Original Article

Association Between Body Mass Index, Blood Pressure, Blood Glucose and Blood Lipid Profile in Academic Staff at Princess of Naradhiwas University

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Abstract

OBJECTIVE: To investigate the links between body mass index (BMI), blood pressure (BP), fasting blood sugar (FBS) and blood lipid profile.

MATERIALS AND METHODS: Subjects of the study are 274 academic staff of Princess of Naradhiwas University who met the set criteria during a health check-up at Galyani Vadhana Karun Hospital. The factors measured in this study include BMI and BP. In 169 subjects with an age of over 35 years old, FBS and blood lipid profile (cholesterol and triglyceride (TG)) were also assessed. Analysis of Variance (ANOVA) and Pearson Correlation coefficient were used for statistical analysis.

RESULTS: The results show that average parameters of these subjects are normal, including BP (122.81/73.48 mmHg), FBS (94.99 mg/dl) and TG (116.31 mg/dl) but, with high BMI (25.02 Kg/m2) and high blood cholesterol (231.25 mg/dl). Spearman correlation coefficient indicated a positive significant correlation between TG level with BMI (r=0.17, $p<0.05$), systolic blood pressure (SBP) (r=0.33, $p < 0.01$), diastolic blood pressure (DBP) (r=0.35, $p<0.01$), cholesterol level (r = 0.24, $p<0.01$) and FBS level (r=0.21, $p<0.01$). The SBP and DBP was a positive significant correlation with BMI (r=0.43, r=0.44, $p<0.01$) and FBS level (r=0.25, r=0.25, $p<0.01$). Total cholesterol level was a positive significant correlation with FBS (r=0.30, $p<0.01$).

CONCLUSION: The main health issue faced by academic staff at Princess of Naradhiwas University is a heightened risk of obesity and hypercholesterolemia. This study shows positive significant correlation between BMI and cholesterol with BP, TG, and FBS. This correlation result may lead to the implementation of health education programs in the near future.

Keywords: association, body mass index, blood pressure, fasting blood sugar, blood lipid profile

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Chronic diseases are long-term medical conditions that are generally progressive. Some examples of chronic diseases include heart disease, cancer, diabetes, stroke, and chronic respiratory problems.[1] At present, these are major causes of disability and death globally. Chronic diseases are also the major cause of premature adult deaths in many parts of the world. According to the World Health Organization (WHO), chronic disease deaths occur in 38 million people each year around the world and account for 68% of total cause of death. In Thailand the 2011 and 2013 the rate of premature mortality due to the four main non-communicable diseases (NCDs) continued to rise. Crude death rate indicates that the number of deaths occurring during the year per 100,000 population is 350.3 and 355.3, respectively. [2]

The major NCD cause of death in the world today is cardiovascular disease with mortality projected to increase to 23 million[3] without prevention and control. In Thailand from 2013 to 2015 the NCDs mortality rate is 84.38, 90.34 and 96.33 per 100,000 population. In the same time period Naradhiwas province had a NCDs mortality rate of 74.43, 110.71 and 138.14 per 100,000 population.[4] This has an effect on public health care costs at an estimated 335,359 million Thai baht each year, therefore NCDs present a major issue and obstacle to socio-economic development in Thailand particularly human resources with the rise of premature death, suffering and loss of career potential.[5]

Since the adoption of a global strategy for the prevention and control of NCDs in 2000, several health assembly resolutions have been adopted and endorsed, and the global aim is to reduce premature mortality rate to 25% by 2025. Thus an action plan was developed to point to the 4 major NCDs diseases, the 4 physiological risk factors and the 4 modifiable health risk behavior factors, called the 4x4x4 model. The 4 main types of non-communicable diseases are 1) cardiovascular diseases 2) diabetes 3) cancers 4) chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma). Key metabolic/physiological changes that increase the risk of NCDs: 1) hyperlipidemia (high levels of fat in the blood) caused by unhealthy lifestyles 2) raised blood pressure 3) hyperglycemia (high blood glucose levels) 4) overweight/ obesity that can contribute to non-communicable diseases, whether from 1) exposure to tobacco smoke 2) the effects of the harmful use of alcohol 3) unhealthy diets 4) physical inactivity.[2]

From the 4x4x4 model, there are biological factors leading to NCDs namely that a BMI increase is linked to diabetes and cardiovascular diseases. BMI is reported to have associations with TG[7] and BP, that is statistically significant.[8] Furthermore, BP is associated with cholesterol and TG and low density lipoprotein (LDL)[9] therefore, the BMI, BP, FBS, cholesterol and TG of the population serve as a base to predict to primary health conditions and NCDs future trends. A proactive survey has been formulated to investigate the risk of diabetes, hypertension, dyslipidemia and obesity in Thai population as part of the National Health plan.

