Prevalence and Factors Associated with Metabolic Syndrome among a Group of Thai Working Population: a Cross Sectional Study

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Objective: To determine prevalence and factors associated with metabolic syndrome (MetS) among employees of the Electricity Generating Authority of Thailand based in Bangkok.
Material and Method: The present study was conducted among 2,544 participants (1,875 men, 669 women) enrolled in the cohort study of Faculty of Medicine, Ramathibodi Hospital. Baseline cross sectional data in 2009 was analyzed. The MetS was defined using NCEP ATP III criteria. Odds ratios (OR) and 95% confidence interval (95%CI) stratified by gender were computed.
Results: Overall prevalence of metabolic syndrome was 16.6%, 18.2% in males and 10.3% in females. More than half of the participants had a low intensity of physical activity. Significant non-modified factors associated with MetS among males were increased age (OR = 1.02; borderline 95%CI 1.00-1.04), levels of education were bachelor degree and lower compared with higher than bachelor degree (OR = 1.87; 95%CI 1.20-2.91 and OR = 2.28; 95%CI 1.32-3.93), working in a middle and lower type of job (OR = 1.44; 95%CI 1.01-2.05, OR = 2.08; 95%CI 0.98-4.40) compared with a high-end type of job. For females, significant factors associated with MetS were increased age (OR = 1.08; 95%CI 1.02-1.15), having middle income compared with high income (OR = 3.01; 95%CI 1.28-7.06).
Conclusion: Modified risk factor in low physical activity should be managed by increased intensity of physical activity among participants in a low and middle type of job and income to reduce cardiovascular risk.

Keywords: Metabolic syndrome, Prevalence, Factors associated with MetS, Thai working adults

Metabolic syndrome (MetS), defined by the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) requires at least 3 from 5 components of diabetes or raised fasting plasma glucose level, abdominal obesity, dyslipidemia of triglyceride and high density of lipoprotein, including high blood pressure, to be classified as MetS[1]. Metabolic syndrome is an important risk factor for cardiovascular disease incidence and mortality[2-5]. To identify high risk individuals for cardiovascular disease (CVD) and stroke, it is very important to identify individuals or group of people who have metabolic syndrome in the community, and put them into health promotion programs to change their lifestyle[3]. Metabolic syndrome usually occurs among adults, especially office working adults. In Thailand, a study in 2001 among Thai professionals and office workers reported a prevalence of MetS by definition of modified NCEP-ATP III in 15.2% of the overall study population, 25.8% among men and 8.2% for women, but a low prevalence was found in 1.04% in Thai medical cadet students[6,7].

The etiologies of metabolic syndrome can be genetics and lifestyle. Lifestyle comes from the regular practice of modifiable risk behaviors of metabolic syndrome such as inadequate physical activity, poor eating habits, smoking and alcohol drinking habits[8]. Non-modified factors such as increasing age, sex, hormonal change, and socioeconomic factors (occupation, income, education) were also reported to be risk factors for metabolic syndrome. A study in Korea reported lower socioeconomic status was associated with a higher risk of metabolic syndrome[9]. A study in Thailand demonstrated a high prevalence of MetS among those who finished bachelor degree and lower[6].

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However, the association between adult social class and MetS was largely explained by behavioral risk factors[10]. The aims of this analysis were to identify behavioral risk and socioeconomic factors associated with metabolic syndrome among employees of the Electricity Generating Authority of Thailand based in Bangkok, Thailand.

Material and Method
Subjects and setting
The present study analyzed cross sectional data at baseline of cohort study in cardiovascular risk factors among employees of the Electricity Generating Authority of Thailand (EGAT 3/1study) in the years 2009. A total of 2,545 employees (1,875 men, 669 women) aged 25-54 years were included.

Measurements
Anthropometric data
The individual waist circumference at half way between the umbilicus and iliac crest at standing position was measured in centimeters (cm) in light clothing.

Blood pressure (BP)
After participants had rested for at least 5 minutes, blood pressure was measured using desk type digital (Omron) twice in the left arm in a seated position. The average was used in the analysis.

Biological measurements
Blood samples were collected after overnight fasting. Measurement of blood chemistry was performed for fasting blood glucose (FBG), triglyceride (TG), and high-density lipoprotein cholesterol (HDL-C) by Ramathibodi Hospital, Faculty of Medicine, Mahidol University. FBG level was detected by hexokinase methods; TG and HDL-C level were determined by enzymatic colorimetric method.

