ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิก ของประชากรในอำเภอเมือง จังหวัดนครราชสีมา

นางสาวรัชฎา สุธาดารัตน์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาเภสัชศาสตรมหาบัณฑิต
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RELATIONSHIP BETWEEN DIETARY PATTERN AND METABOLIC SYNDROME IN POPULATION IN MUEANG DISTRICT, NAKHON RATCHASIMA PROVINCE

Miss Ratchada Sutadarat

A Thesis Submitted in Partial Fulfillment of the Requirements

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รัชฎา สุธาดารัตน์: ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา. (RELATIONSHIP BETWEEN DIETARY PATTERN AND METABOLIC SYNDROME IN POPULATION IN MUEANG DISTRICT, NAKHON RATCHASIMA PROVINCE) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ.ดร. สุญาณี พงษ์ธนานิกร, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: ผศ.ดร. กุลวรา เมฆสวรรค์, 96 หน้า.

การศึกษาเชิงพรรณนา ณ จุดเวลาใดเวลาหนึ่ง ในครั้งนี้มีวัตถุประสงค์เพื่อศึกษาความชุกของกลุ่มอาการเมแทบอลิก และความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา กลุ่มตัวอย่างคือประชากรที่มีอายุ 20 ปีขึ้นไป ที่เข้ารับการตรวจสุขภาพประจำปี ณ โรงพยาบาลมหาราชนครราชสีมา ในช่วงระหว่างเดือนธันวาคม 2551 ถึงเดือนมีนาคม 2552 จำนวน 480 คน (ชาย 230 คน และหญิง 250 คน) การวินิจฉัยกลุ่มอาการเมแทบอลิกใช้เกณฑ์ของ IDF และ NCEP ATP III และใช้เกณฑ์จุดตัดเส้นรอบเอวสำหรับชาวเอเชีย เก็บข้อมูลจากผลการตรวจวัดระดับชีวเคมีในเลือด ความดันโลหิต เส้นรอบเอว และแบบสอบถาม ประเมินความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกโดยใช้สถิติความถดถอยโลจิสติคเชิงพหุ

ผลการศึกษาพบความชุกของกลุ่มอาการเมแทบอลิกตามเกณฑ์ของ IDF ร้อยละ 15.4 (เพศชาย ร้อยละ 13.9 และเพศหญิง ร้อยละ 16.8) และตามเกณฑ์ของ NCEP ATP III ร้อยละ 17.9 (เพศชาย ร้อยละ 18.7 และเพศหญิง ร้อยละ 17.2) โดยไม่พบความแตกต่างอย่างมีนัยสำคัญระหว่างเพศชายและเพศหญิงในทั้งสองเกณฑ์การวินิจฉัย ด้านความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิก พบว่าการบริโภคอาหารมื้อดึก (OR = 9.22, 95% CI = 1.37-61.97, p = 0.022) การดื่มแอลกอฮอล์มากกว่า 30 กรัมต่อวัน (OR = 3.54, 95% CI = 1.04-12.07, p = 0.043) และการบริโภคผลิตภัณฑ์เบเกอรี่มากกว่า 3 วันต่อสัปดาห์ (OR = 5.24, 95% CI = 1.32-20.89, p = 0.019) มีความสัมพันธ์กับการเกิดกลุ่มอาการเมแทบอลิกอย่างมีนัยสำคัญ ผลจากการศึกษานี้แสดงให้เห็นว่ากลุ่มอาการเมแทบอลิกเป็นหนึ่งในปัญหาทางสุขภาพของประชากรเขตเมือง และการบริโภคอาหารเป็นปัจจัยที่มีความสำคัญต่อการเกิดกลุ่มอาการเมแทบอลิก ดังนั้นจึงควรมีการปรับเปลี่ยนแบบแผนการบริโภคอาหารโดยเฉพาะอย่างยิ่งการบริโภคอาหารมื้อดึก การดื่มเครื่องดื่มที่มีแอลกอฮอล์ และการบริโภคอาหารที่มีคาร์โบไฮเดรตและไขมันสูง เพื่อลดความเสี่ยงต่อการเกิดกลุ่มอาการเมแทบอลิกตามมา

ภาควิชา.....อาหารและเภสัชเคมี..... ลายมือชื่อนิสิต.....รัชฎา สุธาดารัตน์.....

สาขาวิชา...อาหารเคมีและโภชนศาสตร์ทางการแพทย์..ลายมือชื่อ อ. ที่ปรึกษาวิทยานิพนธ์หลัก.สุญาณี พงษ์ธนานิกร.....

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##5076585833 : MAJOR FOOD CHEMISTRY AND MEDICAL NUTRITION
KEYWORDS : METABOLIC SYNDROME/DIETARY PATTERN/PREVALENCE
RATCHADA SUTADARAT: RELATIONSHIP BETWEEN DIETARY PATTERN AND METABOLIC SYNDROME IN POPULATION IN MUEANG DISTRICT, NAKHON RATCHASIMA PROVINCE. THESIS ADVISOR: ASST. PROF. SUYANEE PONGTHANANIKORN, Dr.P.H., THESIS CO-ADVISOR: ASST. PROF. KULWARA MEKSAWAN, Ph.D., 96 pp.

This cross-sectional descriptive study aimed to examine the prevalence of metabolic syndrome and the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province. The samples were 480 persons (230 males and 250 females) aged 20 years and over who received the annual health examination at Maharat Nakhon Ratchasima Hospital during December, 2008 through March, 2009. The diagnosis of metabolic syndrome was defined by the IDF and the NCEP ATP III criteria, with the modified waist circumference cut off points for Asian population. The data were collected from blood biochemical test, blood pressure measurement, waist circumference measurement, and questionnaires. The relationship between dietary pattern and metabolic syndrome was evaluated by multiple logistic regression.

The results showed that the prevalence of metabolic syndrome defined by the IDF was 15.4% (13.9% in males and 16.8% in females) and by the NCEP ATP III was 17.9% (18.7% in males and 17.2% in females). No significant difference in prevalence between males and females by both criteria was found. The analysis of the relationship between dietary pattern and metabolic syndrome showed that late night meal intake (OR = 9.22, 95% CI = 1.37-61.97, p = 0.022), alcohol consumption more than 30 grams per day (OR = 3.54, 95% CI = 1.04-12.07, p = 0.043), and bakery product intake more than 3 days per week (OR = 5.24, 95% CI = 1.32-20.89, p = 0.019) were significantly associated with metabolic syndrome. The findings from this study illustrated that the metabolic syndrome was one of health problems in urban population, and dietary pattern was an important factor that influenced the development of metabolic syndrome. Therefore, it is suggested that some dietary patterns should be modified, especially late night meal intake, alcohol consumption and high carbohydrate and fat intake to decrease the risk of metabolic syndrome.

Department:....Food and Pharmaceutical Chemistry.....Student's Signature..Ratchada Sutadarat.....
Field of Study:.Food Chemistry and Medical Nutrition..Advisor's Signature....Suyanee Pongthananikorn.....
Academic Year:.....2009.....Co-Advisor's Signature.....Kulwara Meksawan

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CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

et al.	et alia (and others)
CVD	cardiovascular disease
HDL-C	high-density lipoprotein cholesterol
NCEP ATP III	National Cholesterol Education Program Adult Treatment Panel III
IDF	International Diabetes Federation
cm	centimeter
mg/dl	milligram per deciliter
mmHg	millimeter Hg
type 2 DM	type 2 diabetes mellitus
CRP	C-reactive protein
NEFA	nonesterified fatty acid
PAI-1	plasminogen activator inhibitor-1
WHO	World Health Organization
EGIR	European Group for Study of Insulin Resistance
AACE	American Association of Clinical Endocrinologists
AHA/NHLBI	American Heart Association/National Heart Lung and Blood Institutes
TG	triglycerides
p	*p*-value
BMI	body mass index
kg/m^2	kilogram per square meter
LDL-C	low-density lipoprotein cholesterol
DASH	Dietary Approaches to Stop Hypertension
ml	milliliter
SD	standard deviation
OR	odds ratio
95% CI	95% confidence interval
n	number

min	minimum
max	maximum
vs	versus
HTN	hypertension
DM	diabetes mellitus
kcal	kilocalorie
DRI	dietary reference intake
SBP	systolic blood pressure
DBP	diastolic blood pressure
etc.	et cetera (and others)
VIF	variance inflation factor

CHAPTER 1

INTRODUCTION

1.1 Background and Rationale

The metabolic syndrome is a cluster of metabolic abnormalities such as abdominal obesity, hyperglycemia, dyslipidemia, and hypertension (Grundy et al., 2005). The report of Thailand population health examination survey III in population aged 15 years and over showed that the prevalence of abdominal obesity was 15.0% in males and 36.0% in females, hyperglycemia 15.4% in males and 10.6% in females, dyslipidemia 14.0% in males and 17.0% in females**,** and hypertension 23.0% in males and 21.0% in females (Ministry of Public Health, Health System Research Institute, 2006). These diseases were the components of metabolic syndrome that associated with increased risk of developing cardiovascular disease (CVD) and type 2 diabetes, which were the major causes of mortality and health problem of non-communicable chronic diseases in Thailand.

Several studies in worldwide population aged 20 years and over showed that the prevalence of metabolic syndrome varied from 7% to 42%. Namely, the prevalence of metabolic syndrome was 7.0% in Korean (Lee et al., 2004), 15.0% in European (Hu et al., 2004), 23.7% in American (Ford, Giles and Dietz, 2002), 39.6% in Arabian (Malik and Razig, 2008), and 42.0% in Iranian (Azizi et al., 2003) populations. For Asian countries, China, Taiwan, Hong Kong, Japan, and Thailand had similar prevalence rate ranging between 10-15% (Pan, Yeh and Weng, 2008). In the male population, Thai had higher metabolic syndrome prevalence (25.8%) than those of Japanese (13.3%) and Chinese (9.8%), while in the female population, Thai

had lower prevalence (8.2%) than those of Japanese (11.5%) and Chinese (17.8%) (Gu et al., 2005; Lohsoonthorn, Lertmaharit and Williams, 2007; Shiwaku et al., 2005). In Thailand, the survey of metabolic syndrome prevalence in Bangkok and northeast provinces showed that the prevalence was 15.2% in Bangkok (Lohsoonthorn et al., 2007), 15.0% in Khon Kean Province (Pongchaiyakul et al., 2007), 17.0% in Nong Khai Province (Kaewtrakulpong, 2008), and 24.0% in Surin Province (Wilaisakunyong, Deeying and Wongthimakorn, 2007).

The exact etiology of metabolic syndrome remains unclear, but it is known to be a complex interaction between genetic and environmental factors. Among environmental factors, dietary habits are the major importance for prevention and treatment of the metabolic syndrome (Feldeisen and Tucker, 2007). The consumption of high fat diet, high carbohydrate diet, salty diet, sweetened beverage, and diets low in fruits, vegetables and whole grains associate with increasing of metabolic syndrome (Giugliano, Ceriello and Esposito, 2008). In preceding time, Thailand had rapid socioeconomic growth, resulting in lifestyle changes, especially in the city. Thai population tend to increase consumption of fastfood, which consisted of high fat and carbohydrate and decrease consumption of fruits and vegetables. These dietary habits had promoted the development of metabolic syndrome. The National Statistical Office of Thailand studied the food consumption behavior in Thai population aged 6 years and over. The results showed that the food group consumption of Thai population were ranging from meat and meat products (97.4%), fatty foods (86.3%), processed foods (83.2%), carbonated and sweetened beverages (71.7%), and snacks (49.0%) (Ministry of Information and Communication Technology, National Statistical Office, 2005). In addition, Thai population had increased consumption of sugar and sweetened foods, and consumed fruits and

vegetables below the standard value that recommended the consumption of a minimum of 400 grams per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases such as heart disease, diabetes, and obesity (Ministry of Public Health, Health System Research Institute, 2006). Department of Health, Ministry of Public Health studied the dietary behaviors among Thais working age with sedentary lifestyle in Bangkok. It was found that the person who consumed large dinner, diets low in fish, and repeated dietary type had the increased risk of developing CVD, and the person who consumed high meat and meat products and low grains had the increased risk of developing abdominal obesity (Saiwongse et al., 2008).

In Thailand, most studies examined the prevalence of metabolic syndrome without focusing on the relationship with dietary pattern. There were few studies that assessed the prevalence of metabolic syndrome and its association with dietary behaviors. Therefore, this study was designed to examine the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province for using as the nutritional data for health promotion and prevention of metabolic syndrome.

1.2 Objectives of the Study

The aim of the study was to estimate the prevalence of metabolic syndrome and to determine the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province.

1.3 Research Variables

Independent variables were the dietary pattern and health behaviors (physical activity, cigarette smoking, time spent for sleeping, weight control, dietary supplement intake for weight loss, family history, and medications).

Dependent variable was the metabolic syndrome that consisted of 5 components: waist circumference, fasting plasma glucose, serum triglycerides, serum high-density lipoprotein cholesterol (HDL-C), and blood pressure.

1.4 Scope of the Study

This research was aimed to study among population aged 20 years and over in Mueang District, Nakhon Ratchasima Province who received the annual health examination at Maharat Nakhon Ratchasima Hospital during December, 2008 through March, 2009.

1.5 Operational Definition of Terms

Metabolic syndrome: a cluster of metabolic abnormalities such as abdominal obesity, elevated plasma glucose, elevated serum triglycerides, reduced serum HDL-C, and elevated blood pressure. The diagnostic criteria of metabolic syndrome defined by the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) (National Cholesterol Education Program, 2001) requires three or more of the five components : 1) waist circumference ≥ 90 cm in male and ≥ 80 cm in female, 2) fasting plasma glucose ≥ 100 mg/dl or previously diagnosed type 2 diabetes, 3) triglycerides ≥ 150 mg/dl or drug treatment for elevated triglycerides, 4) HDL-C < 40 mg/dl in male and < 50 mg/dl in female or drug treatment for reduced HDL-C, 5) systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 85

mmHg or drug treatment for hypertension. The diagnostic criteria of metabolic syndrome defined by the International Diabetes Federation (IDF) (Alberti, Zimmet and Shaw, 2005) requires waist circumference ≥ 90 cm in male and ≥ 80 cm in female plus any two or more of the four components as mentioned.

For the waist circumference, the present study used the recommended ethnic-specific cut off points for an Asian population (≥ 90 cm for male and ≥ 80 cm for female) in both the NCEP ATP III and the IDF criteria (Alberti et al., 2005; The World Health Organization Western Pacific Region, the International Association for the Study of Obesity, and the International Obesity Task Force, 2000).

Dietary pattern: a description of dietary behaviors such as the number of meals per day, late night meal intake, large meal intake, favorite cooking method, favorite taste, meal-made pattern, repeated dietary type intake, time between dinner and bedtime, time spent on each meal, beverage consumption, frequency of dietary consumption, total daily energy intake, and energy distribution from carbohydrate, protein and fat intakes.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of Metabolic Syndrome

The metabolic syndrome is a cluster of metabolic abnormalities that is associated with increased risk of developing CVD and type 2 diabetes mellitus (type 2 DM). The abnormalities which are the components of metabolic syndrome such as abdominal obesity, elevated plasma glucose, elevated serum triglycerides, reduced serum HDL-C, and elevated blood pressure. In addition, there are other abnormalities found in person with metabolic syndrome such as proinflammatory state (elevated C-reactive protein (CRP) in blood), prothrombotic state (high fibrinogen or plasminogen activator inhibitor-1 in blood), hyperuricemia, and microalbuminuria (Grundy et al., 2004a). Metabolic syndrome is also known as insulin resistance syndrome, deadly quartet, syndrome X, and Reaven syndrome (Grundy et al., 2005).

2.2 Pathogenesis of Metabolic Syndrome

The exact etiology of metabolic syndrome remains obscure, but it is believed that a complex interaction between genetic and environmental factors such as age, sex, family history, dietary pattern, physical activity, cigarette smoking, alcohol consumption, and stress promote the development of abdominal obesity and insulin resistance, which are dominant risk factors for the presence of metabolic syndrome (Baxter, Coyne and McClintock, 2006; Grundy et al., 2004b). Several studies investigated the risk factors for the presence of metabolic syndrome. Reaven, Strom

and Fox (2000) found that 50% of patients with metabolic syndrome had a cause from genetic factor, and another 50% of those had a cause from lifestyle behaviors. Wu (2002) found that the risk factors that influenced on the presence of metabolic syndrome were high waist circumference (excess fat in abdomen) and family history of diabetes for males, and were high waist circumference and family history of hypertension for females. Ford et al. (2002) found that the prevalence of metabolic syndrome increased with advancing age. The prevalence was 6.7% among 20-29 aged group and increased to 43.5% among 60-69 aged group.

Abdominal obesity is the presence of excessive fat tissue in and around the abdomen. It is the main factor for the rising prevalence of metabolic syndrome. It contributes to hyperglycemia, elevated serum triglycerides, reduced serum HDL-C, and hypertension that associate with higher CVD risk. Abdominal obesity especially correlates with metabolic components. Excess adipose tissue releases several products that apparently exacerbate these components. They include nonesterified fatty acids (NEFA), cytokines, plasminogen activator inhibitor-1 (PAI-1), and adiponectin. A high plasma NEFA level overloads muscle and liver with lipid, which enhances insulin resistance. High CRP level accompanying obesity may signify excessive cytokines and proinflammatory state. An elevated PAI-1 contributes to a prothrombotic state, whereas low adiponectin level that accompany obesity correlates with worsen metabolic components. The strong connection between obesity and metabolic components lead NCEP ATP III to define the metabolic syndrome, essentially as a cluster of metabolic complications of obesity (Grundy et al., 2004a).

