Prevalence of Metabolic Syndrome in Nakhon Sawan Population

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Objective: *Determine the prevalence of metabolic syndrome for comparison.*
Material and Method: *A cross-sectional survey of Nakhon Sawan population aged 15 years and over was conducted in March 2002. There were 636 persons included in the present study, age range from 15 to 87 years, and mean age of 41.4 ± 16.7 years.*
Results: *The prevalence of metabolic syndrome using World Health Organization (WHO), The National Cholesterol Education Program (NCEP) Expert Panel on detection, Evaluation, and Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III, ATP III), and International Diabetes Federation (IDF) definition was 6.2, 20.0, and 18.7%, respectively. This prevalence was high compared with the previous study in Thailand and the estimated global metabolic syndrome for adults above 20 years of age. Women and elders had a higher prevalence than men and youngsters. The authors should search for Thai cut-off values of abdominal obesity in children and adults to have the correct data for public health plan and management. This is because there are variations among the different ethnic background and countries, even within Asia.*
Conclusion: *The prevalence of metabolic syndrome was high. The interventions in prevention and management of the metabolic syndrome should be started for overweight children.*

Keywords: *Metabolic syndrome, Central obesity, Prevalence, Population, Thailand*

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Thailand is in transition from an agricultural to a semi-industrial economy, and lifestyles are changing. Cardiovascular disease (CVD) risk factors in Nakhon Sawan population increased more than that of the previous national surveys[1]. There were high prevalence in physical inactivity, stress, obesity, hypertension, dyslipidemia, and diabetes mellitus[1], which are the risk factors of CVD and components of metabolic syndrome.

The metabolic syndrome is characterized by a group of CVD risk factors in one person. They include abdominal obesity (excessive fat tissue in and around the abdomen), atherogenic dyslipidemia (blood fat disorders-high triglycerides (TG), low high-density lipoprotein cholesterol (HDL-C) and high low-density lipoprotein cholesterol (LDL-C)-that foster plaque buildups in artery walls), elevated blood pressure, insulin resistance or glucose intolerance (the body can't properly use insulin or blood sugar), prothrombotic state (e.g., high fibrinogen or plasminogen activator inhibitor-1 in the blood), and pro-inflammatory state (e.g., elevated C-reactive protein in the blood)[2]. People with the metabolic syndrome are at increased risk of coronary heart disease and other diseases related to plaque buildups in artery walls (e.g., stroke and peripheral vascular disease) and type 2 diabetes. The dominant underlying risk factors for this syndrome appear to be abdominal obesity and insulin resistance. The syndrome is increasing worldwide because of the increasing obesity prevalence.

There are many definitions for diagnosing metabolic syndrome, such as the World Health Organization (WHO)[3]; The National Cholesterol Education Program (NCEP) Expert Panel on detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III, ATP III)[4]; and International Diabetes Federation (IDF) definition[5].

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Table 1. Metabolic risk factors according to WHO definition

Fasting plasma glucose (mg/dL)	Metabolic risk factors*, Number (%)				
	0-1 risk factors		2-4 risk factors		Total n = 636
	Men n = 178	Women n = 458	Men n = 178	Women n = 458	
< 110	103 (57.9)	262 (57.2)	59 (33.5)	157 (34.3)	581 (91.3)
≥ 110 or DM history	6 (3.4)	10 (2.2)	10 (5.7)	29 (6.3)	55 (8.7)
Total	109 (17.1)	272 (42.8)	69 (10.8)	186 (29.3)	636 (100.0)

p-value = 0.043 in men, < 0.001 in women, < 0.001 in total population
= 0.719 comparing men to women
DM = Diabetes mellitus

Age group (years) with FPG ≥ 110 mg/dL or DM history	Metabolic risk factors*, Number (%)		
	0-1 risk factors	2-4 risk factors	Total
15-24 (n = 124)	2 (1.6)	1 (0.8)	3 (2.4)
25-34 (n = 108)	2 (1.8)	0	1 (0.9)
35-44 (n = 150)	6 (4.0)	7 (4.7)	12 (8.1)
45-54 (n = 114)	2 (1.8)	9 (7.9)	11 (9.7)
55-64 (n = 66)	3 (4.5)	11 (16.7)	14 (21.2)
65-74 (n = 52)	3 (5.8)	10 (19.2)	13 (25.0)
≥ 75 (n = 22)	0	1 (4.5)	1 (4.5)
Total (n = 636)	18 (2.8)	39 (6.2)	55 (8.7)

FPG = fasting plasma glucose
p-value < 0.001
* Metabolic risk factors included:
1. High WHR, men > 0.9, women > 0.8; or high BMI, ≥ 25 kg/m^2
2. TG ≥ 150 mg/dL or HDL-C < 35 mg/dL (men), < 39 mg/dL (women)
3. Blood pressure ≥ 140/90 mmHg or taking anti-hypertensive medications
4. Microalbuminuria

The objective of this present study was to determine the prevalence of metabolic syndrome in Nakhon Sawan population in 2002, using WHO, NCEP ATP III, and IDF definitions for comparison.

