INCIDENCE AND RISK FACTORS OF METABOLIC SYNDROME AND 9-YEAR FOLLOW-UP IN NA YAO COMMUNITY, SANAM CHAI KHET DISTRICT, CHACHEONGSAO, THAILAND

Jarukorn Sangbangmud[*], Benyalak Kaewthanasin, Kanit Jintabunyat[*], Chanin Pokabarl[*], Chalisa Limcharoenchai[*], Natnarong Kanchana-Udomkan[*], Tanaporn Apiraksaporn[*], Teeragarn Supapunpinyo[*], Pavitra Charoensrisakkul[*], Phongkon Aiyarakanchanakun[*], Patteera Suriyaraksh[*], Peeraya Permkarnjaroen[*], Vongsathorn Rojanapaitoon[*], Suphat Lorchareonraung[*], Aukrit Luangpattarawong[*], Phunlerd Piyaraj[**], Ram Rangsin[***]*

[*] 5th year Medical Cadet, Phramongkutklao College of Medicine, Bangkok 10400, Thailand

[**] Department of Parasitology, Phramongkutklao College of Medicine, Phramongkutklao College of Medicine, Bangkok 10400, Thailand

[***] Department of Military and Community Medicine, Phramongkutklao College of Medicine, Bangkok 10400, Thailand

Abstract

Background: Metabolic syndrome is an important risk factor for cardiovascular diseases and type 2 diabetes; it comprises a cluster of metabolic abnormalities including central obesity, insulin resistance, hypertension, dyslipidemia and endothelial dysfunction. In Thailand, the prevalence of metabolic syndrome ranges from 13.2 to 33.3% depending on differences in population and timing of each study. Therefore, due to the limitation of data related to incidence and risk factors of metabolic syndrome in Thailand, especially in rural areas, this study was established.

Objectives: To estimate the incidence and risk factors of metabolic syndrome in Na Yao Community, Tha Kradan Subdistrict a rural community, central Thailand.

Methods: From a baseline survey conducted from 2008-2009, a total of 970 metabolic syndrome-free participants were enrolled in Na Yao Community, a rural area of Thailand. However, only 511 (52.6%) cases were re-examined in December 2016 because the majority had died or migrated. The definition of metabolic syndrome was based on the NCEP-ATP III criteria to evaluate cumulative incidence and incidence density. The relative risk of possible risk factors was analyzed using Poisson regression.

Results: During the 9-year follow-up, the cumulative incidence was 14%. The incidence density was 3.47/100 person-years. In multivariate analysis using Poisson regression, being female, having serum cholesterol greater than 200 mg/dL and increased BMI every 1 kg/m^2 were considered risk factors of metabolic syndrome.

Conclusion: The study determined the incidence density of metabolic syndrome in Na Yao Community as 3.47/100 person-years. The significant risk factors of metabolic syndrome were being female, having high serum cholesterol and increased BMI. Therefore, diet control and exercise are recommended to decrease the chance of developing modifiable risk factors (serum cholesterol and BMI). In addition, strategies to detect, treat and prevent metabolic syndrome must be established.

Keywords : Metabolic syndrome, Incidence, Rural Community, Central Thailand

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Correspondence to:
Rangsin R, Department of Military and Community Medicine, Phramongkutklao College of Medicine, Bangkok, Thailand
E-mail : rrangsin@pmk.ac.th

Introduction

Metabolic syndrome is an important risk factor for cardiovascular diseases (CVD) and type 2 diabetes (T2DM); it comprises a cluster of metabolic abnormalities including central obesity, insulin resistance, hypertension, dyslipidemia and endothelial dysfunction.[1] People with metabolic syndrome are more likely to develop CVD and T2DM approximately two and five times than those who are not. The etiology of the syndrome originated from obesity, which is the primary cause leading to insulin resistance and other impending consequences.