Insulin resistance is the impairment of tissue responsiveness to the normal action of insulin. It is linked to obesity, generally rises with increasing body fat

content. Weight gain seems to enhance insulin resistance and metabolic syndrome. Most people with obesity or overweight have postprandial hyperinsulinemia and relatively low insulin sensitivity. When insulin-resistant muscle is already overloaded with lipid from high plasma NEFA level, some excess NEFA presumably are diverted to the liver, promoting fatty liver and atherogenic dyslipidemia. Moreover, hyperinsulinemia may enhance output of very low-density lipoprotein cholesterol and raise triglycerides. Insulin resistance in muscle predisposes to glucose intolerance, which can be worsened by increased hepatic gluconeogenesis in insulin-resistant liver. Finally, insulin resistance may raise blood pressure by a variety of mechanisms (Grundy et al., 2004a).

Beyond the presence of metabolic syndrome increased the risk of CVD and type 2 diabetes, individuals with metabolic syndrome may be susceptible to other conditions such as polycystic ovary syndrome, fatty liver, nonalcoholic steatohepatitis, cholesterol gallstones, asthma, sleep disturbances, and some types of cancer (Grundy et al., 2004a).

2.3 Clinical Diagnosis of Metabolic Syndrome

From clinical standpoint, the presence of the metabolic syndrome identifies a person at increased risk for CVD and/or type 2 diabetes. In the effort to introduce the metabolic syndrome into clinical practice, several organizations have attempted to formulate simple criteria for its diagnosis. Consequently, there are many criteria for diagnosing metabolic syndrome such as the World Health Organization (WHO) 1998, European Group for Study of Insulin Resistance (EGIR) 1999, National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) 2001, American Association of Clinical Endocrinologists (AACE) 2003, International Diabetes

Federation (IDF) 2005, and American Heart Association/National Heart Lung and Blood Institutes (AHA/NHLBI) 2005 (Grundy et al., 2005). However, the NCEP ATP III and the IDF criteria are widely considered useful for assessing the magnitude of metabolic syndrome in general population (Pan et al., 2008; Pongchaiyakul et al., 2007). There are some differences in the detail between the NCEP ATP III and the IDF criteria. The NCEP ATP III considers that each metabolic component has the same importance, whereas the IDF proposes abdominal obesity as the essential condition. In addition, the NCEP ATP III considers the waist circumference cut off points regardless of ethnicity, while the IDF uses ethnic-specific cut off points for waist circumference (Chatngern, 2008; Grundy et al., 2005). Table 1 presents the metabolic syndrome defined by the NCEP ATP III criteria. A person is diagnosed as the metabolic syndrome if he/she has three or more of the five components (National Cholesterol Education Program, 2001). Based on the IDF criteria, a person is diagnosed as the metabolic syndrome if he/she has waist circumference ≥ 90 cm in male and ≥ 80 cm in female plus any two or more of the four components (Alberti et al., 2005). From the different criteria, the estimation of prevalence rate will vary inevitably and long-term cardiovascular risks of these criteria may also differ (Pan et al., 2008).

Table 1 The metabolic syndrome defined by the NCEP ATP III and the IDF criteria

Components	Criteria	
	NCEP ATP III	**IDF**
Waist circumference	male ≥ 90 cm [a] female ≥ 80 cm [a]	male ≥ 90 cm [b] female ≥ 80 cm [b]
Fasting plasma glucose	≥ 100 mg/dl or previously diagnosed type 2 DM	≥ 100 mg/dl or previously diagnosed type 2 DM
Triglycerides	≥ 150 mg/dl or drug treatment for elevated TG	≥ 150 mg/dl or drug treatment for elevated TG
High-density lipoprotein cholesterol	male < 40 mg/dl female < 50 mg/dl or drug treatment for reduced HDL-C	male < 40 mg/dl female < 50 mg/dl or drug treatment for reduced HDL-C
Blood pressure	≥ 130/85 mmHg or drug treatment for hypertension	≥ 130/85 mmHg or drug treatment for hypertension

[a] Using the recommended ethnic-specific cut off points for Asian population according to WHO such as ≥ 90 cm in male and ≥ 80 cm in female (Grundy et al., 2005; The World Health Organization Western Pacific Region et al., 2000)

[b] The recommended ethnic-specific cut off points according to IDF such as ≥ 90 cm in male and ≥ 80 cm in female for South Asian, ≥ 90 cm in male and ≥ 80 cm in female for Chinese, ≥ 85 cm in male and ≥ 90 cm in female for Japanese, and ≥ 94 cm in male and ≥ 80 cm in female for European (Alberti et al., 2005)

2.4 Management of Metabolic Syndrome

The goal of metabolic syndrome management is to reduce risk of developing CVD and diabetes. The NCEP ATP III recommends that obesity is the primary target of the intervention for metabolic syndrome. First-line therapy should be weight reduction with reinforcement of lifestyle modifications by a combination of caloric restriction and increased physical activity (Grundy et al., 2004a). Weight reduction is the major goal and probably the core of the underlying mechanisms that finally lead to

the improvement of the metabolic syndrome components (Fappa et al., 2008). The first aim of weight loss is to achieve a decline of about 7-10% from baseline total body weight during a period of 6 to 12 months. This will require decreasing caloric intake by 500 to 1,000 kilocalories per day. Moderate-intensity exercise at least 30 minutes per day helps to enhance caloric deficit (Thompson et al., 2003). Achieving the recommended amount of weight loss will reduce the severity of the components of metabolic syndrome (Grundy et al., 2004a; Grundy et al., 2005). Muzio et al. (2005) found that patients who had weight loss more than 10% of their initial body weight experienced greater reduction in the metabolic syndrome components compared with those achieving less than 10%. A combination of caloric restriction and increased physical activity could improve individual metabolic syndrome components by promoting weight reduction (Christ et al., 2004). Baxter et al. (2006) found that dietary and exercise therapies have been shown to significantly reduce the progression of metabolic syndrome components. The diet should be low in saturated fats, trans fats, cholesterol, sodium, and simple sugars, and high in fruits, vegetables and whole grains. These dietary patterns have been found to have a beneficial effect on the metabolic syndrome (Fappa et al., 2008; Grundy et al., 2005).

In summary, lifestyle modifications have a favorable effect on the metabolic syndrome. Dietary changes constitute the core of management and the increased exercise has an additional favorable effect for weight reduction that is the primary management for the improvement of metabolic syndrome (Fappa et al., 2008). However, for patients who fail the lifestyle changes, consideration should be given to treat specific abnormalities with drugs. Although drug treatment that directly reduce insulin resistance is promising, clinical trials to prove the reduction of CVD are still lacking (Grundy et al., 2004a).

2.5 Epidemiology of Metabolic Syndrome

Nowadays, the metabolic syndrome tends to increase continuously because the prevalence of obesity and overweight is increasing. The prevalence of metabolic syndrome was widely variable for both males and females across various populations (Lohsoonthorn et al., 2007), depending on race, age and sex. Park et al. (2003) studied in the United State and found the higher prevalence of metabolic syndrome in Maxican-American than African-American. Among the Caucasian, the prevalence of metabolic syndrome in American was higher than European because the prevalence of obesity in American was higher than European. In addition, the study by Yoo et al. (2004) in 1,181 young adults (35% African-Americans and 65% whites) aged 19-38 years using the criteria for metabolic syndrome from the NCEP ATP III. The results showed that the prevalence of metabolic syndrome was 12%. This was higher among white males (15.5%) than African-American males (11.2%), white females (10.7%), or African-American females (10.0%).

Panagiotakos et al. (2007) studied the prevalence of metabolic syndrome in 3,042 Greek adults aged 18-89 years. The metabolic syndrome was defined according to NCEP ATP III. The results showed that the prevalence was 18%, whereas sex-specific prevalence was 23% in males and 13% in females. The prevalence of metabolic syndrome increased accordingly with age (6% in < 35 age group, 24% in 35-65 age group, and 26% in > 65 age group for males; 5% in < 35 age group, 15% in 35-65 age group, and 28% in > 65 age group for females). This result was similar to previous study that the prevalence of metabolic syndrome was 19.8% (25.2% for males and 14.6% for females; $p < 0.001$), and increasing age influenced on an increment of the prevalence of metabolic syndrome (Panagiotakos et al., 2004).

Sodjinou et al. (2008) studied in 200 urban adults in Benin using WHO cut-offs to define CVD risk factors. The results showed that the prevalence of obesity was 18%, abdominal obesity was 32%, hypertension was 23%, and low HDL-C was 13%. The mean body mass index (BMI) and waist circumference were markedly higher in females than males ($p < 0.001$). In contrast, triglyceride concentration was significantly higher in males than females ($p < 0.001$).

In Asian countries, Park et al. (2004) studied in 7,865 South Koreans aged 20-79 years (45.5% in males and 54.5% in females) using the diagnostic criteria from NCEP ATP III. The results showed that the age-adjusted prevalence of the metabolic syndrome was 14.2% for males and 17.7% for females, whereas the age-adjusted prevalence of BMI $\geq$ 30 kg/m^2 was 1.7% and 3.0% for males and females respectively. For the Japanese population, Yoneda et al. (2008) investigated the prevalence of metabolic syndrome in 416 native Japanese in Hiroshima and 574 Japanese-Americans in Los Angeles. The results showed that the prevalence of metabolic syndrome was 20.1% and 6.3% for native Japanese males and females, and 38.7% and 4.5% for Japanese-American males and females respectively. The prevalence was significantly higher in Japanese-American males than in native Japanese males.

In Thailand, Kaewpitoon (2008) studied in 1,008 Ubonrajathanee University personnels aged 20 years and over. The prevalence of metabolic syndrome using WHO and IDF criteria was 6.2 and 18.7% respectively. The prevalence in females was higher than males. Tangpong et al. (2008) studied in 304 Walailak University personnels (115 males and 189 females) aged 25-65 years. The NCEP ATP III criteria was used to estimate the prevalence of metabolic syndrome. The results showed that the overall prevalence was 13.2% with significant difference between

males (9.9%) and females (3.3%). The prevalence increased accordingly with age (7.5% in 25-35 age group, 14.7% in 36-45 age group, 24.2% in 46-55 age group, and 31.2% in 56-65 age group). It was found that the prevalence of metabolic syndrome was significantly higher in older age group than younger age group ($p < 0.05$). However, the study by Banthavan (2006) in 270 persons in Naresuan University without history of hypertension, diabetes, and hyperlipidemia showed that the prevalence of metabolic syndrome (4.44%) was not significantly associated with sex (3.10% for males and 5.67% for females; $p = 0.383$).

For each province in Thailand, Santibhavank (2007) studied in 636 Nakhon Sawan population aged 15-87 years. The results showed that the prevalence of metabolic syndrome using the WHO, NCEP ATP III, and IDF criteria was 6.2, 20.0, and 18.7% respectively. Females and elder people had a higher prevalence than males and younger people respectively. Wilaisakunyong et al. (2007) studied in 250 persons aged 40-90 years, who lived in Chumponburi District, Surin Province. The results showed that the prevalence of metabolic syndrome was 24.4%, and the significant association between age with metabolic syndrome was found. The 60 years and over age group had 2.6 times higher risk of metabolic syndrome than the 40-49 age group. In addition, the study by Kaewtrakulpong (2008) in 1,004 persons (54.6% for males and 45.4% for females) who lived in Sri Chiang Mai District, Nong Khai Province found that the prevalence was 16.9% by NCEP ATP III, 15.0% by IDF, and 3.7% by WHO criteria. For all criteria, the prevalence of metabolic syndrome differed by age group. Elder persons had a higher prevalence of metabolic syndrome than younger persons.

For persons visiting the health examination, Lohsoonthorn et al. (2007) found that 1,339 professionals and office workers (535 males and 804 females) who

participated in the annual health examination at King Chulalongkorn Memorial Hospital in Bangkok had the prevalence of metabolic syndrome defined by the modified NCEP ATP III criteria of 15.2%, and it was approximately 3 times more common among males than females (25.8% vs 8.2%). Males and females with metabolic syndrome were older and were less well-education ($p < 0.05$) than those without metabolic syndrome. The three most common metabolic abnormalities in males were high blood pressure (45.0%), BMI ≥ 25 kg/m^2 (40.7%) and hypertriglyceridemia (38.7%). Among females, high blood pressure (22.8%), BMI ≥ 25 kg/m^2 (20.9%) and low HDL-C (18.4%) were the most common metabolic abnormalities. Pongchaiyakul et al. (2007) studied in healthy participants (307 males and 295 females) aged 20-90 years who came for a health check-up clinic of Srinagarind Hospital. The modified NCEP ATP III criteria was used to estimate the age and sex-specific prevalence of metabolic syndrome, in which BMI ≥ 27 kg/m^2 for males and 25 kg/m^2 for females were used in place of waist circumference. The results showed that the overall prevalence of metabolic syndrome was 15.0%, with no significant difference between males (15.3%) and females (14.6%). In males, the prevalence increased from 9.5% among the 20-39 age group to 24.7% among the 50 up age group. In females, the prevalence also increased with age, from 7.0% in 20-39 age group to 29.5% in 50 up age group.

For rural Thai population, Boonyavarakul (2005) studied in 400 rural population aged 35 years and older. The prevalence of metabolic syndrome was determined using the NCEP ATP III criteria with and without the modified waist circumference criteria for Asian population. The results showed that the prevalence was 18%, but increased to 23% with the modified Asian criteria. It was significantly

influenced by BMI, gender, and age. There was significant association between percentage of body fat and BMI in both males and females in this study.

Regarding the presence of metabolic syndrome and the risk of CVD, Srisara (2007) conducted retrospective cohort study in 3,499 persons of Electricity Generating Authority of Thailand (2,702 males and 797 females). Data were collected from 1985 to 2002 (17 years). The results showed that the prevalence of metabolic syndrome defined by NCEP ATP III, IDF, and WHO criteria were 15.2, 10.1, and 4.5% respectively. The participants with metabolic syndrome by NCEP ATP III had a 2.09 times risk, by IDF had a 1.95 times risk, and by WHO had a 2.94 times risk of morbidity of CVD, when compared to the participants without metabolic syndrome.

2.6 Dietary Pattern and Metabolic Syndrome

Among several factors that can increase the risk of metabolic syndrome, the dietary habit is an important factor, which influences on increasing or decreasing of the prevalence of metabolic syndrome. The consumption of healthy diet, which reduces in sugar, fat and salt intake and increases in fruit and vegetable intake are recommended for prevention and treatment of metabolic syndrome. In contrast, the unhealthy diet consumption such as fatty meat, animal skin, coconut milk, fast food, processed food, fried food, sweetened food, alcohol beverage, and snack intake contribute to obesity and metabolic syndrome (Baxter et al., 2006; Fappa et al., 2008). Excess energy intake raises total cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglyceride levels and lower HDL-C level, and thus it increase the risk of both hypertension and diabetes. Increased energy intake is associated with

elevated plasma insulin, which is a potent factor causing increase in renal sodium reabsorption and consequent blood pressure elevation (Temcharoen, 2001).

The study of Yoo et al. (2004) was designed to examine the relationship between dietary intakes and metabolic syndrome components in 1,181 young adults aged 19-38 years. The participants were divided into 3 groups according to the having number of components (group 1 : no component, group 2 : 1-2 components, and group 3 : 3 components and over). After adjustment for age, total energy intake, BMI, physical activity and dietary intake were compared between the groups. The results showed that group 1 had significantly higher mean intakes of fruits, fruit juice, and vegetables than group 2 ($p < 0.05$). The mean intake of sweetened beverages was significantly lower in group 1 than in group 2 or group 3 among whites ($p < 0.001$) but not among African-Americans. Therefore, this result suggested that low fruit and vegetable consumption and high sweetened beverage consumption were independently associated with the prevalence of metabolic syndrome in specific sex-ethnicity populations.

The Framingham Offspring Spouse Study by Sonnenberg et al. (2005) showed that lower intakes of dietary fiber and vegetables, and higher intakes of fat, energy, and sweetened beverages were associated with the highest prevalence of metabolic syndrome. In addition, whole grain and cereal fiber intakes were associated with a 38% reduced risk of metabolic syndrome (McKeown et al., 2004). For the beverage consumption, Dhingra et al. (2007) studied the soft drink consumption and risk of developing metabolic syndrome in middle-aged adults. The results showed that individuals consuming ≥ 1 soft drink per day had a higher prevalence of metabolic syndrome than those consuming < 1 drink per day. After follow-up for 4 years, it was found that the consumption ≥ 1 soft drink per day was associated with increased odds

of developing metabolic syndrome, obesity, increased waist circumference, hypertension, impaired fasting blood glucose, low HDL-C, and hypertriglyceridemia.

Hu et al. (2000) examined in the US Health Professionals Study. The study identified two dietary patterns, the prudent and the western diet. The results indicated that the western diet, characterized by frequent consumption of red meats and processed meats, was associated with increased risk of fatal coronary heart disease and type 2 diabetes. When dietary patterns were examined independently, processed meat had the strongest association for risk of diabetes. Similarly, Lutsey, Steffen and Stevens (2008) studied in 9,514 participants aged 45-64 years who enrolled in the Atherosclerosis Risk in Communities (ARIC) Study. The results showed that the consumption of the western diet, meat, and fried foods promoted the incidence of metabolic syndrome, whereas dairy consumption provided some protection.

For the healthy diet, Panagiotakos et al. (2004) evaluated the effect of the mediterranean-style dietary pattern on the prevalence of the metabolic syndrome. The samples were Greek adults aged 18 years and over, without any clinical evidence of cardiovascular disease or diabetes mellitus. The result showed that adherence to a mediterranean dietary pattern was associated with a 20% lower risk of metabolic syndrome. In addition, the mediterranean dietary consumption could reduce the risk of coronary heart disease by 23% (Pitsavos et al., 2003). The mediterranean-style dietary pattern was characterized by high intakes of fruits, vegetables, whole grains, beans, nuts, and olive oil and low to moderate intakes of dairy products, fish, poultry, eggs, and wine. The major energy intake from dietary fat was in the form of monounsaturated fats (Kris-Etherton et al., 2001). Therefore, this dietary pattern could reduce the risk of abnormal components of the metabolic syndrome.

