การศึกษาเปรียบเทียบความแตกต่างของดัชนีเม็ดเลือดของประชากรไทยวัยผู้ใหญ่ และการหาความสัมพันธ์ของดัชนีมวลกาย กับดัชนีเม็ดเลือดในประชากรวัยผู้ใหญ่ไทย

Comparison of Different Blood Cell Indicies and Association Between Body Mass Index and Blood Cell Indicies in ThaiAdults

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บทคัดย่อ

ปัญหาภาวะอ้วนจัดเป็นปัญหาโภชนาการที่พบมากที่สุดในโลก ในประชากรไทยพบว่าภาวะอ้วนเป็นสาเหตุหลักที่ทำให้เกิดการเจ็บป่วย ทำให้เสียชีวิตก่อนเวลาอันควร จากกลุ่มโรคไม่ติดต่อเรื้อรัง (Non-communicable Disease : NCDs) การวิจัยนี้ทำการศึกษาค่าความสัมพันธ์ของดัชนีมวลกาย (BMI) และค่าดัชนีเม็ดเลือด (Blood cell indicies) ในผู้ที่มีภาวะอ้วน จากผู้ที่มาใช้บริการตรวจสุขภาพประจำปี และไม่มีโรคประจำตัว ทำการเก็บข้อมูลทั่วไป เพศ อายุ น้ำหนัก ส่วนสูง และผลการตรวจวิเคราะห์ CBC ที่ทำการตรวจวิเคราะห์เรียบร้อยแล้วมาพิจารณาหาความสัมพันธ์เทียบกับค่าดัชนีมวลกาย โดยใช้ข้อมูลที่มีอายุ 18 – 50 ปี BMI >18.5 กก/ม^2 ทั้งเพศชาย และเพศหญิงจำนวน 4,000 ราย ทำการแบ่งกลุ่มตัวอย่างเป็น 4 กลุ่มตามขนาดของ BMI หาค่าเฉลี่ยแต่ละพารามิเตอร์ของแต่ละกลุ่ม และหาความสัมพันธ์ของดัชนีเม็ดเลือดแต่ละพารามิเตอร์ กับค่าดัชนีมวลกาย ผลการวิจัยพบค่าเฉลี่ยของ อายุ น้ำหนัก และส่วนสูงในเพศชายสูงกว่าเพศหญิง ทำการเปรียบเทียบค่าเฉลี่ยของแต่ละพารามิเตอร์ในแต่ละกลุ่ม BMI พบ RBC count, Hb, Hct, Platelet count, MPV, WBC count, neutrophil และ lymphocyte ในกลุ่มคนปกติ (BMI 1) ปกติต่ำกว่าในกลุ่มที่มีภาวะอ้วน (BMI 3, BMI 4) อย่างมีนัยสำคัญทางสถิติ ผลการหาค่าความสัมพันธ์ดัชนีเม็ดเลือดแต่ละพารามิเตอร์กับค่าดัชนีมวลกายพบความสัมพันธ์ระหว่างดัชนีเม็ดเลือด และดัชนีมวลกายอย่างมีนัยสำคัญทางสถิติ $p < (0.05)$ ยกเว้นในพารามิเตอร์ MCV, MCH, MCHC และ basophil และพบว่าความสัมพันธ์ระหว่างค่าเฉลี่ย Neutrophil และ BMI มีความสัมพันธ์เชิงลบอย่างมีนัยสำคัญทางสถิติ

คำสำคัญ:ภาวะอ้วน, ดัชนีมวลกาย, ดัชนีเม็ดเลือด

Abstract

According reported that obesity is the most common malnutrition problem in the world. Report in Thailand health found obesity is main cause of illness and prematurely die with Non-communicable Disease (NCDs). Prevalence of obesity in Thailand stilling increase.This study investigated the correlation of BMI and blood cell indicies in obesity from people who health check up program. All total 4,000 data were 18 – 50 years old and BMI > 25 kg./m^2 record general data for sex, age, weight and laboratory data is CBC data and grouping by BMI for 4 group. All group calculate mean of each parameter then compare between group and correlation BMI and blood cell indicies.Result from the study were mean of age, weight and high in male higher than female. Mean of RBC count, Hb, Hct, Platelet count,

MPV, WBC count neutrophil and lymphocyte in control group (BMI 1) is significant lower than obese group (BMI 3 and BMI 4) at p-value <(0.05). And found significant correlate between blood cell indicies and body mass index (BMI) p-value <(0.05) except parameter in MCV, MCH, MCHC and basophil. In addition found negative correlate between neutrophil and BMI was significant at p-value <(0.05).