Interviewing
Questionnaires were used to obtain socioeconomic status including level of education and monthly income (50,000-99,999 baht (US$ 1,666-3,333). Types of job by upper class referred to mainly office workers such as administrators, heads and chiefs of section, and middle class referred to outdoors or onsite workers such as engineers, mechanics and lower class referred to drivers, guards or janitors. Interview items also included smoking and alcohol consumption habits and physical activity.

Physical activity data and definition
A global physical activity questionnaire (GPAQ) was used in interviewing for physical activity. The evaluation included the three domains of physical activity: work, daily travel to and from places and recreational activities or exercise. GPAQ software on version 2 was used to analyze physical activity in metabolic equivalent (METs). METs, the ratio of a person's working metabolic rate relative to resting metabolic rate, were used to measure energy expenditure. One METs is the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/(kg h). After calculation by computer program, individual physical activities in METs-minutes per week were classified into high, moderate and low levels as shown below[11].

1. High: a person reaching any of the following criteria was classified in this category:
Vigorous-intensity activity at least 3 days a week achieving a minimum of at least 1,500 MET-minutes per week or
Seven or more days of any combination of walking and moderate or vigorous-intensity activities achieving a minimum of at least 3,000 METs-minutes per week.

2. Moderate: a person not meeting the criteria for "high" category but meeting any of the following criteria was classified in this category:
Three or more days of moderate-intensity of at least 20 minutes per day or
Five or more days of moderate intensity activity or walking at least 30 minutes per day or
Five or more days of any combination of walking and moderate or vigorous intensity activities achieving a minimum of at least 600 MET-minutes per week.

3. Low: a person not meeting any of the above-mentioned criteria were classified in this category.

Definition of metabolic syndrome (MetS)
In defining MetS by NCEP-ATP III (1), three or more from five components were used. The five components included 1) hypertriglyceridemia $\geq$150 mg/dL, 2) HDL-C <40 mg/dL in men and <50 mg/dL in women, 3) blood pressure $\geq$130/85 mmHg, 4) FBG $\geq$110 mg/dL and 5) waist circumference $\geq$90 cm in men and $\geq$80 cm in women as recommended by the Ministry of Public Health, Thailand[12,13].

Statistical analysis
Prevalence of MetS was weighted to midyear

population by five-year-age group distribution in Thailand based on the year 2009[14]. Binary logistic regression analysis was carried out to calculate crude and adjusted odds ratio with 95% confidence interval (OR, 95%CI) stratified by sex. The dependent variable was MetS (yes/no), and independent variables included age in years, level of education (secondary and vocational school/bachelor degree/higher than bachelor degree), monthly income (<50,000, 50,000-99,999 or >100,000), types of job (upper, middle or lower class), smoking status (current, previous or none), alcohol consumption habit (yes/no) and physical activity (low, moderate or high). Detection of colinearity between variables was performed before adding to the model with the entry method of significance at 0.05.

Results
Characteristics of the study population

Two thousand and forty-four subjects consisted of 73.2% males with mean age at 41.3±7.2 years, and 26.2% females with mean of age at 40.4±6.7 years. The most common level of education among participants was graduated at bachelor degree, 48.4% among males and 52.6% among females, having level of income lower than 100,000 baht, 88.2% among males and 77.2% among females. Considering types of job, they were mainly in middle class, 66.4% among males and 50.4% among females (Table 1).