Panagiotakos et al. (2007) studied the association between food pattern and the characteristics of metabolic syndrome in 1,514 males and 1,528 females aged 18-89 years. The results suggested that the dietary pattern that included cereals, fish, legumes, vegetables, and fruits was independently associated with reduced levels of clinical and biological markers linking to the metabolic syndrome, whereas meat and alcohol consumption showed the opposite results. This result was similar to previous study that the higher intakes of fruits, vegetables, vegetable oil, and dairy and lower intakes of meat and cholesterol were inversely associated with the metabolic syndrome (Azadbakht, Mirmiran and Azizi, 2005). The three epidemiological studies were summarized by Baxter et al. (2006). The results indicated that consumption high in fruits, vegetables, minimally processed cereals, and fish were associated with reduced prevalence of metabolic syndrome and its components, whereas high fried food intake was associated with increased risk for components of metabolic syndrome.

In Asian countries, Chen, Pang and Li (2008) examined the association between dietary fat and metabolic syndrome in 1,460 Qingdao's adults aged 25 years and over. The results showed that the subjects who had more than 44.4% of energy from fat had 2 times higher risk of metabolic syndrome than the subjects who had less than 28.9% of energy from fat. Therefore, dietary fat were independently associated with the metabolic syndrome. For the study in India, Ghosh, Bose and Chaudhuri (2003) studied in middle aged Bengalee Hindu males. The results revealed that the frequency of egg, fried snacks, and sweets consumptions were positively and significantly related with central obesity. Additionally, Park et al. (2004) found that the consumption of light alcohol (< 15 grams/day) could decrease the risk of the metabolic syndrome in South Korean females.

In Thailand, Chatngern (2008) studied in 344 male naval personnels in Bangkok and suburban aged 35-60 years. The results showed that there was strong association between the consumption of salty foods (> 2 times/week) and metabolic syndrome. As high salt intake could elevate blood pressure and also increase the prevalence of hypertension, therefore, generally salt intake should not over 6 grams or 1 teaspoon or sodium 2,400 milligrams per day. The study of Sacks et al., 2001 indicated that blood pressure could be lowered in consumers of the DASH diet if the sodium intake was reduced from a high level (3.5 grams/day) to an intermediate level (2.3 grams/day) or even from an intermediate level to a lower level (1.2 grams/day).

Department of Health, Ministry of Public Health studied the dietary behaviors in working-age Thais with sedentary lifestyle in Bangkok. It was found that there was a significant relationship between the metabolic syndrome and the consumptions of rice more than 4 ladles at dinner, less amount of fish than pork or beef, and repeated dietary type. The result showed that the prevalences of abdominal obesity (fat in abdomen more than 100 cm^2) were 44.2% for persons who had high meat and low carbohydrate intakes and 31.9% for persons who had equal proportional intakes of meats, grains, fruits and vegetables. The vegetarians who consumed diets high in fish and grains and low in fat, and those who had low meat, milk, butter, and egg intakes had the prevalence of abdominal obesity of 28.1% and 25.7% respectively. Therefore, the consumption of large dinner, low in fish, and repeated dietary type had the increased risk for development of CVD and the consumption of high meat and meat products and low grains had the increased risk of developing abdominal obesity (Saiwongse et al., 2008).

In summary, the epidemiologic studies suggested that no individual dietary component seemed to be wholly responsible for the association of diet and metabolic syndrome. Rather, it was likely that the interaction between many dietary components and the overall diet quality appeared to offer protection against the metabolic syndrome. The increased consumption of vegetables, fruits, and whole grains have shown to be protective for metabolic syndrome, whereas the consumption of high fat diet, high salt diet, high sugar diet, and alcohol and sweetened beverages have been associated with increased risk of the metabolic syndrome (Baxter et al., 2006; Pan et al., 2008). Therefore, the dietary pattern was an important factor that influenced on the developing metabolic syndrome and its components.

CHAPTER 3

MATERIALS AND METHODS

This chapter described the observational study determining the prevalence of metabolic syndrome and the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province who received the annual health examination at Maharat Nakhon Ratchasima Hospital.

3.1 Research Design

This research was an observational, cross-sectional descriptive study.

3.2 Samples

Samples were males and females aged 20 years and over in Mueang District, Nakhon Ratchasima Province who received the annual health examination at Maharat Nakhon Ratchasima Hospital during December, 2008 through March, 2009. They could understand, read and write Thai. None of them were pregnant, lactating, disabled or had incomplete results of health examination.

The study protocol was approved by the Ethical Committee of the Maharat Nakhon Ratchasima Hospital. The participants provided informed consent before the data collection.

3.3 Sample Size

The number of participants enrolled in this study was calculated as follow:

$$n = \frac{(Z_{\alpha/2})^2 PQ}{d^2}$$

While n = number of sample

$Z_{\alpha/2}$ = the standard value under normal curve at 95% = 1.96

P = proportion of the prevalence of metabolic syndrome from Lohsoonthorn et al. (2007) were 0.15

Q = 1-P

d = maximum allowable error between study proportion in sample size and population = 0.05

The number of participants in this study was

$$n = \frac{(1.96)^2 (0.15)(0.85)}{(0.05)^2}$$

$$= 196$$

The number of participants was adjusted 20% for the error in collecting samples (R)

$$\text{sample size} = \frac{n}{(1-R)}$$

$$= \frac{196}{(1-0.2)}$$

$$= 245 \approx 250$$

3.4 Research Instruments

3.4.1 Tools for anthropometric assessment

- Weight and Height Scaling Apparatus
- Bendable measurement tape

3.4.2 Automatic blood pressure monitor for measurement of blood pressure

3.4.3 Laboratory instruments for blood collection and blood chemical parameter analysis

3.4.4 Food pictures for estimation of food quantity for the 24-hour dietary recall (Appendix A)

3.4.5 The information sheet and consent form for the participants (Appendix B)

3.4.6 The questionnaires (Appendix A)

Part 1 Metabolic syndrome assessment

Part 2 Demographic characteristics

Part 3 Dietary pattern

Part 4 Food frequency questionnaire

Part 5 The 24-hour dietary recall

The questionnaire was proved by 5 experts for testing the content validity, and it was revised for clearer content and suitability according to the experts' recommendations. It was subsequently tested the reliability with the group of 30 persons who had similar characteristics to the study samples. The reliability in the part of food frequency questionnaire was presented by Cronbach's alpha that was 0.75 (Appendix C).

3.5 Research Procedure

Data collection was performed with cooperation of a Health Checkup Unit, Maharat Nakhon Ratchasima Hospital.

3.5.1 Self-administered questionnaires were composed of demographic characteristics, health behaviors (physical activity, cigarette smoking, time spent for sleeping, weight control, dietary supplement intake for weight loss, family history, and medications) and dietary pattern. The participants completed the questionnaires in advance and returned them to the researcher on the day visiting the Health Checkup Unit.

3.5.2 Waist circumference was measured with a bendable measurement tape at the end of normal expiration and standing position, measuring at midpoint between the last rib and the iliac crest.

3.5.3 Body weight was measured by participants wearing light clothing and without shoes using a digital scale (SECA®, Germany).

3.5.4 Height was measured without wearing shoes in straight position using a digital scale with height meter (SECA®, Germany).

3.5.5 Body mass index was calculated by dividing body weight in kilograms by square of height in meters.

3.5.6 Blood pressure of the participants was measured using an automatic blood pressure monitor (Kenz-BPM SP-1, Japan) with the participant in a sitting position after 5-10 minutes rest period. Second measurement was done for the participants who had high blood pressure after 10-20 minutes rest.

3.5.7 Blood sampling and analysis

Venous blood sample (10 ml) was drawn from each participant in the morning after at least 8-10 hours of overnight fast. Samples were subsequently analysed at a central laboratory of Maharat Nakhon Ratchasima Hospital. Fasting plasma glucose, total cholesterol, triglycerides, and HDL-C were measured by enzymatic methods (SYNCHRON LX20 PRO automatic analyzer, Beckman Coulter, USA).

3.6 Data Analysis

3.6.1 Number, percentage, mean and standard deviation (SD) were described the demographic characteristics, health behaviors, dietary pattern, and prevalence of metabolic syndrome and its components of the participants.

3.6.2 The total daily energy and nutrient values of the 24-hour dietary recall were quantified by a computerized program (Thai Nutrisurvey, Division of Nutrition, Department of Health & Tropical Medicine, Mahidol University). The standard reference tables (Department of Health, Ministry of Public Health) were used to convert household portions to gram weights.

3.6.3 Multivariate analysis was illustrated the relationship between participant's dietary pattern and metabolic syndrome by multiple logistic regression. Risk of the metabolic syndrome was presented by adjusted odds ratio (OR) and 95% confidence interval (95% CI). Significant statistical level was two-tailed and *p*-value less than 0.05.

CHAPTER 4

RESULTS

The present research was conducted to study the prevalence of metabolic syndrome and the relationship between dietary pattern and metabolic syndrome in population who received the annual health examination at Maharat Nakhon Ratchasima Hospital. The data were collected using the questionnaires and the results of health checkup from the annual health examination.

4.1 Characteristics of the Participants

A total of 525 persons were recruited into the study. Of these, 45 persons who had missing anthropometric measurement, missing blood testing or did not fast before venipuncture were excluded. Therefore, the complete data were obtained from 480 persons for analysis.

4.1.1 Demographic Data

The demographic data of the study population included age, residence, marital status, education level, occupation, and income. The results of demographic characteristics were stratified by gender (Table 2). There were 480 persons participating in this study, 230 males (47.9%) and 250 females (52.1%). The mean age of males and females were 46.45 ± 8.13 and 47.16 ± 9.08 years respectively. Most of the participants aged between 40-49 years (41.7%), lived in suburban (59.6%), and were married (76.5%). There were 45.2% of the participants who completed bachelor degree, 80.2% were government officers or state enterprise workers, and 35.4% had income 10,001-20,000 baht per month.

Table 2 The demographic data of the participants

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Age (years)			
20-29	4 (1.7)	7 (2.8)	11 (2.3)
30-39	45 (19.6)	42 (16.8)	87 (18.1)
40-49	101 (43.9)	99 (39.6)	200 (41.7)
50-59	68 (29.6)	86 (34.4)	154 (32.1)
≥ 60	12 (5.2)	16 (6.4)	28 (5.8)
Mean ± SD	46.45 ± 8.13	47.16 ± 9.08	46.82 ± 8.64
Min-Max	26 - 72	24 - 80	24 - 80
Residence			
Municipality	71 (30.9)	123 (49.2)	194 (40.4)
Suburban	159 (69.1)	127 (50.8)	286 (59.6)
Marital status			
Single	13 (5.7)	50 (20.0)	63 (13.1)
Couple	199 (86.5)	168 (67.2)	367 (76.5)
Divorce/separate/widow	18 (7.8)	32 (12.8)	50 (10.4)
Education level			
Primary school	18 (7.8)	16 (6.4)	34 (7.1)
Secondary school	112 (48.7)	46 (18.4)	158 (32.9)
Bachelor degree	70 (30.4)	147 (58.8)	217 (45.2)
Master degree and over	30 (13.1)	41 (16.4)	71 (14.8)
Occupation			
Government officer/ State enterprise worker	198 (86.1)	187 (74.8)	385 (80.2)
Employee	21 (9.2)	41 (16.4)	62 (12.9)
Housewife/Retiree	4 (1.7)	15 (6.0)	19 (4.0)
Business owner/Trader	7 (3.0)	7 (2.8)	14 (2.9)
Income (baht/month)			
≤ 10,000	25 (10.9)	42 (16.8)	67 (14.0)
10,001-20,000	105 (45.6)	65 (26.0)	170 (35.4)
20,001-30,000	64 (27.8)	53 (21.2)	117 (24.4)
30,001-40,000	20 (8.7)	57 (22.8)	77 (16.0)
≥ 40,001	16 (7.0)	33 (13.2)	49 (10.2)

n - number; SD - standard deviation; min-max - minimum and maximum

4.1.2 Health Behavior Data

The health behavior data included work activity, exercise, going out by walking or bicycle, cigarette smoking, time spent for sleeping, weight control, dietary supplement intake for weight loss, family history, and medications. The results of health behavior data, stratified by gender, are presented in Table 3.

For the physical activity, most of the participants (69.2%) had light work activity (mostly sitting or standing). The number of females who had light work activity was greater than those of males (78.8% vs 58.7%). There was only 19.8% of the participants exercising at least 3 days per week with duration of 30 minutes and over per time (26.1% in males and 14.0% in females). More than 70% of the participants had exercise less than 3 days per week or no exercise. In addition, only 9.6% of participants had going out by walking or bicycle at least 3 days per week with duration of 10 minutes and over per time. Most of the participants were non-smokers (76.0%). Fifty-five participants (11.5%) were smokers and 6.7% of them smoked 1-10 rolls per day. The number of male smokers was higher than female smokers.

For other health behaviors, the results showed that 80.2% of the participants slept for 6-8 hours per day. Almost all participants (99.8%) did not take dietary supplement for weight loss. There were 46.7% of the participants who had weight control, and they reduced amount of food intake (31.1%) rather than fasting (2.1%). The results also found that 58.8% of the participants have family history of hypertension, diabetes mellitus, or dyslipidemia and 18.3% were on medications for these diseases.

Table 3 The health behavior data of the participants

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Work activity			
Inactivity	3 (1.3)	3 (1.2)	6 (1.2)
Light	135 (58.7)	197 (78.8)	332 (69.2)
Moderate	78 (33.9)	43 (17.2)	121 (25.2)
Heavy	14 (6.1)	7 (2.8)	21 (4.4)
Exercise (days/week)			
Never	51 (22.2)	122 (48.8)	173 (36.0)
< 3	106 (46.1)	81 (32.4)	187 (39.0)
≥ 3 (< 30 minutes/time)	13 (5.6)	12 (4.8)	25 (5.2)
≥ 3 (≥ 30 minutes/time)	60 (26.1)	35 (14.0)	95 (19.8)
Going out by walking or bicycle (days/week)			
< 3	205 (89.1)	229 (91.6)	434 (90.4)
≥ 3 (≥ 10 minutes/time)	25 (10.9)	21 (8.4)	46 (9.6)
Cigarette smoking (rolls/day)			
Non-smoker	119 (51.7)	246 (98.4)	365 (76.0)
Ex-smoker	57 (24.8)	3 (1.2)	60 (12.5)
1-10	31 (13.5)	1 (0.4)	32 (6.7)
> 10	23 (10.0)	0 (0.0)	23 (4.8)
Time spent for sleeping (hours/day)			
< 6	37 (16.1)	30 (12.0)	67 (14.0)
6-8	176 (76.5)	209 (83.6)	385 (80.2)
> 8	17 (7.4)	11 (4.4)	28 (5.8)
Weight control			
Never	139 (60.4)	117 (46.8)	256 (53.3)
Reduced quantity intake	46 (20.0)	103 (41.2)	149 (31.1)
Fast	6 (2.6)	4 (1.6)	10 (2.1)
Reduced quantity intake combined with fast	2 (0.9)	1 (0.4)	3 (0.6)
Others	37 (16.1)	25 (10.0)	62 (12.9)

Table 3 The health behavior data of the participants (continued)

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Dietary supplement intake for weight loss			
Yes	0 (0.0)	1 (0.4)	1 (0.2)
No	230 (100.0)	249 (99.6)	479 (99.8)
Family history of HTN/DM/dyslipidemia			
Yes	126 (54.8)	156 (62.4)	282 (58.8)
No	104 (45.2)	94 (37.6)	198 (41.2)
Medications of HTN/DM/dyslipidemia			
Yes	43 (18.7)	45 (18.0)	88 (18.3)
No	187 (81.3)	205 (82.0)	392 (81.7)

HTN - hypertension; DM - diabetes mellitus; n - number

4.1.3 Dietary Pattern Data

The dietary pattern data were assessed by multiple choice questionnaire, food frequency questionnaire, and the 24-hour dietary recall. For the 24-hour dietary recall, total energy intake data was assessed by boxplot analysis and the unreliable data were excluded. The results of dietary pattern of the participants, stratified by gender, are presented in Table 4 and Table 5.

The results showed that 15.6% of the participants had more than 3 meals per day and 6.0% had late night meal intake. About half of the participants had large dinner (49.6%), while only 10.0% had large breakfast. For the preference of cooking method, about one-fifth of the participants liked deep fried cooking (19.2%) and about one-fourth of those liked fried cooking (27.5%). There were 13.5% and 26.5% of the participants who favored salty taste and sweet taste respectively.

