter but rarely use	16.69 ± 0.64	
	1-3 times per week	15.82 ± 0.75	
	4-6 times per week	19.17 ± 1.80	
	Once a day	16.20 ± 2.27	
	More than once a day	17.63 ± 1.13	
	Having hypoglycemia event	18.00 ± 0.94	
Exercise more than 150 minutes per week[1]	No	15.96 ± 0.40	0.179
	Yes	16.97 ± 0.65	

*statistically significant as P-value <0.05

[1]Independent t-test, [2]One-way ANOVA with post-hoc Tukey test

[3]CP score: Score of carbohydrate portion knowledge expressed as mean ± SEM

Self-management information in the study consisted of self-monitoring of blood glucose and exercise more than 150 minutes per week. Only factor about having glucose meter associated with knowledge of carbohydrate portion (p-value=0.042) while frequency of self-monitoring of blood glucose did not show relationship (p-value=0.178). The participants who had glucose meter (16.83 ± 0.41 points) scored better in knowledge of carbohydrate portion than who did not (15.44 ± 0.57 points). As frequency of self-monitoring of blood glucose, the group that rarely use glucose meter, used 1-3 times per week, used 4-6 times per week, once a day, more than once a day and having hypoglycemia events scored 16.69 ± 0.64, 15.82 ± 0.75, 19.17 ± 1.80, 16.20 ± 2.27, 17.63 ± 1.13 and 18.00 ± 0.94 points respectively. Moreover score of carbohydrate portion knowledge did not relate to exercise (p-value=0.179). The

participants who exercised more than 150 minutes per week scored 16.97 ± 0.65 points whereas who did not scored 15.96 ± 0.40 points (Table 4-18)

The score of carbohydrate portion knowledge was no significant difference among diabetes education topics including general diabetes (p-value=0.487), diabetes complication (p-value=0.566), diabetes medication (p-value=0.495), self-monitoring of blood glucose (p-value=0.167), exercise (p-value=0.095) and foot care (p-value=0.436). The participants who received diabetes education about general diabetes scored 16.46 ± 0.48 points while who did not scored 15.98 ± 0.48 points. The participants who received diabetes education about diabetes complication scored 16.03 ± 0.47 points while who did not scored 16.42 ± 0.48 points. The participants who received diabetes education about diabetes medication scored 16.46 ± 0.46 points while who did not scored 16.00 ± 0.50 points. The participants who received diabetes education about self-monitoring of blood glucose scored 16.75 ± 0.50 points while who did not scored 15.81 ± 0.46 points. The participants who received diabetes education about exercise scored 17.04 ± 0.67 points while who did not scored 15.84 ± 0.38 points. The participants who received diabetes education about foot care scored 16.08 ± 0.40 points while who did not scored 16.68 ± 0.63 points. Frequency of diabetes education in 5 years ago did not statistically relate to knowledge of carbohydrate portion (p-value=0.534). The group that did not receive any diabetes education scored 15.52 ± 0.84 points while the group that received 1 times, 2-4 times, 5-10 times and more than 10 times scored 16.48 ± 0.60, 15.90 ± 0.61, 16.57 ± 0.92, 17.53 ± 1.03 points respectively. In addition, the other sources of knowledge including family members (p-value=0.430), friends (p-value=0.549) and media (p-value=0.121) did not had difference between the group that received diabetes knowledge from other sources and who did not. The participants who got more information from family members scored 15.60 ± 0.71 points while who did not scored 16.36 ± 0.38 points. The participants who got more information from friends scored 16.64 ± 0.69 points while who did not scored 16.14 ± 0.39 points. The participants who got more information from friends scored 15.42 ± 0.70 points while who did not scored 16.66 ± 0.37 points. (Table 4-19)

Table 4-19 Relationship between diabetes education and score of carbohydrate portion knowledge

Characteristics			CP score[3]	P-value
Diabetes education from healthcare staffs[1]	General diabetes	No	15.98 ± 0.48	0.487
		Yes	16.46 ± 0.48	
	Diabetes complication	No	16.03 ± 0.47	0.566
		Yes	16.42 ± 0.48	
	Diabetes medication	No	16.00 ± 0.50	0.495
		Yes	16.46 ± 0.46	
	Self-Monitoring of Blood Glucose	No	15.81 ± 0.46	0.167
		Yes	16.75 ± 0.50	
	Healthy diet	No	0.00	-
		Yes	16.24 ± 0.34	
	Excercise	No	15.84 ± 0.38	0.095
		Yes	17.04 ± 0.67	
	Foot Care	No	16.68 ± 0.63	0.436
		Yes	16.08 ± 0.40	
Frequency of diabetes education in past 5 years[2]	Did not receive		15.52 ± 0.84	0.534
	1 time		16.48 ± 0.60	
	2-4 times		15.90 ± 0.61	
	5-10 times		16.57 ± 0.92	
	>10 times		17.53 ± 1.03	
Other source of diabetes knowledge[1]	Family	No	16.36 ± 0.38	0.430
		Yes	15.60 ± 0.71	
	Friend	No	16.14 ± 0.39	0.549
		Yes	16.64 ± 0.69	
	Media	No	15.42 ± 0.70	0.121
		Yes	16.66 ± 0.37	

*statistically significant as P-value <0.05

[1]Independent t-test, [2]One-way ANOVA with post-hoc Tukey test

[3]CP score: Score of carbohydrate portion knowledge expressed as mean ± SEM

4.2.8 Factors related to low level of carbohydrate portion knowledge

Participants were divided into 3 groups by score of carbohydrate portion knowledge test (low, moderate, high). The participants whose score lower than the 1st quartile were considered having low level of knowledge whereas group whose score in between 1st and 3rd quartile had moderate level and above 3rd quartile had high level.

As shown in Table 4-20, variables which related to low level of knowledge were age (p-value=0.005), education level (p-value=0.014), occupation (p-value=0.006), income (p-value<0.001) and receiving diabetes information from media (p-value=0.014). The rest of factors did not show association with low level of carbohydrate portion knowledge

As shown in Table 4-21, knowledge of general diabetes related to low level of carbohydrate portion knowledge (p-value<0.001). Mean score of participants in group of low knowledge level was 14.19 ± 0.61 points while the group of moderate and high knowledge level was 16.97 ± 0.28 points.

Table 4-22 was explained relationship between low level of carbohydrate portion knowledge and selected factors that was determined by chi-square test. It was evaluated strength of association by binary logistical regression. All selected factors was shown association with low knowledge level. The participants who aged 60 years and older was 4.758 times more likely to be in group of low knowledge level. The group with diploma or higher education and low knowledge level was shown negative association (OR=0.364). Among these participants, those who earned income was negatively associated with low knowledge level, but did not order by amount of income. The odds of less than 15,000 baht, 15,000 to 25,000 baht and more than 25,000 baht were 0.335, 0.080 and 0.117 respectively. In addition, the participants who received diabetes information from media was also negatively associated with low knowledge level (OR=0.363). The participants with more knowledge of general diabetes less likely to be assessed as low level of carbohydrate portion knowledge (OR=0.758).

Table 4-20 Relationship between demographic characteristics, medical information, self-management information, diabetes education and low level of carbohydrate portion knowledge

Variable	χ^2	P-value
Gender	1.366	0.277
Age	8.513	0.005*
Education level	5.998	0.014*
Status	2.537	0.469
People who you live with	4.871	0.301
Occupation	12.574	0.006*
Income	20.320	<0.001*
Duration of diabetes	1.785	0.618
Secondary disease	2.210	0.188
Treatment	0.620	0.734
HbA1c	2.295	0.130
Weight change within 6 months	4.054	0.132
Medication change within 6 months	5.254	0.072
Hypoglycemia	3.208	0.119
Having glucose meter	1.455	0.228
Frequency of SMBG	6.588	0.361
Exercise >150 min/week	2.874	0.113
Diabetes education from healthcare staffs		
General diabetes	1.529	0.216
Diabetes complication	1.767	0.184
Medication	0.015	0.901
SMBG	0.048	0.827
Exercise	0.021	0.885
Diabetic foot	0.471	0.492
Frequency of diabetes education in 5 years	2.404	0.662
Diabetes knowledge from other sources		
Family members	0.117	0.733
Friends	0.521	0.616
Media	6.051	0.014*

*statistically significant as P-value <0.05, Chi-square test

Table 4-21 Relationship between knowledge of general diabetes and low level of carbohydrate portion knowledge

Characteristics	Mean score of general diabetes knowledge	P-value
Low knowledge level	14.19 ± 0.61	<0.001*
Moderate and high knowledge level	16.97 ± 0.28	

*statistically significant as P-value <0.05, Independent t-test

Table 4-22 Binary Logistical Regression of low level of carbohydrate portion knowledge and selected factors

Characteristics	OR	95% CI		P-value
		Lower	Upper	
Age				
Younger than 60 years	1			
60 years and older	4.758	1.552	14.587	0.006*
Education level				
Lower than diploma	1			
Diploma and higher	0.364	0.159	0.830	0.016*
Income per month				
No income	1			
Less than 15,000 baht	0.335	0.116	0.972	0.044*
15,000 – 25,000 baht	0.080	0.017	0.374	0.001*
More than 25,000 baht	0.117	0.025	0.554	0.007*
Diabetes knowledge from other sources				
Media	0.363	0.159	0.827	0.016*
General diabetes knowledge	0.758	0.658	0.874	<0.001*

*statistically significant as P-value <0.05

The variables that p-value less than 0.2 were included in multivariable analysis. According to binary logistic regression, all variables were selected into this analysis. The results showed knowledge of general diabetes and income were associated with low level of carbohydrate portion knowledge. Both of them expressed negative association in low level of carbohydrate portion knowledge. If participants had less knowledge of general diabetes, they were expected to have low level of carbohydrate portion knowledge (OR=0.764). Similarly, the participants who did not yield any income, more likely to had low level of carbohydrate portion knowledge if they compare with those who earned income 15,000 to 25,000 baht (OR=0.090) and more than 25,000 (OR=0.122). While, the variable about income less than 15,000 baht did not statistically associate with low knowledge level. Age, education level and receiving more diabetes information from media did not statistically related to low level of carbohydrate portion knowledge (Table 4-23)

Table 4-23 Multivariate analysis

Characteristics	β	OR	95% CI		P-value
			Lower	Upper	
Age					
Younger than 60 years		1			
60 years and older	0.643	1.902	0.482	7.502	0.359
Education level					
Lower than diploma		1			
Diploma and higher	-0.265	1.303	0.426	3.988	0.643
Income per month					
No income		1			
Less than 15,000 baht	-1.152	0.316	0.089	1.125	0.075
15,000 – 25,000 baht	-2.411	0.090	0.015	0.528	0.008*
More than 25,000 baht	-2.100	0.122	0.018	0.831	0.032*
Diabetes knowledge from other sources					
Media	-0.591	0.554	0.200	1.533	0.255
General diabetes knowledge	-0.269	0.764	0.647	0.902	0.002*

*statistically significant as P-value <0.05

4.3 Determining food estimation skills and an in-depth interview

The design was a mixed methods to collect qualitative and quantitative data. The sample group was recruited from participants who completed data collection in previous part. The participants were selected by knowledge level of carbohydrate portion and HbA1c. Participants were divided into 3 groups by quartile of carbohydrate portion knowledge score (low < Q1, moderate Q1-Q3, high >Q3) and HbA1c was divided into 2 groups as well control (HbA1c < 7) and poor control (HbA1c ≥ 7). The total of participants was 24. The number of participants for each group was not equal. It depended on data saturation. The participants were 7 men and 17 women. Mean age with SEM was 59.04±10.13 years. (APPENDIX E)

4.3.1 Quantitative data

A) Rice estimation

In this test, participants were asked amount of steamed rice which is proper amount for them and scooped the amount that they answered. Then, they estimated the steamed rice on plate sample and answered in ladle unit. The correct answer was 3 ladles. Among these participants, error of estimation in grams was 15.29 ± 3.36 and in percentage was 23.79 ± 4.99. The most accurate error of estimation was -0.5 grams and if calculate in percentage, it was 0.91. The highest negative error of estimation in grams was -18 while overestimation was 63 grams. As percentage, 107.25 was maximum error of estimation whereas -32.7% was the largest underestimation. Mean score with SEM of steamed rice on plate sample was 3.33 ± 0.25 points. Maximum and minimum were 1 and 5 points respectively (Table 4-24).

Table 4-24 Percentage error and score of rice estimation (n=24)

Characteristics		**Mean ± SEM****	**Min**	**Max**
Scooping steamed rice for a meal	Error of estimation (g)	15.29 ± 3.36	-18	63
	Error of estimation (%)	23.79 ± 4.99	-32.73	107.27
	Most accurate error of estimation : - 0.5 g Most accurate percentage error of estimation : 0.91			
Steamed rice on plate sample	Full score : 5 points	3.33 ± 0.25	1	5

**Negative values converted to positive values for representing size of error

Table 4-25 and Table 4-26 was explained about number and percentage of participants' answer. In test of scooping steamed rice for a meal. The criteria were not more than 20% or less than -20%. Two-third of participants (66.67%) passed the criteria and 8 participants could not. Three of them underestimated (12.50%) and another five of them overestimated (20.83%) what they scooped. As estimation of steamed rice on the plate sample, only 25% of participants answered correctly. The majority of participants replied number of ladle less than correct answer (70.83%) and 1 participant responded number of ladle more than correct answer (4.17%).

As shown in Table 4-27, the half of participants answered 1 ladle for proper amount of one meal and 6 participants selected half of ladle. For the rest of them, 3 people replied 2 ladles and another 3 answered 3 ladles. All participants who selected 3 ladles were in low level of knowledge. No one in high level of knowledge group did not pass error of estimation criteria. Five participants who did not pass had poor glycemic control while another 3 participants had good glycemic control. Moreover, 9 participants answered 2 ladles for steamed rice on plate sample. Three participants answered 2.5 ladles, another 3 participants replied 1.5 ladles, 2 participants answered 1 ladle and the last participants selected 4 ladles. Four in six participants who replied correct answer were in well control group.

Table 4-25 Description of participants' answer for rice estimation (n=24)

Characteristics	**Participants who answer correct answer**		**Participants who answer less than correct answer**		**Participants who answer more than correct answer**	
	n	%	n	n	%	n
Scooping steamed rice for a meal[***]	16	66.67	3	16	66.67	3
Steamed rice on plate sample	6	25.00	17	6	25.00	17

***Percentage error of estimation more than 20% or less than -20%

Table 4-26 Group of participants' answer for rice estimation (n=24)

Characteristics		Answer	Scooping rice for a meal***		Rice on plate sample	
			n	%	n	%
Well control	High knowledge	Correct	3	100.00	2	66.67
		Less than	0	0.00	1	33.33
		More than	0	0.00	0	0.00
	Moderate knowledge	Correct	2	66.67	1	33.33
		Less than	1	33.33	2	66.67
		More than	0	0.00	0	0.00
	Low knowledge	Correct	2	50.00	1	25.00
		Less than	0	0.00	3	75.00
		More than	2	50.00	0	0.00
	Total	Correct	7	70.00	4	40.00
		Less than	1	10.00	6	60.00
		More than	2	20.00	0	0.00
Poor control	High knowledge	Correct	5	83.33	1	16.67
		Less than	1	16.67	5	83.33
		More than	0	0.00	0	0.00
	Moderate knowledge	Correct	1	25.00	0	0.00
		Less than	0	0.00	4	100.00
		More than	3	75.00	0	0.00
	Low knowledge	Correct	2	50.00	1	25.00
		Less than	2	50.00	2	50.00
		More than	0	0.00	1	25.00
	Total	Correct	8	57.14	2	14.29
		Less than	3	21.43	11	78.57
		More than	3	21.43	1	7.14

***Percentage error of estimation more than 20% or less than -20%

Table 4-27 Number of ladle, estimation error and score for scooping rice estimation and steamed rice on plate sample (n=24)

Characteristics		No.	Scooping rice for a meal			Rice on plate sample	
			Number of ladle	Estimation errors		Number of ladle	Score
				Grams	%		
Well control	**High knowledge**	008	1	6	10.91	2.5	4
		030	0.5	-0.5	-1.82	3	5
		005	1	-10	-18.18	3	5
	Moderate knowledge	013	1	-17	-30.91	2	3
		142	0.5	3.5	-1.82	2	3
		095	1	-1	12.73	3	5
	Low knowledge	045	3	6	3.64	3	5
		104	3	31	18.79	1.5	2
		130	0.5	29.5	107.27	2	3
		136	2	63	57.27	1	1
Poor control	**High knowledge**	081	2	1	5.45	3	5
		016	0.5	4.5	14.55	2	3
		001	1	3	-5.45	2	3
		143	1	8	0.91	2	3
		105	0.5	-1.5	16.36	1.5	2
		088	1	-11	-20.00	2	3
	Moderate knowledge	047	1	11	20.00	2	3
		018	1	41	74.55	2	3
		141	0.5	9.5	34.55	2.5	4
		132	2	20	18.18	1.5	2
	Low knowledge	118	1	-18	-32.73	2.5	4
		014	3	53	32.12	1	1
		042	1	-4	-7.27	4	3
		015	1	-14	-25.45	3	5

B) Food estimation

The results of food estimation skill test was presented in Table 4-28 The test was asked participants to comparing 2 food sample and answered which one contains more amount of carbohydrate or equal. The results showed that percentage of score less than 50 in all units. The lowest percentage of score was fruits unit (20.83%) and desserts unit was inferior (20.84%). Percentage of starchy foods unit and beverages unit were 44.45 and 43.06 respectively. Percentage of total score in food estimation skill test seems to see the trend. The group who had high level of knowledge from paper test did more score than lower group. Similarly, the percentage of desserts unit exhibited same pattern of total score.

Table 4-28 Percentage of score in food estimation skill test

Unit	Percentage of score						
	Well control (n=10)			Poor control (n=14)			Total (n=24)
	High	Mid	Low	High	Mid	Low	
Starchy foods	38.89	50.00	29.17	47.22	50.00	50.00	44.45
Fruits	44.44	22.22	8.33	27.78	8.33	16.67	20.83
Desserts	50.00	16.67	12.50	25.00	25.00	0.00	20.84
Beverages	44.44	22.22	8.33	27.78	8.33	16.67	43.06
Total	42.86	40.50	23.21	44.07	32.14	30.36	35.71

As shown in Table 4-29, all participants correctly estimated porridge when compare with steamed rice. 58.33% of participants selected correct answer for boiled sweet potato. steamed glutinous rice, boiled wide rice noodles (Senyai) and boiled corn were 29.17 % of correct. The lowest percentage of correct answer in this unit was boiled glass vermicelli (Woonsen) with 20.83%. The items in fruits unit were tangerine, guava and papaya. Percentages of correct answer were 16.67, 25.00, and 20.83, respectively. There were 2 items in desserts unit, mock fruits (Look Choup) and rice noodles with coconut cream (Lod Chong). Participants correctly answered at 12.50% and 29.17 %, respectively. The last unit was beverages which contained 3 items (Orange juice, Soymilk, Green tea original flavored). Percentages of correct answer were similar. There were 41.67, 41.67, and 45.83, respectively.

