Appropriate Cut-Off Level of BMI for Screening in Thai Adults

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Objective: *A cut-off level of Body Mass Index (BMI) for cardiovascular risk factors is controversial for its appropriateness in Asians. The present study aimed to determine the appropriate BMI cut-off level for Thai Adults.*

Material and Method: *127 out of 387 teachers of at least 35 years of age from Phuket participated in the present study. Participants completed self-administered questionnaires, and had physical examination and blood drawn for lipid profile.*

Results: *In multivariate analysis, participants with BMI $\geq$ 23 kg/m^2 were 2.7 (95%CI; 1.2, 6.1), 5.4 (2.3, 12.6), 5.1 (1.5, 16.0), and 7.2 (1.5, 34.1) times more likely to have total cholesterol $\geq$ 240 mg/dl, high-density-lipoprotein < 40 mg/dl, low-density-lipoprotein $\geq$ 160 mg/dl, and total cholesterol to HDL ratio > 5.0, respectively.*

Conclusions: *For screening/education program, the BMI of 23 kg/m^2 may be an appropriate cut-off level for being overweight. To support this finding, further studies in other regions and other populations of Thailand are needed.*

Keywords: *BMI, Thailand, Overweight, Asian, CVR*

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Cerebrovascular diseases were in the top ten leading causes of death among the Thai population[1]. Death rates increased from 52.3 per 100,000 population (male 61.5 and female 43.3) in the year 2000 to 63.3 per 100,000 population (male 73.3 and female 53.5) in the year 2004[1]. High serum cholesterol has been reported as a cardiovascular disease risk factor (CVR), as well as other factors including high triglyceride and high blood pressure[2-6]. High serum cholesterol (240 milligram/deciliter (mg/dl)) in Thai males and females aged at least 30 years were 12.2% and 16.9%, respectively[7,8]. Primary prevention toward these factors is a less expensive way to reduce this risk, particularly in Thailand. Anthropometry measurements have been used as indicators for CVR according to public health education[6,9-13]. Another anthropometric indicator, called the height indicator (HI), was proposed by Pruenglampoo et al (Height in centimeter - weight in kilogram). There were five cut-off levels: underweight ($\geq$ 112), normal (< 112-95), overweight (< 95-82), obesity (< 82-57), and extreme obesity (< 57)[14]. Recently, Thaikruea et al found an association between HI and CVR among Thai adults in Phuket province[15]. Body Mass Index (BMI) has been accepted as an indicator for CVR. BMI is calculated by dividing weight (kilogram) with height (meter) squared. The 30.0 kg/m^2 cut-off level for both genders has been recommended by the International Obesity Task Force of the World Health Organization (WHO). A number of previous studies in Europe and the USA have used classifications similar to those of WHO[16,17]. However, these cut-off levels are controversial for their appropriateness for Asian people[6,18]. From the public health perspective, Japan and Taiwan have used lower BMI

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cut-off levels than those of Europe and USA[19,20]. Different cut-off levels for BMI that have been used by different institutes and organizations in Thailand. However, there has been no official document indicating the appropriate level for use in Thai adults. The present study aimed to propose the most appropriate BMI cut-off level that can be used as an indicator for CVR and, thus, would be an appropriate cut-off level for health screening and education programs of Thailand.

Material and Method

The present study was reviewed and approved by the Ethics Committee of Phuket Provincial Public Health Office, Ministry of Public Health, Phuket, Thailand.

Phuket province is an island located in southern Thailand. There are three districts in Phuket. Teachers of at least 35 years of age in 2003 from the Talang district were invited to join the present study. This was a cross-sectional study design. The research staff explained the study to the teachers. Those who were willing to join the study were then asked to sign consent forms. They then completed self-administered questionnaires, and had a physical examination, blood pressure measurements, and blood drawn for lipid profile. The participants wore lightweight clothing and were weighed barefoot for the body height and weight measurements. Standing height was measured in a relaxed position without shoes to the nearest 0.5 cm. After resting for at least 15 minutes, blood pressures of the participants were measured with a traditional sphygmomanometer.