Table 4 The dietary pattern data of the participants

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Number of meals per day			
≤ 3	206 (89.6)	199 (79.6)	405 (84.4)
> 3	24 (10.4)	51 (20.4)	75 (15.6)
Late night meal intake			
Yes	19 (8.3)	10 (4.0)	29 (6.0)
No	211 (91.7)	240 (96.0)	451 (94.0)
Large meal intake			
Dinner	138 (60.0)	100 (40.0)	238 (49.6)
Lunch	55 (23.9)	127 (50.8)	182 (37.9)
Breakfast	29 (12.6)	19 (7.6)	48 (10.0)
No specific	8 (3.5)	4 (1.6)	12 (2.5)
Favorite cooking method			
Deep fry	42 (18.3)	50 (20.0)	92 (19.1)
Fry	64 (27.8)	68 (27.2)	132 (27.5)
Boil/Bake	70 (30.4)	105 (42.0)	175 (36.5)
Toast /Grill	21 (9.1)	11 (4.4)	32 (6.7)
No specific	33 (14.4)	16 (6.4)	49 (10.2)
Favorite taste			
Salt	29 (12.6)	36 (14.4)	65 (13.5)
Sweet	70 (30.4)	57 (22.8)	127 (26.5)
Others	131 (57.0)	157 (62.8)	288 (60.0)
Meal-made pattern			
Non home-made	66 (28.7)	69 (27.6)	135 (28.1)
Home-made	90 (39.1)	69 (27.6)	159 (33.1)
Both	74 (32.2)	112 (44.8)	186 (38.8)
Repeated dietary type intake			
Yes	88 (38.3)	75 (30.0)	163 (34.0)
No	142 (61.7)	175 (70.0)	317 (66.0)

Table 4 The dietary pattern data of the participants (continued)

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Time between dinner and bedtime (hours)			
< 4	92 (40.0)	127 (50.8)	219 (45.6)
≥ 4	138 (60.0)	123 (49.2)	261 (54.4)
Time spent on each meal (minutes/meal)			
< 15	127 (55.2)	115 (46.0)	242 (50.4)
≥ 15	103 (44.8)	135 (54.0)	238 (49.6)
Alcohol consumption (grams/day)			
No drinking	88 (38.3)	228 (91.2)	316 (65.8)
< 15	50 (21.7)	18 (7.2)	68 (14.2)
15-30	22 (9.6)	2 (0.8)	24 (5.0)
> 30	70 (30.4)	2 (0.8)	72 (15.0)
Water intake (glasses/day)			
< 6	78 (33.9)	117 (46.8)	195 (40.6)
6-8	112 (48.7)	103 (41.2)	215 (44.8)
> 8	40 (17.4)	30 (12.0)	70 (14.6)
High-calorie juice intake (glasses/day)			
≤ 1	168 (73.0)	198 (79.2)	366 (76.3)
2-3	54 (23.5)	49 (19.6)	103 (21.4)
> 3	8 (3.5)	3 (1.2)	11 (2.3)
Fatty meat intake			
Never	18 (7.8)	45 (18.0)	63 (13.1)
1-3 days/month	82 (35.7)	118 (47.2)	200 (41.7)
1-3 days/week	97 (42.2)	67 (26.8)	164 (34.2)
> 3 days/week	33 (14.3)	20 (8.0)	53 (11.0)

Table 4 The dietary pattern data of the participants (continued)

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Meat product intake			
Never	15 (6.5)	21 (8.4)	36 (7.5)
1-3 days/month	100 (43.5)	139 (55.6)	239 (49.8)
1-3 days/week	92 (40.0)	72 (28.8)	164 (34.2)
> 3 days/week	23 (10.0)	18 (7.2)	41 (8.5)
Bakery product intake			
Never	59 (25.7)	26 (10.4)	85 (17.7)
1-3 days/month	96 (41.7)	132 (52.8)	228 (47.5)
1-3 days/week	53 (23.0)	68 (27.2)	121 (25.2)
> 3 days/week	22 (9.6)	24 (9.6)	46 (9.6)
Fried food intake			
Never	8 (3.5)	25 (10.0)	33 (6.9)
1-3 days/month	99 (43.0)	121 (48.4)	220 (45.8)
1-3 days/week	91 (39.6)	75 (30.0)	166 (34.6)
> 3 days/week	32 (13.9)	29 (11.6)	61 (12.7)
Coconut milk food intake			
Never	18 (7.8)	28 (11.2)	46 (9.6)
1-3 days/month	103 (44.8)	130 (52.0)	233 (48.5)
1-3 days/week	90 (39.1)	73 (29.2)	163 (34.0)
> 3 days/week	19 (8.3)	19 (7.6)	38 (7.9)
Vegetable intake			
Never	0 (0.0)	1 (0.4)	1 (0.2)
1-3 days/month	8 (3.5)	10 (4.0)	18 (3.7)
1-3 days/week	81 (35.2)	85 (34.0)	166 (34.6)
> 3 days/week	141 (61.3)	154 (61.6)	295 (61.5)
Fruit intake			
Never	2 (0.9)	0 (0.0)	2 (0.4)
1-3 days/month	28 (12.1)	11 (4.4)	39 (8.1)
1-3 days/week	123 (53.5)	88 (35.2)	211 (44.0)
> 3 days/week	77 (33.5)	151 (60.4)	228 (47.5)

Table 4 The dietary pattern data of the participants (continued)

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Whole grain intake			
Never	47 (20.4)	40 (16.0)	87 (18.1)
1-3 days/month	94 (40.9)	100 (40.0)	194 (40.4)
1-3 days/week	56 (24.4)	59 (23.6)	115 (24.0)
> 3 days/week	33 (14.3)	51 (20.4)	84 (17.5)
Single-plate food intake			
Never	16 (7.0)	41 (16.4)	57 (11.9)
1-3 days/month	90 (39.1)	143 (57.2)	233 (48.5)
1-3 days/week	90 (39.1)	45 (18.0)	135 (28.1)
> 3 days/week	34 (14.8)	21 (8.4)	55 (11.5)
Semi-instant food intake			
Never	42 (18.3)	78 (31.2)	120 (25.0)
1-3 days/month	139 (60.4)	134 (53.6)	273 (56.9)
1-3 days/week	40 (17.4)	31 (12.4)	71 (14.8)
> 3 days/week	9 (3.9)	7 (2.8)	16 (3.3)
Salty processed food intake			
Never	22 (9.6)	38 (15.2)	60 (12.5)
1-3 days/month	129 (56.0)	132 (52.8)	261 (54.4)
1-3 days/week	62 (27.0)	64 (25.6)	126 (26.2)
> 3 days/week	17 (7.4)	16 (6.4)	33 (6.9)
High-sugar food intake			
Never	38 (16.5)	37 (14.8)	75 (15.6)
1-3 days/month	111 (48.3)	145 (58.0)	256 (53.3)
1-3 days/week	66 (28.7)	48 (19.2)	114 (23.8)
> 3 days/week	15 (6.5)	20 (8.0)	35 (7.3)
Snack intake			
Never	44 (19.1)	55 (22.0)	99 (20.6)
1-3 days/month	128 (55.7)	130 (52.0)	258 (53.8)
1-3 days/week	49 (21.3)	47 (18.8)	96 (20.0)
> 3 days/week	9 (3.9)	18 (7.2)	27 (5.6)

Table 5 The total energy intake and its distribution of the participants

Variables	Male n = 131	Female n = 187	Total n = 318
Total daily energy intake (kcal)			
Mean ± SD	1,581.69 ± 440.01	1,317.55 ± 379.28	1,426.36 ± 425.15
Min-Max	716.90 – 3,094.70	599.93 – 3,343.40	599.93 – 3,343.40
Calorie from carbohydrate (%)			
Mean ± SD	54.82 ± 10.19	55.48 ± 9.26	55.21 ± 9.64
Min-Max	25.08 - 93.60	27.98 - 79.18	25.08 - 93.60
Calorie from fat (%)			
Mean ± SD	27.34 ± 7.95	27.00 ± 8.25	27.14 ± 8.12
Min-Max	11.00 - 52.41	9.65 - 51.88	9.65 - 52.41
Calorie from protein (%)			
Mean ± SD	17.88 ± 4.80	17.42 ± 4.90	17.61 ± 4.86
Min-Max	7.27 - 33.08	6.82 - 43.00	6.82 - 43.00

n - number; DRI - dietary reference intake; kcal - kilocalorie; SD - standard deviation; min-max - minimum and maximum

For the meal-made pattern, there were 33.1% of the participants who had home-made meal pattern, 28.1% had non home-made meal pattern, and 38.8% had both home-made and non home-made meal pattern. Most of the participants had no repeated dietary type intake (66.0%). Most of them had dinner at least 4 hours before their bedtime (54.4%) and time that they spent for each meal was less than 15 minutes (50.4%).

In this study, 65.8% of the participants did not drink alcohol. Seventy-two participants (15.0%) had alcohol consumption more than 30 grams per day. More than 80% of drinkers were males, and the proportion of male drinkers was about 6.5

times higher than female drinkers. In addition, most of the participants drank 6-8 glasses of water per day (44.8%) and less than 1 glass of high-calorie juice per day (76.3%).

The data of the food frequency assessment was divided into 13 food items. The results showed that the diet that most of the participants consumed for 1-3 days per month included fatty meat (41.7%), meat product (49.8%), bakery product (47.5%), fried food (45.8%), coconut milk food (48.5%), whole grain (40.4%), single-plate food (48.5%), semi-instant food (56.9%), salty processed food (54.4%), high-sugar food (53.3%), and snack (53.8%). The food items that most of participants consumed more than 3 days per week were vegetables (61.5%) and fruits (47.5%).

The data of the 24-hour dietary recall were analyzed for total energy intake and its distribution from carbohydrate, fat, and protein. The data of 162 participants were excluded because of data missing and unusual intake reporting. Therefore, the completed data were obtained from 318 participants for analysis. The total energy intake data was analyzed for examining the unreliable data by boxplot analysis. The results showed that there was no participant who reported unreliable total energy intake (Appendix C). Table 5 presents the total energy intake and its distribution of the participants. The results showed that the mean total daily energy intakes were 1,581.69 ± 440.01 kcal in males and 1,317.55 ± 379.28 kcal in females. The mean percentages of calorie from carbohydrate, fat, and protein were 55.21 ± 9.64, 27.14 ± 8.12, and 17.61 ± 4.86 respectively. The values of dietary intake were compared with dietary reference intake (DRI) for Thais (The committee on recommended daily allowances, 2003). The results indicated that the mean percentages of calorie from carbohydrate and fat were in the standard range (45-65%

and 20-35% respectively). The mean percentage of calorie from protein was higher than the standard range (10-15%).

4.1.4 Clinical Data

The clinical data included waist circumference, fasting plasma glucose, triglycerides, high-density lipoprotein cholesterol, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol, low-density lipoprotein cholesterol, and body mass index (Table 6). The results showed that the mean waist circumference was 86.24 ± 9.14 cm in males and 79.10 ± 10.14 cm in females. The mean fasting plasma glucose was 94.28 ± 24.01 mg/dl. The mean triglycerides was 132.81 ± 58.66 mg/dl. The mean total cholesterol was 217.22 ± 41.05 mg/dl, while the mean HDL-C was 69.28 ± 16.39 mg/dl and the mean LDL-C was 121.21 ± 36.75 mg/dl. The mean SBP and DBP were 122.55 ± 14.78 and 75.29 ± 10.61 mmHg respectively. The mean BMI was 24.10 ± 3.75 kg/m^2.

The results showed that 38.8% of the participants had over waist circumference (≥ 90 cm in males and ≥ 80 cm in females). There were 21.2% of the participants who had fasting plasma glucose 100 mg/dl and over. About 30% of the participants had triglycerides 150 mg/dl and over, and only 3.5% had low HDL-C (< 40 mg/dl in males and < 50 mg/dl in females). For blood pressure, 40.4% of the participants had SBP 130 mmHg and over and/or DBP 85 mmHg and over. Furthermore, there were 65.4% of the participants who had total cholesterol 200 mg/dl and over. Forty percents of the participants had LDL-C 130 mg/dl and over, and 59.2% had BMI 23 kg/m^2 and over.

Table 6 The clinical data of the participants

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Waist circumference (cm)			
< 90/80 (male/female)	154 (67.0)	140 (56.0)	294 (61.2)
≥ 90/80 (male/female)	76 (33.0)	110 (44.0)	186 (38.8)
Mean ± SD	86.24 ± 9.14	79.10 ± 10.14	82.52 ± 10.30
Min-Max	67 - 135	58 - 113	58 - 135
Fasting plasma glucose (mg/dl)			
< 100	169 (73.5)	209 (83.6)	378 (78.8)
≥ 100	61 (26.5)	41 (16.4)	102 (21.2)
Mean ± SD	97.11 ± 22.69	91.68 ± 24.93	94.28 ± 24.01
Min-Max	70 - 304	67 - 340	67 - 340
Triglycerides (mg/dl)			
< 150	141 (61.3)	210 (84.0)	351 (73.1)
≥ 150	89 (38.7)	40 (16.0)	129 (26.9)
Mean ± SD	150.64 ± 68.74	116.42 ± 41.36	132.81 ± 58.66
Min-Max	64 - 462	56 - 427	56 - 462
HDL-C (mg/dl)			
< 40/50 (male/female)	3 (1.3)	14 (5.6)	17 (3.5)
≥ 40/50 (male/female)	227 (98.7)	236 (94.4)	463 (96.5)
Mean ± SD	63.19 ± 13.24	74.89 ± 17.02	69.28 ± 16.39
Min-Max	37 - 130	38 - 129	37 - 130
Blood pressure (mmHg)			
< 130 (SBP) or 85 (DBP)	127 (55.2)	159 (63.6)	286 (59.6)
≥ 130 (SBP) or 85 (DBP)	103 (44.8)	91 (36.4)	194 (40.4)
Mean ± SD			
SBP	125.02 ± 15.35	120.28 ± 13.88	122.55 ± 14.78
DBP	77.16 ± 11.26	73.57 ± 9.68	75.29 ± 10.61
Min-Max			
SBP	90 - 194	80 - 170	80 - 194
DBP	40 - 114	40 - 110	40 - 114

n - number; cm - centimeter; SD - standard deviation; min-max - minimum and maximum; mg/dl - milligram per deciliter; mmHg - millimeter Hg; HDL-C - high-density lipoprotein cholesterol; SBP - systolic blood pressure; DBP - diastolic blood pressure

Table 6 The clinical data of the participants (continued)

Variables	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)
Total cholesterol (mg/dl)			
< 200	69 (30.0)	97 (38.8)	166 (34.6)
≥ 200	161 (70.0)	153 (61.2)	314 (65.4)
Mean ± SD	224.86 ± 43.86	210.20 ± 37.00	217.22 ± 41.05
Min-Max	108 - 361	111 - 335	108 - 361
LDL-C (mg/dl)			
< 130	100 (43.5)	188 (75.2)	288 (60.0)
≥ 130	130 (56.5)	62 (24.8)	192 (40.0)
Mean ± SD	131.81 ± 38.79	111.46 ± 31.87	121.21 ± 36.75
Min-Max	32 - 235	36 - 215	32 - 235
BMI (kg/m^2)			
< 23.00	70 (30.4)	126 (50.4)	196 (40.8)
23.00-24.99	61 (26.5)	44 (17.6)	105 (21.9)
25.00-29.99	83 (36.1)	63 (25.2)	146 (30.4)
≥ 30.00	16 (7.0)	17 (6.8)	33 (6.9)
Mean ± SD	24.65 ± 3.45	23.58 ± 3.94	24.10 ± 3.75
Min-Max	14.79 - 38.89	16.20 - 37.81	14.79 - 38.89

n - number; mg/dl - milligram per deciliter; SD - standard deviation; min-max - minimum and maximum; LDL-C - low-density lipoprotein cholesterol; BMI - body mass index; kg/m^2 - kilogram per square meter

The data showed that males had higher prevalences of elevated fasting plasma glucose, elevated triglycerides, elevated blood pressure, BMI 23 kg/m^2 and over, elevated total cholesterol, and elevated LDL-C than females, whereas females had higher prevalences of abdominal obesity and reduced HDL-C than males. In addition, the results showed that the means of triglycerides, total cholesterol, LDL-C, and BMI in males were higher than the standard values, and the means of total cholesterol and BMI in females were higher than the standard values.

4.2 Prevalence of Metabolic Syndrome and its Components

The prevalence of metabolic syndrome is presented in Table 7 and the results of metabolic syndrome components including waist circumference, fasting plasma glucose, triglycerides, high-density lipoprotein cholesterol, systolic blood pressure, and diastolic blood pressure are presented in Table 8 and Table 9. In this study, the IDF and the NCEP ATP III criteria were used for diagnosis of the metabolic syndrome.

Based on IDF criteria, it was found that the prevalence of metabolic syndrome was 15.4%. There were 13.9% of males and 16.8% of females who had metabolic syndrome. The prevalence of metabolic syndrome defined by the NCEP ATP III criteria was 17.9%. With this criteria, 18.7% of males and 17.2% of females had metabolic syndrome. There was no significant difference in the prevalence of metabolic syndrome in both gender when defined by IDF and NCEP ATP III criteria. In addition, the result showed that the prevalence of metabolic syndrome defined by NCEP ATP III was 2.5% higher than that by IDF.

Table 8 and Table 9 demonstrate the metabolic syndrome components of the participants who had metabolic syndrome as defined by IDF and NCEP ATP III criteria respectively. For the IDF criteria, all participants had abdominal obesity and 62.2% of the participants had elevated fasting plasma glucose. The levels of triglyceride in 75.7% of the participants were elevated, and the levels of HDL-C in 14.9% of the participants were reduced. Blood pressure of most of the participants (82.4%) was elevated. For the NCEP ATP III criteria, 86.0% of the participants had abdominal obesity and 65.1% had elevated fasting plasma glucose. There were 79.1% of the participants who had elevated triglycerides. About 15% of the participants had reduced HDL-C level, and 83.7% had elevated blood pressure.