Table 4-29 Percentage of correct answer in foods estimation test for each group

	Percentage of correct answer						
Glycemic control	**Well control (n=10)**			**Poor control (n=14)**			**Total**
Knowledge group	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**	**(n=24)**
Starchy foods							
Steamed glutinous rice	66.67	33.33	0.00	16.67	50.00	25.00	29.17
Boiled wide rice noodles (Senyai)	33.33	33.33	0.00	16.67	25.00	75.00	29.17
Boiled glass vermicelli (Woonsen)	0.00	33.33	0.00	50.00	25.00	0.00	20.83
Porridge	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Boiled sweet potato	33.33	66.67	50.00	66.67	50.00	75.00	58.33
Boiled corn	0.00	33.33	25.00	33.33	50.00	25.00	29.17
Total of starchy foods	38.89	50.00	29.17	47.22	50.00	50.00	44.45
Fruits							
Tangerine	33.33	33.33	0.00	16.67	0.00	25.00	16.67
Guava	66.67	0.00	0.00	50.00	25.00	0.00	25.00
Papaya	33.33	33.33	25.00	16.67	0.00	25.00	20.83
Total of fruits	44.44	22.22	8.33	27.78	8.33	16.67	20.83
Desserts							
Mock fruits (Look Choup)	33.33	0.00	25.00	0.00	25.00	0.00	12.50
Rice noodles with coconut cream (Lod Chong)	66.67	33.33	0.00	50.00	25.00	0.00	29.17
Total of desserts	50.00	16.67	12.50	25.00	25.00	0.00	20.84
Beverages							
Orange juice	33.33	33.33	50.00	16.67	0.00	25.00	41.67
Soymilk	66.67	0.00	0.00	50.00	25.00	0.00	41.67
Green tea original flavored	33.33	33.33	25.00	16.67	0.00	25.00	45.83
Total of beverages	44.44	22.22	8.33	27.78	8.33	16.67	43.06

4.3.2 Qualitative data

The interviews were transcribed word by word and the transcripts were read multiple times to find topic domains. The 4 major themes were identified as follow:

I) Misunderstandings surrounding the most appropriate diet for diabetics and sources of carbohydrate
II) Problems with the methods of food estimation
III) External factors contributing to overconsumption
IV) Attitudes leading to malpractice

Thai language verbatim transcription see in APPENDIX F

I) <u>Misunderstandings surrounding the most appropriate diet for diabetics and sources of carbohydrate</u>

From qualitative data of this study, all participants understood that diabetes cannot be cured, but it can be controlled. Most of them knew that diet management is important to control diabetes and that this will be a challenge for their whole life:

> *"…When I was diagnosed with diabetes, I thought it would be cured if I could just stop drinking soda. After attending diabetes education class, I learned that diabetes could not be cured. I need to take care of myself. Diet control is definitely very important in diabetes management. I changed my habit of taking white rice to brown rice. I tried to eat desserts less frequently after meals changing it to fruit. I need to change most food I usually eat. This is not just transient. It is a change for the whole of my life …"*
>
> **Participant No. 008**, Female, High knowledge and Well control

Most participants explained characteristics of diet for people with type 2 diabetes as "low amount of rice and high amount of vegetable". In their opinion, a major food of raising blood glucose level was rice. The sugary food was not mentioned until researcher asked about. They explained that avoiding sugary food is a basic concept of diabetes that everyone should know. Healthy food for diabetes was thought in negative way. They complained about taste and appearance. It was described as "unfamiliar". The participants felt that it is good for health, but it takes away eating happiness:

"…Eat small amount of rice, tasteless food and plenty of vegetables. This is the diet that people with diabetes should eat, but we do not like it. We like tasty foods…"

Participant No. 141, Female, Moderate knowledge and Poor control

"…One ladle of rice and tasteless vegetable side dish. It is not tasty, weird taste and unappetizing…"

Participant No. 005, Male, High knowledge and Well control

Most participants focused on amount of rice. They said that their doctor allow only one or half ladle of rice or stop eating rice if you can. They understood that rice, noodle, taro and potato are the same. All of them could raise their blood glucose level, but fruits were different. Even they knew sugar can raise their blood sugar and fruits contain some sugar. They still thought sugar in fruits is different from table sugar that was made from sugarcane. Special types of sugar included all types of nonwhite sugar such as brown sugar, molasses, coconut sugar, etc. They believed that it is similar to rice. If brown rice is better than white rice, brown sugar should be better than white sugar. This concept was adapted to many kinds of food such as corn, cabbage and dragon fruit:

"…My doctor said that one ladle of rice is adequate. If I do not feel full, I will eat fruit after meals..."

Participant No. 018, Female, Moderate knowledge and Poor control

"…Taro, potato, corn are starch. I should not eat them. Eat rice in small amount and eat fruit instead. Eat fruit instead of rice, especially in dinner. Even it is Thai suki, I do not eat glass vermicelli. It can help to reduce weight. As I do not like vegetable, I try to eat more fruit..."

Participant No. 130, Female, Low knowledge and Well control

"…Do not select white sugar because it is not suitable for people with diabetes. Do not trust sugar from sugarcane. I select sugar from coconut that is not white…"

Participant No. 088, Female, High knowledge and Poor control

Most participants defined carbohydrate as rice and starch (Kao Pang), but some participants misunderstood that animal skin and oil also containing carbohydrate. They pointed out that if a doctor said that this food should be limited, it is a high carbohydrate food. On the other hand, food that doctor advised to eat is misinterpreted as free carbohydrate food. In addition, milk and soybean were misunderstood to contain only protein because they are in protein group of five food groups. The participants justified that meat, milk, egg and bean are protein. It is traditional knowledge of food which learned in elementary school:

"...My doctor warned me that coconut milk, fatty foods, fried foods, should be avoided. If I need to use oil, it should be No cholesterol oil because oil is also carbohydrate..."

Participant No. 130, Female, Low knowledge and Well control

"...Meat, milk, egg, bean, guava and no added sugar soybean milk contain very low carbohydrate. School teach this in subject of health and hygiene, shouldn't it ?..."

Participant No. 042, Female, Low knowledge and Poor control

"...If it is natural milk and no added flour, it contain no carbohydrate..."

Participant No. 013, Male, Moderate knowledge and Well control

All participants knew that non-white rice better than white rice, but around half of them misunderstood that brown rice does not contain carbohydrate or contain a little amount. The rest of them explained that brown rice is digested slower and contains vitamins more than white rice. Similarly, some participants confused that guava contains only fiber and it is no carbohydrate food. When they received information about good fruit for diabetes, they misinterpreted that it can decrease their blood glucose level or help to relieve their diabetes. As medical food for diabetes, they tried to add it after meal or between meals to control blood glucose level. In addition,

participants were selected a product with nutrition claim. They thought that it is good for diabetes, even its claim is not related to diabetes:

"…Brown rice, Riceberry rice, Coarse rice have energy equal to white rice, but slower absorption…"

Participant No. 081, Female, High knowledge and Poor control

"…White rice contains more sugar than brown rice, but brown rice contains more vitamins. If I eat brown rice, I feel full and become muscular…"

Participant No. 030, Female, High knowledge and Well control

"…Brown rice contains less starch and more expensive than white rice. If I eat brown rice, my blood glucose level does not raise…"

Participant No. 042, Female, Low knowledge and Poor control

"…My doctor said that I should eat guava. If I do not feel full, I eat guava instead of rice because my blood sugar level will not become high. I heard that berry, kiwi, avocado is good for diabetes. I try to eat them because I want my blood sugar level decrease. They are hard to find in supermarket…"

Participant No. 132, Female, Moderate knowledge and Poor control

"…I feel refreshed after drink GenDM. I heard that it help to control blood sugar level. After dinner I drink one glass of GenDM everyday…"

Participant No. 105, Male, High knowledge and Poor control

"…I am concerned about buying healthy foods. For milk, I choose low fat and high calcium. I can drink it without increasing blood sugar level. I bought product with high fiber because it help to relieve constipation. I choose only good foods…"

Participant No. 016, Male, High knowledge and Poor control

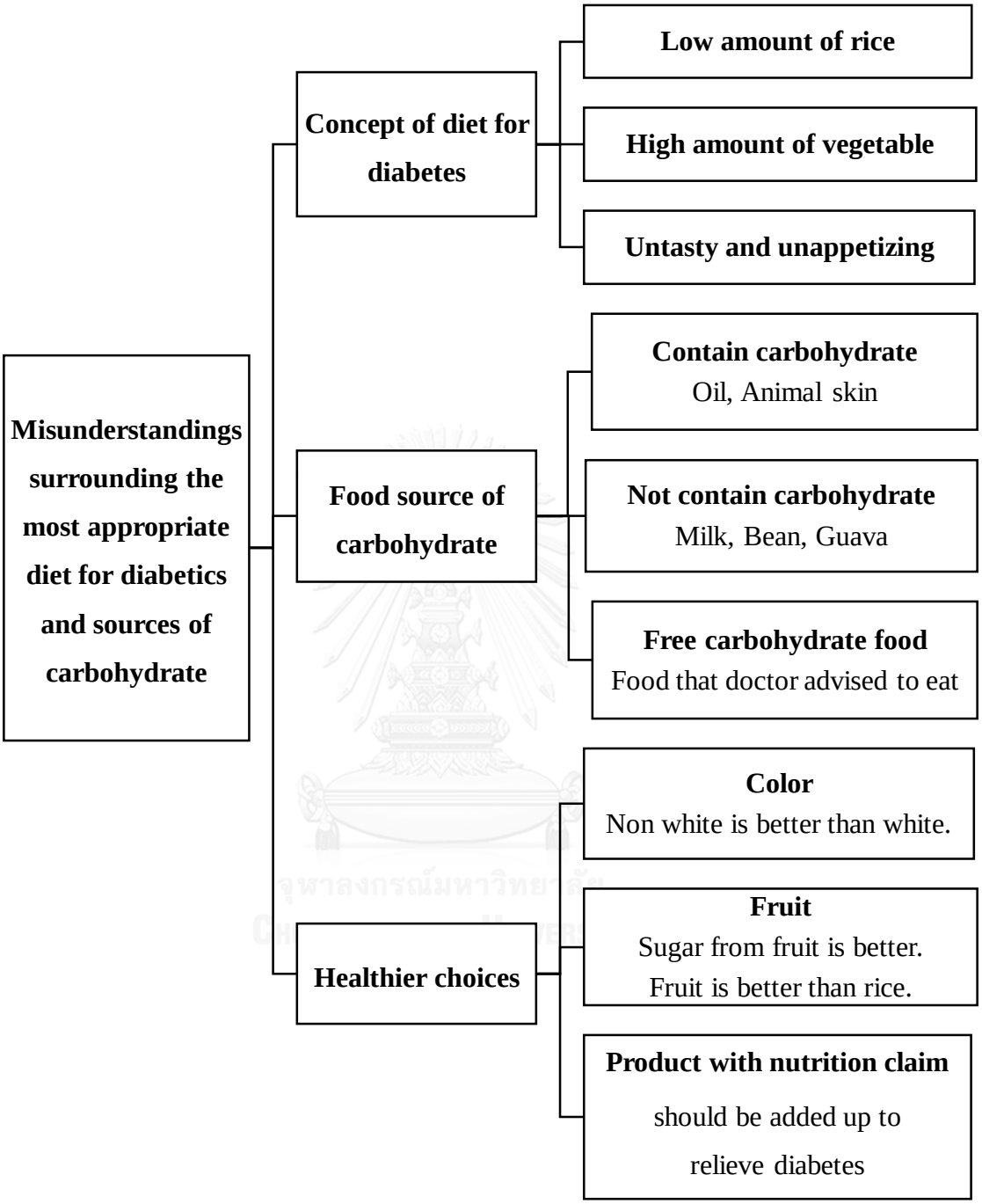

Figure 4-1 Theme analysis of qualitative study: Misunderstandings surrounding the most appropriate diet for diabetics and sources of carbohydrate

II) Problems with the methods of food estimation

Both type and amount of carbohydrate affect to glycemic control. Carb-counting is the most common method to know amount of carbohydrate, but it is needed numeracy skill. The results of this study showed that participants with good glycemic control and high knowledge level use carb-counting to manage their blood glucose level. It helped them to have more flexibility to select menu. It made them less boring their meals:

"...One carb is one slice of whole wheat bread, one apple, one banana, but not Hom variety. If it is Hom variety, one carb is half. I do it every day and it becomes daily life. Two carb for breakfast and three carb for lunch and dinner..."

Participant No. 008, Female, High knowledge and Well control

"...If you use carb counting and set goal, you can eat everything you want, not suffer from eating. Foods look like normal food and make you feel restricted as few as possible..."

Participant No. 030, Female, High knowledge and Well control

Although carb-counting have benefit for people with diabetes, it is not suitable with everyone, especially people with low numeracy skills. Some participants complained about complexity and difficulty. They felt uncomfortable if they have to calculate the number in meal time. In addition, they explained that it is difficult to separate amount of carbohydrate from other nutrients in their plate. The participants confused what ingredients are added in this menu because they did not interest in cooking or had never cooked before:

"...I do not use carb-counting. I set my goal at 1,200 Kcal per day. I eat three meals and limit 400 Kcal per meal. If I eat noodle, I can eat more. If I eat fried noodle with pork, it is over my limit..."

Participant No. 143, Female, High knowledge and Poor control

"...I have never seriously count carbohydrate. I roughly estimate it. For example, this box lunch is too much, I should throw away half of it or if I were home, I will give it to my dog. I do not have time to calculate carbohydrate in my foods..."

Participant No. 142, Female, Moderate knowledge and Well control

"...I received education about food portion, but I do not really pay attention. I think it is too complicated. It is impossible to do it in mealtime..."

Participant No. 104, Male, Low knowledge and Poor control

Although information from nutrition fact labels is useful for food estimation, more than half of participants did not read it properly. They focused on expire date and food weight to buy the best one. Some of them read ingredient lists to check amount of sugar. If it has nutrition claim on the front of label, the participants will ignore ingredient lists and nutrition facts behind the package. Even 8 participants read nutrition facts label, only 2 participants concerned about serving size. The rest of them understood that the number which show on nutrition facts label is for whole package. The most common problem of reading nutrition facts label was too small font size. The elderly participants needed to ask for assistance in reading or used magnifying glass or take a photo by mobile phone and magnify in application:

"...I read expired date, weight to compare with price and amount of sugar..."

Participant No. 014, Male, Low knowledge and Poor control

"...It is very hard to read because letters are very small. I have to take a photo by my mobile phone and enlarge image to see it clearly. It is too difficult and make me do not want to read..."

Participant No. 130, Female, Low knowledge and Well control

Food model is a common tool for teaching portion size. Although most participants agreed that food model represent the portion size of real food better than photo, it is still difficult to remember numerous food items in around 1 hour of nutrition consulting. Thus participants categorized foods according to their experience. Some participants point out that they remember portion size from hospital foods during admission:

"...I choose low calorie vegetable and use food exchange to calculate. I remember it from food models..."

Participant No. 142, Female, Moderate knowledge and Well control

"...I try to eat in same amount of hospital foods when I was admitted in hospital. I remember amount of rice for each meal. In fact my amount of foods less than hospital foods that I remember..."

Participant No. 016, Male, High knowledge and Poor control

A glucose meter was a useful tool to check their blood glucose level after eating. If number of blood glucose is high, participants will label this food is not good for diabetes. As participants who did not have glucose meter or rarely use it, they learned from the result that their doctors told them. When their doctors tell them that blood test results is not good and ask about the food they eat, the food that participants answered will be labeled as bad for diabetes. On the other hand, if participants eat the foods with high sugar, but their blood glucose is still in targeted range. They will think this food may be bad for other, but for me it does not raise my blood glucose level:

"...I cannot remember theory. I know that it is about comparing two foods, but I cannot remember detail. I estimate foods from self-monitoring blood glucose..."

Participant No. 013, Male, Moderate knowledge and Well control

"...I eat durian, but it do not raise my blood glucose and reduce my HbA1c. It may be bad for other, but good for me..."

Participant No. 042, Female, Low knowledge and Poor control

"…I estimate foods from my experience and I test it by myself. For example, I eat two ladle of this and after I checked my blood glucose level, it is high. In next meal, I eat job's tears and my blood glucose level is in normal range. It showed that it can adjust temperature in my body. As taro and potato are bad because if I eat more than 3 bites, my blood glucose level will be raised…"

Participant No. 015, Female, Low knowledge and Poor control

"When I ate 5 pieces of sweet potato paste mixed with sugar, my doctor did not complain anything. I think I can eat it because it is not too sweet…"

Participant No. 132, Female, Moderate knowledge and Poor control

Taste and texture were criteria for selecting healthy food choice, especially if participants do not have glucose meter. The participants understood that if they eat sweet foods, they will have poor glycemic control. If it is very sweet, it should be eaten in a little amount while if it is not too sweet, it can be eaten more. Similarly, soft, sticky and juicy foods were categorized as high carbohydrate foods and tough, dry and crispy foods were categorized as low carbohydrate foods. So, participants said that level of ripeness in fruits influence amount of fruit they decide to eat because taste and texture of fruits are different at each stage of ripeness:

"…Amount of fruits that I eat depend on how sweet of them. I tasted it before I make a decision…"

Participant No. 047, Male, Moderate knowledge and Poor control

"…You will know after taste it. If it contains a lot of sugar, it tastes sweet. If it contains high sodium, it tastes salty. If it is too sweet, I will not buy it next time…"

Participant No. 045, Female, Low knowledge and Well control

"...Just taste it and you will know. When I see the doctor, he always ask me that is it sweet? If it tastes sweet, I eat only one or two bites. If it is not sweet, I will eat more..."

Participant No. 119, Female, Low knowledge and Poor control

"...Guava should not be eaten more than three pieces. If I eat over than that, my blood sugar will be moved up. The ripe one should not be eaten, eat only the unripe one..."

Participant No. 015, Female, Low knowledge and Poor control

"...As fruits should not be too sweet and ripe. The good fruits should be unripe and taste sour. It is hard to chew but healthy. For example, soft and ripe guava is not good. You have to buy the one which was tough and unripe..."