Material and Method

A cross-sectional survey was conducted in March 2002. Multistage random sampling method was used. Three districts were selected, two by random, and Amphur Muang purposely. Each district was selected for municipal and rural areas. Two sub-districts of each municipal and rural area were chosen by stratified random sampling. The population aged 15 years and over were selected in the age group concurred to that of the provincial population. The number of the samples was calculated from the equation: $n = (Z_{\alpha/2})^2 (p) (1-p) / d^2$, and adjusted 15 percent for the error in collecting samples. Six hundred and forty was the calculated samples. Modified WHO Stepwise Approach to Surveillance (STEPS) of NCD Risk Factors was used for interviewing, physical, and laboratory examinations[6]. The present study was approved by the ethic committee of the Ministry of Public Health of Thailand. All participants were informed about the research detail and their rights. Informed consent from all participants was received before enrollment. The present study was a part of the main CVD risk factors research.

The fasting plasma glucose (FPG), total cholesterol (TC), TG, and HDL-C, were measured by enzymatic-colorimetric assay. LDL-C concentration was calculated using the Friedwald formula[7].

The metabolic syndrome was estimated by

Table 2. Metabolic risk factors according to NCEP ATPIII definition

Age group (years)	Metabolic risk factors*, Number (%)		
	0-2 risk factors	3-5 risk factors	Total
15-24 (n = 124)	121 (97.6)	3 (2.4)	124 (100.0)
25-34 (n = 108)	100 (92.6)	8 (7.4)	108 (100.0)
35-44 (n = 150)	120 (80.0)	30 (20.0)	150 (100.0)
45-54 (n = 114)	81 (71.1)	33 (28.9)	114 (100.0)
55-64 (n = 66)	38 (57.6)	28 (42.4)	66 (100.0)
65-74 (n = 52)	34 (65.4)	18 (34.6)	52 (100.0)
≥ 75 (n = 22)	15 (68.2)	7 (31.8)	22 (100.0)
Total (n = 636)	509 (80.0)	127 (20.0)	636 (100.0)

p-value < 0.001

Sex	Metabolic risk factors*, Number (%)		
	0-2 risk factors	3-5 risk factors	Total
Men (n = 178)	153 (86.0)	25 (14.0)	178 (100.0)
Women (n = 458)	356 (77.7)	102 (22.3)	458 (100.0)
Total (n = 636)	509 (80.0)	127 (20.0)	636 (100.0)

p-value = 0.020

* Metabolic risk factors included:

1. Waist circumference ≥ 90 cm (men), ≥ 80 cm (women)
2. TG ≥ 150 mg/dL
3. HDL-C < 40 mg/dL (men), < 50 mg/dL (women)
4. Blood pressure ≥ 130/85 mmHg or taking anti-hypertensive medications
5. FPG ≥ 110 mg/dL or DM history

using all three criteria, WHO, NCEP ATP III, and IDF criteria. The measurements were based on the three criteria mentioned, except for the waist-over-hip (WHR) ratio, body mass index (BMI), and waist circumference, Asian references were used for interpretation[8].

Data processing was done using SPSS/PC program and adjusted value by mid-2002 year estimated population using Questionnaire Processing System Program. Percent, mean, and Chi-squared test were used when appropriate. All p-values were two-sided and significant statistical level was 0.05 or lower.

Results

Six hundred and thirty six persons (99.4% of the calculated sample size) were included in the present study, of which 29.9, 39.0, and 31.1 percent were living in Muang, Tah Tako, and Lat Yao Districts, respectively. Forty-eight percent of subjects were living in municipal and 51.9 percent in rural areas. Men and women were 28.0 and 72.0 percent. The age range was 15 to 87 years, with most of them (23.6%) in the age range of 35-44 years. Mean age was 41.4 ± 16.7 years.