Table 7 The prevalence of metabolic syndrome of the participants

Criteria	Male (n = 230) Number (%)	Female (n = 250) Number (%)	Total (n = 480) Number (%)	*p*-value [a]
IDF	32 (13.9)	42 (16.8)	74 (15.4)	0.382
NCEP ATP III	43 (18.7)	43 (17.2)	86 (17.9)	0.669

[a] Chi-square test for comparison between males and females; n - number; IDF - International Diabetes Federation; NCEP ATP III - National Cholesterol Education Program Adult Treatment Panel III

Table 8 The metabolic syndrome components of the participants defined by IDF criteria

Variables	Metabolic syndrome (n = 74) Number (%)	Non-metabolic syndrome (n = 406) Number (%)	Total (n = 480) Number (%)	*p*-value [a]
Waist circumference (cm)				
< 90/80 (male/female)	0 (0.0)	294 (72.4)	294 (61.2)	< 0.001
≥ 90/80 (male/female)	74 (100.0)	112 (27.6)	186 (38.8)	
Fasting plasma glucose (mg/dl)				
< 100	28 (37.8)	350 (86.2)	378 (78.8)	< 0.001
≥ 100	46 (62.2)	56 (13.8)	102 (21.2)	
Triglycerides (mg/dl)				
< 150	18 (24.3)	333 (82.0)	351 (73.1)	< 0.001
≥ 150	56 (75.7)	73 (18.0)	129 (26.9)	
HDL-C (mg/dl)				
< 40/50 (male/female)	11 (14.9)	6 (1.5)	17 (3.5)	< 0.001 [b]
≥ 40/50 (male/female)	63 (85.1)	400 (98.5)	463 (96.5)	
Blood pressure (mmHg)				
< 130 (SBP) or 85 (DBP)	13 (17.6)	273 (67.2)	286 (59.6)	< 0.001
≥ 130 (SBP) or 85 (DBP)	61 (82.4)	133 (32.8)	194 (40.4)	

[a] Chi-square test for comparison between metabolic syndrome and non-metabolic syndrome;
[b] Fisher's exact test for comparison between metabolic syndrome and non-metabolic syndrome;
IDF - International Diabetes Federation; n - number; cm - centimeter; mg/dl - milligram per deciliter; HDL-C - high-density lipoprotein cholesterol; mmHg - millimeter Hg; SBP - systolic blood pressure; DBP - diastolic blood pressure

Table 9 The metabolic syndrome components of the participants defined by NCEP ATP III criteria

Variables	Metabolic syndrome (n = 86) Number (%)	Non-metabolic syndrome (n = 394) Number (%)	Total (n = 480) Number (%)	*p*-value [a]
Waist circumference (cm)				
< 90/80 (male/female)	12 (14.0)	282 (71.6)	294 (61.2)	< 0.001
≥ 90/80 (male/female)	74 (86.0)	112 (28.4)	186 (38.8)	
Fasting plasma glucose (mg/dl)				
< 100	30 (34.9)	348 (88.3)	378 (78.8)	< 0.001
≥ 100	56 (65.1)	46 (11.7)	102 (21.2)	
Triglycerides (mg/dl)				
< 150	18 (20.9)	333 (84.5)	351 (73.1)	< 0.001
≥ 150	68 (79.1)	61 (15.5)	129 (26.9)	
HDL-C (mg/dl)				
< 40/50 (male/female)	13 (15.1)	4 (1.0)	17 (3.5)	< 0.001 [b]
≥ 40/50 (male/female)	73 (84.9)	390 (99.0)	463 (96.5)	
Blood pressure (mmHg)				
< 130 (SBP) or 85 (DBP)	14 (16.3)	272 (69.0)	286 (59.6)	< 0.001
≥ 130 (SBP) or 85 (DBP)	72 (83.7)	122 (31.0)	194 (40.4)	

[a] Chi-square test for comparison between metabolic syndrome and non-metabolic syndrome;
[b] Fisher's exact test for comparison between metabolic syndrome and non-metabolic syndrome;
NCEP ATP III - National Cholesterol Education Program Adult Treatment Panel III; n - number; cm - centimeter; mg/dl - milligram per deciliter; HDL-C - high-density lipoprotein cholesterol; mmHg - millimeter Hg; SBP - systolic blood pressure; DBP - diastolic blood pressure

The above-mentioned results indicated that the prevalence of abdominal obesity was lower in NCEP ATP III than IDF criteria. While the prevalences of the other components were higher in NCEP ATP III than IDF criteria. For both IDF and NCEP ATP III criteria, the results showed that the first 3 prevalences of metabolic syndrome components in the participants with metabolic syndrome were abdominal obesity, elevated blood pressure, and elevated triglycerides respectively. In addition, the prevalence of abdominal obesity, elevated fasting plasma glucose, elevated triglycerides, reduced HDL-C, and elevated blood pressure in the participants with metabolic syndrome were significantly higher than those in participants without metabolic syndrome.

4.3 The Relationship between Dietary Pattern and Metabolic Syndrome by Multiple Logistic Regression Analysis

In this study, 318 participants completed the questionnaire for analysis of the relationship between dietary pattern and metabolic syndrome. Fifty-two participants were excluded because they took medications for treatment of hypertension, diabetes mellitus, or dyslipidemia. The dietary behavior of these participants was altered. Therefore, the remaining 266 participants (112 males and 154 females) were included for analysis of the relationship between dietary pattern and metabolic syndrome.

Multivariate analysis by multiple logistic regression was performed. Table 10 presents the odds ratio for the relationship between dietary pattern and metabolic syndrome. The metabolic syndrome was a dependent variable, and the dietary patterns were independent variables.

Table 10 The relationship between dietary pattern and metabolic syndrome

Variables	Metabolic syndrome Number (%) n = 34	Non-metabolic syndrome Number (%) n = 232	OR	95% CI	*p*-value [a]
Number of meals per day					
> 3	4 (11.8)	34 (14.7)	0.28	0.05-1.48	0.136
≤ 3	30 (88.2)	198 (85.3)	1.00		
Late night meal intake					
Yes	4 (11.8)	8 (3.5)	9.22	1.37-61.97	0.022
No	30 (88.2)	224 (96.5)	1.00		
Large meal intake					
Dinner	19 (55.9)	118 (50.9)	0.92	0.40-2.14	0.845
Others	15 (44.1)	114 (49.1)	1.00		
Favorite cooking method					
Deep fry/Fry	18 (52.9)	118 (50.9)	1.08	0.46-2.55	0.866
Others	16 (47.1)	114 (49.1)	1.00		
Favorite taste					
Salt/Sweet	15 (44.1)	96 (41.4)	1.49	0.60-3.67	0.392
Others	19 (55.9)	136 (58.6)	1.00		
Meal-made pattern					
Non home-made	8 (23.5)	62 (26.7)	1.14	0.36-3.58	0.827
Both	15 (44.1)	96 (41.4)	1.12	0.43-2.94	0.811
Home-made	11 (32.4)	74 (31.9)	1.00		
Repeated dietary type intake					
Yes	15 (44.1)	74 (31.9)	2.00	0.78-5.11	0.149
No	19 (55.9)	158 (68.1)	1.00		
Time between dinner and bedtime (hours)					
< 4	18 (52.9)	104 (44.8)	1.52	0.64-3.63	0.345
≥ 4	16 (47.1)	128 (55.2)	1.00		

[a] Significant level: $p < 0.05$; n - number; OR - odds ratio; 95% CI - 95% confidence interval

Table 10 The relationship between dietary pattern and metabolic syndrome (continued)

Variables	Metabolic syndrome Number (%) n = 34	Non-metabolic syndrome Number (%) n = 232	OR	95% CI	*p*-value [a]
Time spent on each meal (minutes/meal)					
< 15	21 (61.8)	116 (50.0)	1.66	0.68-4.06	0.263
≥ 15	13 (38.2)	116 (50.0)	1.00		
Alcohol consumption (grams/day)					
> 30	8 (23.6)	20 (8.6)	3.54	1.04-12.07	0.043
15-30	1 (2.9)	9 (3.9)	1.37	0.14-13.17	0.784
< 15	5 (14.7)	38 (16.4)	0.94	0.30-2.95	0.914
No drinking	20 (58.8)	165 (71.1)	1.00		
Water intake (glasses/day)					
≤ 8	26 (76.5)	199 (85.8)	0.44	0.15-1.30	0.136
> 8	8 (23.5)	33 (14.2)	1.00		
High-calorie juice intake (glasses/day)					
> 1	8 (23.5)	55 (23.7)	0.70	0.24-2.06	0.523
≤ 1	26 (76.5)	177 (76.3)	1.00		
Fatty meat intake (days/week)					
> 3	3 (8.8)	22 (9.5)	0.80	0.15-4.27	0.797
≤ 3	31 (91.2)	210 (90.5)	1.00		
Meat product intake (days/week)					
> 3	2 (5.9)	18 (7.8)	0.65	0.10-4.06	0.645
≤ 3	32 (94.1)	214 (92.2)	1.00		

[a] Significant level: $p < 0.05$; n - number; OR - odds ratio; 95% CI - 95% confidence interval

Table 10 The relationship between dietary pattern and metabolic syndrome (continued)

Variables	Metabolic syndrome Number (%) n = 34	Non-metabolic syndrome Number (%) n = 232	OR	95% CI	*p*-value [a]
Bakery product intake (days/week)					
> 3	5 (14.7)	24 (10.3)	5.24	1.32-20.89	0.019
≤ 3	29 (85.3)	208 (89.7)	1.00		
Fried food intake (days/week)					
> 3	5 (14.7)	29 (12.5)	1.86	0.38-9.24	0.447
≤ 3	29 (85.3)	203 (87.5)	1.00		
Coconut milk food intake (days/week)					
> 3	2 (5.9)	22 (9.5)	0.24	0.02-2.30	0.213
≤ 3	32 (94.1)	210 (90.5)	1.00		
Vegetable intake (days/week)					
> 3	21 (61.8)	137 (59.1)	1.00		
≤ 3	13 (38.2)	95 (40.9)	0.88	0.35-2.24	0.787
Fruit intake (days/week)					
> 3	14 (41.2)	114 (49.1)	1.00		
≤ 3	20 (58.8)	118 (50.9)	1.15	0.44-3.01	0.772
Whole grain intake (days/week)					
> 3	5 (14.7)	34 (14.7)	1.00		
≤ 3	29 (85.3)	198 (85.3)	1.21	0.32-4.61	0.777
Single-plate food intake (days/week)					
> 3	3 (8.8)	30 (12.9)	0.65	0.13-3.15	0.589
≤ 3	31 (91.2)	202 (87.1)	1.00		

[a] Significant level: $p < 0.05$; n - number; OR - odds ratio; 95% CI - 95% confidence interval

Table 10 The relationship between dietary pattern and metabolic syndrome (continued)

Variables	Metabolic syndrome Number (%) n = 34	Non-metabolic syndrome Number (%) n = 232	OR	95% CI	*p*-value [a]
Semi-instant food intake (days/week)					
> 3	1 (2.9)	11 (4.7)	0.39	0.02-8.16	0.542
≤ 3	33 (97.1)	221 (95.3)	1.00		
Salty processed food intake (days/week)					
> 3	1 (2.9)	17 (7.3)	0.26	0.02-3.36	0.305
≤ 3	33 (97.1)	215 (92.7)	1.00		
High-sugar food intake (days/week)					
> 3	2 (5.9)	20 (8.6)	0.79	0.10-6.56	0.827
≤ 3	32 (94.1)	212 (91.4)	1.00		
Snack intake (days/week)					
> 3	1 (2.9)	16 (6.9)	0.41	0.02-7.14	0.538
≤ 3	33 (97.1)	216 (93.1)	1.00		
Calorie from carbohydrate (%)					
> 65	2 (5.9)	32 (13.8)	0.28	0.04-1.82	0.180
≤ 65	32 (94.1)	200 (86.2)	1.00		
Calorie from protein (%)					
> 15	27 (79.4)	161 (69.4)	1.81	0.60-5.49	0.295
≤ 15	7 (20.6)	71 (30.6)	1.00		
Calorie from fat (%)					
> 35	6 (17.6)	34 (14.7)	1.12	0.37-3.39	0.846
≤ 35	28 (82.4)	198 (85.3)	1.00		

[a] Significant level: $p < 0.05$; n - number; OR - odds ratio; 95% CI - 95% confidence interval

The results indicated that the risk of metabolic syndrome found in the participants who had favor of deep fried/fried cooking, favor of salty/sweet taste, non home-made meal pattern, and both non home-made and home-made meal pattern was increased. The risk of metabolic syndrome was also increased in participants who had repeated dietary type intake, time between dinner and bedtime less than 4 hours, and time spent on each meal less than 15 minutes. The drinkers who consumed 15-30 grams of alcohol per day had increased risk of metabolic syndrome. Moreover, the consumption of more than 3 days per week of fried food, 3 days and less per week of fruits and whole grains, more than 15% of calorie from protein, and more than 35% of calorie from fat influenced the increased risk of metabolic syndrome. However, the increase in the risk of metabolic syndrome influenced by these dietary patterns were not significant.

There were significant relationships between late night meal intake, alcohol consumption, and bakery product intake and metabolic syndrome. The participants who had late night meal intake had 9.22 times higher risk of metabolic syndrome than the participants who had not (95% CI = 1.37-61.97, p = 0.022). The participants with and without metabolic syndrome had 11.8% and 3.5% of late night meal intake respectively. The participants who had alcohol consumption more than 30 grams per day had 3.54 times higher risk of metabolic syndrome than the participants who had not (95% CI = 1.04-12.07, p = 0.043). The participants with and without metabolic syndrome had 23.6% and 8.6% of alcohol consumption more than 30 grams per day respectively. The participants who had bakery product intake more than 3 days per week had 5.24 times higher risk of metabolic syndrome than the participants who had bakery product intake 3 days and below per week (95% CI = 1.32-20.89, p = 0.019).

The participants with and without metabolic syndrome had 14.7% and 10.3% of bakery product intake more than 3 days per week respectively.

The equation for prediction of the metabolic syndrome

The result in Table 10 showed that late night meal intake, alcohol consumption, and bakery product intake were significantly related to metabolic syndrome ($p < 0.05$). These variables were taken into the equation for prediction of the metabolic syndrome. This equation had accuracy of prediction 88.3%. The equation was as follow:

Probability of metabolic syndrome $= \frac{1}{1+ e^{-(\beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p)}}$ (Amornnimit, 2003)

While β_0 = constant of the equation

β_i ; i = 1,2,…,p = coefficients of the predictive variables

X = predictive variable

In this study, the 3 predictive variables were taken into the equation for prediction of the metabolic syndrome (Appendix C).

Probability of metabolic syndrome $= \frac{1}{1+ e^{-(-2.84 + 2.22 X_1 + 1.27 X_2 + 1.66 X_3)}}$

While X_1 = late night meal intake

(0 = no, 1 = yes)

X_2 = alcohol consumption

(0 = no drinking, 1 = drinking > 30 grams per day)

X_3 = frequency of bakery product intake

(0 = ≤ 3 days per week, 1 = > 3 days per week)

CHAPTER 5

DISCUSSION

The present study was proposed to examine the prevalence of metabolic syndrome and the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province who received the annual health examination at Maharat Nakhon Ratchasima Hospital.

5.1 Characteristics of the Participants

In this study, there were 480 participants (230 males and 250 females) aged 20 years and over who received the annual health examination at Maharat Nakhon Ratchasima Hospital. All of them were population in Mueang District, Nakhon Ratchasima Province. The proportion of males and females who participated in this study was similar. The participants had mean age of 46.82 years. Most of them were married, completed bachelor degree, had income 10,001-20,000 baht per month, and were government officers or state enterprise workers. These characteristics were similar to the previous studies (Lohsoonthorn et al., 2007; Thanatadthanakul, 2007) that investigated in population who visited the health examination. Thanatadthanakul (2007) studied in urban Thai population and found that the participants were urban government officer who had mean age of 45.6 years. Most of them were married and had light work. Lohsoonthorn et al. (2007) studied in professional and office workers in Bangkok and found that most participants completed bachelor degree. The participants with metabolic syndrome were older, and the level of education was

lower than those without metabolic syndrome. Several research studied in urban working-age population (aged 20 years and over) because people in this age range had inappropriate lifestyles that could be the causes of obesity, hypertension, diabetes, and dyslipidemia. As most of the participants who received the annual health examination in the present study were government officers or state enterprise workers and had age range 40-49 years, therefore these samples might represent urban population who were in working age.

Regarding health behaviors, most of the participants had light work, less exercise, and no weight control. More than 50% of the participants had family history of hypertension, diabetes mellitus, or dyslipidemia. About one-fifth of the participants had medications for hypertension, diabetes mellitus, or dyslipidemia. These health behaviors were the risk factor of developing metabolic syndrome. Chen et al. (2008) found that the sedentary behavior was independently associated with the metabolic syndrome. For the cigarette smokers, most of them smoked 1-10 rolls per day, and males had smoking greater than females. Similarly, the Ministry of Public Health, Health System Research Institute (2006) found that males had cigarette smoking 20 times more than females. Male and female smokers had mean cigarette smoking 12 and 8 rolls per day respectively.

Regarding the clinical data, the prevalences of hypercholesterolemia, overweight/obesity, and hypertension were the first 3 health problems of the participants. It was found that the average levels of triglycerides, total cholesterol, LDL-C, and BMI in males and the average levels of total cholesterol and BMI in females were higher than the standard level. These results indicated that dyslipidemia and overweight/obesity were the major problems of the participants in this study. Therefore, the participants should concern on lifestyle modification as it is a primary

treatment of these problems. The avoidance of high-fat consumption and increased physical activity were important factors for solving such problems.

5.2 Prevalence of Metabolic Syndrome and its Components

For the present study, the metabolic syndrome was defined by the IDF and the NCEP ATP III criteria because these criteria were simple and more suitable for the routine health examination in hospital's laboratory. The recommended waist circumference was derived from the ethnic-specific cut off points for an Asian population (≥ 90 cm for male and ≥ 80 cm for female) in both IDF and NCEP ATP III criteria.

In this study, the metabolic syndrome prevalences according to IDF and NCEP ATP III criteria were 15.4% and 17.9% respectively. It was found that the prevalence of metabolic syndrome in this study was similar to the previous studies in Thailand. The prevalences of metabolic syndrome defined by NCEP ATP III in the participants who received the health examination was 15.2% among professional and office workers in Bangkok (Lohsoonthorn et al., 2007) and 24.4% among population in Chumponburi District, Surin Province (Wilaisakunyong et al., 2007). In the prevalences of metabolic syndrome defined by IDF, there were 18.7% among Nakhon Sawan population (Santibhavank, 2007) and 15.0% among population in Si Chiang Mai District, Nong Khai Province (Kaewtrakulpong, 2008). Moreover, the metabolic syndrome prevalence in this study was similar to the previous studies in Asian countries (China, Taiwan, Hong Kong, and Japan), which had the prevalence rate ranging between 10-15% (Pan et al., 2008).