Participant No. 141, Female, Moderate knowledge and Poor control

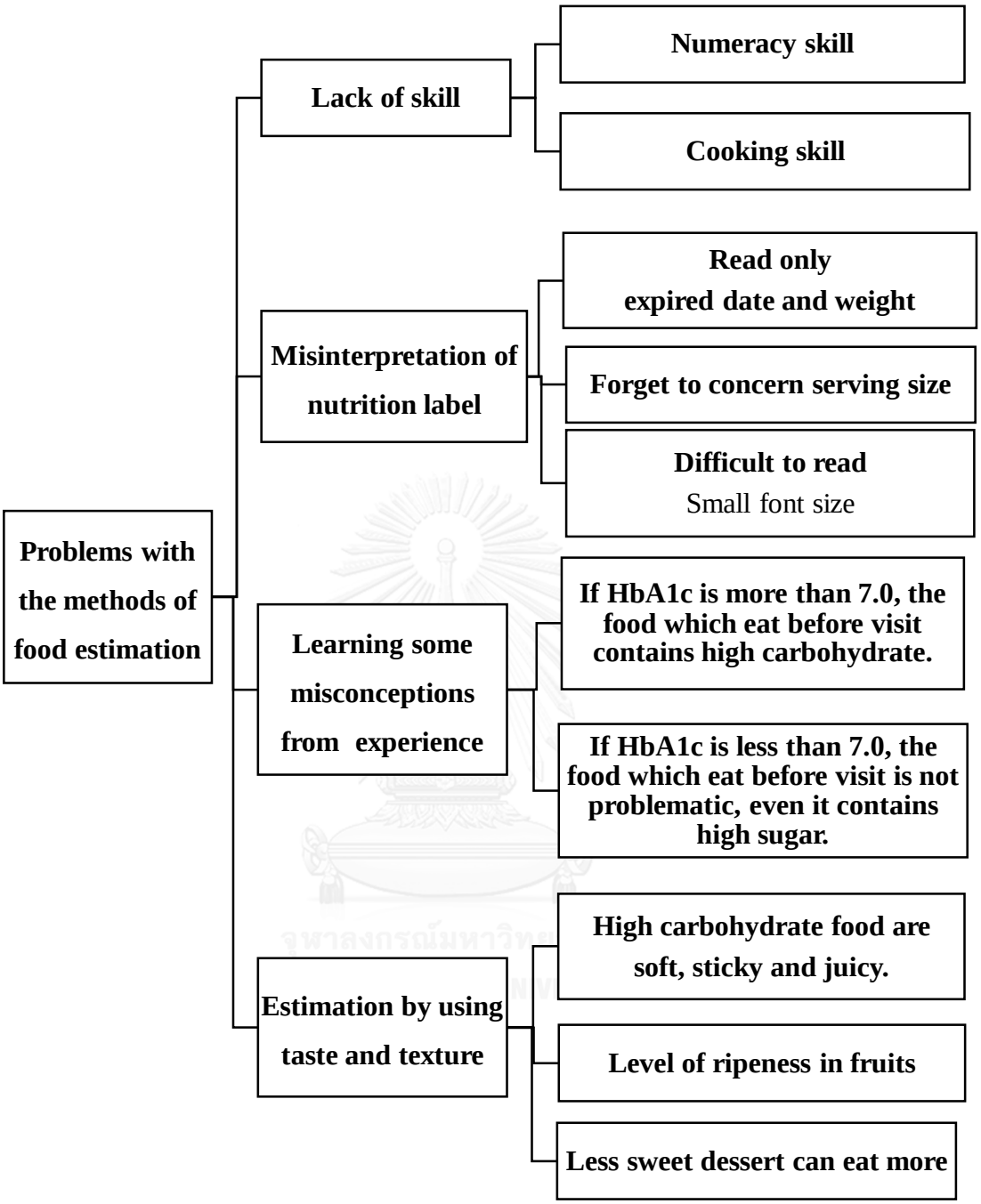

Figure 4-2 Theme analysis of qualitative study: Problems with the methods of food estimation

III) External factors contributing to overconsumption

All participants in this qualitative study agreed that family members and friends influence to their diet. Their children or friends often buy their favorite desserts or snacks and they cannot resist temptation. On the other hand, if participants eat the desserts less than usual, their family members or friends who bought snacks will encourage them to eat more and they may feel neglected if participants still refuse to eat more. In addition, it was very had to stay healthy when eating out with their friends or family because a buffet restaurant is mostly selected. However, there were family members and friends who help to manage it better. It depended on how much they understand diabetes:

"...My daughter always buy some desserts for me. I told her that if you buy some desserts, I cannot stop myself from eating it, especially sticky rice with black beans..."

Participant No. 136, Female, Low knowledge and Well control

"...Buy, buy, buy again and again. I knew she love me, but she does not care about my blood glucose level. If I do not eat snacks which she bought, she will be angry with me. She said that small amount of snack cannot harm you and you should go back to manage blood sugar level tomorrow..."

Participant No. 018, Female, Moderate knowledge and Poor control

"...My son bought bakery from department store. I eat it because it is so expensive..."

Participant No. 005, Male, High knowledge and Well control

"...My goal is eating at buffet once a week, but I failed to reach my goal when my friends ask me to go out..."

Participant No. 095, Female, Moderate knowledge and Well control

"...If I stay in my room and do not meet anybody, I do not want to eat anything. When I go out and meet my friends, I go out to eat..."

Participant No. 105, Male, High knowledge and Poor control

"...I want to eat dried rice balls sweetened with sirup. I know it contains a lot of sugar. My friend share it with me, but not in half, just quarter or an eighth. She said that please do not swallow, just hold it in your mouth and spit it out. A little sugar can be absorbed..."

Participant No. 118, Female, Low knowledge and Poor control

"...My colleagues said that you cannot eat this. What do you eat today? Did you have lunch? If I pick up some desserts, they will ask me that how many pieces of them that you ate?..."

Participant No. 136, Female, Low knowledge and Well control

Some participants who still work complained about amount of rice that their doctor suggested. They explained that if they eat only 1 ladle of rice, they do not have enough energy to do their jobs. In addition, one participants could not refuse to work overtime and it made her increase number of her meals. Three participants pointed out that frequency of eating dessert increase according to frequency of meeting in their works. A cup of coffee and a piece of cake or pastry were served, especially in long meeting. One participant is a taxi-driver. He had a problem with eating at the same time and had hypoglycemia events. He always keep candies in his car to prevent hypoglycemia:

"...I am hard worker. I have to eat a lot because I need energy or if I eat something sweet, I will not feel tried and can do my job well..."

Participant No. 105, Male, High knowledge and Poor control

"...I have to work overtime and I feel hungry. I may not eat two meals, but eat four meals. It is impossible to control my weight..."

Participant No. 047, Male, Moderate knowledge and Poor control

"...It always has some snacks at the meeting. If it is a long meeting, I will be hungry and I eat snack with coffee. After that my blood glucose level will be risen up..."

Participant No. 142, Female, Moderate knowledge and Well control

"...My doctor said that you should have meal at the same time. I try to do it, but sometime I have passengers. If I feel dizzy, I will eat my candy. I try to follow the doctor's suggestion. I know I should take care of myself..."

Participant No. 104, Male, Low knowledge and Well control

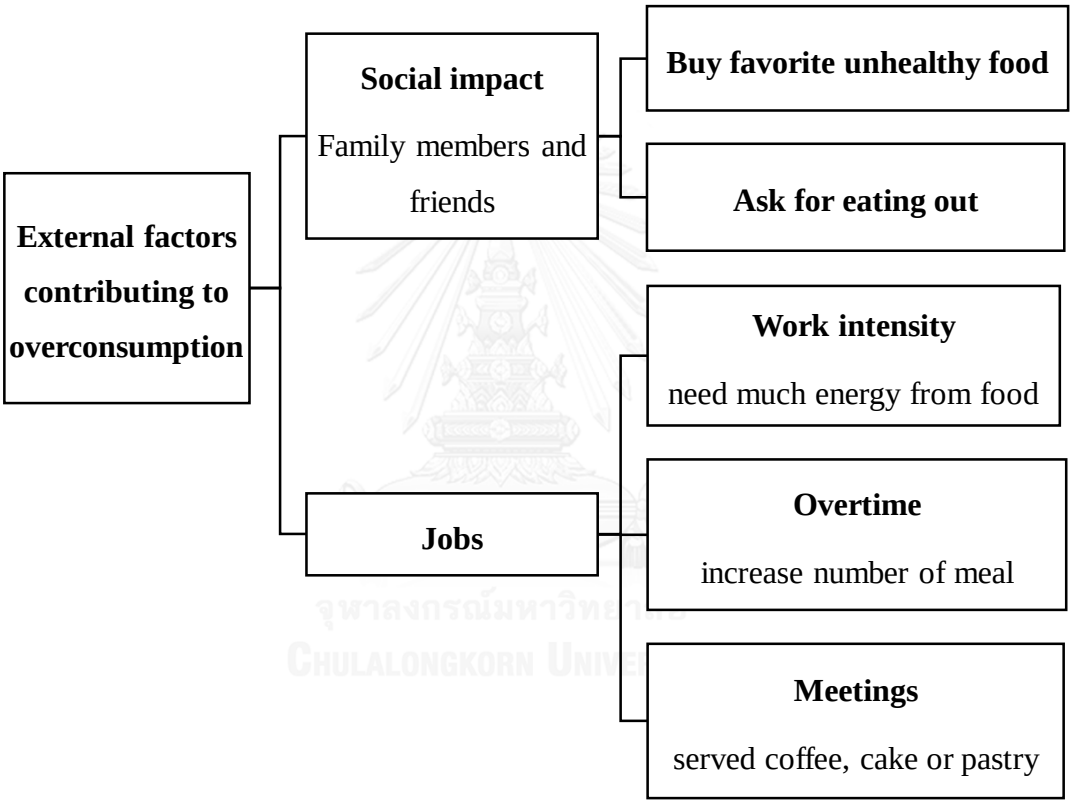

Figure 4-3 Theme analysis of qualitative study: External factors contributing to overconsumption

IV) Attitudes leading to malpractice

Nutrition knowledge is important to control blood glucose level, but some participant with high knowledge level still had poor glycemic control. Some participants blamed their genes and insisted that they selected good food choices and proper portion size. Among participants in this qualitative study, 2 of 14 participants with HbA1c level of more than 7.0 were unsatisfied with their current glycemic control. The rest of them did not focus on HbA1c. They relied on before breakfast SMBG. Each participant had their own criteria. The range of their SMBG criteria was 100 to 200 mg/dl. Most people with poor glycemic control point out that HbA1c of less than 7.0 is very strict criteria for elderly. They had nocturnal hypoglycemia if their HbA1c was controlled. One participant told that he did not pay attention how high his blood glucose level if he can work normally. Moreover, participants with high education or high income mostly thought that they have high knowledge about diabetes. Some of them were in high knowledge group, but some were not. They tried to say that I knew all about diabetes because they have been with it for more than 10 years. In fact, their misconception were not fixed and it might cause of poor glycemic control. They never paid attention in diabetes education because they presumed that nothing they do not know:

"…I rarely eat dessert. I wonder why I became diabetic. I think it come from genes and cannot be controlled…"

Participant No. 141, Female, Moderate knowledge and Poor control

"…It is because of my genes. I choose only good foods, not sweet foods, but my blood sugar level is still high. It did not relate with my diet because other eat more than me but their sugar level still is not high. People Metabolism is different for each person…"

Participant No. 016, Male, High knowledge and Poor control

"…My sugar level from glucose meter that I checked before breakfast is not more than one hundred. It means very good. If it is less than one hundred and twenty, it means fair. I am satisfied with this…"

Participant No. 018, Female, Moderate knowledge and Poor control

"...In fact the doctor said that sugar level should be one hundred, but I think not more than one hundred and forty is fair. For me, I am satisfied..."

Participant No. 015, Female, Low knowledge and Poor control

"...My sugar level is around one hundred forty to one hundred fifty. I am satisfied with this, but it should be not more than two hundred..."

Participant No. 001, Female, High knowledge and Poor control

"...I am satisfied because I am fine, healthy, have no symptoms. My doctor complained about some blood tests, but I do not care if I can work normally..."

Participant No. 014, Male, Low knowledge and Poor control

"...You should not choose me for interview because I know everything. You have to choose someone who know nothing. I learn about diabetes many times. Whatever you ask I can answer it..."

Participant No. 042, Female, Low knowledge and Poor control

"...I am so bored when I have to go to the room for diabetes education. It wasted my time because I heard about this lesson more than 10 times. It is extremely boring. If I stay silent, it will be ended faster..."

Participant No. 104, Male, Low knowledge and Poor control

Some participants explained that they do not believe nutrition facts label. They did not rely on standard of nutrition facts label because the taste is not like they expected. It was too sweet to be sugar free product. Participants pointed out that all nutrition facts label on product show only good point. It is only advertisement that is waste time to read.

"...Can I trust the nutrition facts label? I have never found a product with high amount of sugar..."

Participant No. 095, Female, Moderate knowledge and Well control

"…It is an advertisement. Some of them presented low sugar, but it tastes very sweet. Some of them contains high fat. Even it is labeled 0% sugar, it still tastes sweet…"

Participant No. 136, Female, Low knowledge and Well control

"….The numbers look a lot different, but the products look similar. Are they in the same standard if they comes from China, Japan, Korea? Are they in the same standard between Samut Sakhon and Bangkok?…"

Participant No. 081, Female, High knowledge and Poor control

One more factors that participants of qualitative study mentioned was serving size. They feel shame if they leave food on their plate. In their opinion, wasting food is guilty, but it is almost impossible to buy smaller serving size. The average size is bigger than they need. Some participants tried to solve this problem by dividing food into 2 or 3 meals, but this solution need refrigerator. The other way was giving leftover to a dog. Moreover, if their family members buy some food and cannot finish it all, they will help, especially the food is expensive:

"…A doctor told that eating one ladle of rice, but no one sell rice in one ladle. I have to eat it all, I cannot leave it. My parents taught me that my family are farmer and growing rice is hard work…"

Participant No. 104, Male, Low knowledge and Well control

"…When I go to buy my food, I told them that I want small amount of rice, but they still give me normal portion size. I have to eat it all. I heard that someone divide it for more meals, but I cannot because I do not have refrigerator. If I keep it, it will become spoiled..."

Participant No. 143, Female, High knowledge and Poor control

"…I divide my foods which I bought into two meals and keep half of it in my refrigerator…"

Participant No. 130, Female, Low knowledge and Well control

"...One package of rice is very big. I can share it for three meals and the smallest amount is in my dinner or I give some to my dog..."

Participant No. 030, Female, High knowledge and Well control

"...When I received some food a lot, I keep it only I can eat. The rest of them will become my dog's food..."

Participant No. 001, Female, High knowledge and Poor control

"...I bought sticky rice with ripe mango for my father. It is very expensive, but my father eat only two or three spoons of it and leave around half of kilogram. Then, I eat it all..."

Participant No. 132, Female, Moderate knowledge and Poor control

"...It cost one hundred something for one piece and it was eaten only a few bite. I ate it instead of wasting it...."

Participant No. 045, Female, Low knowledge and Well control

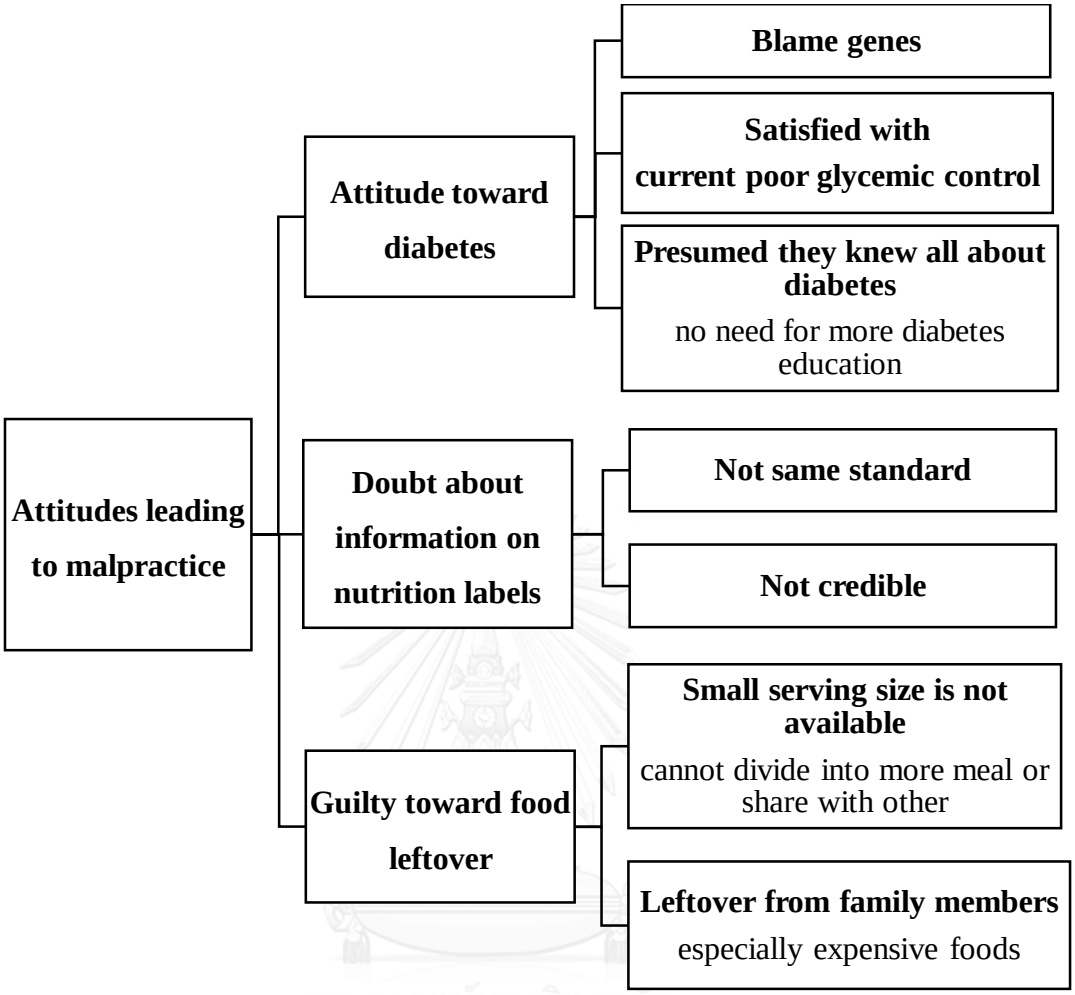

Figure 4-4 Theme analysis of qualitative study: Attitudes leading to malpractice

CHAPTER 5
DISCUSSION

This research was designed as a cross-sectional mixed methods study. This study aimed to evaluate understanding of carbohydrate portion in adults with type 2 diabetes including determine relationship between carbohydrate portion knowledge and variables (socio-demographic characteristics, medical history, self-management information, general diabetes knowledge and glycemic control). The test which was used to evaluate carbohydrate portion knowledge was developed in the first part of the study. It contained 29 items and its reliability coefficient was 0.827. In second part of this study, 135 participants with type 2 diabetes were recruited. All data collection forms including knowledge test were filled by the researcher from asking participants. After the second part was finished, 24 participants who were selected by HbA1c and knowledge level attended food estimation skill test and were interviewed their opinions.

5.1 Score of general diabetes knowledge and carbohydrate portion knowledge

The mean score of general diabetes knowledge test in this study was 16.32 points, maximum was 21 points and minimum was 3 points. The number was similar to previous study which used the same test to determine knowledge in 241 outpatients at King Chulalongkorn Memorial Hospital. It showed mean score was 14.37 points, maximum was 21 points and minimum was 5 points[67]. As carbohydrate portion knowledge test, mean score was 16.24 points, maximum was 25 points and minimum was 4 points. Percentage of mean score was used to compare the scores from 2 tests because full scores were not equal for each test. So, the participants did better scores on the general diabetes knowledge test (77.71%) than the carbohydrate portion knowledge test (56.00%). For each unit of carbohydrate portion knowledge test, there were 2 units (reading the nutrition facts label and amount of carbohydrate in foods) which mean score of participants were less than half of full score. Both units need basic calculation skills. Deficit in understanding nutrition labels was indicated by previous study. Literacy and numerical skills were highly correlated with correct interpretation, even people with average literacy might have difficulty of calculating carbohydrate from nutrition facts label[68].