When using WHO criteria, there were 10 (5.7%) men and 29 (6.3%) women who had metabolic syndrome [fasting plasma glucose (FPG) more than 110 mg/dL or had diabetes mellitus (DM), and had other 2-4 metabolic risk factors]. There was no statistical significant difference in the prevalence of metabolic syndrome between men and women (p = 0.719) (Table 1). While comparing among age groups, the prevalence of metabolic syndrome increased with the increasing age except for the oldest age group (≥ 75 years), and there was statistical difference among age groups (p < 0.001). Total prevalence of metabolic syndrome was 39 (6.2%) (Table 1).

Using NCEP ATP III definition (had a total of 3-5 metabolic risk factors), there were 127 (20.0%) of the population [men 25 (14.0%) and women 102 (22.3%)] who had metabolic syndrome. The highest prevalence was noted in the 55-64 years age group

Table 3. Metabolic risk factors according to IDF definition

Waist circumference*	Metabolic risk factors**, Number (%)				
	0-1 risk factor		2-4 risk factors		Total (n = 636)
	Men (n = 178)	Women (n = 458)	Men (n = 178)	Women (n = 458)	
Normal	101 (56.7)	228 (49.8)	39 (21.9)	51 (11.1)	419 (65.9)
High	17 (9.6)	81 (17.7)	21 (11.9)	98 (21.4)	217 (34.1)
Total	118 (66.3)	309 (67.5)	60 (33.8)	149 (32.6)	636 (100.0)

p-value = 0.001 in men group
< 0.001 in women group
= 0.779 comparing men to women
* High waist circumference: men ≥ 90 cm, women ≥ 80 cm

Age group (years) with high waist circumference*	Metabolic risk factors**, Number (%)		
	0-1 risk factor	2-4 risk factors	Total
15-24 (n = 124)	8 (6.4)	3 (2.4)	11 (8.9)
25-34 (n = 108)	12 (11.1)	8 (7.4)	20 (18.5)
35-44 (n = 150)	22 (14.6)	24 (16.0)	46 (30.7)
45-54 (n = 114)	31 (27.1)	35 (30.7)	66 (57.9)
55-64 (n = 66)	13 (19.7)	23 (34.9)	36 (54.5)
65-74 (n = 52)	8 (15.3)	18 (34.6)	26 (50.0)
≥ 75 (n = 22)	4 (18.2)	8 (36.4)	12 (54.5)
Total (n = 636)	98 (15.4)	119 (18.7)	217 (34.1)

* High waist circumference: men ≥ 90 cm, women ≥ 80 cm
p-value < 0.001
** Metabolic risk factors included:
1. TG ≥ 150 mg/dL
2. HDL-C < 40 mg/dL (men), < 50 mg/dL (women)
3. Blood pressure ≥ 130/85 mmHg or taking anti-hypertensive medications
4. FPG ≥ 100 mg/dL or DM history

(42.4%), followed by 65-74 years (34.6%) and ≥ 75 years (31.8%), respectively. There was statistical difference both among age groups ($p < 0.001$) and between gender ($p = 0.020$) (Table 2).

The prevalence of metabolic syndrome using IDF definition (high waist circumference with 2-4 other metabolic risk factors), was 119 (18.7%) in total population [21 (11.9%) in men and 98 (21.4%) in women], and increased with increasing age. Statistical difference was noted only among age groups ($p < 0.001$) not between gender ($p = 0.779$) (Table 3).

Discussion

When comparing the three definitions, NCEP ATP III had the highest prevalence (20.0% of the total population), followed by IDF (18.7% of the total population) and WHO (6.2% of the total population) definitions, in detecting the prevalence of metabolic syndrome. May be, the first fixed criteria (FPG and waist circumference in WHO and IDF definitions, respectively) caused such lower prevalence. Otherwise, waist circumference is more accurate than BMI in a part of detecting metabolic syndrome, because waist circumference determines the central fat that leads to insulin resistance; while BMI determines the total body fat, so it is not the ideal marker of the central fat, and in addition, it can increase from people who have bulge muscle mass, not fat accumulation[9]. Thus, the NCEP ATP III and the IDF definitions, which used waist circumference in a part of detecting metabolic syndrome,