A cohort of academic staff at Princess of Naradhiwas University was selected during a health check-up at Galyani Vadhana Karun Hospital. The hospital's mission is to improve the health and health education for general customers so the hospital has promoted the need for an annual check-up every year. This study used data of staff who had a health check-up at Galyani Vadhana Karun hospital that examined: BMI, BP, FBS, cholesterol and TG as part of a strategic plan to promote health in line with the country health plan. The study is intended to help improve the quality of life of academic staff, to increase effectiveness of their work and ultimately lead to collection of primary health indicators that may be used to predict NCDs in the future.

Materials and Methods

This is a descriptive study and correlational research aimed to study factors associated with BMI, BP, FBS, cholesterol and TG. The subjects are 274 academic staff at Princess of Naradhiwas University who were sampled and selected purposively during an health annual check-up at Galyani Vadhana Karun hospital at the outpatient department from May 2 to 31, 2016. The factors measured in this study include BMI and BP. In 174 subjects with an age of over 35 years old, FBS and blood lipid profile (cholesterol and TG) were also assessed but 5 subjects refused, so 169 subjects were used for analysis.

Data collection

The researcher evaluated and collected primary data including body weight, height and waist circumference to calculate BMI, vascular function by systolic blood pressure (SBP) and diastolic blood pressure (DBP). In subjects aged 35 years and older, FSB and blood lipid profile (cholesterol and TG) were also tested via arm vein.

Part 1: General record and health check-up record such as age, weight, height, BMI, waist circumference and BP.

Part 2: Laboratory reports such as FBS, cholesterol and TG (in subjects aged 35 years and older).

Data analysis

Statistical analysis was performed by SPSS software. Descriptive statistics were used for describing the mean and frequency of the data obtained. The comparison variables factors: Sex, Age, BMI, BP, FBS, Cholesterol and TG was tested using Analysis of Variance (ANOVA) and Least Significant Difference (LSD). The correlations between variables factors were also analyzed. by using Pearson Correlation coefficient. P-values less than 0.05 were considered significant.

Results

Out of all 274 cases studied, 134 (48.90%) males and 140 (51.10%) females were examined. The mean age was 39.92±1.17 years. Among the cases we found three categories for weight in descending order: Obese class II (32.10%), Normal weight (28.50 %) and Obese class I (21.50 %), respectively. The mean BMI was 25.02 Kg/m^2. The mean waist circumference was 85.81 cm. Among the subject females there was an abnormally high waist circumference (81.84 cm). The mean of SBP and DBP were normal (122.81/73.48 mmHg). For the age group older than 35 years a total of 169 persons were examined, and most had normal FBS (84.00%), hyperglycemia (9.50%) and hypoglycemia (6.50%), respectively. Mean FBS was 94.99 mg/dl, while for cholesterol there were cases of hypercholesterolemia (39.10%), pre-hypercholesterolemia (36.70%) and normal cholesterol (24.30%), respectively. The mean cholesterol was 231.25 mg/dl. Mean TG was 116.31 mg/dl (Table 1-2).

Comparison of these variable factors between males and females, and then between subjects older than 35 years and younger than 35 years of age showed that BMI was higher in males than females (25.52 Kg/m^2 versus 24.54 Kg/m^2) and was higher in subjects older than 35 years than those individuals of a younger age (25.44 Kg/m^2 versus 24.29Kg/m^2). BP was not different between males, females and age groups. The age group older than 35 years showed that cholesterol was significantly higher in males than females (233.34 mg/dl versus 222.29 mg/dl), however, both males and females were found to have normal FBS and TG levels (Table 2).

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SBP and DBP increased significantly with increasing BMI status, FBS groups and TG groups. Cholesterol and TG was also significantly higher in those with elevated FBS but FBS did not rise with increasing BMI status (Table 3-7).