As correlation, score from general diabetes knowledge test significantly correlated with score from carbohydrate portion knowledge test including both sections in this test. The correlation between scores from 2 tests was not strong (R=0.351, p-value <0.001). However, correlation coefficient between diabetes knowledge score and health literacy score was also weak correlation (R=0.446, p-value = <0.001)[6]. While, relationship between health literacy and diabetes knowledge was demonstrated in many studies [69-71].

5.2 Misunderstanding about carbohydrate and diabetes

From quantitative and qualitative data in this study, people with type 2 diabetes have 7 misconceptions about carbohydrate and diabetes as follows:

(1) People with type 2 diabetes should eat carbohydrate foods as few as they can.

As carbohydrate portion knowledge test, 9.63% of participants responded correctly on question 1 in the section of general knowledge of diabetes diet and 88.15% of participants misunderstood that they should eat amount of carbohydrate as few as possible. Similarly, qualitative data from interview showed that characteristics of diet for people with type 2 diabetes were low amount of rice and high amount of vegetable. In addition, the question 1 was related to glycemic control (p-value=0.038). According to the results of food estimation test, 6 people answered that amount of rice for each meal should be a half of ladle. Half of 24 participants in the third part of the study replied 1 ladle. Two ladles was answered by 3 people and 3 ladles was responded by the last 3 people. It demonstrated that most participants understood that they should eat small amount of rice. The findings are consistent with previous study. Youth with diabetes defined that healthy eating is eating low-carbohydrate foods [72].

In fact, the American Diabetes Association's (ADA) standards of medical care in diabetes 2017 do not indicate proper amount of carbohydrate for people with diabetes including ideal caloric distribution. It depends on each individual, but there are suggestions about good sources of carbohydrate that help to promote higher fiber and lower glycemic load[5]. Carbohydrate restriction is usually selected as the first dietary treatment. The strong point of this strategy is apparent impact on lowering postprandial blood glucose level including HbA1c. It is easier to achieve glycemic control more than weight reduction[73]. Moreover, the major nutrient which contribute excessive energy intake is carbohydrate. Percentage of energy from carbohydrate increase when obese

people increase their total energy intake[74]. Previous studies presented that low carbohydrate diet helps people with diabetes improve weight loss, however, it should not be used longer than 6 months. Systematic review of low carbohydrate diet indicated that there were insufficient evidences to see benefit of low carbohydrate diet for glycemic control. It may have some benefits, but it is not recommended for people aged more than 50 years, using longer than 90 days and limiting amount of carbohydrate less than 20 grams[75].

(2) Some fruits do not contain carbohydrate.

Question 4 of the section of general knowledge of diabetes diet was "Natural sugar in fruits is not dangerous and no need to limit natural sugar intake". More than 70% of response (74.07%) of this question were correct, but correct response about fruits in the section of carbohydrate portion control were less than 50%. However, most participants (72.59%) misunderstood that guava does not have carbohydrate and 60.00 % of participants replied that watermelon has no carbohydrate. Both items did not show relationship with glycemic control (p-value=0.962, 0.259 respectively). As the results of food estimation test, unit of fruits was 20.83% of correct response and the item which compared between 2 serving of guava and 1 serving of banana, Namwa variety was 25% correct response. 83.33% of correct response came from participants with high knowledge level. Data from qualitative interview reported that participants with low knowledge level misunderstood that guava is fiber and does not contain carbohydrate. Some participants explained that doctors suggested them to eat guava and they received information about benefit of guava from media such as television, facebook and line. It promoted guava as the best fruit for people with diabetes. They interpreted that guava is safe to eat and does not increase blood glucose level. In addition, participants presumed that if they do not feel full after meal, they can eat unlimited guava to fill up their stomach and still keep blood glucose level in control. As misconception about low amount of carbohydrate, participants tried to decrease amount of rice for a meal and ate higher amount of fruits instead. Participants described that taste and texture are used to decide including level of ripeness. In their opinion, an unripe, tough and tasteless guava is in the best stage with no sugar. So, the participants misinterpreted that an unripe guava does not contain starch or carbohydrate.

Diabetes management guidelines usually recommend about high intake of fruits and vegetables for each meal. High fiber intake helps to manage type 2 diabetes. Fruits contain fiber, vitamins, minerals and antioxidants, but they also contain sugar. Fresh fruits are better choices for sweet than sugary desserts, but need to concern about carbohydrate in them[5]. However, the results of previous study in Chinese women indicated that high vegetable consumption associated with lowering risk of diabetes while, fruit consumption did not[76]. In addition, fruit and fruit juice were misunderstood that they do not affect blood glucose level [12, 77].

(3) Cow milk contains no carbohydrate because it is in the protein group.

Participants' answers about cow milk were controversial. In unit of types of foods that contain carbohydrate, 36.30% of participants correctly replied that cow milk is a source of carbohydrate, while this items did not related to glycemic control (p-value=0.536). On the other hand, unit of sugar-sweetened beverages contained 2 items about cow milk (whole milk and skim milk). One Third of participants (33.33%) misunderstood that whole milk is a sugar-sweetened beverage, while their responds in the previous question were "cow milk does not contain carbohydrate". Researchers asked definition of carbohydrate to participants again and confirm that participants did not misunderstand meaning of carbohydrate. Participants explained that whole milk is different from skim milk because whole milk is added flour and sugar in process. Similarly, data from participants' interview supported this misconception. Participants pointed out that natural milk with no added flour does not contain carbohydrate. In their opinions, milk is in the protein food group, not carbohydrate food group in 5 food groups which learnt in an elementary school. High protein food and food with low carbohydrate were mentioned together as being good for diabetes[72]. It may be easy to misunderstand that high protein food also low in carbohydrate.

(4) Glass vermicelli (Woonsen) contains nearly no carbohydrate.

Almost half of responses (48.89%) for question 9 in unit of types of foods that contain carbohydrate were "No". Almost half of participants misunderstood that glass vermicelli does not contain carbohydrate. Participants knew glass vermicelli as the best food choice for diabetes. The food that is recommended for people with diabetes is easy to misunderstand as no carbohydrate food likewise fruits. Question 3 in unit of amount of carbohydrate in foods had 12.59% correct answer. Most participants (87.41 %)

answered 1 ladle of steamed rice contains amount of carbohydrate more than 1 ladle of glass vermicelli. As relationship between above mentioned questions and glycemic control, it was presented in question 3 of the amount of carbohydrate in foods unit (p-value=0.041), while was not in question 9 of types of foods that contain carbohydrate unit (p-value=0.264). Around seventy percent of participants (70.58%) who selected correct answer in question 3 had good glycemic control. In the same way, percentage of correct answer in food estimation test was 20.83%. Participants explained that glass vermicelli contains carbohydrate, but in very low amount. They thought that this is a reason why doctors recommended glass vermicelli for a meal. Moreover, glass vermicelli made from mung bean and mung bean is in the protein food groups likewise milk. However, participants described that it is difficult to eat glass vermicelli instead of rice.

(5) Fried food and animal fat contain carbohydrate.

Around forty percent of participants (42.22%) answered that soybean oil is a source of carbohydrate, even this item is not significantly related to glycemic control (p-value=0.257). This misconception was also found in previous study. It reported that 50% of participants answered baked potato had lower carbohydrate when compare with Swiss cheese and peanut butter[77]. Overestimation of carbohydrate content in high caloric foods such as fried foods was found in the study about accuracy of estimation in Japan. Patient without carb-counting experience confused between calorie and carbohydrate content[78]. Qualitative data may help to explain this result. Participants pointed out that what doctor said not to eat is a high carbohydrate food. Coconut oil, fried food and animal fat were foods that doctor advised participants to avoid. In this study, 85.19% of participants had dyslipidemia and the percentage of participants with dyslipidemia in this qualitative study was similar (83.33%). It is possible that the doctor aim to manage dyslipidemia or control weight. However, people with type 2 diabetes explained their emotion about comorbidity management as confused, discouraged and upset with many treatments and advice. It showed that difficulties to solve conflicting in dietary advice[79].

(6) Product with nutrition claim is healthy and contains low sugar.

As unit of sugar-sweetened beverages, 45.19% of participants misunderstood that low fat drinking yogurt is not sugar-sweetened beverages and 58.52% of

participants thought that vegetarian soymilk is not sugar-sweetened beverages. Both of items did not related to glycemic control (p-value=0.279, 0.550, respectively). In the same way, qualitative data indicated that participants is interested in health claim on the front of package more than the amount of carbohydrate in nutrition labels. They presumed that it is healthy for them, even health claim is not related to diabetes. One participant with high knowledge and poor control told that he drinks medical food for diabetes every day after dinner. He misunderstood that if add up this product after meal, it will help to control blood glucose level. Elderly with health problems and low income was type of consumer who interested in products with health claims[80]. Participants possibly tried to selected products which help to improve their health problem, but they do not clearly understand about nutrition claims. The findings are consistent with the study of Labiner-Wolfe et al (2010). Consumers read only health claims in front of a package to indicate product benefits, even it has nutrition facts label[81].

(7) Tough textured and non-white foods is good for diabetes, in the same way brown rice is better than white rice.

Less than twenty percent of participants (14.81%) answered that amount of carbohydrate in white rice and brown rice are similar at the same portion size. This items did not show relationship with glycemic control (p-value=0.815). From qualitative interview, one of participants' criteria for healthy food was color. Participants misunderstood that non-white food is always healthier than white food. For example, they presumed that brown sugar, coconut sugar and honey are healthier than white sugar. Participants explained that process of non-white sugar and white sugar are different. Then, they thought that non-white sugar has less effect on blood sugar level. Next of participants' criteria for healthy food were taste and texture. It was demonstrated in question 2 of the same unit. Almost eighty percent of participants (77.78%) correctly respond that 1 ladle of glutinous rice contains carbohydrate more than 1 ladle of white rice. It may be easy to remember because of rice texture. Participants described that tasteless, tough, and crunchy are characteristics of low carbohydrate food. On the other hand, participants defined characteristics of high carbohydrate food as sweet, sticky and soft. So, any kind of rice which texture is harder than white rice, might be indicated that it contains lower amount of carbohydrate than white rice.

5.3 Food estimation

As scooping steamed rice in food estimation test, mean error of estimation was 15.29 ± 3.36 grams and mean of percentage error was 23.79 ± 4.99. The next one was steamed rice on plate sample with 5 points of full score. Mean score was 3.33 ± 0.25 points or 66.6%. Number of participants with error of scooped rice less than 20% were 17 (70.83%) and number of participants with accurate amount of rice on plate were 6 (25%). Rice is amorphous shaped food and its shape depends on container. Foods with amorphous shape are harder to estimate than geometric shape[82]. This results showed that scooping rice by themselves was more precise than estimating rice on plate. It may be easier to use tool for measuring, even it is not a standard household measurement. People with type 2 diabetes may underestimate the amount of rice and consume more carbohydrate than their meal plan. It could be cause of poor glycemic control. The results of this study showed that 70% of participants in well glycemic control group could scoop rice with less than 20% error, while percentage of participant in poor glycemic control group was 57.14. Similarly, 40% of participants with the well control responded correct answer, while the poor control group was 14.29%. In addition, 8 participants who scooped rice with error more than 20%, 5 participants (62.5%) scooped rice more than reference weight, while 17 of 18 participants estimated rice on plate less than correct answer. Study of Huizinga et al. (2009) also aimed to evaluate accuracy of portion size estimation, but in a primary care patients. The items were 3 solid food and 1 beverage. The participants were asked to estimate serving size that they eat and specified amount of food. The results showed that 65% of participants can estimate accurate single serving and 62% can accurately estimate specific amount. After multivariate analyses, inaccuracy of estimation skill was related to less than 9th grade education (OR 2.54)[83].

It is interesting to find that the participant who did maximum error was in the low knowledge level and well control group. Maximum of percentage error was 107.27 or double size of correct portion. Maximum error in grams was 63 grams and the error weight was more than 1 serving of rice in Thai food exchange list. Both participants explained in interview that they do not understand carbohydrate counting or food estimation, but they know exactly proper amount of rice for their meal. It is possible that they can control blood glucose level in the normal range because they eat in the

same amount almost every meal. They precisely estimate only one portion size, even they do not know amount of carbohydrate in it.

Normally, Thai cuisine consists of at least 2 side dishes with rice in plates. Rice is the most common ingredient in Thai foods and Thai people used to eat rice every day[84]. We cannot deny that rice is the greatest impact on diet therapy. It is challenge to find the way to cutting down amount of rice while amount of carbohydrate in other foods do not increase.

Moreover, participants who did high score in paper test, seem to estimate food better than who did lower score. Fruits and desserts units were low percentages of correct answer. There were 20.83%, 20.84%, respectively. In both units, only the high knowledge and well control group selected correct answer more than 30%. Percentage of correct answer in fruits unit was 44.44 for the high knowledge and well control group, while 27.28% for the high knowledge and poor control group. Similarly, unit of desserts was 50.00% correct response of the high knowledge and well control, but the poor control and high knowledge group did 25.00% of correct. From this results, inaccurate estimation of fruits and desserts possibly affect to blood glucose level. Similarly, the results of previous study in Finland presented that snacks, vegetables and fruits were overestimated[85]. The similar results of study in Japan was reported that most of food in fruits and desserts groups were overestimated [78].

As each item in food estimation test, mock fruit (Look Choup) was the lowest percentage of correct answer (12.50%) and boiled glass vermicelli (Woonsen) had 20.83% of correct. Like misconception that is written above, boiled glass vermicelli was misunderstood as very low carbohydrate food because it is made from mung bean. Mock fruits are also made from mung bean and may be misunderstood in the same way. On the other hand, steamed glutinous rice was an interesting item. In paper test, 77.78% of participants answered that 1 ladle of glutinous rice contains more carbohydrate than 1 ladle of steamed rice. When question in estimation test was comparing between 3 serving of glutinous rice (90 g) and 3 serving of steamed rice (165 g), most participants (70.83%) still answered glutinous rice had more carbohydrate. Similarly, 1 serving of tangerine and papaya were misunderstood that contain carbohydrate less than 1 serving of banana, Namwa variety. Percentages of correct answer were 16.67, 20.83, respectively. Participants pointed out a reason in the interview that their doctors suggest

to avoid this kinds of food. Then, they memorized that glutinous rice and banana were high carbohydrate food. In fact, participants did not know how much carbohydrate in glutinous rice and banana. They misunderstood that they are prohibited from eating them and did not pay attend to learnt about proper amount. The results were supported by the findings of the previous study. It showed that participants were confused about appropriate amount of food, but they understood about good food choices[43].

According to the American Diabetes Association's (ADA) standards of medical care in diabetes 2017, healthy meal plans are goals of diet therapy. It promotes a wide variety of food with nutrient density in proper portion sizes[5]. Portion size estimation is an important skill for people with type 2 diabetes. Inaccurate estimation of carbohydrate content was related to unstable blood glucose level[86]. However, carbohydrate restricted diet could increase risk of hypoglycemia. Although mild hypoglycemia is a common adverse effect from treatment, it is an important problem if it became fear. Fear of hypoglycemia was not directly related to high HbA1c, while was significantly associated with blood glucose fluctuations[87]. People with diabetes should understand effect of carbohydrate on their blood glucose in order to prevent hypoglycemia. Knowledge about carbohydrate foods is needed for meal plan[88]. So, accurate food estimation may help to prevent hypoglycemia event and keep blood glucose level stable.

Food exchange is a common method to estimate food in Thailand and food models are important tools for serving size education[89]. Although serving sizes of Thai food exchange list are used household measurement, it is still hard to understand for people who are not familiar with cooking. Lack of cooking skill affects estimation skill. They have a problem to memorize amount of food in diabetes education because they do not familiar with food measurement. Hands are selected to solve this problem. The health professionals in western countries created “finger width method” to guide size of portion, but accuracy depends on shape of food. It is suitable for food with geometric shape and should be considered to use with amorphous shape[90]. However, character of Thai foods are different from western foods. Thai foods commonly mixed several ingredients together. It is more difficult to estimate because ingredients in same food groups are separated on the plate. The finding of previous study was found that mixed

dishes is the greatly overestimated than other types of food[91]. In addition, various different numbers in food exchange are hard to remember.

As qualitative data, participants choose the best method for themselves. Carb-counting method was used by participants in group of high knowledge and well control. This method is good because meal plan become more flexible. However, participants in other groups pointed out that carb-counting is complicated, especially people with education lower than a high school. They have a problem with numeracy skill. From the finding of previous study, mean scores of accuracy of carb-counting was 44% and increasing of score did not related with HbA1c. At the end of study, participants were asked to pay more attention to food labels and serving size[92]. It is possible that carb-counting is not appropriate method for everyone.

As nutrition facts label, participants complained that nutrition facts label is difficult to read and interpret. This problem was supported by score of paper test. Around one third of participants (37.78%) responded that do not know about nutrition facts label. In other items, percentage range of participants who replied do not know was 0.00-14.07. The first items in unit of nutrition facts label was not complex. If participants know which number on nutrition facts label represent amount of carbohydrate, they can respond correctly. However, less than half of participants selected correct answer (40.74%). The second item was more difficult because serving size was needed to calculate. Percentage of correct answer was only 5.93%. The first question was not related to glycemic control (p-value=0.979), while the second question showed relationship (p-value=0.027). It is possible that misinterpretation of nutrition facts label contribute to poor glycemic control in people with type 2 diabetes. Literacy and numerical skills is needed for correct interpretation. American people also had a problem about understanding of nutrition label, even people with average literacy[68]. Moreover, some participants described that they do not trust nutrition facts label. Standard of nutrition facts label was doubted.

Participants with low knowledge had a problem with calculation. Eating food in the same pattern was a strategy to keep their blood glucose level in appropriate range. Participants with low knowledge and well control tried to eat same menu or same ingredients at a same restaurant. They did not calculate amount of carbohydrate, but they knew appropriate amount of food. For example, fried rice should be divided into

half for 2 meals. American Diabetes Association's (ADA) standards of medical care in diabetes 2017 is written that patients on fixed insulin can set both amount and time of carbohydrate consumption like a pattern.

Glucose meter is an important tool, when participants try a new food or food which they do not know amount of carbohydrate. It helps people with type 2 diabetes evaluate appropriate amount of food. Paired-meal SMBG testing helps to enhance knowledge about carbohydrate. It represents carbohydrate content in a meal and its effect size. People with diabetes have more motivation to adjust their diet[93]. This can be called self-regulation[94]. If participants do not have glucose meter, they evaluate from character of food as taste and texture.