Table 1. Characteristics of EGAT 3/1 study population

Characteristics	Overall (n = 2,545)		Men (n = 1,875)		Women (n = 669)	
	Number	Percent	Number	Percent	Number	Percent
Age group (years)						
25-29	195	7.7	156	8.3	39	5.8
30-34	281	11.0	191	10.2	90	13.5
35-39	515	20.2	326	17.4	189	28.3
40-44	712	28.0	542	28.9	170	25.4
45-49	489	19.2	387	20.6	102	15.2
50-54	352	13.9	273	14.6	79	11.8
Age, year, means (SD)	41.1 (7.1)		41.3(7.2)		40.4 (6.7)	
Education						
Lower than bachelor degree	694	27.3	610	32.8	75	11.7
Bachelor degree	1,262	49.4	909	48.4	352	52.6
Higher than bachelor degree	598	23.3	356	18.8	242	35.7
Income, Baht						
<50,000	1,101	43.2	881	46.8	220	32.9
50,000-99,999	1,072	42.1	776	41.4	296	44.2
>99,999	371	14.7	221	11.8	153	22.9
Types of job						
Lower class	67	2.7	61	3.3	6	0.9
Middle class	1,392	54.5	950	50.4	442	66.4
Upper class	1,085	42.8	864	46.3	221	32.7
Smoking						
Current	480	18.9	454	24.2	26	3.9
Previous	208	8.2	195	10.4	13	1.9
None	1,856	72.9	1,226	65.4	630	94.2
Alcohol						
Yes	1,602	62.9	1,380	73.5	222	33.2
No	942	37.1	495	26.5	447	66.8
Physical activity						
Low	1,481	58.2	1,081	57.6	400	59.7
Moderate	576	22.6	426	22.7	150	22.4
High	481	19.2	368	19.7	119	17.9

* Chi-square test

Behavioral risk factors of metabolic syndrome

Smoking every day and alcohol consumption was found in 24.2% and 73.5% among males, and 3.9% and 33.2% among females, respectively (Table 1).

Prevalence of metabolic syndrome and its components

The overall prevalence of metabolic syndrome was 16.6%, while 18.22% was found in males and 10.3% in females. Considering the five criteria of MetS, high prevalence among males was defined as having high waist level at 43.4%, having high blood pressure at 40.7% and having high level of triglyceride at 33.8%, which were higher than among females. Among females, 41% had high waist level and low level of high density of lipoprotein (HDL), 22.7%, higher than among males. Prevalence of having a high level of fasting blood glucose was quite low among this group, 8.6% in males and 3.5% in females (Fig. 1).

Physical activity

Types of physical activity

Male and female participants had the same common types of physical activity, which were physical activity from work, 40% among males and 41% among females. In addition, they had physical activity from daily traveling was 39% among males and 43% among females. The physical activity from leisure time or exercise was only 21% among males and 16% among females, respectively (data not shown). Regarding intensity of physical activity, the most common intensity of physical activity among this group was low, 57.9% for overall participants, 53.4% for males, and 70.8% for females, which was significant different between sexes (p-value <0.001) (Fig. 2).

Results from multivariate analysis

Among males, significant factors associated with MetS were annual increase in age (OR = 1.02; 95%CI 1.00-1.04), having level of education lower than bachelor degree (OR = 2.28; 95%CI 1.32-3.93) and bachelor degree (OR = 1.87; 95%CI 1.20-2.91) compared with those who had a higher level of education than bachelor degree. The findings of those in middle class by type of job (OR = 1.44; 95%CI 1.01-2.05) and lower class by type of job (borderline significant OR = 2.08; 95%CI 0.98-4.40) were compared with those in upper class by type of job are shown in Table 2.

Among females, significant factors associated with MetS were annual increase in age (OR = 1.08; 95%CI 1.02-1.15) and having incomes between 50,000-
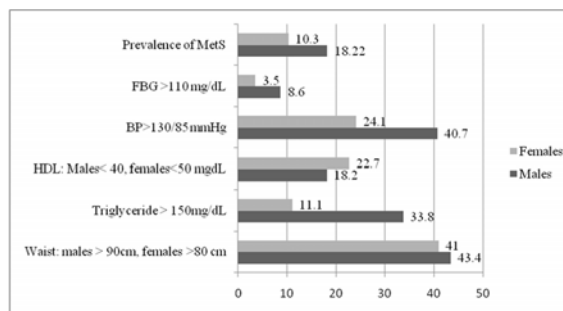

Fig. 1 Prevalence of 5 components of metabolic syndrome among EGAT 3/1 population.
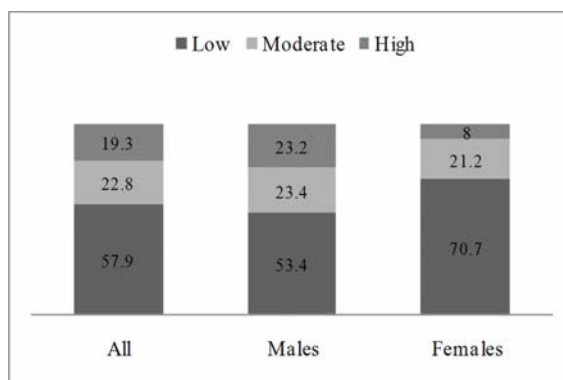

Fig. 2 Proportions of participants by intensity of physical activity and by sex.