Bivariate correlation analysis showed that BMI, SBP, DBP, FBS and cholesterol had a positive correlation with TG (p<0.05). A significant correlation (p<0.001) was found between FBS with SBP, DBP and cholesterol. The variables also showed a positive correlation (p<0.001) between BMI with SBP and DBP except that the FBS was not correlated with BMI

Table 1: The number and percentage of respondents' variable factors (n=274)

Variable Factors	Normal Range	Frequency
n	-	274
Age (years)		
< 35	-	100 (36.50)
≥ 35	-	174 (63.50)
Gender		
Male	-	134 (48.90)
Female	-	140 (51.10)
BMI Classification (Kg/m2)		
Underweight	<18.00	14 (5.10)
Normal weight	18.00 - 22.99	78 (28.50)
Obese I	23.00 - 24.99	59 (21.50)
Obese II	25.00 - 29.99	88 (32.10)
Obese III	≥30	35 (12.80)
Waist Circumference (cm)		
Normal	Male ≤ 90 / Female < 80	145 (52.90)
Abnormal (elevated)	Male >90 / Female > 80	129 (47.10)
Systolic blood pressure (mmHg)		
Hypotension	≤ 89	0 (0)
Normal	90-134	209 (76.30)
Pre-hypertension	135-139	15 (5.50)
Hypertension	≥140	50 (18.20)
Diastolic blood pressure		
Hypotension	≤59 mmHg	47 (17.20)
Normal	84-60 mmHg	166 (60.60)
Pre-hypertension	85-89 mmHg	21 (7.70)
Hypertension	≥90 mmHg	40 (14.60)
n	-	174
Fasting Blood Sugar		
Subject Refused Testing	-	5 (0)
Hypoglycemia	<74 (mg/dl.)	11 (6.50)
Normal	74-106 (mg/dl.)	142 (84.00)
Hyperglycemia	≥106 (mg/dl.)	16 (9.50)
Cholesterol		
Subject Refused Testing	-	5 (0)
Normal	≤200 (mg/dl.)	41 (24.30)
Pre-hypercholesterolemia	201-239 (mg/dl.)	62 (36.70)
Hypercholesterolemia	≥240 (mg/dl.)	66 (39.10)
Triglyceride		
Subject Refused Testing	-	5 (0)
Normal	≤150 (mg/dl.)	128 (75.70)
Pre- hypertriglyceridemia	151-199 (mg/dl.)	24 (14.2)
Hypertriglyceridemia	≥200 (mg/dl.)	17 (10.1)

Table 2: Sex and age group distribution of mean values of variable factor

Variable Factors	Total	Sex Mean (95% CI)		*p*	Age group (years) Mean (95% CI)		*p*
		Male	Female		<35	≥35	
n		134	140		100	174	
Age (years)	39.92±1.17	40.30 (42.10-38.49)	39.55 (38.01-41.09)	0.533	29.89±0.61	45.68±1.14	0.000
BMI (Kg/m^2)	25.02 (24.44-25.60)	25.52 (24.63-26.41)	24.54 (23.78-25.30)	0.100	24.29 (23.23-25.35)	25.44 (24.75-26.13)	0.062
SBP (mmHg)	122.81 (120.86-124.77)	129.51 (126.86-132.17)	116.40 (113.96-118.84)	0.000	120.51 (117.55-123.47)	124.14 (121.58-126.70)	0.078
DBP (mmHg)	73.48 (71.89-75.08)	78.75 (76.44-81.07)	68.44 (66.57-70.30)	0.000	70.77 (68.33-73.21)	75.04 (72.98-77.10)	0.011
n		82	87		0	169	
FBS (mg/dl)	-	96.48 (89.72-103.24)	93.60 (84.29-102.91)	0.623	-	94.99 (89.24-100.75)	-
Cholesterol (mg/dl.)	-	233.34 (222.42-244.26)	222.29 (219.85-238.72)	0.576	-	231.25 (224.13-238.37)	-
Triglyceride (mg/dl.)	-	144.93 (122.78-167.07)	89.34 (79.80-98.89)	0.000	-	116.31 (103.88-128.74)	-

Table 3: Distribution of mean value BP, lipid profile and FBS according to BMI groups