5.4 Factors associated with poor glycemic control

From the results of this study, factors which associated with poor glycemic control were income, treatment, self-monitoring blood glucose and score of carbohydrate portion knowledge. After multivariate analysis, score of carbohydrate portion knowledge is the best factor to predict people with poor glycemic control. It was negative correlation (β=-0.164) and had odd ratio of 0.844. This could be interpreted that the risk of poor glycemic control is reduced 15.6% when score of carbohydrate portion knowledge increased for every 1 point. The results are consistent with previous studies. Findings of Bains et al. (2011)'s study was reported that only score of diabetes knowledge and health status were associate with glycemic control. Age, sex, race, education, income and self-care did not show relationship. Bains et al' study used different diabetes knowledge test from the present study. They selected Diabetes Knowledge Questionnaire (DKQ) which was developed by Garcia et al.[6]. Association between diabetes knowledge and poor glycemic control was also found in study of Al-Qazaz et al. (2011). The researchers selected Michigan diabetes knowledge test (MDKT) for knowledge evaluation and criteria of poor glycemic control was HbA1c > 6.5[95]. On the other hand, the results of He et al. (2007)'s study were different from the present study. It showed no difference of diabetes knowledge between people with good and poor glycemic control. The knowledge test was Diabetes Knowledge Scale (DKN) which was developed by Dunn et al. (1984)[96].

As qualitative data, opinions of participants against factors associated poor eating habits and glycemic control was divided in 4 main topics.

(1) Attitude for diabetes: Causes of diabetes are both genetics and lifestyle factors. International Diabetes Federation (IDF) classifies it into 2 groups; non-modifiable and modifiable. Genes or family history is in a non-modifiable group including gender and age while important modifiable factors are obesity, physical inactivity and diet[97]. All participants understood benefits of lifestyle modification, especially dietary management. However, some of them pointed out their blood glucose levels are still high, even following all doctor's instruction. They assumed that their bodies and genes are different from others with diabetes because genes also affect to risk of diabetes.

According to American Diabetes Association's (ADA) standards of medical care in diabetes 2017, goal for blood glucose control is different. It depends on life expectancy, hypoglycemia events and complications. Normal HbA1c for non-pregnant adults is less than 7.0 and this criteria also used in this study. It becomes less strict for some patients such as those who have history with severe hypoglycemia. This is possible that participants was satisfied with easier target that they heard from others. Moreover, glycemic goals for capillary blood test are 80-130 mg/dl for pre meal and less than 180 for post meal. Participants who was satisfied with 140 or 160 mg/dl for pre-prandial glucose level may be confused between target of pre and post meal[5].

Hypoglycemia is a major barrier for diabetes management. Strict glycemic control increase risk of hypoglycemia and this can be developed anxiety, especially severe hypoglycemia. Weakness, fatigue and sweating were the most frequent reported hypoglycemia symptoms. It is a big problem when hypoglycemia happens at work and consequences were unpleasant. This may be a reason why participants were satisfied with high HbA1c. They tried to prevent hypoglycemia events [98, 99].

According to result of this qualitative study, although participants had a chance to meet diabetes educator, some of them pointed out that it is useless and boring. Characteristics of respected care providers were reported in previous study. They listened, showed their care and involved patients to make decision together in non-hurried consultation. Patients were confident in healthcare staffs if they received clear answer to improve their understanding[100]. According to public health statistics 2016, proportion population and health staffs in Bangkok were 716 per 1 physician and 205 per 1 professional nurse. For whole country, physician to population ratio was 1:2035

and professional nurse to population was 1:436[101]. It is possible that insufficient health care professional is related to length of counseling. Some miscommunication may occur in short conversation.

(2) Social impact: In Asian culture, food and eating have meanings. It represents social bonding, good health and human interaction. Friends and family members involves in eating activity. The greeting of Asian people may be not "How are you ?", but it is "Have you eaten?" or in Thai "kin khaao reuu yang". Asian foods contain higher carbohydrate portion than Western style and foods usually have high glycemic index. Beloved elderly people received their favorite foods or traditional food as gifts [14, 102]. It is hard to denied eating because it reflects love and care. Similarly, eating out is related to excess energy intake[103], but refusing invitation could be mean refusing relationship. It is difficult to meet friends without eating out. This results are consistent with findings in a previous study. The common barrier to healthy eating was family environment. It is difficult to stay healthy while the junk food was available at home [72].

(3) Occupation: Although occupation in quantitative data did not show association with glycemic control, but qualitative interview found some interesting data. Types of occupation were significantly related to daily physical activity. Examples of strenuous physical activity were farmers, laborers, cleaners and waiters. Hypoglycemia is a major concern for people with strenuous activity. It may happen after many hours of work. Hypoglycemia prevention requires knowledge and a glucose meter for carbohydrate adjustment. Unfortunately, people with strenuous activity work usually have low income and low education [104, 105]. They possibly choose easier way to prevent hypoglycemia. It is consumption of high carbohydrate meal.

In this study, participants complained that overtime caused one more meal. Finding of previous studies in Japan was found that men with more than 50 hours of overtime and women with more than 41 hours overtime had higher risk of type 2 diabetes than who less hours of overtime [106, 107]. On the other hand, recent study in Japan which included 40,861 Japanese employees argued this results. The researchers pointed out that number of hours in overtime work was not associated with higher prevalence of diabetes. Association between working overtime and prevalence of diabetes was U-shape. However, the researchers did not found clear explanation, but

they explained that Japanese law required long overtime workers received health guidance from a doctor[108].

Participants who are company employees described that snacks in the meetings usually are unhealthy. Their blood glucose cannot be in a target range because snacks in meetings are high in sugar and fat. Unhealthy snack consumption was association with non-designated eating places like a work place. There are candies, cookies or pastries, chips or other salty snacks, frozen desserts, and deep fried food that is convenience to consumption[109].

(4) Guilty to leftover food: Participants had a problem with portion size of food. Restaurants were available in one portion size and it was larger than they should eat for a meal. They were taught to not throw away food. This results are consistent with findings in previous study. It reported that energy intake was association with amount of food that is presented in a meal. Larger portion sizes affected to increase energy intake. It is possible that served food in a plate is expected to provide in proper amount [110]. The trends of larger food portion sizes was found in Netherlands[111]. If a trend of Thailand is similar, it may be more difficult to buy appropriate amount of food in single portion.

5.5 Factors associated with carbohydrate portion knowledge

In the same way as written above, knowledge of carbohydrate portion was statistically related to glycemic control. Although all participants in this study received diabetes education about healthy diet, half of them still could not achieve the glycemic target. Previous study also reported about problem with nutritional diabetes education. 96.8% of participants were instructed about diet, but percentage of correct answer in the diet topic was only 60. As other topic, 96.8% of participants received education about exercise and 94.8 % was given information about foot care. Correct answer of exercise and foot care were 92.7% and 91.6%, respectively. This may be explained by attitude in education. The scores were not different between participants who did not want more education and those who want [77]. This is similar to some participants in the present study. In qualitative interview, they insisted that they knew everything about diabetes and no need to attend more diabetes education, even their knowledge scores were not high.

One more possible explanation is that participants' understanding were affected by other factors. In this study, the variables which associated with carbohydrate portion knowledge were age, education level, occupation, income and having glucose meter. Age was a controversial variable about direction of relationship. In this study, participants who aged younger significantly scored higher than older participants. The negative relationship was agreed with other studies [96, 112, 113]. However, some studies argued that it should be positive relationship [16, 114-116]. Effect of education level may be explained by study of Kim et al. (2015). The results indicated that people with lower education had less awareness of diabetes[46]. In addition, literacy help people more easily understand new information[6]. The results of the present study indicated that government officer or state enterprise employee had better score than other jobs. It was found relationship between diabetes knowledge and occupation in other studies, but the difference was shown in housewives and retired people[96, 117]. It is possible that association with occupation was resulted from income or education level. Household income was reported that it impacted on eating behavior in finding of previous study. One of barriers against good diet was high cost of healthy food [118]. High income family had more opportunity to buy more variety of foods[37]. Thus, this may affect to an attention in diabetes education. The people who had high income were interested in how to select a good food choice[119]. Many studies demonstrated that self-monitoring blood glucose helped type 2 diabetes patients to have good glycemic control and healthy lifestyle [120-122]. Moreover, previous study found self-monitoring blood glucose associated with the higher knowledge. It may be easier to understand about diabetes knowledge with performance of self-monitoring blood glucose[123].

As risk of low knowledge about carbohydrate portion, variables that related to people with low carbohydrate portion knowledge were age, education level, income, receiving diabetes information from media and score of general diabetes. However, factors which predict risk of people with low carbohydrate portion knowledge were income and score of general diabetes knowledge. Both factors had negative correlation. As income, 15,000-25,000 baht monthly income had odd ratio of 0.090 and more than 25,000 baht monthly income had odd ratio of 0.122. It could be interpreted that risk of low carbohydrate portion knowledge is reduced 91% if people received income of 15,000-25,000 baht and 87.8% if people received income of more than 25,000 baht.

Moreover, general diabetes knowledge had odd ratio of 0.764. It could be interpreted that the risk of low carbohydrate portion knowledge is reduced 23.6% when score of general diabetes knowledge increased every 1 point.

5.6 Limitations

This study was conducted on people who able to read Thai. They were recruited because the knowledge test had questions about interpretation of nutrition facts label. The participants were recruited at King Chulalongkorn Memorial Hospital which is a tertiary care hospital. The results may not be generalized to patients in a hospital with different health care system. All participants in the third part of study lived in the capital city, Bangkok. People who live in rural areas may have different experiences with diabetes. In estimation skill test, there were only one portion size for each food items. It may be better to present accuracy of estimation skill by means of several portion sizes. Also this study is a cross-sectional design so it could not show changes of understanding or eating habits which would become evident in a longitudinal study.

CHAPTER 6
CONCLUSION

This cross-sectional study aimed to evaluate understanding about carbohydrate portion in adults with type 2 diabetes including factors which associated with carbohydrate portion knowledge. The group of participants was 135 adults with type 2 diabetes who came for treatment at diabetic clinic of King Chulalongkorn Memorial Hospital. Knowledge of carbohydrate portion was evaluated by the tool which was developed in this study and data collection forms consisted of socio-demographic characteristics, medical information, self-management information, diabetes education and general diabetes knowledge. After this process was completed, 24 participants were selected by purposive sampling based on level of carbohydrate portion knowledge and HbA1c.

The result of this study showed people with type 2 diabetes had carbohydrate portion knowledge less than general diabetes knowledge (percentage of mean score were 56.00 and 77.71 respectively). People with type 2 diabetes described carbohydrate as rice and starch (KaoPang) and know effect of carbohydrate to their blood glucose level. However, the misconceptions were found in this study as follow:

For grain and cereal group, the misconception was diet for diabetes is low carbohydrate diet. From paper test of carbohydrate portion knowledge, 88.15% of participants misunderstood that people with type 2 diabetes should eat carbohydrate foods as few as they can. In rice estimation test, Two-third of participants answered that one ladle or lower was proper amount of rice for a meal.

For fruit group, more than 70% of participants knew that they need to limit fruits intake, most participants misunderstood that guava and watermelon do not contain carbohydrate (72.59%, 60.00%, respectively). In food estimation test, the fruits group had the lowest correct response.

For fat and oil group, the foods in this group are high in energy (calories) and were misunderstood that they are also high in carbohydrate. Data from the interview was found that participants include oil and animal fat in carbohydrate foods and paper

test also showed 42.22% of participants misunderstood that soybean oil contains carbohydrate.

For nutrition facts label, it should help to estimate carbohydrate content in food, but people with type 2 diabetes had problems with interpretation. In addition, some of them did not pay attention about reading it.

Therefore, people with type 2 diabetes seem to have problem with identifying foods that contain carbohydrate and estimating carbohydrate content in foods.

This study found association between carbohydrate portion knowledge and glycemic control. The 5 factors associated with carbohydrate portion knowledge from analysis by independent t-test and ANOVA. There were age (p-value=0.004), education level (p-value<0.001), occupation (p-value=0.002), income (p-value<0.001) and having glucose meter (p-value=0.042). In the same way, analysis of chi-square test and binary logistical regression showed low level of carbohydrate portion knowledge was associated with 5 variables; age, education level, income, receiving diabetes information from media and score of general diabetes.

Recommendations

This study was found some misconceptions about carbohydrate portion in people with type 2 diabetes. The data from interview pointed out that people with type 2 diabetes misinterpreted their doctors and diabetes educators' word. It is important to be careful with incomplete and unclear message. When healthcare staffs give nutritional advices to people with diabetes, it may be better to mention both type and amount of the food that is recommended. If length of counseling is enough, it is good to explain the reason why this food is suggested to eat or avoid. It may help to reduce misunderstanding.

Two-third of participants received diabetes information from media such as television, magazine, website, facebook and line. The information is often unreliable. It may cause misunderstanding, especially in people with low health literacy. Development of educational tools that are easy to access may help to distribute correct information.

From the results of this study, people with high education level did not have problem with numeracy skill and literacy. It was easier to use carb-counting or food

exchange list and interpret nutrition facts label. The people with low knowledge fixed a problem about numeracy by eating same pattern. However, it is important to tailored diabetes education for individual because each person has different characteristics.

Recommendations for further study

1. Some elderly with low literacy were not enrolled in this study due to ability to read Thai. It may be useful to conduct in people with type 2 diabetes with low literacy and limited ability to read for more understanding.
2. This study was conducted at the diabetic clinic of King Chulalongkorn Memorial Hospital. This place is a tertiary care hospital. The result may be different in an internal medicine clinic or a primary care hospital.
3. Estimation skill test had one portion size for each type of food. It may be better to measure people with type 2 diabetes knowledge with more variety of portion sizes.
4. It is interesting to explore more about group of people which received diabetes education, but still have low knowledge level, especially group with no income.

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APPENDIX A

แบบบันทึกข้อมูลงานวิจัย

งานวิจัยเรื่อง การวิจัยแบบผสมผสานเชิงคุณภาพและเชิงปริมาณเกี่ยวกับความเข้าใจของผู้ป่วยในการประมาณสัดส่วนคาร์โบไฮเดรตในผู้ป่วยเบาหวานชนิดที่สอง

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ส่วนที่ 1 ข้อมูลทั่วไป

1. เพศ

   O ชาย O หญิง

2. อายุ (ระบุ) ..... ปี

3. ระดับการศึกษา

   O ประถมศึกษา O มัธยมศึกษา O อนุปริญญา

   O ปริญญาตรี O สูงกว่าปริญญาตรี

4. สถานภาพสมรส

   O โสด O สมรส O หย่าร้าง O อื่นๆ (โปรดระบุ).....

5. ท่านอาศัยอยู่กับใคร (ตอบได้มากกว่าหนึ่งข้อ)

   O อยู่คนเดียว O อยู่กับคู่สมรส O อยู่กับบิดามารดา

   O อยู่กับบุตรหลาน O อยู่กับเพื่อน O อื่นๆ (โปรดระบุ).....

6. อาชีพหลัก

   O ข้าราชการ/พนักงานของรัฐ/พนักงานรัฐวิสาหกิจ O ค้าขาย/ธุรกิจส่วนตัว

   O พนักงานเอกชน/ลูกจ้างเอกชน O รับจ้างทั่วไป

   O เกษตรกร O แม่บ้าน

   O เกษียณ / ไม่ได้ประกอบอาชีพ O อื่นๆ(โปรดระบุ).....

7. รายได้ต่อเดือน

   O น้อยกว่า 10,000 บาท O 10,000 ถึง 15,000 บาท

   O 15,001 บาท ถึง 20,000 บาท O 20,001 บาท ถึง น้อยกว่า 25,000 บาท

   O 25,000 บาท ขึ้นไป O ไม่มีรายได้

ส่วนที่ 2 ข้อมูลเกี่ยวกับโรคเบาหวานและการดูแลตนเอง

1. ท่านเป็นโรคเบาหวานมานานเท่าใด

   O น้อยกว่า 1 ปี O 1 ถึง 5 ปี O 5 ถึง 10 ปี O มากกว่า 10 ปี

2. ท่านมีโรคประจำตัวอื่น นอกจากโรคเบาหวานหรือไม่

   O ไม่มีโรคประจำตัวอื่น

   O โรคความดันโลหิตสูง O โรคไขมันในเลือดสูง

   O โรคไต O อื่นๆ (โปรดระบุ).....

3. การรักษาเบาหวานที่ท่านได้รับในขณะนี้ (ตอบได้มากกว่า หนึ่งข้อ)

   O ควบคุมด้วยอาหาร O ยาเม็ด O ยาฉีด

4. ท่านมีเครื่องตรวจน้ำตาลที่บ้านหรือไม่

   O มี O ไม่มี

   หากมี ท่านใช้เครื่องตรวจน้ำตาลในเลือดบ่อยเพียงใด

   O น้อยกว่า 1 ครั้งต่อสัปดาห์ O 1 ถึง 3 ครั้งต่อสัปดาห์

   O 4 ถึง 6 ครั้งต่อสัปดาห์ O วันละ 1 ครั้ง O มากกว่าวันละ 1 ครั้ง

   O เฉพาะเวลาที่มีอาการน้ำตาลในเลือดต่ำ

5. ขณะนี้ท่านออกกำลังกายอยู่หรือไม่

   O ออกกำลังกาย O ไม่ได้ออกกำลังกาย

   หากท่านออกกำลังกาย ท่านออกกำลังกายด้วยวิธีใด

   O เดิน O วิ่ง O ไทเก๊ก

   O โยคะ O ถีบจักรยาน O เต้นแอโรบิค

   O **เล่นกีฬา เช่น ว่ายน้ำ ปิงปอง แบดมินตัน เทนนิส ฟุตบอล ฯลฯ**

   O อื่นๆ (โปรดระบุ).....

   ท่านออกกำลังกาย.....วันต่อสัปดาห์ ระยะเวลา.....นาทีต่อครั้ง

6. ท่านเคยได้รับความรู้เบาหวานจากบุคลากรทางการแพทย์ เช่น แพทย์ พยาบาล หรือ นักโภชนาการ เกี่ยวกับเรื่องเบาหวานหรือไม่

O เคย O ไม่เคย

หากเคย ความรู้เบาหวานนั้นเป็นเรื่องใดบ้าง (ตอบได้มากกว่าหนึ่งข้อ)

O ลักษณะทั่วไปของโรคเบาหวาน O ภาวะแทรกซ้อนของโรคเบาหวาน

O การใช้ยา O การใช้เครื่องตรวจน้ำตาล

O อาหารกับโรคเบาหวาน O การออกกำลังกายในผู้ป่วยเบาหวาน

O การดูแลเท้า O อื่นๆ (โปรดระบุ).....

ท่านเคยได้รับความรู้เกี่ยวกับโรคเบาหวานทั้งหมดกี่ครั้ง ในช่วงระยะเวลา 5 ปีนี้

O 1 ครั้ง O 2-4 ครั้ง

O 5-10 ครั้ง O มากกว่า 10 ครั้ง

7. ท่านได้รับความรู้เรื่องเบาหวานจากแหล่งอื่น นอกจากโรงพยาบาลหรือไม่

O ครอบครัว / ญาติ O เพื่อน / คนรู้จัก

O สื่อต่างๆ เช่น วิทยุ โทรทัศน์ หนังสือ อินเตอร์เน็ต

O อื่นๆ (โปรดระบุ).....