Definition and diagnostic criteria of metabolic syndrome have been described by several organizations such as the World Health Organization (WHO), National Cholesterol Education Program-adult Treatment Panel 2 (NCEP-ATP III), the American Association of Clinical Endocrinologist (AACE), the International Diabetes Federation (IDF) and the American Heart Association (AHA) in coordination with the National Heart Lung and Blood Institute (NHLBI). The basic concepts of these criteria are the same but differ somewhat in details.

In the worldwide population, the IDF reported the prevalence of metabolic syndrome in 2006 ranged from 20 to 25%.[2] This strong evidence implies an important, chronic health problem in both urban and rural areas will lead to other health complications and economic problems. In Thailand, the prevalence of metabolic syndrome ranges from 13.2 to 33.3% depending on the differences in population and timing of each study.[3-7]

Therefore, due to the limitation of data related to incidence and risk factors of metabolic syndrome in Thailand, especially in rural areas, this study aimed to estimate the incidence and risk factors of metabolic syndrome in a rural community, central Thailand.

Methods

Study population

People were selected by a whole population living in Village 11, 15, 16, 18 and 19 of Na Yao Community. These people had their waist circumference and blood pressure examined and blood tested for fasting plasma glucose, triglyceride and high-density lipoprotein-cholesterol. A baseline survey was performed at Na Yao, a rural area of Thailand, from 2007-2008. At the time of baseline survey, a total of 1,362 people were recruited. Then 392 subjects were excluded for having a diagnosis of metabolic syndrome in 2008 and 2009. Therefore, our target population consisted of 970 subjects who were re-examined in December 2016. In addition, 246 did not participate in the study in 2016 because 155 died, 68 permanently migrated and 23 went missing. As a result, the actual target population totaled 724 subjects. However, only 516 were reexamined. Therefore, the follow-up rate was 53.2%. Subjects who were lost to follow-up were considered as censored cases and were not included in the statistical analysis.

Data was collected on the incidence and risk factors of metabolic syndrome using a set of questionnaires, physical examinations and biochemical measurements. The questionnaires were related to demographic data (age, sex, educational status, income, occupation, and underlying diseases), alcohol consumption (yes, no), smoking status (smoker, nonsmoker), physical activity (moderate, vigorous), eating behavior, and sedentary lifestyle. Physical examinations included height, body weight, waist circumference and blood pressure. Body weight was examined using an analog scale while all subjects dressed in light clothing and were barefoot. Waist circumference was measured in centimeters at the reference point of the anterior superior iliac spine (ASIS). Blood pressure was obtained twice by well-trained attendants in a seated position using a standard sphygmomanometer at 5-minute intervals. The first and fifth Korotkoff sounds were used to estimate systolic and diastolic blood pressure. However, when the blood pressure after the second attempt was more than 140/90 mmHg, the participants were required to rest 15 minutes before a third attempt was conducted. Blood samples were collected (7 mL) by well-trained medics from an antecubital vein after 8-hour fasting. Each tube was divided in 4 and 3 mL to determine the level of fasting blood sugar, total cholesterol, triglyceride and high-density lipoprotein cholesterol (HDL-cholesterol) using an automatic analyzer (Vitros950, Integra400 and Hitachi917). The definition of diagnosis of metabolic syndrome was based on the Third Report of the NCEP-ATP III. However, the definitions of central obesity by the IDF criteria were used due to South Asian ethnicity cut-points. Metabolic syndrome was diagnosed when participants met the criteria at least three out of five

characteristics: triglyceride ≥150 mg/dL, HDL- cholesterol <40 mg/dL in men and <50 mg/dL in women, blood pressure ≥130/85 mmHg or antihypertensive drug medications, fasting blood glucose ≥110 mg/dL or antidiabetic drug medications and waist circumference ≥90 cm in men and ≥80 cm in women.

Statistical analysis

STATA was used to perform statistical analysis. Descriptive statistics were analyzed using mean and standard deviation for continuous variables and frequency for categorical variables. Statistical analysis was analyzed by Poisson regression, both univariate and multivariate analysis, to identify risk factors of metabolic syndrome. These included sex, age group, educational status, occupation, income, BMI, smoking, alcohol consumption, serum LDL-c, serum cholesterol and family history of DM.