When comparing the prevalence of metabolic syndrome defined by the IDF and the NCEP ATP III criteria, the results showed that the prevalence of metabolic syndrome classified by the NCEP ATP III criteria was 2.5% higher than that by the IDF criteria. This was similar to the previous studies (Kaewtrakulpong, 2008; Santibhavank, 2007). It may be because the IDF requires that all participants with metabolic syndrome must have abdominal obesity as the essential condition, while the NCEP ATP III considers that the importance of all metabolic syndrome components are the same. Thus, the prevalence of metabolic syndrome was variable across studies according to the selection of diagnostic criteria. In addition, the present study showed that the prevalence was higher in males than in females when using the NCEP ATP III criteria, but the prevalence was higher in females than in males when using the IDF criteria. However, the difference between genders was not significant for both criteria. The results were similar to the previous study that males and females had no significant difference in the prevalence of metabolic syndrome (Pongchaiyakul et al., 2007).

For the metabolic syndrome components, the highest to lowest prevalence of metabolic syndrome components in the participants with metabolic syndrome were abdominal obesity, elevated blood pressure, elevated triglycerides, elevated fasting plasma glucose, and reduced HDL-C respectively. This result was consistent with the study in professionals and office workers in Bangkok that the highest prevalence of the participants was hypertension (Lohsoonthorn et al., 2007). However, the present result was inconsistent with the study in Walailak University that the highest prevalence of the participants was low HDL-C (Tangpong et al., 2008). These different results may be due to the different characteristics of the participants such as dietary behavior, exercise, smoking, alcohol drinking, stress, etc. Furthermore, the

results showed that the prevalences of all metabolic syndrome components were significantly higher among participants with metabolic syndrome than the participants without metabolic syndrome. Therefore, all components of metabolic syndrome should be concerned and treated in the participants with metabolic syndrome for preventing the development of CVD and diabetes mellitus.

5.3 The Relationship between Dietary Pattern and Metabolic Syndrome

The multiple logistic regression was used to analyze the relationship between dietary pattern and metabolic syndrome. This statistical analysis could evade the influence of confounding factors, which may affect the relationship between metabolic syndrome and associated factors. Thus, using of multiple logistic regression in this study could control the effects of potential confounders. After confounding factors were adjusted, there were 3 factors of dietary pattern that showed significant relationships with the metabolic syndrome. These factors included late night meal intake, alcohol consumption and bakery product intake.

The first significant factor was late night meal intake. The consumptions of total energy, carbohydrate, or fat at night were associated with higher overall daily energy intake (Castro, 2007). The present study showed a significant relationship between late night meal intake and metabolic syndrome. The participants who had late night meal intake were 9.22 times more likely to have the metabolic syndrome when compared with the participants who had not. It was found that the participants with and without metabolic syndrome had 11.8% and 3.5% of late night meal intake respectively. This result was consistent with the study of Berg et al. (2009) who studied in men and women aged 25-74 years and found that eating at night was significantly associated with obesity (OR = 1.62, 95% CI = 1.10-2.39). Geliebter et al.

(2000) found that subjects who worked during the night shift had significant weight gain greater than subjects who worked during the day shift, because night shift workers consumed the last daily meal later than day shift workers.

The second significant factor was alcohol consumption. The evidence of alcohol consumption that associated with the metabolic syndrome varied. There was either positive or negative association in the cross-sectional study. The present study showed that alcohol consumption was significantly related to the metabolic syndrome. The participants who consumed alcohol more than 30 grams per day had 3.54 times more likely to have the metabolic syndrome when compared with the participants who did not. The participants with and without metabolic syndrome had 23.6% and 8.6% of consuming alcohol more than 30 grams per day respectively. Similarly, Kloimklinsuk (2007) found that the current drinkers had 1.34 times higher risk of metabolic syndrome than the non-drinkers. Panagiotakos (2007) found that alcohol intake was positively correlated with the metabolic syndrome (OR = 1.26, 95% CI = 1.21-1.33). In contrast, Lohsoonthorn et al. (2007) found that alcohol consumption was not significantly associated with the metabolic syndrome in males and females. Some studies showed that mild to moderate alcohol consumption was associated with lower prevalence of the metabolic syndrome, with a favorable influence on lipids, waist circumference, and fasting insulin (Freiberg et al., 2004), while the heavy alcohol consumption led to increased serum triglycerides (Rimm et al., 1999). These different results might be due to the different characteristics of samples and method of data collection that lacked the direct measurement of alcohol consumption.

The last significant factor was bakery product intake. Bakery products consisted of high refined carbohydrate and high fat. The diets with high refined carbohydrates were positively associated with the cardiovascular risk factors, and the

high consumption of fat was associated with adverse blood lipid profile (Yao et al., 2003). In this study, there was the significant relationship between bakery product intake and metabolic syndrome. The participants who had bakery product intake more than 3 days per week were 5.24 times more likely to have the metabolic syndrome when compared with the participants who had bakery product intake 3 days and below per week. The participants with and without metabolic syndrome had 14.7% and 10.3% of consuming bakery product more than 3 days per week respectively. The study of Anderson et al. (1991) showed that a small increase in soluble-fiber intake (~6 grams per day) from refined, wheat-based bakery product could decrease serum total cholesterol and LDL-C in hypercholesterolemic subjects. Additionally, Wirfalt et al. (2001) found that women who consumed refined bread had increased risk of hyperinsulinaemia, whereas the intake of high-fiber bread was associated with lower central obesity and dyslipidemia in men. These results suggested that the consumption of high-fiber bakery product had adversely associated with the metabolic syndrome components, while a refined, low-fiber bakery product was favorable associated with the metabolic syndrome components.

According to the present study, there were some factors of dietary pattern that were not significantly related to the metabolic syndrome. The insignificant results might be due to the small sample size. Increasing the number of participants may lead to better explanation on the relationship of dietary pattern and metabolic syndrome. This study was a cross-sectional study that the measurement of exposure and outcome were in the same period, so the study could not disclose the direct relationship between metabolic syndrome and associated dietary pattern. In addition, there are several factors of lifestyle that influence on the developing metabolic syndrome such as physical inactivity, cigarette smoking, stress, knowledge of participants, etc.

Thus, the strategies for prevention and treatment of metabolic syndrome and for protecting the development of CVD and diabetes mellitus, should include lifestyle modification such as increased exercise combined with dietary habit modification. However, the dietary pattern is still an important factor that influences the presence of metabolic syndrome (Fappa et al., 2008).

In this study, almost 50% of the participants had a large dinner, while only 10% had a large breakfast. This was a poor dietary behavior because dietary intake at breakfast appeared to be protective against metabolic syndrome, while a high load at dinner favored this syndrome (Esquirol et al., 2009). In addition, Saiwongse et al. (2008) found that there was a significant relationship between the consumption of a large dinner and repeated dietary type and metabolic syndrome. For other dietary behaviors, more than 50% of the participants in this study spent time on each meal less than 15 minutes. Shin et al. (2009) found that the subjects with metabolic syndrome had approximately 2 times faster eating than those without metabolic syndrome. This indicated that the faster eating was associated with the risk of metabolic syndrome.

For beverage consumption, most participants had 6-8 glasses per day of water drinking. The intake of water 1 liter or more per day was associated with significantly increased odds of recovering from metabolic syndrome over 12 months (OR = 3.9, 95% CI = 1.7-8.8, $p = 0.001$) (Stookey, Gardner and Popkin, 2008). Most participants had 1 glass and below per day of high-calorie juice intake. The coffee was a popular beverage among the participants. Hino et al. (2007) found that the intake of coffee was inversely associated with all components of the metabolic syndrome except HDL-C ($p < 0.01$). Moreover, Dhingra et al. (2007) found that the consumption of ≥ 1 soft drink per day was associated with increased odds of developing metabolic

syndrome (OR = 1.44, 95% CI = 1.20-1.74), obesity (OR = 1.31, 95% CI = 1.02-1.68), increased waist circumference (OR = 1.30, 95% CI = 1.09-1.56), impaired fasting glucose (OR = 1.25, 95% CI = 1.05-1.48), higher blood pressure (OR = 1.18, 95% CI = 0.96-1.44), hypertriglyceridemia (OR = 1.25, 95% CI = 1.04-1.51), and low HDL-C (OR = 1.32, 95% CI = 1.06-1.64).

Regarding the frequency of dietary intake, most of the participants consumed the unhealthy diet (1-3 days per month) such as fatty meat, meat product, bakery product, fried food, coconut milk food, single-plate food, semi-instant food, salty processed food, high-sugar food, and snack. For the healthy diet, most of them often consumed fruits and vegetables (more than 3 days per week) and seldom consumed whole grains. Several studies indicated that the consumption of healthy diet was generally found to be associated with lower prevalence of metabolic syndrome, while the consumption of unhealthy diet appeared to be associated with increased risk of metabolic syndrome (Baxter et al., 2006; Pan et al., 2008).

For the data of daily energy intake, there was no significant relationship between carbohydrate, fat, and protein intake and the metabolic syndrome. It may be influenced by several factors. The participants might have recall bias, especially type and amount of dietary intake that they could not remember or clearly estimate their dietary intake. Thus, the data of energy intake might be under or overestimated. However, the single 24-hour dietary recall was useful for estimating the mean intake of population (Park et al., 2004).

Several studies indicated that there were several factors (sedentary behavior, cigarette smoking, alcohol consumption, high fat and carbohydrate consumption, stress, etc.) that influenced the presence of metabolic syndrome. The present study illustrated that there were 3 factors of dietary pattern including late night meal intake,

alcohol consumption more than 30 grams per day, and bakery product intake more than 3 days per week that were significantly related to the metabolic syndrome. The dietary pattern is one of the important factors that play a role in increasing or decreasing the metabolic syndrome.

CHAPTER 6

CONCLUSION

This research was a cross-sectional study that determined the prevalence of metabolic syndrome and the relationship between dietary pattern and metabolic syndrome in population in Mueang District, Nakhon Ratchasima Province who received the annual health examination at Maharat Nakhon Ratchasima Hospital during December, 2008 through March, 2009. There were 480 participants (230 males and 250 females) enrolled in this study. The data were collected from blood test, blood pressure measurement, waist circumference measurement, and self-administered questionnaire. The results showed that the prevalence of metabolic syndrome defined by the IDF was 15.4% (13.9% in males and 16.8% in females) and by the NCEP ATP III, with the modified waist circumference cut off points for an Asian population, was 17.9% (18.7% in males and 17.2% in females). Males and females had no significant difference in the prevalence of metabolic syndrome defined by both criteria. The analysis of the relationship between dietary pattern and metabolic syndrome by the multiple logistic regression showed that late night meal intake, alcohol consumption, and bakery product intake were significantly associated with the metabolic syndrome. Thus, the population should avoid late night meal intake and should have the appropriate consumption of alcohol and the products with high carbohydrate and fat. The present study illustrated that the metabolic syndrome was a health problem found in urban population, and the dietary pattern was an important factor for the risk of developing metabolic syndrome.

Recommendations for further study

1. The sample size should be increased for better explanation of some factors that are related to the metabolic syndrome.
2. The data collection of the 24-hour dietary recall may use the multiple replicate 24-hour dietary recall and the data of food frequency questionnaire may be recalled for longer period so as to decrease the error of dietary assessment.
3. The study should be designed for representation of all population in Mueang District, Nakhon Ratchasima Province.

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Appendices

Appendix A

Questionnaire

แบบสอบถาม

โครงการวิจัยเรื่อง "ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารและกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา"

คำชี้แจง

โครงการวิจัยนี้เป็นส่วนหนึ่งของวิทยานิพนธ์ระดับปริญญาโท ภาควิชาอาหารและเภสัชเคมี คณะเภสัชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย โดยมีการเก็บข้อมูลผลการตรวจสุขภาพ และข้อมูลเกี่ยวกับแบบแผนการบริโภคอาหารของผู้ที่เข้ารับการตรวจสุขภาพจากโรงพยาบาลมหาราชนครราชสีมา ท่านเป็นผู้หนึ่งที่ได้รับคัดเลือกให้เป็นกลุ่มตัวอย่างของงานวิจัยในครั้งนี้ ผู้วิจัยจึงขอความกรุณาจากท่าน…

1. ลงนามแสดงความยินยอมใน "ใบยินยอมด้วยความสมัครใจ" เพื่อให้ผู้วิจัยสามารถนำผลการตรวจสุขภาพของท่าน (ผลการตรวจร่างกาย ผลการตรวจเลือด และข้อมูลต่างๆ ที่ได้จากการตอบแบบสอบถาม) มาใช้วิเคราะห์ในโครงการวิจัยนี้
2. ขอให้ท่านตอบแบบสอบถาม โดยโปรดตอบให้ครบทุกข้อตามความเป็นจริง แบบสอบถามนี้ ประกอบด้วย 5 ส่วน ได้แก่

   ส่วนที่ 1 ข้อมูลการประเมินกลุ่มอาการเมแทบอลิก (สำหรับผู้วิจัย) ***ท่านไม่ต้องตอบ***

   ส่วนที่ 2 ข้อมูลทั่วไป มี 15 ข้อ

   ส่วนที่ 3 ข้อมูลแบบแผนการบริโภคอาหาร มี 9 ข้อ

   ส่วนที่ 4 แบบบันทึกความถี่ในการบริโภคอาหาร มี 13 ข้อ

   ส่วนที่ 5 แบบบันทึกการบริโภคอาหารย้อนหลัง 24 ชั่วโมง

ทั้งนี้ ผลการตรวจสุขภาพของท่าน ผู้วิจัยจะติดตามจากโรงพยาบาลมหาราชนครราชสีมาด้วยตนเอง ผู้วิจัยขอรับรองว่าข้อมูลของท่านจะถูกเก็บเป็นความลับ และจะนำเสนอผลการวิจัยในลักษณะภาพรวมเท่านั้น ผู้วิจัยขอขอบคุณทุกท่านที่ให้ความร่วมมือมา ณ โอกาสนี้

เภสัชกรหญิงรัชฎา สุธาดารัตน์
นิสิตปริญญาโท ภาควิชาอาหารและเภสัชเคมี
คณะเภสัชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

โปรดกรอกข้อมูล วันที่ ……/……..……/…….…… ตัวอย่างที่ □□□

ชื่อ (นาย/ นาง/ นางสาว) ..... **นามสกุล** .....

ที่อยู่ปัจจุบัน บ้านเลขที่ ..... **หมู่** ……..... **ซอย** ..... **ถนน** .....

ตำบล ..... **อำเภอ** ..... **จังหวัด** .....

รหัสไปรษณีย์ ..... **เบอร์โทรศัพท์ที่ติดต่อได้** .....

<u>ส่วนที่ 1</u> ข้อมูลการประเมินกลุ่มอาการเมแทบอลิก *(สำหรับผู้วิจัย)*

ตัวชี้วัด	เกณฑ์การวินิจฉัยกลุ่มอาการเมแทบอลิก ตาม NCEP ATP III	เกณฑ์การวินิจฉัยกลุ่มอาการเมแทบอลิก ตาม IDF	การวินิจฉัยกลุ่มอาการเมแทบอลิก				code	
			NCEP ATP III		IDF			
			1) เข้าเกณฑ์	2) ไม่เข้าเกณฑ์	1) เข้าเกณฑ์	2) ไม่เข้าเกณฑ์	NCEP ATPIII	IDF
1) WC …… cm	ชาย ≥ 90 cm, หญิง ≥ 80 cm	ชาย ≥ 90 cm, หญิง ≥ 80 cm						
2) FPG …… mg/dl	≥ 100 mg/dl หรือ type 2 DM	≥ 100 mg/dl หรือ type 2 DM						
3) TG …… mg/dl	≥ 150 mg/dl หรือ ได้รับยา	≥ 150 mg/dl หรือ ได้รับยา						
4) HDL-C…… mg/dl	ชาย < 40 mg/dl, หญิง < 50 mg/dl หรือ ได้รับยา	ชาย < 40 mg/dl, หญิง < 50 mg/dl หรือ ได้รับยา						
5) BP …… mmHg	≥ 130/85 mmHg หรือ ได้รับยา	≥ 130/85 mmHg หรือ ได้รับยา						
ผลการประเมินกลุ่มอาการเมแทบอลิก								

<u>อื่นๆ</u> : น้ำหนัก …… kg

: ส่วนสูง ……..... cm

: BMI ……..... kg/m^2 ☐ 1) < 18.50 kg/m^2 ☐ 2) 18.50 – 22.99 kg/m^2

☐ 3) 23.00 – 24.99 kg/m^2 ☐ 4) 25.00 – 29.99 kg/m^2 ☐ 5) ≥ 30.00 kg/m^2

: Total cholesterol…….mg/dl ☐ 1) < 200 mg/dl ☐ 2) ≥ 200 mg/dl

: LDL-C…….mg/dl ☐ 1) < 130 mg/dl ☐ 2) ≥ 130 mg/dl

<u>ส่วนที่ 2</u> ข้อมูลทั่วไป

<u>คำชี้แจง</u> โปรดใส่เครื่องหมาย ✓ ลงในช่อง ☐ หรือเติมข้อความลงในช่องว่าง

1. เพศ

   ☐ 1) ชาย ☐ 2) หญิง

2. อายุ ..... ปี

3. สถานภาพสมรส

   ☐ 1) โสด ☐ 2) คู่/สมรส ☐ 3) หย่า/แยก/หม้าย

4. ระดับการศึกษา

   ☐ 1) ไม่ได้เรียนหนังสือ ☐ 2) ประถมศึกษา ☐ 3) มัธยมต้น/ปวช.