ส่วนที่ 3 ความรู้ทั่วไปเกี่ยวกับโรคเบาหวาน

ข้อคำถาม	ถูก	ผิด	ไม่ทราบ
1. โรคเบาหวานสามารถรักษาให้หายขาดได้			
2. อินซูลินสร้างมาจากไต			
3. ค่าปกติของระดับน้ำตาลในเลือดเมื่อออดอาหาร ตลอดคืน คือ 90-130 มิลลิกรัม/เดซิลิตร			
4. ความเครียดเป็นสาเหตุที่ทำให้ระดับน้ำตาลในเลือดเพิ่มสูงขึ้นได้			
5. สาเหตุหนึ่งของโรคเบาหวานเกิดจากความผิดปกติทางกรรมพันธุ์			
6. เมื่อร่างกายมีระดับน้ำตาลในเลือดต่ำจะมีอาการแสดง คือ เหงื่อออก ใจสั่น หน้ามืด			
7. ผู้ป่วยโรคเบาหวานมีโอกาสเป็นโรคหลอดเลือด หัวใจตีบได้มากกว่าผู้ที่ไม่เป็นโรคเบาหวาน			

ข้อคำถาม	ถูก	ผิด	ไม่ทราบ
8. การควบคุมระดับน้ำตาลในเลือดได้ไม่ดีสามารถ ทำให้เกิดอาการชาโดยเฉพาะปลายมือและเท้าได้			
9. การควบคุมระดับน้ำตาลในเลือดได้ไม่ดีสามารถ ก่อให้เกิดภาวะไตวายได้			
10. การควบคุมระดับน้ำตาลในเลือดให้อยู่ในเกณฑ์ปกติจะลดอาการแทรกซ้อนหรือทำให้อาการแทรกซ้อนเกิดได้ช้าลง			
11. การดื่มเครื่องดื่มแอลกอฮอล์เช่น เหล้า ไวน์ ยาดอง มีผลเปลี่ยนแปลงระดับน้ำตาลในเลือดได้			
12. ผู้ป่วยโรคเบาหวานที่ป่วยมากหรือมีอาการเจ็บหน้าอกไม่ควรหยุดออกกำลังกาย			
13. ผู้ป่วยโรคเบาหวานควรตรวจเท้าทุกวัน			
14. ผู้ป่วยโรคเบาหวานเมื่อเกิดภาวะการติดเชื้อ จะทำให้ระดับน้ำตาลในเลือดอยู่ในระดับสูงได้มากกว่าช่วงเวลาปกติ			
15. ผู้ป่วยโรคเบาหวานเมื่อไม่สบายควรดื่มน้ำมากๆ และไม่ควรงดอาหาร			
16. ในช่วงเวลาที่ไม่สบายผู้ป่วยโรคเบาหวานไม่จำเป็นต้องรับประทานยาลดระดับน้ำตาล เนื่องจากระดับน้ำตาลในเลือดต่ำอยู่แล้ว			
17. การกินยาเม็ดลดระดับน้ำตาลในเลือด ถ้าลืมกินยาให้รีบกินทันทีที่นึกได้แต่ถ้าท่านนึกได้ในเวลาที่ใกล้ถึงเวลากินยาของมื้อถัดไปแล้วก็ให้งดมื้อที่ลืมไปแล้วกินยาในมื้อต่อไปตามปกติ ไม่ต้องเพิ่มขนาดยาเป็น 2 เท่า			
18. ขณะที่ใช้ยาถ้าท่านมีอาการของภาวะน้ำตาลในเลือดลดต่ำกว่า ปกติให้กินของหวานๆเช่น น้ำหวานเพื่อบรรเทาอาการและควรแจ้งให้แพทย์ทราบเพื่อปรับขนาดยาให้เหมาะสม			
19. ถ้าท่านต้องกินยาเม็ดลดระดับน้ำตาลในเลือด ก่อนอาหารแต่ท่านไม่ได้กินอาหารหลังจากกินยาจะมีผลทำให้ระดับน้ำตาลในเลือดของท่าน ลดลงต่ำกว่าปกติได้			
20. การดื่มเครื่องดื่มเช่น เหล้า ยาดอง ไวน์ อาจมีผลต่อยาเม็ดลดระดับน้ำตาลในเลือดที่ท่านรับประทานได้			
21. การที่ผู้ป่วยกินยาลดระดับน้ำตาลในเลือด แต่ยังคงกินอาหารที่มีรสหวานเช่นทองหยิบ ทองหยอดอยู่จะมีผลทำให้การควบคุมระดับน้ำตาลในเลือดได้ผลไม่ดีนัก			

ส่วนที่ 4 ความรู้เรื่องอาหารกับโรคเบาหวาน

ความรู้ทั่วไปเรื่องอาหาร

ข้อ	หัวข้อ	ถูก	ผิด	ไม่ทราบ
1	อาหารที่เหมาะกับผู้ที่เป็นเบาหวานคือ อาหารที่มีคาร์โบไฮเดรตน้อยที่สุดเท่าที่จะเป็นไปได้			
2	ผู้ที่เป็นเบาหวานควรได้รับคาร์โบไฮเดรตต่อวันในปริมาณเท่ากันทุกคน			
3	ผู้ที่เป็นเบาหวานควรรับประทานเนื้อสัตว์ที่มีไขมันต่ำ			
4	น้ำตาลในผลไม้เป็นน้ำตาลจากธรรมชาติ ผู้ป่วยเบาหวานจึงไม่จำเป็นต้องจำกัดปริมาณการรับประทานผลไม้			
5	ผู้ที่เป็นเบาหวานควรรับประทานผักวันละ 4-6 ทัพพี			
6	คาร์โบไฮเดรตที่เหมาะสำหรับผู้ที่เป็นเบาหวานควรมาจาก ผัก ผลไม้, ธัญพืชที่ไม่ขัดสี, ถั่วเมล็ดแห้ง			

ความรู้เรื่องการประเมินคาร์โบไฮเดรต

1. อาหารประเภทใดต่อไปนี้ มีคาร์โบไฮเดรตเป็นส่วนประกอบ ต้องนำมาคำนวณในปริมาณคาร์โบไฮเดรตที่รับประทานในแต่ละวัน (ตอบได้มากกว่า หนึ่งข้อ)

   O เผือก O เนื้ออกไก่ O วุ้นเส้น

   O ฟักทอง O หมูสามชั้น O น้ำมันถั่วเหลือง

   O มันเทศ O นมถั่วเหลือง O ฝรั่ง

   O ข้าวโพด O นมรสจืด O แตงโม

2. เครื่องดื่มใดต่อไปนี้ในท้องตลาด **<u>ไม่ใช่</u>** เครื่องดื่มที่มีน้ำตาลสูง (ตอบได้มากกว่า หนึ่งข้อ)

   O นมรสจืด O นมรสจืดไขมันต่ำ O นมเปรี้ยวไขมันต่ำ

   O นมถั่วเหลืองสูตรเจ O นมถั่วเหลืองสูตรไม่เติมน้ำตาล

3. โปรดเปรียบเทียบปริมาณคาร์โบไฮเดรตในอาหาร 2 ประเภทต่อไปนี้ อาหารประเภทใดมีปริมาณคาร์โบไฮเดรตมากกว่า

   3.1 O ข้าวขาว 1 ทัพพี O ข้าวกล้อง 1 ทัพพี O มีเท่ากัน

   3.2 O ข้าวขาว 1 ทัพพี O ข้าวเหนียว 1 ทัพพี O มีเท่ากัน

   3.3 O ข้าวขาว 1 ทัพพี O วุ้นเส้น 1 ทัพพี O มีเท่ากัน

   3.4 O ซาลาเปาไส้ครีม 1 ลูก O ขนมปัง 1 แผ่น O มีเท่ากัน

4. การอ่านฉลากโภชนาการ

ข้อมูลโภชนาการ

หนึ่งหน่วยบริโภค: 1 ถ้วย (30 กรัม)
จำนวนหน่วยบริโภคต่อกล่อง : 1

คุณค่าทางโภชนาการต่อหนึ่งหน่วยบริโภค
พลังงานทั้งหมด 100 กิโลแคลอรี (พลังงานจากไขมัน 5 กิโลแคลอรี)

		ร้อยละของปริมาณที่แนะนำต่อวัน*
ไขมันทั้งหมด	0.5 ก.	1 %
ไขมันอิ่มตัว	0 ก.	0 %
โคเลสเตอรอล	20 มก.	7 %
โปรตีน	4 ก.	
คาร์โบไฮเดรตทั้งหมด	20 ก.	7 %
ใยอาหาร	0 ก.	0 %
น้ำตาล	2 ก.	
โซเดียม	840 มก.	35 %

ร้อยละของปริมาณที่แนะนำต่อวัน*			
วิตามินเอ	0 %	**วิตามินบี 1**	0 %
วิตามินบี 2	0 %	**แคลเซียม**	2 %
เหล็ก	62 %		

*ร้อยละของปริมาณสารอาหารที่แนะนำให้บริโภคต่อวันสำหรับคนไทยอายุตั้งแต่ 6 ปีขึ้นไป (Thai RDI) โดยคิดจากความต้องการพลังงานวันละ 2,000 กิโลแคลอรี

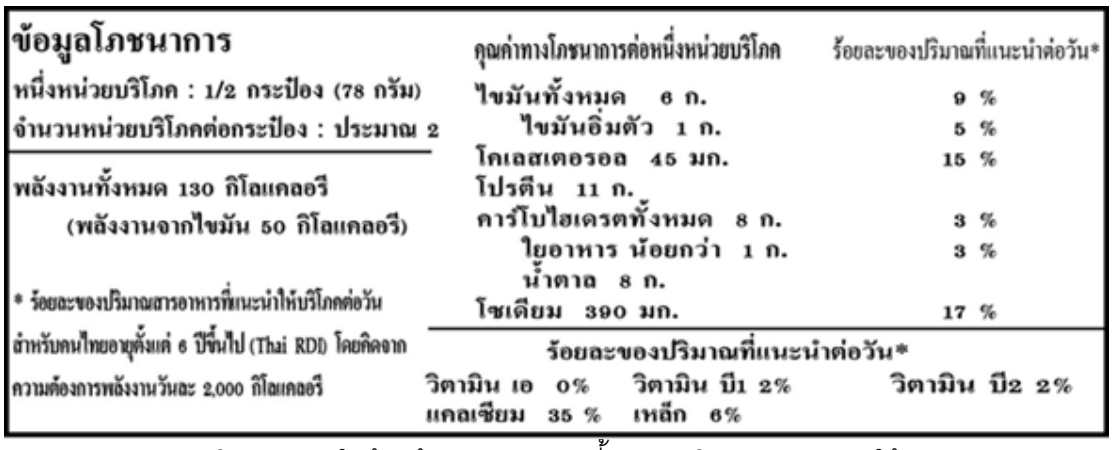
ความต้องการพลังงานของแต่ละบุคคลแตกต่างกัน ผู้ต้องการพลังงานวันละ 2,000 กิโลแคลอรี ควรได้รับสารอาหารต่างๆ ดังนี้

ไขมันทั้งหมด	น้อยกว่า	65 ก.
ไขมันอิ่มตัว	น้อยกว่า	20 ก.
โคเลสเตอรอล	น้อยกว่า	300 มก.
คาร์โบไฮเดรตทั้งหมด		300 ก.
ใยอาหาร		25 ก.
โซเดียม	น้อยกว่า	2,400 มก.

พลังงาน (กิโลแคลอรี) ต่อกรัม : ไขมัน = 9 ; โปรตีน = 4 ; คาร์โบไฮเดรต = 4

4.1 จากฉลากโภชนาการในข้างต้น อาหารชนิดนี้ หากบริโภค 1 ถ้วย ให้ปริมาณคาร์โบไฮเดรตเท่าไร

O 2 กรัม O 20 กรัม O 22 กรัม O 100 กรัม



ข้อมูลโภชนาการ

หนึ่งหน่วยบริโภค : 1/2 กระป๋อง (78 กรัม)
จำนวนหน่วยบริโภคต่อกระป๋อง : ประมาณ 2

พลังงานทั้งหมด 130 กิโลแคลอรี
(พลังงานจากไขมัน 50 กิโลแคลอรี)

* ร้อยละของปริมาณสารอาหารที่แนะนำให้บริโภคต่อวัน สำหรับคนไทยอายุตั้งแต่ 6 ปีขึ้นไป (Thai RDI) โดยคิดจากความต้องการพลังงานวันละ 2,000 กิโลแคลอรี

คุณค่าทางโภชนาการต่อหนึ่งหน่วยบริโภค	ร้อยละของปริมาณที่แนะนำต่อวัน*
ไขมันทั้งหมด 6 ก.	9 %
ไขมันอิ่มตัว 1 ก.	5 %
โคเลสเตอรอล 45 มก.	15 %
โปรตีน 11 ก.	
คาร์โบไฮเดรตทั้งหมด 8 ก.	3 %
ใยอาหาร น้อยกว่า 1 ก.	3 %
น้ำตาล 8 ก.	
โซเดียม 390 มก.	17 %

ร้อยละของปริมาณที่แนะนำต่อวัน*

วิตามิน เอ 0% วิตามิน บี1 2% วิตามิน บี2 2%
แคลเซียม 35 % เหล็ก 6%

4.2 จากฉลากโภชนาการในข้างต้น อาหารชนิดนี้ หากบริโภค 1 กระป๋อง ให้ปริมาณคาร์โบไฮเดรตเท่าไร

O 8 กรัม O 16 กรัม O 32 กรัม O 130 กรัม

****

ข้อมูลจากเวชระเบียน

Last updated HbA1C _____ Date_____

Weight _____Kg Date_____

Weight _____Kg Date_____

Antidiabetic prescriptions

Oral medication :_____

_____

Insulin :_____

Hypoglycemia events : _____

APPENDIX B

แบบบันทึกข้อมูลการทดสอบการประเมินปริมาณอาหาร

งานวิจัยเรื่อง การวิจัยแบบผสมผสานเชิงคุณภาพและเชิงปริมาณเกี่ยวกับความเข้าใจของผู้ป่วยในการประมาณสัดส่วนคาร์โบไฮเดรตในผู้ป่วยเบาหวานชนิดที่สอง

****

1. คิดว่าในหนึ่งมื้อ ตัวเองควรกินข้าวสวยกี่ทัพพี ?

จำนวนที่ผู้เข้าร่วมวิจัยตอบ	น้ำหนักอ้างอิง	น้ำหนักข้าวที่ชั่งได้	% ความคลาดเคลื่อน

2. ประเมินปริมาณข้าวสวยในจานตัวอย่างว่า เป็นข้าวกี่ทัพพี

คำตอบที่ถูกต้อง	คำตอบของผู้เข้าร่วมวิจัย	คะแนน
3		

3.1 เปรียบเทียบอาหารตัวอย่างต่อไปนี้กับ ข้าวสวยในจานตัวอย่าง น้ำหนัก 165 กรัม

ข้อ	ชื่อ	น้ำหนัก (กรัม)	คำตอบของผู้เข้าร่วมวิจัย			คะแนน
			น้อยกว่า	เท่ากัน	มากกว่า	
1.	ข้าวเหนียว	90				
2.	เส้นใหญ่ลวก	180				
3.	วุ้นเส้นต้ม	240				
4.	ข้าวต้ม	110				
5.	มันเทศต้ม	200				
6.	ข้าวโพดต้ม	130				

3.2 เปรียบเทียบผลไม้ตัวอย่างต่อไปนี้กับ กล้วยน้ำว้า 1 ผล น้ำหนัก 45 กรัม

ข้อ	ชื่อ	น้ำหนัก (กรัม)	คำตอบของผู้เข้าร่วมวิจัย			คะแนน
			น้อยกว่า	เท่ากัน	มากกว่า	
1.	ส้มเขียวหวาน	150				
2.	ฝรั่ง	240				
3.	มะละกอ	150				

3.3 เปรียบเทียบขนมตัวอย่างต่อไปนี้กับ ข้าวสวยในจานตัวอย่าง น้ำหนัก 165 กรัม

ข้อ	ชื่อ	น้ำหนัก (กรัม)	คำตอบของผู้เข้าร่วมวิจัย			คะแนน
			น้อยกว่า	เท่ากัน	มากกว่า	
1.	ลูกชุบ	90				
2.	ลอดช่อง	120				

3.4 เปรียบเทียบเครื่องดื่มตัวอย่างต่อไปนี้กับ น้ำตาลทราย น้ำหนัก 15 กรัม

ข้อ	ชื่อ	ปริมาตร (ml)	คำตอบของผู้เข้าร่วมวิจัย			คะแนน
			น้อยกว่า	เท่ากัน	มากกว่า	
1.	น้ำส้ม	200				
2.	นมถั่วเหลือง	250				
3.	ชาเขียวรสต้นตำรับ	500				

APPENDIX C

Interview guide

1. การรับรู้สภาวะของตนเอง
    - เป็นเบาหวานมานานเท่าใด มีโรคอย่างอื่นร่วมด้วยไหม ?
    - ขณะนี้ได้รับการรักษายังไงบ้าง ใช้ยาอะไรบ้าง ใช้เครื่องตรวจน้ำตาลไหม บ่อยเพียงใด
    - ความคิดเห็นที่มีต่อโรคเบาหวาน และปัจจัยใดบ้างที่มีผลต่อโรคนี้
    - ท่านคิดว่า ตนเองควบคุมโรคเบาหวานได้ดีหรือไม่
2. ความรู้เกี่ยวกับโรคเบาหวาน
    - เคยได้รับความรู้เกี่ยวกับโรคเบาหวานไหม ? เรื่องอะไรบ้าง ?
    - ความรู้ที่ได้นั้นมาจากแหล่งใดบ้าง ?
    - คิดว่า ความรู้ในเรื่องใดมีส่วนช่วยในการควบคุมโรคเบาหวานบ้าง
    - คิดว่า ความรู้เหล่านั้นง่ายหรือยากต่อการนำไปใช้ในชีวิตประจำวันหรือไม่ อย่างไร
3. การเลือกรับประทานอาหาร
    - คิดว่า อาหารที่เหมาะสำหรับผู้ป่วยเบาหวานมีลักษณะอย่างไร
    - ท่านสามารถนำเอาความรู้นั้นไปทำได้จริงในชีวิตประจำวันหรือไม่ ยากง่ายเพียงใด
    - มีอุปสรรคและปัญหาอะไรบ้าง ?
4. คาร์โบไฮเดรต
    - คาร์โบไฮเดรตคืออะไร
    - คาร์โบไฮเดรตมีความสัมพันธ์กับระดับน้ำตาลในเลือดอย่างไร
    - คาร์โบไฮเดรตอยู่ในอาหารประเภทใดบ้าง ลองยกตัวอย่าง
    - ท่านมีหลักการในการเลือกคาร์โบไฮเดรตอย่างไร ว่าแบบไหนดีหรือไม่ดี
    - ท่านคิดว่า ข้าวกับน้ำตาล ส่งผลต่อระดับน้ำตาลในเลือดเหมือนกันหรือไม่ อย่างไร
5. ประเมินปริมาณ
    - ท่านวางแผนการรับประทานอาหารในแต่ละมื้อหรือไม่
    - ท่านกำหนดปริมาณอาหารในแต่ละมื้ออย่างไร
    - ท่านมีวิธีการใดที่ช่วยในการประเมินปริมาณของอาหาร
6. ฉลากโภชนาการ
    - ท่านรู้จักฉลากโภชนาการหรือไม่
    - ท่านสามารถใช้ฉลากโภชนาการประเมินคาร์โบไฮเดรตได้หรือไม่
    - ท่านคิดว่า ฉลากโภชนาการมีประโยชน์ต่อการควบคุมเบาหวาน หรือไม่ อย่างไร