Subjects lost to follow-up were compared for difference with follow-up subjects using chi-square. Cumulative incidence was calculated to clarify meaning. Incidence density was calculated using the number of new cases divided by person-years of observation. In addition, incidence densities of each component of metabolic syndrome such as decreased serum HDL-c, hypertension, DM, increased waist circumferences and increased triglyceride were also calculated. Statistical significance was defined as a *p*-value of <0.05.

Ethic statements

The study protocol was approved by the IRB of the Royal Thai Army Medical Department. All participants were provided all of the information about this study by the investigators. Written informed consent was obtained from all participants.

Results

During the 9-year follow-up, 139 new diagnoses were made of metabolic syndrome implying the cumulative incidence was 14%. Therefore, the incidence density of metabolic syndrome was 3.47 per100 person-years. **Table 1** shows the comparison of baseline characteristics between responders and nonresponders in this study. Significant differences were found in age group, occupation and income. The most common age group of responders was 40-49 (31.5%) years while nonresponders were 30-39 (29.41%) years old. The most common occupation was farmer among both responders and nonresponders. However, the percentages differed (responders, 67.9%; nonresponders, 55.9%). For both responders and nonresponders, monthly income was mostly below 500 THB. However, only the percentages differed (responders, 53.8%; nonresponders, 66.1%). No difference was found in other characteristics, i.e., sex, village, educational status, alcohol consumption and smoking status.

Table 1. Comparison of baseline characteristics between responders and non-responders in the study

	Enrollment		*p*-value
	Responders	Non-responders	
Gender			0.633
Male	216 (42.27%)	201 (43.79%)	
Female	295 (57.73%)	258 (56.21%)	
Village			0.412
11	34 (6.65%)	36 (7.89%)	
15	232 (45.40%)	179 (39.25%)	
16	24 (4.70%)	26 (5.70%)	
18	62 (12.13%)	59 (12.94%)	
19	159 (31.12%)	156 (34.21%)	

	Enrollment		*p*-value
	Responders	Non-responders	
Age group (years old)*			0.000
20-29	9 (1.76%)	18 (3.92%)	
30-39	114 (22.31%)	135 (29.41%)	
40-49	161 (31.51%)	132 (28.76%)	
50-59	133 (26.03%)	75 (16.34%)	
>60	94 (18.40%)	99 (21.57%)	
Occupation*			0.008
Unemployed	23 (6.35%)	38 (13.62%)	
Farmer	246 (67.96%)	156 (55.91%)	
Contractor	66 (18.23%)	60 (21.51%)	
Shopkeeper	21 (5.80%)	22 (7.89%)	
Government officer	4 (1.10%)	2 (0.72%)	
Monk	0 (0%)	0 (0%)	
Constructor	0 (0%)	0 (0%)	
Student	0 (0%)	1 (0.36%)	
Others	2 (0.55%)	0 (0%)	
Income (Baht/ month)*			0.007
< 500	259 (53.85%)	288 (66.06%)	
500 - 1,999	33 (6.86%)	29 (6.65%)	
2,000 - 4999	137 (28.48%)	87 (19.95%)	
5,000 - 9,999	30 (6.24%)	21 (4.82%)	
10,000 - 19,999	11 (2.29%)	6 (1.38%)	
20,000 - 50,000	11 (2.29%)	5 (1.15%)	
> 50,000	0 (0%)	0 (0%)	

	Enrollment		*p*-value
	Responders	Non-responders	
Educational status			0.497
Uneducated	26 (6.28%)	15 (4.92%)	
Primary school	350 (84.54%)	260 (85.25%)	
Secondary school	19 (4.59%)	16 (5.25%)	
High school	14 (3.38%)	6 (1.97%)	
Diplomate	4 (0.97%)	5 (1.64%)	
Above bachelor degree	1 (0.24%)	3 (0.98%)	
Alcohol consumption			0.587
No	178 (50.71%)	130 (48.51%)	
Yes	173 (49.29%)	138 (51.49%)	
Smoking habit			0.145
Current smoker	107 (32.92%)	66 (26.09%)	
Ex-smoker	16 (4.92%)	18 (7.11%)	
Non-smoker	202 (62.15%)	169 (66.80%)	