99,999 baht (OR = 3.01; 95%CI 1.28-7.06) compared with those who had incomes 100,000 baht and higher. Other factors did not demonstrate significant associations (Table 3).

Discussion

Results of this analysis demonstrated a prevalence of MetS among the urban working population at 16.6%. Studies usually had differences in cutoff of waist circumferences across various countries, which made differences in definition and prevalence of MetS[15]. The present study used a cutoff at 90 cm for men and 80 mm for women, as recommended by the Thai Ministry of Public Health[12]. Study in Korea used 90 cm for men and 85 cm for women[9], study in Japan in 2005 used a cutoff at 85 cm for men and 90 cm for women[8] and study among Thai workers in 2007 used body mass index instead of waist circumference[6]. Prevalence of MetS among this group of participants in Bangkok was found to be higher than prevalence among Thai medical cadets, and Thais in Nong Kai in the northeast region of Thailand by the same definition

Table 2. Crude and adjusted associations (OR; 95%CI) of factors associated with metabolic syndrome among male EGAT 3/1 participants

Factors	Metabolic syndrome				Crude OR		Adjusted OR*	
	MetS		Normal		OR (95%CI)	p-value	OR (95%CI)	p-value
	n	%	n	%				
Age (years)					1.04 (1.02-1.06)	<0.001	1.02** (1.00-1.04)	0.054
Education								
Secondary and vocational school	168	44.0	429	29.6	3.31 (1.44-3.08)	<0.001	2.28** (1.32-3.93)	0.003
Bachelor degree	177	46.3	709	48.9	2.11 (2.25-4.86)	<0.001	1.87** (1.20-2.91)	0.006
Higher than bachelor degree	37	9.7	313	21.6	1		1	
Income (Baht)								
<50,000	177	46.5	671	46.3	1.87 (1.22-2.87)	0.016	1.45 (0.89-2.37)	0.131
50,000-99,999	175	45.9	594	41.1	1.68 (1.10-2.57)	0.004	1.26 (0.74-2.15)	0.386
>100,000	29	7.6	185	12.8	1		1	
Types of job								
Lower class	20	5.2	37	2.5	3.05 (1.71-5.42)	<0.001	2.08 (0.98-4.40)	0.054
Middle class	233	61.1	687	47.3	1.91 (1.50-2.43)	<0.001	1.44** (1.01-2.05)	0.044
High class	129	33.8	728	50.1	1		1	
Smoking habits								
Current	112	32.7	321	23.9	1.01 (0.68-1.51)	0.940	0.89 (0.57-1.39)	0.623
Previous	35	10.2	153	11.4	1.54 (1.18-2.01)	0.001	1.06 (0.78-1.44)	0.697
None	196	57.1	870	64.7	1		1	
Alcohol drink								
Yes	270	71.4	1,051	73.8	0.88 (0.68-1.14)	0.353	0.92 (0.68-1.24)	0.603
No	108	28.6	373	26.2	1			
Physical activity								
Low level	211	55.1	770	52.8	0.93 (0.79-1.39)	0.670	1.03 (0.96-1.54)	0.853
Moderate level	84	21.9	348	23.9	1.05 (0.66-1.29)	0.704	1.33 (0.95-1.86)	0.093
High level	88	23.0	339	23.3	1		1	1

* Adjusted for all variables in table; ** Significant adjusted variables

of MetS[7,16].

    Considering the proportion of each component of MetS, results from this analysis demonstrated the most common abnormalities were high abdominal obesity in both sexes, high blood pressure and high triglyceride levels among male participants and higher than female participants do. High fasting blood sugar did not produce a high magnitude of problems by prevalence in both sexes, which were consistent with studies among working Thais in 2007[6,7].