APPENDIX D

ความรู้ทั่วไปเรื่องอาหาร

คำถาม : ข้อความใดต่อไปนี้ถูกต้อง

ข้อ	คำถาม	IOC	Discrimination index
1.	อาหารที่เหมาะกับผู้ป่วยเบาหวานคือ อาหารที่มีคาร์โบไฮเดรตน้อยที่สุดเท่าที่จะเป็นไปได้	0.5	0.63
2.*	ผู้ป่วยเบาหวานควรรับประทานอาหารให้ครบ 3 มื้อ	1	0
3.	ผู้ป่วยเบาหวานทุกคนควรได้รับคาร์โบไฮเดรตในปริมาณเท่ากัน	0.5	0.5
4.*	หากมีปัญหาเรื่องระดับน้ำตาลในเลือดต่ำ ผู้ป่วยเบาหวานควรรับประทานอาหารว่างระหว่างมื้อ	0	-
5.*	ผู้ป่วยเบาหวานควรรับประทานเนื้อสัตว์ที่มีไขมันต่ำ	0.5	0.25
6.*	อาหารที่มีดัชนีน้ำตาลต่ำเป็นอาหารที่เหมาะกับผู้ป่วยเบาหวาน	0.75	-0.13
7.	น้ำตาลในผลไม้เป็นน้ำตาลจากธรรมชาติ ไม่เป็นอันตรายต่อผู้ป่วยเบาหวาน ไม่จำเป็นต้องจำกัดปริมาณ	0.5	0.38
8.	ผลไม้ที่มีรสเปรี้ยว เช่น มะขาม ไม่จำเป็นต้องจำกัดปริมาณการรับประทาน	0	-
9.*	ผู้ป่วยเบาหวานควรรับประทานผักวันละ 4-6 ทัพพี	1	0.25
10.*	คาร์โบไฮเดรตที่เหมาะสำหรับผู้ป่วยเบาหวานควรมาจากผักผลไม้สด, ธัญพืชที่ไม่ขัดสี, ถั่วเมล็ดแห้ง	0.75	0.25

*ข้อที่ประโยคดังกล่าวถูกต้อง

ความรู้เรื่องการประเมินคาร์โบไฮเดรต

ข้อ	คำถาม	IOC	Discrimination index
1.	อาหารใดต่อไปนี้ จัดอยู่ในจำพวกที่ต้องนับปริมาณคาร์โบไฮเดรต (ตอบได้มากกว่า หนึ่งข้อ)		
1.1	ข้าวสวย *	0.75	0
1.2	เผือกมัน *	0.75	0.25
1.3	ฟักทอง *	0.75	0.38
1.4	มันแกว *	0.75	0.50
1.5	ข้าวโพด *	0.75	0.38
1.6	เนื้อปลา	0.75	0
1.7	เนื้ออกไก่	0.75	0.25
1.8	หมูสามชั้น	0.75	0.25
1.9	นมถั่วเหลือง *	0.75	0.75
1.10	นมรสจืด *	0.75	0.50
1.11	วุ้นเส้น *	0.75	0.75
1.12	น้ำมันถั่วเหลือง	0.75	0.38
1.13	ฝรั่ง *	0.75	0.50
1.14	แตงโม *	0.75	0.38
1.15	น้ำตาลทราย *	0.75	0.13

*ข้อที่จัดอยู่ในจำพวกที่ต้องนับปริมาณคาร์โบไฮเดรต

ข้อ	คำถาม	IOC	Discrimination index
2.	เครื่องดื่มใดต่อไปนี้ในท้องตลาด **ไม่จัด**อยู่ในกลุ่มเครื่องดื่มที่มีน้ำตาลสูง (ตอบได้มากกว่า หนึ่งข้อ)		
2.1	น้ำอัดลม	0.75	0
2.2	โซดา *	0.25	-
2.3	นมรสจืด *	0.75	0.25
2.4	นมรสจืดไขมันต่ำ *	0.75	0.38
2.5	นมรสสตอเบอรี่	0.75	0
2.6	นมเปรี้ยวรสผลไม้รวม	0.75	0
2.7	นมเปรี้ยวไขมันต่ำ	0.75	0.38
2.8	นมถั่วเหลืองสูตรเจ	0.75	0.38
2.9	นมถั่วเหลืองสูตรไม่เติมน้ำตาล *	0.75	0.38
2.10	กาแฟกระป๋อง	0.25	-
2.11	ชาเขียวรสน้ำผึ้งผสมมะนาว	0.75	0
2.12	เครื่องดื่มชูกำลัง	0.75	0
2.13	เครื่องดื่มเกลือแร่	0.75	0
2.14	เครื่องดื่มช็อกโกแลต	0.75	0
2.15	น้ำผลไม้แท้ 100% *	0.75	0

*ข้อที่ไม่จัดอยู่ในกลุ่มเครื่องดื่มที่มีน้ำตาลสูง

ข้อ	คำถาม			IOC	Discrimination index
3.	อาหารใดต่อไปนี้ มีคาร์โบไฮเดรตมากกว่า				
3.1	ข้าวขาว 1 ทัพพี	ข้าวกล้อง 1 ทัพพี	มีเท่ากัน *	0.75	0.38
3.2	ข้าวขาว 1 ทัพพี	ข้าวเหนียว 1 ทัพพี *	มีเท่ากัน	0.75	0.25
3.3	ข้าวขาว 1 ทัพพี	วุ้นเส้น 1 ทัพพี	มีเท่ากัน *	0.75	0.63
3.4	ซาลาเปาไส้ครีม 1 ลูก *	ขนมปัง 1 แผ่น	มีเท่ากัน	0.75	0.25
3.5	น้ำตาลทราย 1 ช้อนโต๊ะ	น้ำผึ้ง 1 ช้อนโต๊ะ	มีเท่ากัน *	0.75	-0.13
4.	ผลไม้ใดต่อไปนี้ มีใยอาหารมากกว่า				
4.1	ส้มโอ 2 กลีบใหญ่	เงาะ 4 ผลกลาง	มีเท่ากัน *	0.5	0.13
4.2	มะละกอ 8 ชิ้น (ยาว 1 นิ้ว)	แอบเปิ้ล 1 ผลเล็ก *	มีเท่ากัน	0.5	0
4.3	ฝรั่ง 1/3 ผลกลาง	แอบเปิ้ล 1 ผลเล็ก	มีเท่ากัน *	0.5	0
5.1	จากฉลากโภชนาการในข้างต้น อาหารชนิดนี้ หากบริโภค 1 ถ้วย ให้ปริมาณคาร์โบไฮเดรตเท่าไร			0.5	0.25
	2 กรัม	20 กรัม *			
	22 กรัม	100 กรัม			
5.2	จากฉลากโภชนาการในข้างต้น อาหารชนิดนี้ หากบริโภค 1 กระป๋อง ให้ปริมาณคาร์โบไฮเดรตเท่าไร				0.63
	8 กรัม	16 กรัม *			
	32 กรัม	130 กรัม			

*คำตอบที่ถูกต้อง

APPENDIX E

Participants' information in part 3 of the study (n=24)

Glycemic control group	Knowledge group	No.	Gender	Age	HbA1c	CP score[+]	GD score[++]
Well control	High knowledge	8	Female	67	5.9	25	21
		30	Female	80	6	22	18
		5	Male	70	6.2	20	18
	Moderate knowledge	13	Male	62	6.7	14	17
		142	Female	53	6.2	19	19
		95	Female	48	6.5	15	15
	Low knowledge	45	Female	58	6.1	10	13
		104	Male	50	6.9	12	14
		130	Female	68	6.4	13	9
		136	Female	62	6.7	8	15
Poor control	High knowledge	81	Female	51	8	21	19
		16	Male	54	9.5	20	16
		1	Female	70	8.1	20	16
		143	Female	35	8.2	25	18
		105	Male	41	8.9	20	20
		88	Female	60	7.2	21	21
	Moderate knowledge	47	Male	51	8.2	16	15
		18	Female	59	7.4	16	18
		141	Female	60	7.8	16	18
		132	Female	71	8.6	15	21
	Low knowledge	118	Female	71	8.6	9	16
		14	Male	63	8.9	13	7
		42	Female	58	7.6	12	18
		15	Female	55	8.4	13	21

[+] CP score: Score of carbohydrate portion knowledge

[++]GD score: Score of general diabetes knowledge

APPENDIX F

Interview translation from Thai to English

Thai	English
“…ตอนที่รู้ว่าเป็นเบาหวาน คิดว่าแค่หยุดกินเป๊ปซี่ก็หาย แต่หลังจากได้เรียนเรื่องเบาหวานก็รู้ว่า มันไม่หาย ต้องพยายามดูแลตัวเอง แน่นอนว่าเรื่องอาหารสำคัญมากสำหรับเบาหวาน ก็เลยเลิกกินข้าวขาวมากินข้าวกล้อง ลดการกินของหวานหลังมื้ออาหาร เปลี่ยนเป็นผลไม้ได้ก็เปลี่ยน เอาจริงๆ ก็เปลี่ยนไปเกือบหมดของที่เคยกินมาก่อนหน้านี้ แล้วก็ไม่ใช่เปลี่ยนแค่ประเดี๋ยวประด๋าวนะ นี่คือเปลี่ยนไปทั้งชีวิตเลย...”	“…When I was diagnosed with diabetes, I thought it would be cured if I could just stop drinking soda. After attending diabetes education class, I learned that diabetes could not be cured. I need to take care of myself. Diet control is definitely very important in diabetes management. I changed my habit of taking white rice to brown rice. I tried to eat desserts less frequently after meals changing it to fruit. I need to change most food I usually eat. This is not just transient. It is a change for the whole of my life …”
"…กินข้าวน้อยๆ รสจืดๆ เต็มไปด้วยผักเขียวๆ นั่นแหละที่ควรกิน แต่คนเป็นเบาหวานเขาไม่ชอบหรอก เขาชอบรสจัด…"	“…Eat small amount of rice, tasteless food and full of vegetable. This is diet that people with diabetes should eat, but they do not like it. They like tasty foods…”
"…ข้าวทัพพีเดียว กับข้าวจืดๆ ผักๆ ไม่อร่อย รสชาติแปลกๆ หน้าตาไม่น่ากิน…"	“…One ladle of rice and tasteless vegetable side dish. It is not tasty, weird taste and unappetizing…”
"…หมอบอกว่า ให้กินข้าวแค่ทัพพีเดียวก็พอ เวลาป้าไม่อิ่มก็กินผลไม้ต่อ…”	“…My doctor said that one ladle of rice is adequate. If I do not feel full, I will eat fruit after meals.”

Thai	English
“…พวกเผือก พวกมัน พวกข้าวโพด เป็นแป้ง ไม่ต้องกิน ข้าวกินน้อยหน่อย กินผลไม้แทน โดยเฉพาะมื้อเย็น กินผลไม้แทนข้าว ขนาดกินสุกี้ก็ไม่ใส่วุ้นเส้น กินแล้วน้ำหนักจะได้ลง อย่างป้าไม่ชอบกินผัก ก็พยายามกินผลไม้ทดแทน…”	“…Taro, potato, corn are starch. I should not eat them. Eat rice in small amount and eat fruit instead. Eat fruit instead of rice, especially in dinner. Even it is Thai suki, I do not eat mungbean noodle. It can help to reduce weight. As I do not like vegetable, I try to eat more fruit.”
“…อย่าเลือกน้ำตาลทรายขาว เพราะคนเป็นเบาหวานกินไม่ได้ อย่าไปเชื่อใจน้ำตาลที่มาจากอ้อย ให้ใช้น้ำตาลที่มาจากมะพร้าว แบบที่มันไม่ใช่สีขาว…”	“…Do not select white sugar because it is not suitable for people with diabetes. Do not trust sugar from sugarcane. I select sugar from coconut that is not white…”
"…หมอเตือนให้เลิกกะทิ งด พวกมัน พวกทอด พวกผัด น้ำมันต้อง No cholesterol มันก็เป็นคาร์โบไฮเดรตเหมือนกัน…"	“…My doctor warned me that coconut milk, fatty foods, fried foods, should be avoided. If I need to use oil, it should be No cholesterol oil because oil is also carbohydrate…”
“…เนื้อ นม ไข่ ถั่ว ฝรั่ง แล้วก็นมถั่วเหลือง ถ้าไม่ได้เติมหวาน ตามธรรมชาติมีคาร์โบไฮเดรตน้อยมาก ที่โรงเรียนก็มีสอนไม่ใช่เหรอ ? ในวิชาสุขศึกษา…”	“…Meat, milk, egg, bean, guava and no added sugar soybean milk contain very low carbohydrate. School teach this in subject of health and hygiene, shouldn’t it ?...”
“…ถ้านมสดแท้ ไม่เติมแป้ง จะไม่มีคาร์โบไฮเดรต…”	“…If it is natural milk and no added flour, it contain no carbohydrate…”
“…อย่างข้าวกล้อง ข้าวไรซ์เบอรี่ ข้าวซ้อมมือ ให้พลังงานเท่ากับข้าวขาว แต่ลดเรื่องการดูดซึม…”	“…Brown rice, Riceberry rice, Coarse rice have energy equal to white rice, but slower absorption…”

Thai	English
“…ข้าวขาวจะเป็นน้ำตาลเยอะกว่า แต่ข้าวกล้องจะทำให้กินแล้วอ้วน มีวิตามินที่ทำให้อิ่มและอ้วน อ้วนแบบเนื้อแข็ง…”	“…White rice contains more sugar than brown rice, but brown rice contains more vitamins. If I eat brown rice, I feel full and become muscular…”
“…ข้าวกล้องมีแป้งปริมาณน้อยกว่า แพงกว่า เพราะข้าวกล้องน้ำตาลในเลือดไม่ขึ้น…”	“…Brown rice contains less starch and more expensive than white rice. If I eat brown rice, my blood glucose level does not raise…”
“…หมอบอกให้กินฝรั่ง เวลากินข้าวไม่อิ่มก็กินแทนข้าว น้ำตาลจะได้ไม่ขึ้น พวกเบอรี่ กีวี่ อโวคาโด เขาก็บอกว่าดี ก็พยายามหามากิน อยากให้น้ำตาลมันลด ไปหาซื้อที่โลตัสก็ไม่ค่อยจะมีขาย…”	“…My doctor said that I should eat guava. If I do not feel full, I eat guava instead of rice because my blood sugar level will not become high. I heard that berry, kiwi, avocado is good for diabetes. I try to eat them because I want my blood sugar level decrease. They are hard to find in supermarket…”
“…กิน GenDM เสริม กินแล้วสดชื่นดี เขาบอกว่า กินแล้วช่วยควบคุมน้ำตาลในเลือดได้ ชงกินหลังกินข้าวเย็น 1 แก้วทุกวัน…”	“…I feel refreshed after drink GenDM. I heard that it help to control blood sugar level. After dinner I drink one glass of GenDM everyday…”
“…จะซื้ออะไรก็ต้องดูก่อนว่า ดีไหม อย่างนม ก็ซื้อพวกโลว์แฟต แคลเซียมสูง ไม่งั้นกินแล้วก็จะน้ำตาลขึ้น อันไหนเขียนไว้ว่า ใยอาหารเยอะ ช่วยเรื่องการขับถ่ายก็ซื้อมากิน เลือกแต่ของที่ดีเท่านั้น...”	“…I am concerned about buying healthy foods. For milk, I choose low fat and high calcium. I can drink it without increasing blood sugar level. I bought product with high fiber because it help to relieve constipation. I choose only good foods…”

Thai	English
"…1 คาร์บ ก็เป็นขนมปังโฮลวีต 1 แผ่น แอบเปิ้ล 1 ลูก กล้วย 1 ใบ ไม่ใช่กล้วยหอมนะ ถ้ากล้วยหอมต้องแบ่งครึ่ง ทำไปเรื่อยๆ ชีวิตมันก็เป๊ะไปเอง มื้อเช้า 2 มื้อเที่ยงมื้อเย็นไม่เกิน 3…"	"…One carb is one slice of whole wheat bread, one apple, one banana, but not Hom variety. If it is Hom variety, one carb is half. Do it every day and it becomes daily life. Two carb for breakfast and three carb for lunch and dinner…"
"…ถ้านับแล้ว ได้ตามเป้า ก็กินอะไรก็ได้ขอให้กินลง ไม่ใช่ทนกิน หน้าตาเหมือนอาหารของคนปกติ ทำให้รู้สึกจำกัดน้อยที่สุด…"	"…If you use carb counting and set goal, you can eat everything you want, not suffer from eating. Foods look like normal food and make you feel restricted as few as possible…"
"…ไม่ได้นับแยกเป็นคาร์โบไฮเดรต ตั้งเป้าหมาย ไม่เกินพันสองต่อวัน วันหนึ่งสามมื้อก็ได้ มื้อละสี่ร้อย อย่างกินก๋วยเตี๋ยวน้ำก็ยังหาอะไรกินเพิ่มได้ ถ้ากินผัดซีอิ๊วก็เกิน…"	"…I do not use carb-counting. I set my goal at 1,200 Kcal per day. I eat three meals and limit 400 Kcal per meal. If I eat noodle, I can eat more. If I eat fried noodle with pork, it is over my limit…"
"…พี่ไม่เคยนับจริงจัง แค่กะว่า ข้าวกล่องนี้มันเยอะ ก็เหลือทิ้งสักครึ่งหนึ่ง หรือถ้าอยู่บ้าน ก็อาจจะให้หมาไป มัวแต่มานั่งนับ ก็ไม่ต้องทำอะไรกันพอดี…"	"…I have never seriously count carbohydrate. I roughly estimate it. For example, this box lunch is too much, I should throw away half of it or if I were home, I will give it to my dog. I do not have time to calculate carbohydrate in my foods…"
"…เคยเรียนนับส่วนอาหาร แต่ว่าเอาจริงๆนะ ไม่ได้สนใจฟัง รู้สึกมันยุ่งยาก จะกินข้าวแล้วให้มาบวก ทำไม่ได้หรอก…"	"…I received education about food portion, but I do not really pay attention. I think it is too complicated. It is impossible to do it in mealtime..."