yielded the higher prevalence than WHO definition, which used BMI in a part of detecting metabolic syndrome. The NCEP ATP III is risk factor-based definition but WHO is disease-based definition, so the NCEP ATP III definition should be more predictive of the syndrome than that of WHO. In addition, waist circumference is easier to measure than BMI and WHR, and microalbuminuria or albumin/ creatinine ratio in parts of WHO definition, are hard to measure. Thus, NCEP ATP III definition should be more practical in determining metabolic syndrome. However, in the youngsters, BMI with adjusted Z-score was reported more correlated to metabolic syndrome than waist circumference[11]. However, another study found that waist circumference in the youngsters was also significantly associated with all components of metabolic syndrome[12]. The prevalence of metabolic syndrome in the previous studies was 10-40% in most Asian countries[10], and 12.0-25.0% in Europe, the United States, and Australia[13-19]. In Thailand, the estimated prevalence of metabolic syndrome using NCEP ATP III criteria in an annual health examination was 12.8%[20]. Thus, metabolic syndrome in the present study, using NCEP ATP III criteria (20.0%) was higher than the previous study in Thailand (12.8%). This may be from the different population studied. The previous study population was purposely only ones who concerned about their health and seeking for annual health examination. However, in the present study, it was the general population selected randomly. Estimated current global metabolic syndrome prevalence for adults > 20 years of age is 16.0%[21], which is lower than the present study. When compared to other countries, the prevalence was in the midst of Asia and comparable to the higher level of Europe, the United States, and Australia. However, it is also depended on the criteria in diagnosing the syndrome. The highest prevalence was noted in the 55-64 years age group in NCEP ATP III definition (42.4%), 65-74 years age group in WHO definition (19.2%), and $\geq$ 75 years age group in IDF definition (36.4%). Elderly populations tend to have a high degree of stress, physical inactivity, and consume less fruit and vegetables[1,19]. This leads to a high prevalence of metabolic syndrome. However, in the youngest population (age group 15-24 years), there were 0.8% in WHO, 2.4% in NCEP ATP III, and 2.4% in IDF definitions who had metabolic syndrome. It is indicated that children and adolescents are also at high risk of becoming overweight and obese, and have metabolic syndrome[11, 23]. Public health interventions in prevention and decreasing these risks should be done since they are children. Because prevalence of impaired FPG has been low, and impaired glucose tolerance has been strikingly high among overweight children and adolescents[12], glucose tolerance test should be one of the good predictors of metabolic syndrome in adults while they are youngsters. There is evidence that the pathology of the metabolic syndrome begins early in life, and prevalence of the metabolic syndrome is very high (30%) in overweight children compared to very low in normal weight children[12]. However, the cut-off values and definition of abdominal obesity are varied among countries and ethnicity, even in Asia[24,25].

Conclusion

The prevalence of metabolic syndrome in Nakhon Sawan population in 2002 was high, especially when using NCEP ATP III criteria (20.0%). The interventions in prevention and management of the metabolic syndrome should be started in overweight children. However, the authors should first search for the own cut-off values in Thai children and adults, to have the correct data for a public health plan and management.

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References

1. Santibhavank P, Namwat C, Satitvipawee P, Podang J, Sukkosa S, Vaiyanate N, et al. Cardiovascular disease risk factors: a population-based study in Nakhon Sawan Province. Intern Med J Thai 2004; 20: 112-21.
2. American Heart Association. Metabolic syndrome. 2007. Available from: http://www.americanheart.org/presenter.jhtml?identifier=4756
3. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications. Geneva, Switzerland: WHO; 1999.
4. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA 2001; 285: 2486-97.
5. Alberti KG, Zimmet P, Shaw J. The metabolic syndrome - a new worldwide definition. Lancet 2005; 366: 1059-62.
6. World Health Organization. Noncommunicable Diseases and Mental Health Surveillance: The