    Non-modified risk factors found among these

Table 3. Crude and adjusted associations (OR; 95%CI) of factors associated with metabolic syndrome among female EGAT 3/1 population

Factors	Metabolic syndrome				Crude OR		Adjusted OR*	
	MetS		Normal		OR (95%CI)	p-value	OR (95%CI)	p-value
	n	%	n	%				
Age (years)					1.07 (1.03-1.11)	<0.001	1.08** (1.02-1.15)	0.004
Education								
Secondary and vocational school	15	20.3	61	10.4	2.82 (1.35-5.87)	0.006	1.59 (0.61-4.12)	0.333
Bachelor degree	40	54.1	310	52.6	1.48 (0.83-2.62)	0.180	1.14 (0.58-2.26)	0.692
Higher than bachelor degree	19	25.7	218	37.0	1		1	
Income (Baht)								
<50,000	29	39.2	188	32.1	1.30 (0.66-2.57)	0.439	1.58 (0.72-3.45)	0.248
50,000-99,999	32	43.2	260	44.4	1.63 (0.82-3.56)	0.161	3.01** (1.28-7.06)	0.011
>100,000	13	17.6	138	23.5	1		1	
Types of job								
Lower class	1	1.4	5	0.9	1.83 (0.20-16.48)	0.587	0.65 (0.06-7.18)	0.732
Middle class	51	69.9	386	66.1	1.21 (0.71-2.07)	0.478	0.74 (0.38-1.43)	0.383
Upper class	21	28.8	193	33.0	1		1	
Alcohol drink								
Yes	26	36.1	197	33.8	1.10 (0.66-1.84)	0.695	1.15 (0.64-2.06)	0.640
No	46	63.9	386	66.2	1		1	
Menopause								
Yes	17	24.3	73	13.0	2.14 (1.17-3.90)	0.013	1.05 (0.47-2.32)	0.904
No	53	75.7	488	87.0	1		1	
Physical activity								
Low level	51	68.9	417	70.7	1.42 (0.50-4.04)	0.508	2.01 (0.60-6.67)	0.253
Moderate level	18	24.3	124	21.0	1.19 (0.45-3.14)	0.713	1.77 (0.57-5.42)	0.317
High level	5	6.8	79	8.3	1		1	

* Adjusted for all variables in table; ** Significant adjusted variables

group of working population were increased age, lower education and working in lower types of jobs, especially among male participants. It was consistent with previous studies[6,8,9]. Meanwhile, there were no significant of associations between potentially modified risk factors and MetS such as cigarette smoking, alcohol drinking including being in low categories of physical activity measured and analyzed by international standard questionnaire in MET (GPAQ).

This group of the study population mainly had physical activity from working and daily traveling which may not be intense enough in spending energy from eating, and lack of recreation or exercise after work, and weekends was found. Non-significant associations between physical activities with MetS in both sexes found in this study were inconsistent with

a study in Iran that demonstrated a significant relationship between MetS and various aspects of physical activity. It was proved that longer duration of moderate and vigorous intensity was associated with reduced odds of MetS[17], and well-known associations between normal components of MetS can be reduced with adequate intensity of exercise[1].

This analysis produced increased trends of the effects (ORs) to develop MetS among non-modifiable socioeconomic factors. Among male participants, there were increasing trend of effects (ORs) when the level of education, and types of job among males decreased to lower socioeconomic status among total participants. In female participants, trends of effects (ORs) increased when the level of education and physical activity decreased which was also found in previous studies[6,8,9,18,19]. These findings suggest the high-risk group for MetS among this working population group needs to modify risk in their behavior by urgent intervention strategies though good health promotion programs at workplace to reduce proportion of abnormal MetS components.

The limitation of this study was cross-sectional data, which provided association not causation between factors and MetS. It suggests confirming by future follow-up analysis with a bigger sample size. International standard questionnaire in MET (GPAQ) should be used and analyzed carefully.

In Thailand, nearly half of the total population (48% in 2009) comprises the working population[14]. Many government and private organizations including EGAT usually provide health care facilities such as annual health examination and health education for their workers or employees. Health promotion programs in the workplace to modify lifestyle can help to decrease the prevalence of metabolic syndrome and its components. Good surveillance and evaluation of programs from annual health examination every 2-3 years are very useful and important to improve health of employees. These activities can help the organization to reduce costs for treatment of chronic non-communicable diseases that are usually very high among population. With this, healthy and productive lives of employees can be achieved.