Thai	English
"...อ่านว่า มันหมดอายุเมื่อไหร่ น้ำหนักเท่าไร เทียบดูราคา แล้วก็ดูว่ามีน้ำตาลเยอะไหม มีกี่เปอร์เซ็นต์..."	"...I read expired date, weight to compare with price and amount of sugar..."
"...ตัวหนังสือมันเล็กมาก อ่านแทบไม่เห็น ต้องใช้วิธีเอามือถือถ่ายรูปมาขยายดูอีกที จะดูทีก็ลำบาก ไม่อยากอ่าน..."	"...It is very hard to read because letters are very small. I have to take a photo by my mobile phone and enlarge image to see it clearly. It is too difficult and make me do not want to read..."
"...เราก็เลือกผักที่มีแคลอรี่น้อย ดูจากอาหารแลกเปลี่ยน เขาจะมีรายละเอียดว่าอะไรเท่าไร เขามีโชว์อาหารปลอมให้ดู ก็ตามนั้น..."	"...I choose low calorie vegetable and use food exchange to calculate. I remember it from food models..."
"...พยายามกินตามปริมาณที่เคยแอดมิดในโรงพยาบาล ตอนนั้นจำไว้ว่าให้ข้าวมื้อละเท่าไร ที่จริงตอนนี้กินน้อยกว่าตอนนั้นอีก..."	"...I try to eat in same amount of hospital foods when I was admitted in hospital. I remember amount of rice for each meal. In fact my amount of foods less than hospital foods that I remember..."
"...เราจำทฤษฎีที่เรียนมาไม่ได้หรอก เรารู้ว่าเขามีอะไรให้เปรียบเทียบ แต่เราจำไม่ได้ เราประเมินด้วยสิ่งที่เราเห็นจากการเจาะเลือดดู..."	"...I cannot remember theory. I know that it is about comparing two foods, but I cannot remember detail. I estimate foods from self-monitoring blood glucose..."
"...กินทุเรียนแล้วน้ำตาลไม่ขึ้นนะ แถมน้ำตาลสะสมยังลดอีก อาจจะไม่ดีกับคนอื่น แต่ว่าถูกโฉลกกับเรา..."	"...I eat durian, but it do not raise my blood glucose and reduce my HbA1c. It may be bad for other, but good for me..."

Thai	English
"...เราใช้ประสบการณ์ที่เคยกินมา ใช้ทดลองด้วยตนเอง อันนี้กินสองทัพพี มาเจาะเลือดดูน้ำตาลสูง อีกมื้อเรามากินลูกเดือย น้ำตาลปกติ แสดงว่ามันปรับเปลี่ยนอุณหภูมิในร่างกายของเราได้ดีมาก อย่างเผือกมันนี่สุดยอด เผือกมันอย่าเกินสามคำ สามคำนี่ น้ำตาลขึ้น..."	"…I estimate foods from my experience and I test it by myself. For example, I eat two ladle of this and after I checked my blood glucose level, it is high. In next meal, I eat job's tears and my blood glucose level is in normal range. It showed that it can adjust temperature in my body. As taro and potato are bad because if I eat more than 3 bites, my blood glucose level will be raised…"
"...ตอนนั้นกินมันกวนไปตั้ง 5 ชิ้น แต่หมอก็เฉยๆไม่ได้ว่าอะไร น้ำตาลก็ดี คงเพราะมันไม่ได้หวานเจี๊ยบ กินได้ ไม่เป็นไร..."	"…When I ate 5 pieces of sweet potato paste mixed with sugar, my doctor did not complain anything. I think I can eat it because it is not too sweet…"
"...ความหวานของผลไม้ มีผลต่อการตัดสินใจว่า จะกินมากหรือน้อย ชิมก่อนแล้วค่อยตัดสินใจ..."	"…Amount of fruits that I eat depend on how sweet of them. I tasted it before I make a decision…"
"...ซื้อมาชิมเอาก็รู้ ถ้าน้ำตาลเยอะ ก็หวาน โซเดียมเยอะก็เค็ม แค่นั้น หวานมากคราวหน้าก็ไม่ซื้อ..."	"…You will know after taste it. If it contains a lot of sugar, it tastes sweet. If it contains high sodium, it tastes salty. If it is too sweet, I will not buy it next time…"
"...ชิมดูก็รู้ เวลามาหาหมอ หมอยังชอบถามเลยว่า แล้วมันหวานไหมครับ ป้า ? ถ้าหวานก็คำสองคำ ไม่หวานก็กินเยอะหน่อย..."	"…Just taste it and you will know. When I see the doctor, he always ask me that is it sweet? If it tastes sweet, I will eat only one or two bites. If it is not sweet, I will eat more…"

Thai	English
“…ฝรั่งไม่ให้เกินสามชิ้น ถ้าเกินจากนี้ น้ำตาลจะเขยิบ ไม่ให้กินแบบสุก ให้กินแบบกรอบๆ…”	“…Guava should not be eaten more than three pieces. If I eat over than that, my blood sugar will be moved up. The ripe one should not be eaten, eat only the unripe one…”
“…ผลไม้ต้องไม่หวานจัด ไม่สุกงอม ผลไม้ดิบหรือผลไม้เปรี้ยวถึงจะดี มันเคี้ยวยากหน่อยแต่ว่าดีนะ อย่างเช่น ฝรั่งนิ่มๆสุกๆ นี่คือไม่ดี ต้องซื้ออันที่แข็งๆและดิบอยู่…”	“…As fruits should not be too sweet and ripe. The good fruits should be unripe and taste sour. It is hard to chew but healthy. For example, soft and ripe guava is not good. You have to buy the one which was tough and unripe…”
“…ลูกหิ้วขนมกลับบ้านมาตลอด เราก็ได้แต่บ่นๆว่า ซื้อมาทำไม ซื้อมาก็อดกินไม่ได้ อย่างข้าวเหนียวถั่วดำ…”	“…My daughter always buy some desserts for me. I told her that if you buy some desserts, I cannot stop myself from eating it, especially sticky rice with black beans…”
“…ซื้อ ซื้อ ซื้อแล้วซื้ออีก ป้ารู้นะว่าลูกมันรักป้า แต่มันไม่เคยสนใจเลยว่า น้ำตาลป้าจะได้เท่าไร ถ้าไม่กินที่มันซื้อมานะ มันก็โกรธป้าอีก มันชอบบอกว่า แม่ๆ กินนิดเดียว ทำไรแม่ไม่ได้หรอก เดี๋ยวพรุ่งนี้แม่ค่อยกลับไปคุมนะ ...”	“…Buy, buy, buy again and again. I knew she love me, but she does not care about my blood glucose level. If I do not eat snacks which she bought, she will be angry with me. She said that small amount of snack cannot harm you and you should go back to manage blood sugar level tomorrow…”
“…ลูกซื้อเบเกอรี่มาจากพารากอน ชิ้นละตั้งเป็นร้อย เราก็เลยกิน…”	“…My son bought bakery from department store. I eat it because it is so expensive…”

Thai	English
“…ตั้งใจไว้ว่า อาทิตย์หนึ่งจะกินบุฟเฟ่ต์ไม่เกินหนึ่งครั้ง แต่ทำไม่สำเร็จ เพื่อนชวนก็ไป…”	“…My goal is eating at buffet once a week, but I failed to reach my goal when my friends ask me to go out…”
“…ถ้าอยู่ห้องเฉยๆ ไม่เจอใคร ไม่เห็นอะไร ก็ไม่นึกอยากนะ แต่พอออกไปข้างนอก เห็นคนนั้นคนนี้ เพื่อนชวนก็เอา…”	“…If I stay in my room and do not meet anybody, I do not want to eat anything. When I go out and meet my friends, I go out to eat…”
“…เราอยากกินข้าวตู น้ำตาลเยอะที่สุด เพื่อนไม่ได้ให้ครึ่งหนึ่งนะ แบ่งสี่แบ่งแปด แล้วบอกว่า เจ้อมไว้ อย่ากลิน ก็อมแล้วก็คายทิ้ง น้ำตาลก็เข้านิดเดียว…”	“…I want to eat dried rice balls sweetened with sirup. I know it contains a lot of sugar. My friend share it with me, but not in half, just quarter or an eighth. She said that please do not swallow, just hold it in your mouth and spit it out. A little sugar can be absorbed…”
“…พี่ที่ทำงาน น้องที่ทำงานก็จะบอกว่า พี่อย่างนี้ไม่ได้นะ วันนี้กินอะไร วันนี้กินยัง พอเห็นหยิบขนมก็ พี่กี่ชิ้นแล้ว…”	“…My colleagues said that you cannot eat this. What do you eat today? Did you have lunch? If I pick up some desserts, they will ask me that how many pieces of them that you ate?...”
“…งานของเราเป็นงานที่ใช้แรงกำลัง ใช้แรงงาน ข้าวก็ต้องกินเยอะ จะได้มีแรง หรือไม่ก็กินหวาน แล้วจะไม่เหนื่อย สู้งานได้…”	“I am hard worker. I have to eat a lot because I need energy or if I eat something sweet, I will not feel tried and can do my job well…”
“…เราต้องทำโอที เราหิว เราอาจจะไม่ได้กินสองมื้อ แต่เป็นสี่มื้อ เรื่องลดน้ำหนักไม่ต้องพูดถึง…”	“…I have to work overtime and I feel hungry. I may not eat 2 meals, but eat 4 meals. It is impossible to control my weight…”

Thai	English
“…ประชุมทีก็มีขนมตลอด ยิ่งประชุมยาวๆ เราก็หิว ยังไงก็ต้องกินทั้งขนมทั้งกาแฟ จากนั้นน้ำตาลก็จะพุ่งปรี๊ด…”	“…It always has some snacks at the meeting. If it is a long meeting, I will be hungry and I eat snack with coffee. After that my blood glucose level will be risen up…”
“…คุณหมอบอกว่า ให้ผมกินข้าวตรงเวลา ผมก็พยายามนะ แต่บางทีก็ติดผู้โดยสาร ถ้าวันไหนใจมันเริ่มสั่น ก็เอาลูกอมขึ้นมาอม เขาแนะนำอะไรก็พยายามทำให้ได้ เราต้องดูแลตัวเอง…”	“…My doctor said that you should have meal at the same time. I try to do it, but sometime I have passengers. If I feel dizzy, I will eat my candy. I try to follow the doctor‘s suggestion. I know I should take care of myself…”
“…เป็นคนไม่กินขนม ยังสงสัยว่า เบาหวานมาจากไหน สงสัยเป็นกรรมพันธุ์ คุมเท่าไรก็ไม่ลด…”	“…I rarely eat dessert. I wonder why I became diabetic. I think it come from genes and cannot be controlled…”
“…เป็นที่ยีนส์แล้วล่ะ เลือกสรรแต่ของดีแล้ว ไม่หวาน แต่น้ำตาลก็ยังขึ้น ไม่น่าเกี่ยวกับอาหาร บางคนกินเยอะกว่าเรา น้ำตาลไม่เห็นขึ้น เมตะบอลิสมของแต่ละคนต่างกัน…”	“…It is because of my genes. I choose only good foods, not sweet foods, but my blood sugar level is still high. It did not relate with my diet because other eat more than me but their sugar level still is not high. People Metabolism is different for each person…”
“…ตอนนี้เจาะน้ำตาลปลายนิ้วตอนเช้า ก่อนกินข้าว ไม่เคยเกินร้อย ถือว่าดีมากๆ ถ้าตรวจน้ำตาลแล้วน้อยกว่า 120 ก็โอเคแหละ พอใจกับจุดนี้…”	“…My sugar level from glucose meter that I checked before breakfast is not more than one hundred. It means very good. If it is less than one hundred and twenty, it means fair. I am satisfied with this…”

Thai	English
"…ที่จริงหมอเขาก็เคยบอกว่า น้ำตาลต้องได้ 100 แต่ไม่เกิน 140 ก็ยังพอใช้ได้นะ ส่วนตัวเราพอใจ…"	"…In fact the doctor said that sugar level should be one hundred, but I think not more than one hundred and forty is fair. For me, I am satisfied…"
"…น้ำตาลได้ 140-150 ก็พอใจนะ เอาไม่เกิน 200 เกินก็ไม่ไหว…"	"…My sugar level is around one hundred forty to one hundred fifty. I am satisfied with this, but it should be not more than two hundred…"
"…พอใจ เพราะ สบายดี แข็งแรง ไม่มีอาการอะไร หมอเคยบ่นเหมือนกันว่า ค่าอะไรสักอย่างไม่ดี แต่เราทำงานได้ปกติ ก็โอเคแล้ว…"	"…I am satisfied because I am fine, healthy, have no symptoms. My doctor complained about some blood tests, but I do not care if I can work normally…"
"…หนูควรจะไปเลือกถามคนอื่นนะ ไม่ใช่ป้า เพราะว่าป้ารู้ทุกเรื่อง น่าจะไปเลือกคนที่เขาไม่ค่อยรู้เรื่องอะไร ป้าเรียนมาหมดแล้ว เรียนมาหลายรอบ เรื่องเบาหวานเนี่ย อะไรที่ถามมาป้าตอบได้หมด…"	"…You should not choose me for interview because I know everything. You have to choose someone who know nothing. I learn about diabetes many times. Whatever you ask I can answer it…"
"…เบื่อมากเวลาที่ต้องเข้าห้องสอนแสดง มันเสียเวลามากเลยนะ เรื่องที่สอนนี่ฟังมาเกินสิบหนได้แล้วมั้ง ขอโทษ แต่ต้องใช้คำว่า มันโคตรน่าเบื่อเลย เข้าไปก็นั่งเงียบๆสักพัก ก็จะเลิกไปเอง..."	"…I am so bored when I have to go to the room for diabetes education. It wasted my time because I heard about this lesson more than 10 times. It is extremely boring. If I stay silent, it will be ended faster…"
"…มันเชื่อถือได้จริงๆเหรอ ? อ่านดู ไม่เห็นน้ำตาลเยอะสักอย่าง…"	"…Can I trust the nutrition facts label? I have never found a product with high amount of sugar…"

Thai	English
"...มันคือคำโฆษณา บางอันนี่หลอก เขียนว่าน้ำตาลน้อย กินเข้าไปแล้วหวาน บางอันก็ไขมันเยอะ ทั้งที่บอกน้ำตาล 0% แต่ทำไมถึงยังมีรสหวาน..."	"…It is an advertisement. Some of them presented low sugar, but it tastes very sweet. Some of them contains high fat. Even it is labeled 0% sugar, it still tastes sweet…"
"...ตัวเลขมันดูแตกต่างกันเยอะ ทั้งที่ของมันหน้าตาคล้ายๆกัน มาตรฐานเดียวกันไหม ถ้ามาจากจีน ญี่ปุ่น เกาหลี มาตรฐานเดียวกับสมุทรสาคร หรือมาตรฐานกรุงเทพฯไหม..."	"….The numbers look a lot different, but the products look similar. Are they in the same standard if they comes from China, Japan, Korea? Are they in the same standard between Samut Sakhon and Bangkok?..."
"...หมอให้กินข้าวทัพพีเดียว แต่มันซื้อทัพพีเดียวไม่ได้ เชาไม่ชาย ก็ต้องกินให้หมด เหลือทิ้งไม่ได้หรอก พ่อแม่สอนมา เราเป็นลูกชาวนา ปลูกข้าวมันลำบากนะลูก..."	"…A doctor told that eating one ladle of rice, but no one sell rice in one ladle. I have to eat it all, I cannot leave it. My parents taught me that my family are farmer and growing rice is hard work…"
"...เวลาไปซื้อเขา บอกเขาข้าวน้อย แต่เขาก็ยังตักปกติ ซื้อมาเราก็ต้องกินให้หมด บางคนก็แบ่งนะ แต่เราแบ่งไม่ได้ ไม่มีตู้เย็น เก็บไว้ก็เสียอยู่ดี..."	"…When I go to buy my food, I told them that I want small amount of rice, but they still give me normal portion size. I have to eat it all. I heard that someone divide it for more meals, but I cannot because I do not have refrigerator. If I keep it, it will become spoiled..."
"...แบ่งอาหารที่ซื้อมา กินสองมื้อ โดยเก็บครึ่งหนึ่งไว้ในตู้เย็น..."	"…I divide my foods which I bought into two meals and keep half of it in my refrigerator…"

Thai	English
“…ข้าวถุงหนึ่งเยอะมาก เอามาแบ่งกินสามมื้อ มื้อเย็นน้อยที่สุด หรือไม่ก็ให้หมาไป…”	“…One package of rice is very big. I can share it for three meals and the smallest amount is in my dinner or I give some to my dog…”
“…เวลาได้อะไรมาเยอะๆ ก็แบ่งออกมาเท่าที่จะกิน ที่เหลือก็ตกเป็นของน้องหมา…”	“…When I received some food a lot, I keep it only I can eat. The rest of them will become my dog’s food…”
“…ซื้อข้าวเหนียวมะม่วงให้พ่อกิน ตั้ง 200 พ่อกินไปสองสามช้อน เหลือค่อนกิโล ก็ซัดซะ…”	“…I bought sticky rice with ripe mango for my father. It is very expensive, but my father eat only two or three spoons of it and leave around half of kilogram. Then, I eat it all…”
“…ซื้อมาชิ้นละร้อยกว่า กินไปนิดเดียว เสียดาย เราก็กินแทน…”	“…It cost one hundred something for one piece and it was eaten only a few bite. I ate it instead of wasting it….”

APPENDIX G

Permission Letter to use the instrument

Subject: Re: Permission to use diabetes knowledge questionnaire
From: "Supakit Wongwiwatthananukit" <supakit@hawaii.edu>
To: "Pornsawan Prutanopajai" <Pornsawan.Pr@student.chula.ac.th>
Cc:
Recieved: Fri Jan 22 16:01:02 ICT 2016
Folder: INBOX

Sawasdee Krub Pornsawan,

You have my permission to use this instrument. Instructions for using this instrument already indicated in that published paper.

Wishing you the best of luck with your project.

Supakit

On Jan 21, 2016, at 9:03 PM, Pornsawan Prutanopajai <Pornsawan.Pr@student.chula.ac.th> wrote:

> Dear Asst. Prof. Dr. Supakit Wongwiwatthananukit
>
> I am a master's degree student in Food and Nutrition program of Chulalongkorn University. I am writing my thesis proposal about nutrition knowledge in type 2 diabetes patients. My research aims to determine understanding of carbohydrate portion in type 2 diabetes patients. I would like your permission to use the validated instrument to assess the general knowledge of patients with diabetes that is published in Thai Journal of Pharmaceutical Sciences (2004). I will use the instrument only for my research study and will not sell or use it with any compensated or curriculum development activities. If my request is granted, please send me your letter of permission and any suggestion of using through email: Pornsawan.Pr@student.chula.ac.th
>
> Sincerely,
>
> Pornsawan Prutanopajai

VITA

Ms. Pornsawan Prutanopajai was born on May, 11th, 1987 in Bangkok Thailand. She graduated with Bachelor degree of Sciences (Nutrition and Dietetics) with second class honours from Faculty of Allied Health Sciences, Chulalongkorn University in 2009. She has worked at the department of dietetics and diet therapy, King Chulalongkorn Memorial Hospital as a nutritionist.