Keywords: Obesity, Body Mass Index, Blood cell indicies

1.Introduction

Obesity has more than doubled in the world in the last two decades, according to the statistics issued by the World Health Organization (WHO). Based on relates reports issued from Southeast Asia in 2014, over the adults age18,600 million were obese. Population that have Body Mass Index (BMI) > 25 kg/m^2 approximately 1.9 billion people and BMI > 30 kg/m^2 at least 600 million people or 39% that have overweight or obesity [1]. However, there is no specific reportRaised BMI is a major risk factor for non-communicable disease (NCD) such as: cardiovascular disease (mainly heart disease and stroke), which were the leading cause of death in 2011; musculoskeletal disorder (especially osteoarthritis and degenerative disease of the joints); some cancers (endometrial, breast, and colon) [2]. The prevalence of obesity shows increasingly high numbers and affects all age ranges. The data from Thai population health surveyshow obesity that cause the main problem of illness and early death in men more than women [3].

Obesity, which should be considered a low-level inflammatory condition, is a pro-inflammatory state with hypertrophy and hyperplasia of adipocyte related to metabolic and cardiovascular disorders, such as type 2 diabetes, hypertension, atherosclerosis, dyslipidemia and acute and chronic inflammatory processes. This is due to the fact that the white adipose tissue produces adipocytokines involved in this process [4,5].Because of the association between inflammation and obesity, several studies have examined the relationship between degree of obesity and the peripheral circulating white blood cells (WBCs) [6]. Moreover, there are many studies evaluation the correlations between WBC and metabolic syndrome component in some cross-sectional studies [7,8]. Numerous investigations previously reported that erythrocyte parameters, including red blood cell (RBC) count, hematocrit (Hct), haemoglobin (Hb), and red cell distribution (RDW) were positively associated with obesity and chronic low grade inflammation [9]. Importantly, mean platelet volume (MPV) is also elevated in some risk conditions such as hepercholesterolemia, diabetes, and hypertension [10].

In fact,red blood cell indices, white blood cell count, and platelet volume were demonstrated in several studies worldwide to correlate with many components in obesity andmetabolic syndrome. Demographic, environmental, geographical area, and ethnic population are factors that may contribute to variations in blood cell indices around the world. However, the association between blood

cell indices and obesity condition specifically in Thai populationsremain controversial, because the results reported are inconsistent depending on the different ethnic populations studied. Discrepancies in the results may be partly attributed to differences between obesity class. The information ofblood cells parameters maybe serves as effective marker for early detection of the risk of obesity.Moreover, no studies were conducted in Thailand. Therefore, the aim ofthis study was to explore the association between blood cell indices and body mass index (BMI) with a representative sample of adult Thai population.

2.Materials and Methods

A cross-sectional study was conducted among 4,000 subjects aged 18-50 years. All subjects were recruited through the Police General Hospital between January 2017 and December 2017. Participants with a history of hematologic disease, cardiovascular disease, cancers, liver or kidney dysfunction, and severe inflammatory disease were excludedand without congenital disease.The study was approved by the ethic review committee at Thammasat University (No.008/2561). The measurement of weight and height is an objective starting point for the health assessment and BMI calculation. BMI was calculated as weight (kg) divided by height (m^2). Following a BMI determination term such as normal weigh, overweigh, obesity class 1a, and obesity class 1b are used to describe the participant. The WHO has developed BMI classification aimed for international use. Weight classification based on BMI is shown in **Table 1**[11].

Medical history, and anthropometric parameters (sex, age, weight, and height) of subjects were obtained by medical records. The blood indices; red blood cells parameters (RBC count, Hct, Hb, MCV, MCH, MCHC, RDW), platelet parameters (platelet count and mean platelet volume (MPV), white blood cells parameters (WBC count, neutrophil, lymphocyte, monocyte, eosinophil, basophil) were measured by an automate analyzer (PCL Holding, Thailand).

Statistical analysis

All statistical analyses were performed using SPSS software package version 24.0 for windows. Data are presented as mean±SD or frequency (percentage). The t-test was used to evaluate difference in characteristics of the study subjects with obesity by sex. One – Sample Kolmogorov – Smirnov test was conducted to test the distribution of data. A one – way ANOVA was used to compare each parameter of blood cell indicesfor all 4 groups. In addition, Post Hoc multiple comparison were tested for pair group difference. A spearman's rank correlation was used to evaluate the correlation between each parametersand p – value less than 0.05was considered to be statistically significant.