   ☐ 4) มัธยมปลาย/ปวส. ☐ 5) ปริญญาตรี ☐ 6) สูงกว่าปริญญาตรี

   ☐ 7) อื่นๆ ระบุ .....

5. อาชีพ

   ☐ 1) ข้าราชการ/พนักงานรัฐวิสาหกิจ ☐ 2) ลูกจ้าง ☐ 3) แม่บ้าน/เกษียณ

   ☐ 4) ธุรกิจส่วนตัว/ค้าขาย ☐ 5) อื่นๆ ระบุ.....

6. รายได้เฉลี่ยต่อเดือน

   ☐ 1) ต่ำกว่า 5,000 บาท ☐ 2) 5,000-10,000 บาท ☐ 3) 10,001-20,000 บาท

   ☐ 4) 20,001-30,000 บาท ☐ 5) 30,001-40,000 บาท ☐ 6) 40,001 บาท ขึ้นไป

7. โดยปกติ การทำงานของท่านมี <u>อิริยาบถส่วนใหญ่</u> เป็นแบบใด

   ☐ 1) นั่งหรือยืน อาจเดินบ้างแต่ไม่เกินครั้งละ 10 นาที

   ☐ 2) ออกแรงปานกลาง (ออกแรงจนหายใจเร็วขึ้น เหนื่อยเล็กน้อย) ตั้งแต่ครั้งละ 10 นาทีขึ้นไป

   ☐ 3) ใช้กำลังมาก หรือยกสิ่งของที่มีน้ำหนักมาก ตั้งแต่ครั้งละ 10 นาทีขึ้นไป

   ☐ 4) ไม่ได้ทำงาน

8. โดยปกติ ท่านออกกำลังกายหรือไม่

   ☐ 1) ไม่ได้ออกกำลังกาย ☐ 2) 1-2 วันต่อสัปดาห์ ☐ 3) 3 วันต่อสัปดาห์

   ☐ 4) 4 วันต่อสัปดาห์ ☐ 5) 5 วันขึ้นไปต่อสัปดาห์

   (ถ้ามี) ชนิดของการออกกำลังกาย คือ ..... ครั้งละ ..... นาที

9. ปกติ ท่านเดินทางไปทำงาน ไปธุระนอกบ้าน ด้วยวิธีใด

   ☐ 1) นั่งรถ อาจเดินบ้างแต่ไม่เกินครั้งละ 10 นาที

   ☐ 2) เดินเท้าหรือขี่จักรยานอย่างต่อเนื่องเป็นเวลาตั้งแต่ 10 นาทีขึ้นไป สัปดาห์ละ.....วัน

10. ท่าน นอนหลับ พักผ่อน วันละ ..... ชั่วโมง

11. ท่านสูบบุหรี่ หรือไม่

☐ 1) ไม่เคยสูบ ☐ 2) เคยสูบ แต่เลิกแล้ว

☐ 3) สูบ จำนวน…....มวนต่อวัน

12. ปัจจุบันท่านควบคุมน้ำหนักตัวหรือไม่

☐ 1) ไม่เคยควบคุมน้ำหนักตัว ☐ 2) ควบคุมด้วยวิธีการลดปริมาณอาหาร

☐ 3) ควบคุมด้วยวิธีการอดอาหาร ☐ 4) ควบคุมด้วยวิธี ระบุ……..

13. ปัจจุบันท่านรับประทานยารักษาโรคใดบ้าง

☐ 1) โรคความดันโลหิตสูง ☐ 2) โรคเบาหวาน

☐ 3) โรคไขมันในเลือดสูง ☐ 4) โรคอื่นๆ ระบุ.....

☐ 5) ไม่มี

14. ท่านรับประทานผลิตภัณฑ์เสริมอาหารหรือวิตามินบำรุงหรือไม่

☐ 1) ไม่รับประทาน

☐ 2) รับประทาน เพื่อ……

15. ท่านมีญาติสายตรงเป็นโรคต่อไปนี้หรือไม่ โปรดระบุว่าเป็นใคร

	พ่อแม่	พี่น้อง	ปู่ย่า	ตายาย
1) โรคความดันโลหิตสูง				
2) โรคเบาหวาน				
3) โรคไขมันในเลือดสูง				
4) อื่นๆ ระบุ.....				
5) ไม่มี ☐				

<u>ส่วนที่ 3</u> ข้อมูลแบบแผนการบริโภคอาหาร

<u>คำชี้แจง</u> โปรดใส่เครื่องหมาย ✓ ลงในช่อง ☐ หรือเติมข้อความลงในช่องว่าง

1. ปกติท่านรับประทานอาหารมื้อใดบ้าง

☐ 1) มื้อเช้า ☐ 2) อาหารว่างเช้า ☐ 3) มื้อกลางวัน

☐ 4) อาหารว่างบ่าย ☐ 5) มื้อเย็น ☐ 6) มื้อดึก

2. ปกติท่านรับประทานอาหารมื้อใด ใน<u>ปริมาณมากที่สุด</u>

☐ 1) มื้อเช้า ☐ 2) มื้อกลางวัน ☐ 3) มื้อเย็น

☐ 4) มื้ออื่นๆ ระบุ .....

3. ท่านชอบรับประทานอาหารที่ปรุงด้วยวิธีใดมากที่สุด

☐ 1) ทอด ☐ 2) ผัด ☐ 3) ลวก/ต้ม/อบ

☐ 4) ปิ้ง/ย่าง ☐ 5) อื่นๆ ระบุ.....

4. ท่านชอบรับประทานอาหารรสชาติใดมากที่สุด

☐ 1) เค็ม ☐ 2) หวาน ☐ 3) เปรี้ยว

☐ 4) จืด ☐ 5) เผ็ด ☐ 6) อื่นๆ ระบุ .....

5. โดยส่วนใหญ่ ท่านรับประทานอาหารแบบใด (ตอบได้มากกว่า 1 ข้อ)

☐ 1) ปรุงอาหารเองที่บ้าน

☐ 2) ซื้ออาหารปรุงสำเร็จมารับประทานที่บ้าน

☐ 3) รับประทานอาหารนอกบ้าน

☐ 4) อื่นๆ ระบุ .....

6. ท่านดื่มน้ำเปล่าวันละประมาณเท่าใด

☐ 1) น้อยกว่า 6 แก้วต่อวัน

☐ 2) 6-8 แก้วต่อวัน

☐ 3) มากกว่า 8 แก้วต่อวัน

7. ท่านดื่มเครื่องดื่มแอลกอฮอล์ หรือไม่

☐ 1) ไม่ดื่ม

☐ 2) ดื่มแอลกอฮอล์ – ชนิดใดบ้าง

☐ 2.1) เบียร์ สัปดาห์ละ ..... แก้ว (360ซีซี)

☐ 2.2) สุรา สัปดาห์ละ ..... แก้ว (45ซีซี)

☐ 2.3) ไวน์ สัปดาห์ละ ..... แก้ว (150ซีซี)

8. เครื่องดื่มชนิดใดที่ท่านมักดื่มเป็นประจำ (ตอบได้มากกว่า 1 ข้อ)

☐ 1) น้ำอัดลม สัปดาห์ละ ..... แก้ว

☐ 2) ชา/กาแฟ สัปดาห์ละ ..... แก้ว

☐ 3) น้ำผลไม้ สัปดาห์ละ ..... แก้ว

☐ 4) อื่นๆ ระบุ..... สัปดาห์ละ ..... แก้ว

9. โดยปกติ การรับประทานอาหารของท่านเป็นแบบใด (ตอบได้มากกว่า 1 ข้อ)

☐ 1) มักรับประทานอาหารซ้ำๆ กันทุกวัน

☐ 2) รับประทานอาหารมื้อเย็นห่างจากเวลานอน น้อยกว่า 4 ชั่วโมง

☐ 3) ใช้เวลาในการรับประทานอาหารแต่ละมื้อ 15 นาทีขึ้นไป

<u>ส่วนที่ 4</u> แบบบันทึกความถี่ในการบริโภคอาหาร

<u>คำชี้แจง</u> ในระหว่าง 1 เดือนที่ผ่านมา ท่านรับประทานอาหารต่างๆ เหล่านี้ บ่อยครั้งเพียงใด โปรดใส่เครื่องหมาย ✓ ลงในช่องว่าง แต่ละข้อเลือกเพียงคำตอบเดียว

	4 วันขึ้นไป ต่อสัปดาห์	**1 - 3 วัน ต่อสัปดาห์**	**1 - 3 วัน ต่อเดือน**	**ไม่เคย**
1. เนื้อสัตว์ปนมัน/หนังสัตว์ เช่น หมูสามชั้น หมูกรอบ หนังหมู ฯลฯ				
2. ผลิตภัณฑ์จากสัตว์ เช่น เครื่องในสัตว์ ไข่แดง กุนเชียง ไส้กรอก หมูยอ แหนม แฮม เบคอน ฯลฯ				
3. อาหารที่มีแป้ง-เนยสูง เช่น ขนมปังทาเนย เค้ก คุกกี้ โดนัท ฯลฯ				
4. อาหารทอด อาหารมัน เช่น หมูทอด ไก่ทอด ไข่เจียว ทอดมัน ฯลฯ				
5. อาหารใส่กะทิ เช่น แกงใส่กะทิ ขนมหวานใส่กะทิ				
6. ผักต่างๆ เช่น ผักใบเขียว ฯลฯ				
7. ผลไม้ต่างๆ เช่น ส้ม มะละกอ ฝรั่ง แอปเปิ้ล ฯลฯ				
8. ธัญพืชไม่ขัดสี เช่น ข้าวกล้อง ขนมปังโฮลวีท งา ลูกเดือย ฯลฯ				
9. อาหารจานเดียว เช่น ข้าวมันไก่ ข้าวขาหมู หอยทอด ผัดไท ฯลฯ				
10. อาหารกึ่งสำเร็จรูป เช่น บะหมี่กึ่งสำเร็จรูป โจ๊กกึ่งสำเร็จรูป ฯลฯ				
11. อาหารแปรรูปประเภทใส่เกลือเป็นหลัก เช่น เนื้อเค็ม ปลาเค็ม ไข่เค็ม ปลาร้า กะปิ ผัก-ผลไม้ดอง				
12. อาหารที่มีน้ำตาลสูง เช่น ขนมหวาน ผลไม้แช่อิ่ม				
13. ขนมสำหรับกินเล่น เช่น มันฝรั่งทอด ถั่วทอด ข้าวเกรียบกุ้ง กล้วยแขก ปาท่องโก๋ ฯลฯ				

<u>ส่วนที่ 5</u> **แบบบันทึกการบริโภคอาหารย้อนหลัง 24 ชั่วโมง**

<u>คำชี้แจง</u> กรุณาบันทึก **อาหาร เครื่องดื่ม และขนมทุกชนิด** ที่ท่านรับประทาน<u>เมื่อวานนี้ตลอดทั้งวัน</u>

วันที่บันทึก ……. **เดือน** ……..…….. **พ.ศ**. ……

มื้ออาหาร	**สถานที่รับประทาน**	**รายการอาหาร**	**ส่วนประกอบ (คร่าวๆ)**	**ปริมาณที่รับประทาน** (ระบุเป็นหน่วยที่ใช้ในครัวเรือน เช่น ถ้วย ทัพพี ช้อนโต๊ะ ช้อนชา แก้ว มิลลิลิตร ชิ้น ลูก ผล ฯลฯ)
<u>ตัวอย่าง</u> มื้อเย็น	ร้านอาหาร	ก๋วยเตี๋ยวปลา	เส้นใหญ่ เนื้อปลา ถั่วงอก	2 ทัพพี 4 ช้อนโต๊ะ 1 ทัพพี
เช้า				
กลางวัน				
เย็น				
ค่ำ หรือ อาหารว่าง				

อาหารที่รับประทาน ☐ เหมือนปกติ ☐ น้อยกว่าปกติ เพราะ …….....

☐ มากกว่าปกติ เพราะ …….....

ภาพตัวอย่างเพื่อใช้กะประมาณปริมาณอาหารที่รับประทาน

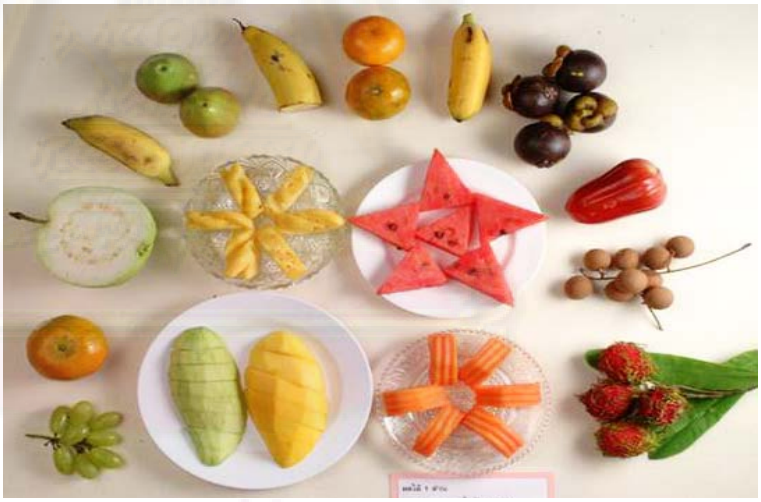
สำหรับบันทึกการบริโภคอาหารย้อนหลัง 24 ชั่วโมง

(ระบุเป็นหน่วยที่ใช้ในครัวเรือน เช่น ถ้วย ทัพพี ช้อนโต๊ะ ช้อนชา แก้ว มิลลิลิตร ชิ้น ลูก ผล ฯลฯ)

กลุ่มข้าว-แป้ง เช่น ข้าวสวย 1 ทัพพี = 5 ช้อนกินข้าว

กลุ่มเนื้อสัตว์ เช่น เนื้อสัตว์ 1 ช้อนกินข้าว = ปลาทู ½ ตัว = ไข่ ½ ฟอง = ตับ 1 ช้อนกินข้าว = ลูกชิ้น 2 ลูก เป็นต้น

กลุ่มผัก เช่น ผัก 1 ทัพพี



กลุ่มผลไม้ ผลไม้ 1 ส่วน = ผลไม้ขนาดเล็ก 6-8 ผล (เช่น ลำไย องุ่น) = ผลไม้ขนาดกลาง 1-2 ผล (เช่น ชมพู่ ส้ม) = ผลไม้ขนาดใหญ่ 6-8 ชิ้น (เช่น มะม่วง มะละกอ แตงโม สับปะรด)

กลุ่มนม เช่น นม 1 กล่อง

กลุ่มเครื่องดื่ม เช่น เบียร์ 1 แก้ว

กลุ่มขนมกินเล่น เช่น ปาท่องโก๋ 1 ตัว

ภาพแสดง: ตัวอย่างอาหารสำหรับประมาณปริมาณอาหารที่บริโภค (Damapong, 2007)

Appendix B

- **Approval of certificate from Maharat Nakhon Ratchasima Hospital**
- **Information sheet for participants**
- **Consent form**

เลขที่ใบรับรอง 082/2008

คณะกรรมการสนับสนุนการศึกษาวิจัยในคน
(Institutional Review Board)
โรงพยาบาลมหาราชนครราชสีมา

โครงการวิจัยเรื่อง : ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารและกลุ่มอาการเมแทบอลิก ของประชากรในอำเภอเมือง จังหวัดนครราชสีมา

ผู้วิจัย : นางสาวรัชฎา สุธาดารัตน์

หน่วยงานที่สังกัด : นิสิตปริญญาโท คณะเภสัชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

คณะกรรมการสนับสนุนการศึกษาวิจัยในคน โรงพยาบาลมหาราชนครราชสีมา ได้ผ่านการรับรองในแง่จริยธรรม โดยยึดหลักเกณฑ์ตามคำประกาศเฮลซิงกิ (Declaration of Helsinki) และหลักเกณฑ์การปฏิบัติการวิจัยทางคลินิกที่ดี (ICH-GCP) โดยให้ดำเนินการศึกษาวิจัยเรื่องข้างต้นได้

โดยให้ผู้วิจัยรับเงื่อนไขที่เสนอดังต่อไปนี้

1. ให้แจ้งคณะกรรมการสนับสนุนการศึกษาวิจัยในคนในกรณีที่แก้ไขเปลี่ยนแปลงโครงการวิจัยหรือหยุดโครงการก่อนกำหนด
2. รายงานเหตุการณ์ที่ไม่พึงประสงค์ที่ร้ายแรงหรือที่ไม่คาดคิด
3. รายงานเหตุการณ์ที่ไม่คาดคิด
4. รายงานข้อมูลข่าวสารที่คณะกรรมการสนับสนุนการศึกษาวิจัยในคนควรได้รับระหว่างดำเนินการวิจัย
5. ส่งรายงานฉบับสมบูรณ์เมื่อเสร็จสิ้นโครงการวิจัย

.....ประธาน
(นายกวี ไชยศิริ)
ผู้อำนวยการโรงพยาบาลมหาราชนครราชสีมา

รับรองวันที่ 15 ธันวาคม 2551 (ใบรับรองมีระยะเวลา 1 ปี หลังจากวันที่อนุมัติ)

คณะกรรมการสนับสนุนการศึกษาวิจัยในคน โรงพยาบาลมหาราชนครราชสีมา
สำนักงาน : ศูนย์แพทยศาสตรศึกษาชั้นคลินิก โรงพยาบาลมหาราชนครราชสีมา
49 ถ. ช้างเผือก ต.ในเมือง อ.เมือง จ.นครราชสีมา 30000
โทร. (044)295614-5 โทรสาร (044)295614-5

เอกสารแนะนำสำหรับผู้เข้าร่วมการวิจัย

1. ชื่อโครงการวิจัย

(ภาษาไทย) ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา

(ภาษาอังกฤษ) RELATIONSHIP BETWEEN DIETARY PATTERN AND METABOLIC SYNDROME IN POPULATION IN MUEANG DISTRICT, NAKHON RATCHASIMA PROVINCE