Variable Factors	BMI Groups Mean(SD)					*p*	F
	Underweight	Normal weight	Obese I	Obese II	Obese III		
SBP	112.57 ± 6.2	114.19 ± 2.7	124.34 ± 4.14	126.32 ± 3.24	134.74 ± 6.59	<0.001	15.08
DBP	64.64 ± 6.64	66.15 ± 2.19	74.63 ± 3.22	77.20 ± 2.65	82.06 ± 5.38	<0.001	15.44
FBS	83.14 ± 6.82	83.10 ± 2.31	113.80 ± 21.13	93.59 ± 8.44	94.54 ± 12.85	0.008	3.54
Cholesterol	213.29 ± 31.27	227.58 ± 12.47	243.26 ± 21.05	232.87 ±10.34	220.88 ± 21.63	0.308	1.21
Triglyceride	115.71 ±1 46.42	89.23 ± 19.62	111.57 ± 18.65	124.02 ± 21.83	148.33 ± 39.81	0.066	2.25

Table 4: Results of least significant different (LSD) between BMI Group with SBP, DBP and FBS

Variable Factors	Mean	Mean Different				
		Underweight	Normal weight	Obese I	Obese II	Obese III
Systolic Blood Pressure						
Underweight	112.57	-	-1.62	-11.77*	-13.75*	-22.17*
Normal weight	114.19	1.62	-	-10.15*	-12.13*	-20.55*
Obese I	124.34	11.77*	10.15*	-	-1.98	-10.40*
Obese II	126.32	13.75*	12.13*	1.98	-	-8.42*
Obese III	134.74	22.17*	20.55*	10.40*	8.42*	-
Diastolic Blood Pressure						
Underweight	64.64	-	-1.51	-9.98*	-12.56*	-17.41*
Normal weight	66.15	1.51	-	-8.47*	-11.05*	-15.90*
Obese I	74.63	9.98*	8.47*	-	-2.58	-7.43*
Obese II	82.06	12.56*	11.05*	2.58	-	-4.85*
Obese III	73.48	17.42*	15.90*	7.43*	4.85*	-
Fasting Blood Sugar						
Underweight	83.14	-	0.04	-30.66*	-10.44	-11.40
Normal weight	83.10	-0.42	-	-30.70	-10.49	-11.44
Obese I	113.80	30.66*	30.70*	-	20.21*	19.26*
Obese II	93.59	10.44	10.49	-20.21*	-	-0.95
Obese III	94.54	11.40	11.44	-19.26*	0.95	-

* The mean difference is significant at 0.05 level

Table 5: Distribution of mean value BP and lipid profile according to FBS groups

Variable	FBS (Mean ± SD)			*p*	F
	Hypoglycemia	Normal	Hyperglycemia		
SBP	113.73 ± 10.47	123.95 ± 2.77	136.63 ± 7.95	0.002	6.76
DBP	68.73 ± 7.36	74.84 ± 2.27	84.31 ± 6.56	0.008	5.01
Cholesterol	218.64 ± 20.15	229.13 ± 7.18	258.81 ± 39.31	0.036	3.40
Triglyceride	80.36 ± 20.30	114.65 ± 13.67	155.81 ± 47.70	0.050	3.02

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Table 6: Results of Least Significant Difference (LSD) between FBS Group with SBP, DBP and cholesterol

Variable Factors	Mean	Mean Different		
		Underweight	Normal weight	Obese I
Systolic Blood Pressure				
Hypoglycemia	113.73	-	-10.22*	-22.90*
Normal	123.95	10.22*	-	-12.67*
Hyperglycemia	136.63	22.90*	12.67	12.67*
Diastolic Blood Pressure				
Hypoglycemia	68.73	-	-6.11	-15.59*
Normal	74.84	6.11	-	-9.47*
Hypoglycemia	84.31	15.59*	9.47*	-
Cholesterol				
Hypoglycemia	218.64	-	-10.49	-40.18*
Normal	229.13	10.49	-	-29.69*
Hypoglycemia	258.81	40.18*	29.69*	-

* The mean difference is significant at 0.05 level

Table 7: Distribution of mean value BP according to cholesterol groups and triglyceride group