In this study, using univariate by Poisson regression analysis according to each possible risk factor, revealed 4 factors (sex, BMI, serum LDL-c, serum cholesterol) showing significant association with a higher rate of metabolic syndrome as shown in **Table 2**. The incidence density of metabolic syndrome increased among females compared with males with a relative risk of 1.59 (95%CI; 1.10-2.34, *p*=0.009). For BMI, the incidence density increased in overweight participants (BMI 23 - 30 kg/m^2) with a relative risk of 1.66 (95%CI; 1.05-2.63, p=0.032) and obese participants (BMI > 30 kg/m^2) with a relative risk of 2.80 (95%CI; 1.89-4.14, *p*=0.000). Serum LDL-c greater than 130 mg/dL was associated with increased incidence density with a relative risk of 1.66 (95%CI; 1.13-2.41, *p*=0.007). Finally, serum cholesterol greater than 200 mg/dL was associated with increased incidence density with a relative risk of 1.62 (95%CI; 1.14-2.29, *p*=0.005).

Table 2. Univariate analysis of incidence density and crude incidence rate ratio according to each risk factors of metabolic syndrome with 95% confidence interval by Poisson regression

	Number of Metabolic Syndrome (person) (n=139)	Person-year of Observation (Person-year)	Incidence rate (per 100 person-year)	Crude Incidence Rate ratio (95% CI)	*p*-value
Gender					
Male	43	1,678	2.57	1	
Female*	96	2,336	4.11	1.59 (1.10-2.34)	0.009
Age group (years)					
<39	24	944	2.54	1	
40-49	47	1,278	3.68	1.45 (0.88-2.36)	0.141
50-59	43	1030	4.17	1.64 (0.99-2.71)	0.052
>60	25	754	3.32	1.30 (0.74-2.28)	0.353
Educational Status					
Uneducated	7	176	3.98	1	
Primary education	124	3,542	3.50	0.88 (0.41-1.88)	0.743
Above primary education	8	288	2.78	0.70 (0.25-1.93)	0.488
Occupation					
Farmer	108	3096	3.48	1	
Others	31	910	3.40	0.98 (0.63-1.48)	0.922
Income (Baht/ month)*					
<1,999	11	296	3.72	1	
200-4,999	114	3046	3.74	1.01 (0.54-1.87)	0.982
≥5,000	14	664	2.11	0.57 (0.26-1.25)	0.160

	Number of Metabolic Syndrome (person) (n=139)	Person-year of Observation (Person-year)	Incidence rate (per 100 person-year)	Crude Incidence Rate ratio (95% CI)	*p*-value
Smoking					
Non smoker	117	3,196	3.66	1	
Smoker	22	810	2.72	0.74 (0.45-1.18)	0.194
BMI					
<23 kg/m^2	40	1,919	2.08	1	
23-30 kg/m^2*	33	955	3.46	1.66 (1.05-2.63)	0.032
>30 kg/m^2*	66	1132	5.83	2.80 (1.89-4.14)	0.000
Serum LDL-c					
<130 mg/dl	96	3,156	3.04	1	
≥130 mg/dl*	43	710	5.06	1.66 (1.13-2.41)	0.007
Serum cholesterol					
<200 mg/dl	75	2,624	2.86	1	
≥200 mg/dl*	64	1,382	4.63	1.62 (1.14-2.29)	0.005
Alcohol consumption					
No	86	2,626	3.27	1	
Yes	53	1,380	3.84	1.17 (0.82-1.67)	0.362
Family history of DM					
No	108	3283	3.29	1	
Yes	31	723	4.29	1.30 (0.84-1.96)	0.199
Difference of BMI during the time of observation*	139	4006	3.47	1.04 (1.003-1.07)	0.028

Table 3 shows the incidence rate ratio of metabolic syndrome according to possible and associated risk factors using multivariate analysis. However, this analysis excluded serum LDL-c due to collinearity with serum cholesterol. Being female, having serum cholesterol greater than 200 mg/dL and increased BMI every 1 kg/m^2 were considered risk factors with relative risks of 1.52 (95%CI; 1.002-2.32, p=0.049), 1.605 (95%CI; 1.14-2.25, p=0.01) and 1.038 (95%CI; 1.005-1.07, p=0.02), respectively.