CVRs included high blood pressure (systolic SBP $\geq$ 140 or diastolic DBP $\geq$ 90 mmHg), high total cholesterol (CHOL $\geq$ 240 mg/dl), high low-density-lipoprotein (LDL $\geq$ 160 mg/dl), high triglyceride (TG $\geq$ 150 mg/dl), and high total cholesterol to HDL ratio (THR > 5.0). For low high-density-lipoprotein (HDL), there are two criteria that are commonly used in Thailand (HDL< 40 mg/dl) and the value recommended by WHO (HDL< 40 mg/dl in males and < 50 mg/dl in females)[16]. Total cholesterol, HDL, and triglycerides were measured with a Human Cholesterol liquicolor test kit (Wiesbaden, Germany). All procedures were performed according to the manufacturer's protocol. LDL was calculated as total cholesterol minus a summation of HDL and one fifth of TG (CHOL – (HDL + TG/5)).

Statistical analysis

Descriptive analyses included Chi-square tests, Fisher's exact tests, Student's t tests, and Kruskal Wallis tests, according to the data distribution, with alpha level set at 0.05. For univariate analyses, a risk ratio (RR) and 95 percent confidence interval (95%CI: lower - upper) for each factor of interest was calculated. Multivariate analysis included unconditional logistic regression. Data management and analyses were performed using Epi Info version 6 (CDC, Atlanta, GA), Epi Info 2000 Version 3.3.2 (CDC, Atlanta, GA) and STATA version 8 (Statacorp. 2001. Stata Statistical Software: Release 8.0 College Station, TX: Stata Corporation).

Results

Sample demographics

At the time of present study, there were 387 teachers in the Talang district aged at least 35 years. One hundred and twenty seven teachers (32.8%) participated in the present study. The majority was women (70.1%), married (75.4%), and had a bachelor's degree (90.5%). The mean age was 49.35 years (SD 4.74 years). A small number of the participants drank alcohol regularly (3) and smoked cigarettes (8). Only three participants were diabetic.

Table 1 shows that the top three prevalence

Table 1. The prevalence of Cardiovascular Risk Factors among the participants (n = 127)

CVR*	Number of High level n (%)	Number of normal level n (%)
High blood pressure (systolic $\geq$ 140 mmHg or diastolic $\geq$ 90 mmHg)	14 (11.1)	113 (88.9)
Total cholesterol $\geq$ 240 mg/dl	51 (40.2)	76 (59.8)
LDL $\geq$ 160 mg/dl	21 (16.5)	106 (83.5)
HDL < 40 mg/dl	119 (93.7)	8 (6.3)
HDL < 40 mg/dl in male and < 50 mg/dl in female	110 (86.6)	17 (13.4)
Triglyceride $\geq$ 150 mg/dl	48 (37.8)	79 (62.2)
Total cholesterol to HDL ratio > 5.0	18 (14.2)	109 (85.8)

of CVR were high cholesterol (40.2%), TG ≥150 mg/dl (37.8%), and high LDL (16.5%).

Univariate analysis

The proportion of the participants who had BMI equal to or above the cut-off levels were 55.1% at 23 kg/m^2, 36.2% at 25 kg/m^2, and 15.0% at 27.5 kg/m^2. There were significant associations between high BMI and CVR in regards to different cut-off levels of BMI. At 23 kg/m^2 cut-off level, high BMI was statistically significantly associated with high blood pressure (RR; 95%CI = 1.7; 1.0-2.7), high CHOL (1.6; 1.0-2.6), high LDL (3.5; 1.2-9.7), TG ≥ 150 mg/dl (2.7; 1.5-4.9) and high THR (6.5; 1.6, 27.2) (Table 2). Low HDL (< 40 in males and < 50 mg/dl in females) was marginally associated with p-value of 0.057 (2.6; 0.9-7.7). At 25 kg/m^2 cut-off level, high BMI was statistically significantly associated with high cholesterol (1.8; 1.2-2.8), HDL < 40 mg/dl cut-off (5.3; 1.1-25.1), high LDL (2.4; 1.1-5.2), TG ≥ 150 mg/dl (2.7; 1.7-4.2), and high THR (4.6; 1.7-12.0) (Table 2).