Variable Factors	Cholesterol Groups Mean(SD)			*p*	F	Triglyceride Groups Mean(SD)			*p*	F
	Normal	Pre-hypercho-lesterolemia	Hypercho-lester-olemia			Normal	Pre-Hypertrigly-ceridemia	Hypertrigly-ceridemia		
SBP	122.24 ± 5.03	123.06 ± 4.72	127.21 ± 3.93	0.244	1.42	121.83 ± 2.91	129.25±7.41	137.76±5.94	<0.001	8.33
DBP	75.17 ± 4.02	73.56 ± 4.67	77.11 ± 3.36	0.347	1.07	73.50 ± 2.40	76.46±5.54	87.59±3.8	<0.001	8.71

Table 8: Distribution of mean value SBP and DBP according to cholesterol groups and triglyceride group (n=274)

Para-meters	BMI	SBP	DBP	FBS	Cholesterol	Triglyceride
BMI	1					
SBP	0.43** (0.000)	1				
DBP	0.44** (0.000)	0.79** (0.000)	1			
FBS	0.05 (0.495)	0.25** (0.001)	0.25** (0.001)	1		
Cholesterol	-0.03 (0.717)	0.09 (0.271)	0.03 (0.665)	0.30** (0.000)	1	
Triglyceride	0.17*(0.027)	0.33** (0.000)	0.35** (0.000)	0.21* (0.006)	0.24* (0.002)	1

* $p < 0.05$ ** $p < 0.001$

Discussion

The leading health issue for academic staff at Princess of Naradhiwas University is a heightened risk of obesity and hypercholesterolemia. The findings suggest that there are factors associated with being overweight and having abnormal fat deposits. There could be a possible interplay of genetic factors, sedentary lifestyle, food and lack of exercise.

Our study showed a positive correlation ($p<0.001$) between BMI with SBP and DBP. These findings are similar to most results reported in a range of Asian populations showing that high BP is linked in several ways to overweight levels and obesity. A large body size may increase BP because the heart needs to pump harder to supply blood to all cells. Excess fat may also damage the kidney, which helps to regulate BP.[10,11] A few studies showed a statistically significant correlation between BMI and raised BP where BMI increased by 1kg/m^2, SBP/DBP increased by 2/1.5mmHg.[12] In addition a study in Abeokuta of Nigerians showed a positive correlation of SBP and DBP with age, BMI and waist circumference.[13,14]

Our study showed that SBP and DBP increased significantly with increasing FBS groups, while in a similar study about Risk and Nature of CVD the same is demonstrated in diabetes with an increase of FBS due to the insulin resistance leading to metabolic disorder that in turn inhibits fat burning and increases fat deposits. This contributes to plaque formation leading to arthrosclerosis that makes the heart pump harder.[15] A study in Iran found a positive correlation of FBS with BP in hypertension and pre-hypertension above normal-hypertension levels.[16]

Furthermore, the correlation ($p<0.001$) of FBS with cholesterol and TG was significant. et al.,[17] had similar findings in which cholesterol and triglyceride were significantly positive with FBS and BP in both males and females.Furthermore a study of diabetes combined with atherosclerosis showed that fatty deposits rose due to free fatty acid that stimulates lipoprotein in the liver to produce triglyceride in the blood stream. Combined with induced insulin resistance, the body is unable to convert blood sugar efficiently into energy. High levels of fat or fatty deposits can be attributed to high FBS.[18]

What is more, the correlation of triglycerides with other variable factors was significantly positive. The result of the study revealed that the main cause of hypertriglyceridemia is that eating was disproportionate to the expenditure of energy and excess carbohydrate is taken in. TG in the body is absorbed and then transported through the blood to the cells that need energy. So excess TG is deposited in fat tissue across the body. Therefore, a high volume of TG can cause blood clotting and blockage of blood vessels, especially to the heart and brain.[19] Thus, any increases in blood lipid levels and BMI are important predictors of cardiovascular disease risk, including conditions such as hypertension, coronary artery disease and cardiovascular disease[20].

Conclusion

The main health issue faced by academic staff at Princess of Naradhiwas University is a heightened risk of obesity and hypercholesterolemia. This study shows positive significant correlation between BMI and cholesterol with BP, TG, and FBS.This correlation result may lead to the implementation of health education programs in the near future.

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