3.Results and Discussion

The study included 4,000 adult subjects (1,888 men and 2,112 women) with an average age of 40.6±9.8 years. Overall, 37% were normal weight, 17% were overweight, 34.4% were class 1a obesity, 11.6% were 1b obesity. Additional,

information on the characteristics of study subjects, stratified by sex, are presented in **Table 2**. In the present study, it was observed that the group with excess weight showed higher prevalence of obesity (46%) in Thai population. The prevalence of obesity was higher in woman than in men (52.8% vs. 47.2%). Sex has been demonstrated to be a predictor factor for obesity. Several studies have shown that women have a higher prevalence of obesity than men [12, 13]. A large scale study conducted in United States in 2011-2012 reported that the prevalence of obesity was 56.6% in women and 43.4% in men [12]. Another study performed in Thai adult aged 20 and over in 2009 presented that the prevalence of obesity, as determined by the criteria for asian population was 39.6% in women and 33.0% in men [13]. Our study outcomes are in accordance with these reports.

Table 3 shows the number of blood cell indicies parameters, the number of RBC was higher in BMI 3 (obesity class 1a) and BMI 4 (obesity class 1b). RBC count, Hct, Hb, and MCV were significantly higher in the obesity groups than in normal weight and overweight ($p<0.05$).Proportionate to BMI, platelet counts and mean plate volume showed an increased in obesity. However, only mean platelet volume was significantly high in BMI 4 (obesity class 1b). The study showed that the levels of WBC count, neutrophil, and monocyte clearly increased with the obesity class ($p<0.05$), shown in Table 3. It is well known that obesity seem to be more associated with abdominal fat and dyslipidemia. Previous studies demonstrated that RBC and Hb levels clearly increased with the degree of obesity [14,15], and this is demonstrated in our outcomes. Based on the fact that level of RBC, Hct, and Hb are significantly associated with whole blood viscosity [16]. We hypothesized that increased levels of RBC parameters tested in this study may be indicative of the blood viscosity in obese people. The pathogenesis of fat formation may, in part, be causative of blood viscosity, erythrocyte deformability, and alter erythrocyte morphology. Prooxidants and adipocytokines generated in obesity can be altered erythrocyte aggregation and membrane surface charge causing high viscosity [17].

The results of this study showed that the number of platelets was high in obesity groups (class 1a and 1b). In contrast, there was no significant difference between obese and overweight subjects in the number of platelets compared to the subgroup of normal weight. The platelet counts and mean platelet volume increased with BMI. Charles et.al. (2007) reported that increase in tertiles of abdominal fat would significantly be associated with an increase in platelet count, result similar to those obtained in the present study. Investigation of the association of obesity condition with platelet count revealed a statistically significant correlation between BMI and waist circumference with indices of platelet count [18].

We found a significant trend in the number of white blood cells by increasing with BMI, without significant difference in overweight. The most consistent association was found between the number of WBC and the measurements of the generalized abdominal

obesity and circumference of the waist.**Table 4** shows the correlation between blood cell indices with BMI. Almost variables showed positive correlation with the exception of MCV, MCH, RDW, and neutrophil, which were negatively correlated with BMI. The results of our study however showed that BMI had no association with haemoglobin, MCV, and other red cell indices. This result consistent with previous studies [19]. There was also no association between the red blood cell counts, haemoglobin concentration, haematocrit and BMI in our different BMI subgroups. However, there is strong evidence of an association between obesity and the WBC count increases in previous report [20]. Studies have found that there is some sort of association between the increase number of immune cells and obesity as a result of a chronic inflammation condition which is created by an increase in the production of cytokines by adipose tissue. It has also been show that obesity is associated with low-grade subclinical inflammation [21, 22]. Similar health effects of low-grade systemic inflammation in healthy adults have found in cardiovascular disease and diabetes mellitus [23]. In support of previous findings, the positive associations between the number of cells and obesity have been reported in a number of cross sectional studies [18, 24]. Another study found higher rate of inflammation markers, including a 17% higher WBC count in participants with a central obesity as compared with those whose body fat was distributed normally [25]. In addition, the increase in leukocytes associated with obesity is clinically important because neutrophils and monocytescan release substances such as free radicals and proteolytic enzymes into blood which are of potentially harm to the health [18].The number of RBC, WBC, and platelet still are the most common tests used to diagnose disease, it seems we should start to consider these parameters as a good predictor of obesity condition as well.

our study is the firstinvestigation of the association of blood cell indicies and degree of obesity with a large sample size in Thais. However, this study suffered from some limitations. There is no information of many confounding such as physical activity, depression, and diet. These confounders may affect the number of blood indices. Moreover, the relationship of obesity with other factors in the immune system such as Interleukin and C-reactive protein level should be considered.

4.Conclusion

Blood cell indicies parameter is associated to obesity condition presented higher amounts of red blood cell, white blood cell, and platelet count. This has important clinical implications for health professionals. Blood cells parameters may serve as effective indicies for early detection of the risk of obesity.