Multivariate analysis

Based on unconditional multiple logistic regression analysis, BMI at 23 kg/m^2 and 25 kg/m^2 cut-off levels were statistically significant in models of CHOL, LDL, TG, and THR after adjusting for age and gender. The participants with BMI ≥ 23 kg/m^2 were 2.7 times (95%CI; 1.2-6.1), 5.4 times (2.3-12.6), 5.1 times (1.5-16.0), and 7.2 times (1.5-34.1) more likely to have high total CHOL, low HDL, high LDL, and high THR, respectively. The participants with BMI ≥ 25 kg/m^2

Table 2. Univariate analysis of the association between CVR and BMI by different cut-off levels

CVR	RR of 23 kg/m^2 (95%CI)	RR of 25 kg/m^2 (95%CI)	RR of 27.5 kg/m^2 (95%CI)
High Blood pressure(systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg)	1.7 (1.0, 2.7)*	1.4 (0.9-2.2)	1.3 (0.8-2.2)
Total cholesterol ≥ 240 mg/dl	1.6 (1.0-2.6)*	1.8 (1.2-2.8)*	1.2 (0.7-2.1)
HDL < 40 mg/dl	5.7 (0.7-45.0)	5.3 (1.1-25.1)**	1.9 (0.4-8.7)
HDL < 40 mg/dl in male and < 50 mg/dl in female	2.6 (0.9-7.7)***	1.9 (0.8-4.8)	2.4 (0.9-5.9)
LDL ≥ 160 mg/dl	3.5 (1.2-9.7)*	2.4 (1.1-5.2)*	1.0 (0.3-2.9)
Triglyceride ≥ 150 mg/dl	2.7 (1.5-4.9)*	2.7 (1.7-4.2)*	1.5 (0.9-2.5)
Total cholesterol to HDL ratio > 5.0	6.5 (1.6-27.2)*	4.6 (1.7-12.0)*	1.6 (0.6-4.4)

* Chi square p-value < 0.05
** Fisher exact test p-value < 0.05
*** Chi square p-value = 0.057

Table 3. Multivariate analysis of the association between CVR and BMI by different cut-off levels

CVR	Adjusted OR of 23 kg/m^2 cut-off level (95%CI)	Adjusted OR of 25 kg/m^2 cut-off level (95%CI)	Adjusted OR of 27.5 kg/m^2 cut-off level (95%CI)
High Blood pressure (systolic ≥ 140 mmHg or diastolic ≥ 90 mmHg)	1.4 (0.3-5.4)	2.2 (0.6-8.0)	0.6 (0.1-5.5)
Total cholesterol ≥240 mg/dl	2.7 (1.2-6.1)*	3.6 (1.6-8.3)*	1.3 (0.5-3.7)
HDL < 40 mg/dl	4.4 (0.5-39.0)	5.1 (1.0-27.3)	1.7 (0.3-9.7)
HDL < 40 mg/dl in male and < 50 mg/dl in female	5.4 (2.3-12.6)*	2.3 (0.7-6.6)	2.5 (0.8-8.4)
LDL ≥ 160 mg/dl	5.1 (1.5-16.0)*	3.0 (1.1-7.9)*	1.0 (0.3-4.0)
triglyceride ≥ 150 mg/dl	3.2 (0.9-10.7)	5.8 (2.6-12.9)*	2.1 (0.8-5.8)
Total cholesterol to HDL ratio > 5.0	7.2 (1.5-34.1)*	5.5 (1.8-16.9)*	1.7 (0.5-6.4)

* Adjusted odds ratio derived from unconditional multiple logistic regression, control for gender and age (under 50 years and at least 50 years)

were 3.6 times (95%CI; 1.6-8.3), 3.0 times (1.1-7.9), 5.8 times (2.6-12.9), and 5.5 times (1.8-16.9) more likely to have high total CHOL, high LDL, TG ≥ 150 mg/dl, and high THR, respectively (Table 3).

Discussion

There have been reports of a relationship between waist circumference (WC) and CVR[10,12,21]. However, some studies in Asia showed controversial results of WC or waist to hip ratio[12,20,21]. With regard to anthropometry indicators for CVR, BMI has been accepted among health professionals. Nevertheless, it has been controversial for cut-off level in health prevention perspective. The trend of cardiovascular diseases has been increasing in Thailand recently. Thus, effective health education is needed. The present study aimed to propose the appropriate cut-off level of BMI for health screening and prevention programs in a Thai population.