Table 3. Multivariate analysis by Poisson regression of incidence rate ratio of metabolic syndrome according to possible and associated risk factors in univariate analysis

	Incidence Rate Ratio	Standard Error	p-value	95% Confidential interval
Gender	1.525	0.33	0.049	(1.00-2.32)
Age	1.009	0.007	0.24	(0.99-1.02)
Serum Cholesterol	1.605	0.28	0.01	(1.14-2.25)
Smoking	0.947	0.26	0.84	(0.56-1.61)
BMI change	1.038	0.02	0.02	(1.01-1.07)

Discussion

In this study, the incidence density of metabolic syndrome at Na Yao Community, a rural community, central Thailand (3.47/100 person-years) resembling the study results in Dalseong-gun, a rural area of Korea (men, 30.0/1,000 person-years; women, 46.4/1,000 person-years). In addition, the cumulative incidence of our study (14%) also resembled the study results in Korea (men, 13.9%; women, 20.8%).[8] This could be explained by the similar race and lifestyle, such as food and type of occupation. However, the incidence density in this study was lower than that of a study among Portuguese (47.2/1000 person-years), [9] which could be explained by the differences in ethnicity and living habits. In Portugal, the major population is Caucasian but in Thailand, Asian. Apart from that, Portuguese usually consume meat and dairy products instead of vegetables unlike in Thailand.

After univariate analysis by Poisson regression, four significant risk factors were identified, i.e., being female, increased BMI, serum LDL and serum cholesterol. These risk factors were all the same factors found in a USA survey from 1988-1994 by the Third National Health and Nutrition Examination.[10] The reason why metabolic syndrome is found among females more than males can be explained by a higher prevalence of dysglycemia and difference of hormones regulating body weight and lipid distribution between males and females. Moreover, decreased estrogen occurring only among females, is also associated with decreased metabolism that can cause both obesity and metabolic syndrome as consequences. [11] Increased BMI is caused by increased body weight, which is also associated with lipid accumulation in the body. Metabolic syndrome then occurs as a result. Serum LDL and serum cholesterol, which are collinearity to each other, can lead to dyslipidemia that also can aggravate metabolic syndrome.

The strength of this study is being a retrospective cohort with long follow-up period. Furthermore, this is the first study of metabolic syndrome incidence in a rural community, central Thailand. On the other hand, the limitation of this study was a high lost to follow-up rate of 47.4% that may have resulted in bias. Nevertheless, the comparison between subjects who were responders and nonresponders showed no significant differences among

other factors except age group, occupation and income. Using multivariate analysis, these factors were not potential risk factors of metabolic syndrome in this study.

We recommend diet control and exercise to lower the chance of developing high cholesterol levels and increased BMI. These findings indicate the urgent need to establish and strengthen strategies to detect, treat and prevent metabolic syndrome.

The study determined the incidence density of metabolic syndrome in Na Yao community, a rural area of Thailand, as 3.47/100 person-years. The significant risk factors from multivariate analysis using Poisson regression were being female, serum cholesterol greater than 200 mg/dL and increased BMI every 1 kg/m^2. Therefore, diet control and exercise are recommended to decrease the chance of developing modifiable risk factors (serum cholesterol and BMI). In addition, the primary healthcare unit should provide early detection and prevention of metabolic syndrome including health literacy, supporting physical activities and dietary controlled. Moreover, the people with metabolic syndrome should be received medical treatment at a community hospital.

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