2. ชื่อผู้วิจัย ภ.ญ. รัชฎา สุธาดารัตน์ **ตำแหน่ง** เภสัชกร

3. สถานที่ปฏิบัติงาน กลุ่มงานเภสัชกรรม โรงพยาบาลมหาราชนครราชสีมา

โทรศัพท์ ที่ทำงาน 0-4423-5078 เคลื่อนที่ 08-4036-0973

4. เนื้อหาสาระของโครงการวิจัยและความเกี่ยวข้องกับผู้เข้าร่วมการวิจัย ได้แก่

4.1 เหตุผลและความจำเป็นที่ต้องทำการศึกษาวิจัย

กลุ่มอาการเมแทบอลิก หรือโรคอ้วนลงพุง คือ การมีความผิดปกติต่างๆ ได้แก่ เส้นรอบเอวเกินมาตรฐาน ระดับน้ำตาลในเลือดสูง ระดับไตรกลีเซอไรด์ในเลือดสูง ระดับเอช-ดี-แอลคอเลสเตอรอลในเลือดต่ำ และความดันโลหิตสูง ผู้ที่มีความผิดปกติ 3 ใน 5 อย่างนี้ ถือว่าเป็นโรคอ้วนลงพุง ซึ่งเป็นปัจจัยเสี่ยงที่ทำให้เกิดโรคหัวใจและหลอดเลือด และโรคเบาหวาน ตามมาได้ ปัจจุบันพฤติกรรมการบริโภคอาหารของคนไทยเปลี่ยนแปลงไปจากเดิม โดยเฉพาะคนในเขตเมืองมีการบริโภคเนื้อสัตว์ แป้ง และไขมันเพิ่มขึ้น แต่บริโภคผักและผลไม้ลดลง ทำให้มีความเสี่ยงต่อการเกิดโรคอ้วนลงพุงมากขึ้น จากรายงานการวิจัยพบว่าผู้ที่รับประทานอาหารมื้อเย็นมาก รับประทานปลาน้อย และรับประทานอาหารซ้ำซาก มีโอกาสเสี่ยงต่อการเกิดโรคหัวใจและหลอดเลือดเพิ่มขึ้น ส่วนผู้ที่รับประทานแบบเน้นเนื้อสัตว์โดยลดปริมาณข้าว มีโอกาสเสี่ยงต่อการมีไขมันสะสมบริเวณหน้าท้องมากที่สุด จากที่กล่าวมาจะเห็นว่าพฤติกรรมการบริโภคอาหารเป็นปัจจัยที่มีความสำคัญต่อการเกิดโรคอ้วนลงพุง การวิจัยนี้จึงทำการสำรวจความชุกของโรคอ้วนลงพุง และแบบแผนการบริโภคอาหารที่มีผลต่อการเกิดโรคอ้วนลงพุงของประชากรในอำเภอเมือง จังหวัดนครราชสีมา เพื่อใช้เป็นข้อมูลพื้นฐานทางโภชนาการสำหรับการรณรงค์ส่งเสริมสุขภาพของประชาชนต่อไป

4.2 วัตถุประสงค์ของการวิจัย

เพื่อศึกษาความชุกของกลุ่มอาการเมแทบอลิก และความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา

4.3 วิธีการศึกษาวิจัย

ผู้วิจัยขอให้ท่านปฏิบัติตามขั้นตอน ดังนี้

1) ขอให้ท่านลงนามแสดงความยินยอมเข้าร่วมโครงการวิจัยใน “ใบยินยอมด้วยความสมัครใจ” เพื่อให้ผู้วิจัยสามารถนำผลการตรวจสุขภาพของท่าน (ผลการตรวจร่างกาย ผลการตรวจเลือด และข้อมูลต่างๆ ที่ได้จากการตอบแบบสอบถาม) มาใช้วิเคราะห์ในโครงการวิจัยนี้
2) ท่านทำการตอบแบบสอบถามข้อมูลทั่วไป ข้อมูลแบบแผนการบริโภคอาหาร ข้อมูลความถี่ในการบริโภคอาหาร และบันทึกการบริโภคอาหารย้อนหลัง 24 ชั่วโมง
3) ท่านเข้ารับการตรวจสุขภาพประจำปี โดยดำเนินการตามขั้นตอนที่ได้รับการชี้แจงจากเจ้าหน้าที่ของโรงพยาบาลมหาราชนครราชสีมา
4) ผู้วิจัยจะติดตามผลการตรวจสุขภาพจากแฟ้มประวัติของท่าน ณ โรงพยาบาลมหาราชนครราชสีมา ด้วยตนเอง

4.4 ระยะเวลาที่ผู้เข้าร่วมการวิจัยต้องเกี่ยวข้องในการศึกษาวิจัย

1 วัน (วันที่เข้ารับการตรวจสุขภาพ)

4.5 ประโยชน์ที่คาดว่าจะได้รับ

ได้ข้อมูลความชุกของกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา และแนวโน้มการบริโภคอาหารที่ทำให้เกิดหรือป้องกันการเกิดกลุ่มอาการเมแทบอลิก ซึ่งใช้เป็นแนวทางในการรณรงค์ส่งเสริมการบริโภคอาหารเพื่อสุขภาพที่ดีต่อไป

4.6 ความเสี่ยง ความไม่สบาย และผลข้างเคียงที่อาจเกิดขึ้น

ไม่มี เนื่องจากการวิจัยนี้เป็นการตอบแบบสอบถาม และผลการตรวจสุขภาพ ผู้วิจัยจะติดตามจากแฟ้มประวัติของท่าน ณ โรงพยาบาลมหาราชนครราชสีมา

4.7 การรักษาความลับของบันทึกทางการแพทย์ และข้อมูลการศึกษาวิจัย

ข้อมูลของท่านจะถูกเก็บเป็นความลับ และจะเปิดเผยในรูปสรุปผลการวิจัยหรือเปิดเผยต่อผู้มีหน้าที่ที่เกี่ยวข้องกับการสนับสนุนและกำกับดูแลการวิจัยเท่านั้น

4.8 ค่าใช้จ่ายและค่าชดเชย

ไม่มี

4.9 สิทธิในการถอนตัวออกจากการศึกษาวิจัย

ท่านมีสิทธิบอกเลิกการเข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลต่อการรักษาโรคที่ท่านจะได้รับต่อไป

4.10 การสอบถามข้อสงสัย

ในกรณีที่มีปัญหาหรือข้อสงสัย ท่านสามารถติดต่อผู้วิจัย :

เภสัชกรหญิง รัชฎา สุธาดารัตน์ กลุ่มงานเภสัชกรรม โรงพยาบาลมหาราชนครราชสีมา

โทรศัพท์ที่ทำงาน 0-4423-5078 โทรศัพท์เคลื่อนที่ 08-4036-0973 (ติดต่อได้ 24 ชั่วโมง)

ใบยินยอมด้วยความสมัครใจ

การวิจัยเรื่อง (ภาษาไทย) ความสัมพันธ์ระหว่างแบบแผนการบริโภคอาหารกับกลุ่มอาการเมแทบอลิกของประชากรในอำเภอเมือง จังหวัดนครราชสีมา

(ภาษาอังกฤษ) RELATIONSHIP BETWEEN DIETARY PATTERN AND METABOLIC SYNDROME IN POPULATION IN MUEANG DISTRICT, NAKHON RATCHASIMA PROVINCE

วันที่ให้ความยินยอม วันที่..... เดือน..... พ.ศ. .....

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีวิจัย รวมทั้งประโยชน์ที่เกิดขึ้นจากการวิจัยอย่างละเอียด และมีความเข้าใจดีแล้ว

ผู้วิจัยรับรองว่าจะตอบคำถามต่างๆ ที่ข้าพเจ้าสงสัยด้วยความเต็มใจ ไม่ปิดบัง ซ้อนเร้น จนข้าพเจ้าพอใจ

ข้าพเจ้ามีสิทธิที่จะบอกเลิกการเข้าร่วมในโครงการวิจัยนี้เมื่อใดก็ได้ และเข้าร่วมโครงการนี้โดยสมัครใจ และการบอกเลิกการเข้าร่วมการวิจัยนี้ จะไม่มีผลต่อการรักษาโรคที่ข้าพเจ้าจะได้รับต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้เฉพาะสรุปผลการวิจัย หรือการเปิดเผยข้อมูลต่อผู้มีหน้าที่ที่เกี่ยวข้องกับการสนับสนุนและกำกับดูแลการวิจัยเท่านั้น

ในการวิจัยครั้งนี้ ข้าพเจ้ายอมให้ผู้วิจัยนำผลการตรวจร่างกาย ผลการตรวจเลือด และข้อมูลต่างๆ ที่ได้จากการสัมภาษณ์หรือการตอบแบบสอบถามการวิจัย มาใช้วิเคราะห์ในโครงการวิจัยนี้

ข้าพเจ้าได้อ่านข้อความข้างต้น และมีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ลงนาม ..... **ผู้ยินยอม**

(.....) ชื่อตัวบรรจง

วันที่ …….. เดือน …….. พ.ศ.……

ลงนาม ..... **ผู้วิจัย**

ลงนาม ..... **พยาน**

ลงนาม ..... **พยาน**

Appendix C

Data analyses

Data analyses

The data analyses used in this study included:

1. Content validity test

The content validity test is one of the questionnaire's quality examination. In this study, all parts of questionnaire were proved by 5 experts for testing content validity. Then, the questionnaire was revised for clearer content and suitability according to the experts' recommendations. Finally, the questionnaire was divided into 5 parts that consisted of part 1: metabolic syndrome assessment (5 items), part 2: demographic characteristics (15 items), part 3: dietary pattern (9 items), part 4: food frequency questionnaire (13 items), and part 5: the 24-hour dietary recall.

2. Reliability test

The reliability test is one of the questionnaire's quality examination. The Cronbach's alpha is a popular technique for reliability test. The Cronbach's alpha normally ranges between 0-1 and the acceptable reliability of questionnaire should have the Cronbach's alpha more than 0.70 (George and Mallery, 2003). In this study, the reliability of food frequency questionnaire was tested with the group of 30 persons who had similar characteristics to the study samples. The reliability was presented by Cronbach's alpha that was 0.75. This value indicated that the food frequency questionnaire had an acceptable reliability. Therefore, this questionnaire was suitable for data collection.

3. Boxplot analysis

In this study, the 24-hour dietary recall was used for estimating the total daily energy intake and its distribution. The standard household measuring cups and spoons and food pictures were used to assist in the estimating the portion sizes. However, the data obtained from the 24-hour dietary recall may have under or over-report because the participants could not remember or clearly estimate their dietary intakes. Thus, the boxplot analysis was used for excluding the unreliable total energy intake data that were extreme outlier (more than third quartile + 3 interquartile range or less than first quartile - 3 interquartile range). The result showed that no participant reported the unreliable total energy intake data (Figure C-1). Thus, the data of all participants could be taken into the analysis.

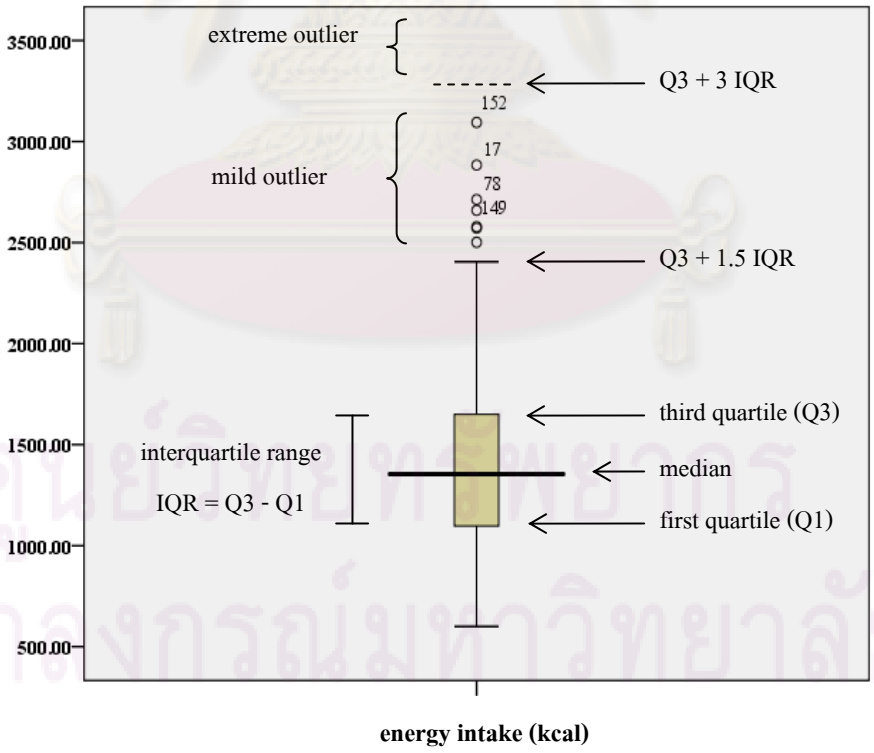


Figure C-1 The boxplot analysis

4. Multicollinearity test

For the multiple logistic regression analysis, there is the condition that the predictive variables should not have multicollinearity. The multicollinearity makes it difficult to determine whether predictor is important in a regression equation. Therefore, multicollinearity among predictive variables was assessed by tolerance and variance inflation factor (VIF).

Tolerance ($1-R^2$) was used to examine the strength of the linear relationship among predictive variables that was used as a measure of collinearity. The tolerance of 0 indicates a perfect collinearity that can range from 0.00-1.00, whereas the tolerance values of 0.10 or less means that multicollinearity may be a problem.

VIF is the index for analysis of multicollinearity. It measures the effect of other predictive indicators on regression coefficient. VIF is inversely related to the tolerance value. A usual threshold of VIF values is 10.0. This value corresponds to a tolerance of 0.10 that indicates a high degree of collinearity or multicollinearity among the independent variables (Temcharoen, 2001).

In this study, the results showed that all predictive variables had no multicollinearity, tolerance was higher than 0.10 and VIF was lower than 10.0 (Table C-1).

Table C-1 Multicollinearity test by tolerance and VIF among predictive variables

	Collinearity statistics	
Variables	**Tolerance**	**VIF**
Number of meals per day	.792	1.263
Late night meal intake	.725	1.379
Large meal intake	.869	1.150
Favorite cooking method	.837	1.195
Favorite taste	.809	1.236
Meal-made pattern	.834	1.200
Repeated dietary type intake	.750	1.333
Time between dinner and bedtime	.815	1.227
Time spent on each meal	.803	1.246
Alcohol consumption	.800	1.250
Water intake	.861	1.162
High-calorie juice intake	.832	1.202
Fatty meat intake	.687	1.456
Meat product intake	.730	1.371
Bakery product intake	.703	1.422
Fried food intake	.545	1.834
Coconut milk food intake	.561	1.782
Vegetable intake	.708	1.412
Fruit intake	.704	1.420
Whole grain intake	.883	1.133
Single-plate food intake	.701	1.427
Semi-instant food intake	.730	1.370
Salty processed food intake	.732	1.365
High-sugar food intake	.708	1.412
Snack intake	.554	1.806
Calorie from carbohydrate	.707	1.415
Calorie from protein	.683	1.464
Calorie from fat	.890	1.124

VIF - variance inflation factor

5. The equation for prediction of the metabolic syndrome

In present study, the equation had accuracy of prediction 88.3%. The equation was as follow:

$$\text{Probability of metabolic syndrome} = \frac{1}{1+ e^{-(-2.84 + 2.22\, X_1 + 1.27\, X_2 + 1.66\, X_3)}}$$

While X_1 = late night meal intake

(0 = no, 1 = yes)

X_2 = alcohol consumption

(0 = no drinking, 1 = drinking > 30 grams per day)

X_3 = frequency of bakery product intake

(0 = ≤ 3 days per week, 1 = > 3 days per week)

Example of the equation

1) The data of case number 15 were taken to test in the equation

$$\text{Probability of metabolic syndrome} = \frac{1}{1+ e^{-(-2.84 + 2.22(0) + 1.27(0) + 1.66(0))}}$$

$$= \frac{1}{(1+ e^{2.84})}$$

$$= \frac{1}{(1+ 17.12)}$$

$$= 0.06$$

Regarding the equation, the participants with metabolic syndrome must have the probability of metabolic syndrome more than 0.50. The probability of metabolic syndrome of this case was 0.06. Therefore, the equation predicted that this case had not the metabolic syndrome. This result was accurate because this participant was not classified in the metabolic syndrome group.

2) The data of case number 341 were taken to test in the equation

$$\text{Probability of metabolic syndrome} = \frac{1}{1+ e^{-(-2.84 + 2.22(1) + 1.27(0) + 1.66(0))}}$$

$$= \frac{1}{(1+ e^{0.62})}$$

$$= \frac{1}{(1+ 1.86)}$$

$$= 0.35$$

The probability of metabolic syndrome of this case was 0.35. Therefore, the equation predicted that this case had not the metabolic syndrome. This result was inaccurate because this participant was classified in the metabolic syndrome group.

This equation may predict accurately or inaccurately because its accuracy of prediction is 88.3%.

BIOGRAPHY

NAME	Miss Ratchada Sutadarat
DATE OF BIRTH	March 13, 1980
PLACE OF BIRTH	Nakhon Ratchasima, Thailand
INSTITUTIONS ATTENDED	Khon Kean University, 1999-2004; Bachelor of Science in Pharmacy Chulalongkorn University, 2007-2009; Master of Science in Pharmacy (Food Chemistry and Medical Nutrition)
OCCUPATIONS	Pharmacist at Buriram Hospital, 2004-2005 Pharmacist at Maharat Nakhon Ratchasima Hospital, 2005-present