With regard to the latest WHO guideline (WHO), BMI for each country should be defined for its own population[2]. There is a range of BMI levels and their associations with CVR. The present study chose three cut-off levels for investigation, namely 23, 25, and 27.5 kg/m^2. The results showed that a cut-off level as low as 23 kg/m^2 was statistically significantly associated with high blood pressure in univariate analysis. These associations were also found in multivariate analysis after adjusting for age and gender. The present study did not include alcohol consumption and smoking in the multiple logistic regression models, partly due to a small number of participants who drank alcohol (3 participants) or smoked cigarettes (8 participants). In addition, the amount of cigarettes or alcohol consumed by the participants was not clinically significant. The participants with BMI ≥ 23 kg/m^2 were 2.7 times to 7.2 times more likely to have high CVR (high total CHOL, low HDL, high LDL, high TG, and high THR). There were similar findings at 25 kg/m^2 but not at 27.5 kg/m^2. One of the reasons that no association was found at 27.5 kg/m^2 was due to the small sample size. Many recent studies and reports from other countries and WHO found an increasing risk for CVR at a low level such as 23 kg/m^2 [2,18,22]. Lee et al performed a study among 702 Hong Kong Chinese. They found that BMI levels used for defining obesity and their associations with CVR were lower than the cut-off levels established for Caucasians[23]. The results also showed that hypertension, dyslipidemia, and albuminuria were found at a BMI of 23 kg/m^2. For Asian adults, overweight and obesity are proposed by the Regional Office for Western Pacific Region of WHO (WPRO) as BMI ≥ 23 and ≥ 25 kg/m^2, respectively[23,24]. Shiwaku et al found that a BMI of 23-24.9 kg/m^2 as overweight criteria proposed by WPRO was suitable for screening multiple metabolic disorders for Japanese, whereas the WHO criteria was suitable for Mongolians[22]. A population-based study in Japan found similar results[25]. These studies in Asia support the present findings.

There were some limitations in the present study. The study population was selected from the same profession (teacher) in one out of three districts and the sample size was small, therefore, generalizing the present findings to the Thai population should be done with caution. The cross-sectional design can determine association but cannot guarantee a causal relationship. However, based on results and evidence from other studies, a BMI of 23 kg/m^2 may be an appropriate cut-off point for being overweight for Thai adults.

Conclusion

For health screening and education programs, the cut-off level of 23 kg/m^2 should be proposed for overweight adults in Thailand. Further studies in other regions of Thailand need to be performed to confirm this finding.

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เกณฑ์ที่เหมาะสมของดัชนีมวลกายสำหรับประชากรผู้ใหญ่ไทย

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ดัชนีมวลกาย (BMI) มีความสัมพันธ์กับปัจจัยเสี่ยงของโรคหัวใจและหลอดเลือด (CVR) เกณฑ์ BMI ที่เหมาะสมในการคัดกรอง CVR สำหรับคนเอเชียยังเป็นข้อถกเถียงกันอยู่ วัตถุประสงค์ของการศึกษาเพื่อหาระดับ BMI ที่เหมาะสมสำหรับคนไทย โดยครูที่มีอายุตั้งแต่ 35 ปีในอำเภอถลางจังหวัดภูเก็ตจำนวน 127 คน จาก 387 คน เข้าร่วมการศึกษานี้ มีการตอบแบบสอบถาม ตรวจร่างกาย และตรวจทางห้องปฏิบัติการ ผลการศึกษาพบว่า ด้วยสถิติถดถอยโลจิสติคพหุนั้นผู้ที่มีBMI $\geq$ 23 กก./ม.^{2} มีระดับโคเลสเตอรอลรวมสูง 2.7 เท่า (95%CI; 1.2, 6.1) LDL สูง 5.1 เท่า (1.5, 16.0) HDL ต่ำ 5.4 เท่า (2.3, 12.6) ไตรกลีเซอไรด์สูง 5.4 เท่า (1.4, 20.6) และอัตราส่วนโคเลสเตอรอลรวมต่อ HDL 7.2 เท่า (1.5, 34.1) เมื่อเทียบกับผู้ที่มี BMI < 23 กก./ม.^{2} ดังนั้น BMI $\geq$ 23 กก./ม.^{2} น่าจะเหมาะสมในการใช้เป็นเกณฑ์ชี้บ่งภาวะน้ำหนักเกินเพื่อการคัดกรอง CVR หรือให้สุขศึกษาสำหรับประชากรผู้ใหญ่ไทย ซึ่งควรมีการศึกษาเพิ่มเติมในพื้นที่ และกลุ่มประชากรอื่นของประเทศไทยต่อไป