WHO STEPwise approach to surveillance (STEPS) of NCD risk factors. Geneva: WHO; 2001.
7. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; 18: 499-502.
8. National Institute of Health and Clinical Excellence. Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children. NICE guideline: first draft for consultation. March 2006. London: NICE. Available from: http://www.publichealth.nice.org.uk/page.aspx?o=obesity.
9. University of Southampton School of Medicine. Why is waist circumference used as a measure of overweight rather than BMI? In: Metabolic syndrome: metabolic syndrome simplified. Available from: http://www.metabolicsyndrome.org.uk/Simplified/default.htm.
10. Chan J. The metabolic syndrome: an Asian perspective. Diabetes Voice 2006; 51: 18-20. Available from: http://www.diabetesvoice.org/issues/2006-05/The_metabolic_syndrome_an_Asian_perspective. pdf
11. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, et al. Obesity and the metabolic syndrome in children and adolescents. N Engl J Med 2004; 350: 2362-74.
12. Cruz ML, Goran MI. The metabolic syndrome in children and adolescents. Curr Diab Rep 2004; 4: 53-62.
13. Sattar N, Gaw A, Scherbakova O, Ford I, O'Reilly DS, Haffner SM, et al. Metabolic syndrome with and without C-reactive protein as a predictor of coronary heart disease and diabetes in the West of Scotland Coronary Prevention Study. Circulation 2003; 108: 414-9.
14. Rennie KL, McCarthy N, Yazdgerdi S, Marmot M, Brunner E. Association of the metabolic syndrome with both vigorous and moderate physical activity. Int J Epidemiol 2003; 32: 600-6.
15. Laaksonen DE, Lakka HM, Niskanen LK, Kaplan GA, Salonen JT, Lakka TA. Metabolic syndrome and development of diabetes mellitus: application and validation of recently suggested definitions of the metabolic syndrome in a prospective cohort study. Am J Epidemiol 2002; 156: 1070-7.
16. Villegas R, Perry IJ, Creagh D, Hinchion R, O'Halloran D. Prevalence of the metabolic syndrome in middle-aged men and women. Diabetes Care 2003; 26: 3198-9.
17. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA 2002; 287: 356-9.
18. Ridker PM, Buring JE, Cook NR, Rifai N. C-reactive protein, the metabolic syndrome, and risk of incident cardiovascular events: an 8-year follow-up of 14 719 initially healthy American women. Circulation 2003; 107: 391-7.
19. Cameron AJ, Shaw JE, Zimmet PZ, Chitsan P, Alberti KG, Tuomilehto J. Comparison of metabolic syndrome definitions in the prediction of diabetes over 5-years in Mauritius. Diabetologica 2003; 46: A145-6.
20. Lohsoonthorn V, Dhanamun B, Williams MA. Prevalence of metabolic syndrome and its relationship to white blood cell count in a population of Thai men and women receiving routine health examinations. Am J Hypertens 2006; 19: 339-45.
21. Wild SH, Byrne CD. The global burden of the metabolic syndrome and its consequences for diabetes and cardiovascular disease. In: Byrne CD, Wild SH, editors. The metabolic syndrome. London: Wiley; 2005: 1-43.
22. Porrapakkham Y, Boonyarattapan P. The report of Thailand population health examination survey III. Available from: http://library.hsri.or.th/?fn=hs1282
23. Hirschler V, Aranda C, Calcagno ML, Maccalini G, Jadzinsky M. Can waist circumference identify children with the metabolic syndrome? Arch Pediatr Adolesc Med 2005; 159: 740-4.
24. Bei-Fan Z. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults: study on optimal cut-off points of body mass index and waist circumference in Chinese adults. Asia Pac J Clin Nutr 2002; 11 Suppl 8: S685-S693.
25. Misra A, Vikram NK, Gupta R, Pandey RM, Wasir JS, Gupta VP. Waist circumference cutoff points and action levels for Asian Indians for identification of abdominal obesity. Int J Obes (Lond) 2006; 30: 106-11.

ความชุกของกลุ่มอาการ metabolic syndrome ในประชากรจังหวัดนครสวรรค์

ปณิธาน สันติภวังค์

จากการสำรวจภาคตัดขวางในประชากรจังหวัดนครสวรรค์ อายุตั้งแต่ 15 ปีขึ้นไปในเดือนมีนาคม พ.ศ. 2545 มีประชากรที่ศึกษาจำนวน 636 ราย อายุ 15-87 ปี อายุเฉลี่ย 41.4 $\pm$ 16.7 ปี พบว่าความชุกของ metabolic syndrome ในประชากรจังหวัดนครสวรรค์ เมื่อใช้คำจำกัดความขององค์การอนามัยโลก, NCEP ATP III, และสมาพันธ์เบาหวานระหว่างประเทศ มีค่าร้อยละ 6.2, 20.0, และ 18.7 ตามลำดับ ซึ่งสูงกว่าที่เคยมีการรายงานในประเทศไทย และค่าคาดประมาณของประชากรโลกที่มีอายุมากกว่า 20 ปี เพศหญิงและวัยสูงอายุมีความชุกสูงกว่าเพศชายและวัยเยาว์ ประเทศไทยควรจะมีค่าจุดตัดในการวินิจฉัยภาวะอ้วนลงพุงในเด็กและผู้ใหญ่ของเราเอง เนื่องจากมีความแตกต่างกันในระหว่างเชื้อชาติ ประเทศและแม้แต่ในประเทศเอเชียด้วยกันก็ตาม เพื่อให้การวางแผนสาธารณสุขในการป้องกันควบคุมภาวะนี้เป็นไปอย่างถูกต้องตามความเป็นจริงควรเริ่มดำเนินการตั้งแต่วัยเด็กที่มีภาวะน้ำหนักเกิน