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Table 1 Obesity and overweight indicies

Variables	BMI)kg/m^2(	Obesity class
BMI 1 :Normal weight	18.5 –22.9	Normal weight
BMI 2 :Overweight	23.0 –24.9	Overweight
BMI 3 :Obesity	25.0 –29.9	Class 1 a
BMI 4 :Obesity	> 30	Class 1b

Table2 The Average of demographic data in the study subjects

	Male (n = 1,888)	Female (n = 2,112)
Age (year)	42.2 ± 9.2	39.3 ± 10.2
High (cm.)	168.2 ± 6.9	156.5 ± 6.7
Weight (kg.)	70.6 ± 13.9	60.9 ± 12.7

Table3 Comparison of the mean values of blood cell indicies according to BMI

Parameters	BMI 1 (18.5 – 22.9 kg/m^2)	BMI 2 (23.0 – 24.9 kg/m^2)	BMI 3 (25.0 – 29.9 kg/m^2)	BMI 4 (> 30.0 kg/m^2)	p-value ANOVA test
Number of participants	1479 (37)	680 (17)	1377 (34.4)	464 (11.6)	
RBC count (x 10^6 /ul.)	4.5 ± 1.35	4.5 ± 1.34	4.7 ± 2.88 [b]	4.7 ± 1.26 [c]	0.039*
Hb (g./dl.)	12.6 ± 3.47	12.9 ± 3.23[a]	13.2 ± 3.19[b]	13.2 ± 3.24[c]	0.000*
Hct (%)	38.2 ± 9.64	38.9 ± 9.43[a]	40.0 ± 9.27[b]	39.8 ± 9.31[c]	0.000*
MCV (fl.)	85.9 ± 16.15	86.6 ± 15.13	85.5 ± 15.12	86.7 ± 14.27	0.114
MCH (pg.)	27.4 ± 6.12	28.7 ± 5.70[a]	28.3 ± 5.61	28.4 ± 5.39	0.036*
MCHC (g./dl.)	33.0 ± 1.37	33.1 ± 1.44[a]	33.0 ± 1.54	33.1 ± 1.48	0.000*
RDW (%)	15.0 ± 4.33	14.8 ± 4.36	14.8 ± 7.95	14.7 ± 3.35	0.993
Platelet count (x 10^3 /ul.)	239.9 ± 162.17	243.0 ± 143.61	245.7 ± 139.79[b]	256.2 ± 156.38[c]	0.003*
MPV (fl.)	8.1 ± 2.16	8.1 ± 1.84	8.2 ± 1.84	8.2 ± 1.94[c]	0.002*
WBC count (x 10^3 /ul.)	7.9 ± 6.14	7.9 ± 5.96	8.0 ± 5.67	8.6 ± 5.60[c]	0.001*
Neutrophil (%)	62.1 ± 22.71	62.8± 24.34[a]	61.8± 24.72	62.8± 23.59[c]	0.020*
Lymphocyte (%)	25.0 ± 21.24	26.0 ± 20.46[a]	27.1 ± 21.07[b]	26.2 ± 20.29	0.001*
Monocyte (%)	7.7 ± 5.81	7.7 ± 5.14	7.4 ± 4.84	7.8 ± 5.35[c]	0.002
Eosinophil(%)	2.7 ± 6.83	2.9 ± 5.63	3.0 ± 6.84	3.0 ± 6.07	0.097

Basophil (%)	0.5 ± 0.79	0.6 ± 0.78	0.6 ± 0.72	0.6 ± 0.84	0.999

Data represented in Median±S.E.

RBC :red blood cell; Hb :hemoglobin; Hct :hematocrit; MCV :mean corpuscular volume; MCH :mean corpuscular hemoglobin; MCHC :mean corpuscular hemoglobin concentration; RDW :red blood cell distribution width; MPV :mean platelet volume; WBC: white blood cell

Multiple comparisons using Post hoc test : [a] BMI 1 was significantly different from BMI 2; [b] BMI 1 was significantly different from BMI 3; [c] BMI 1 was significantly different from BMI 4

ANOVA test was performed*p-value significant at p-value < 0.05

Table4 Correlation between BMI and Blood cell indicies

Blood indicies	Spearman 's correlation	p-value
Neutrophil	0.440	0.002*
Hct	0.144	0.014*
Hb	0.139	0.008*
RBC count	0.093	0.034*
WBC count	0.080	0.005*
Platelet count	0.063	0.001*
Lymphocyte	0.054	0.036
Eosinophil	0.053	0.004
Monocyte	0.051	0.002*
MPV	0.041	0.032*
MCHC	0.023	0.085
Basophil	0.012	0.068
MCH	-0.025	0.124
MCV	-0.030	0.137
RDW	-0.041	0.0023*

*p-value significant at p-value < 0 .05