Conclusion

When cutoff of waist circumference was 90 cm and 80 cm for females were used, the overall prevalence of MetS among urban Thai working population was 16.2%; male participants had a higher prevalence of MetS than female participants did. Male participants with lower level of educational and working onsite or outdoors such as an engineer or mechanic, including laymen such as drivers, guards and janitors, while female participants with middle income were more likely to develop MetS. The high proportion of modified risk factors in physical activity by exercise should be the concern among the high-risk group.

Potential conflicts of interest

None.

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ความชุกและปัจจัยที่เกี่ยวข้องกับภาวะกลุ่มอาการทางเมตาบอลิซึมในกลุ่มประชากรไทยวัยทำงาน

จงกล โพธิแดง, ปิยมิตร ศรีธรา, กุลยา นาคสวัสดิ์

วัตถุประสงค์: ศึกษาความชุกของภาวะกลุ่มอาการทางเมตาบอลิซึมและปัจจัยที่ที่ความสัมพันธ์กับการมีภาวะกลุ่มอาการทาง เมตาบอลิซึมในกลุ่มประชากรไทยวัยแรงงานของการไฟฟ้าฝ่ายผลิตในกรุงเทพมหานคร

วัสดุและวิธีการ: ทำการวิเคราะห์ข้อมูลทุติยภูมิภาคตัดขวางที่จุดเริ่มต้นที่ได้จากโครงการวิจัยศึกษาปัจจัยเสี่ยงของการเกิด โรคหัวใจและหลอดเลือดที่ประกอบด้วยประชากรศึกษา 2,554 ราย (เพศชาย 1,875 ราย เพศหญิง 669 ราย)

ผลการศึกษา: พบความชุกปรุงปรับด้วยอายุโดยรวมเท่ากับร้อยละ 16.6 ในเพศชายร้อยละ 18.2 และเพศหญิงร้อยละ 10.3 โดยพบความผิดปกติที่น่าสนใจได้แก่ การมีขนาดของเอวใหญ่กว่าปกติ การมีความดันโลหิตสูงกว่าปกติ และมีระดับไขมัน HDL-cholesterol ต่ำกว่าปกติในทั้งสองเพศ สำหรับเพศชายพบการมีไขมันไตรกลีเซอไรด์สูง พบส่วนใหญ่มีกิจกรรมทางกาย ที่อยู่ในเกณฑ์ต่ำและกิจกรรมทางกายส่วนใหญ่มาจากการทำงานและการเดินทางประจำวัน ปัจจัยที่มีความสัมพันธ์กับการ มีภาวะกลุ่มอาการทางเมตาบอลิซึมในเพศชายได้แก่ อายุที่เพิ่มในแต่ละปี (OR = 1.02; 95%CI 1.00-1.04) การมีระดับ การศึกษาระดับปริญญาตรีและต่ำกว่า (OR = 2.28; 95%CI 1.32-3.93 และ OR = 1.87; 95%CI 1.20-2.91) และมีระดับการทำงานอยู่ในกลุ่มปานกลางและระดับต่ำ (OR = 1.44; 95%CI 1.01-2.05 และ OR = 2.08; 95%CI 0.98-4.40) สำหรับผู้หญิง ได้แก่ อายุที่เพิ่มในแต่ละปี (OR = 1.08; 95%CI 1.02-1.15) และมีรายได้อยู่ในระดับ ปานกลางของกลุ่ม (OR = 3.01; 95%CI 1.28-7.06)

สรุป: ผลการวิเคราะห์สามารถบอกได้ถึงกลุ่มเสี่ยงที่มีอยู่ในตำแหน่งการทำงานในระดับปานกลางเช่น ผู้ตรวจการ ช่างและในระดับล่างในเพศชาย และผู้ที่มีรายได้ปานกลางในเพศหญิงมีแนวโน้มที่จะเกิดภาวะกลุ่มอาการทางเมตาบอลิซึม การลดอัตราการมีภาวะกลุ่มอาการทางเมตาบอลิซึมโดยการเพิ่มความเข้มข้นของการออกกำลังกายให้มากขึ้น จะสามารถ ช่วยลดความเสี่ยงของโรคหลอดเลือดหัวใจและโรคหลอดเลือดสมองได้ดียิ่ง