International Journal of Gerontology 6 (2012) 201–205

Contents lists available at SciVerse ScienceDirect

International Journal of Gerontology

journal homepage: www.ijge-online.com

Original Article

Association Between Platelet Count and Components of Metabolic Syndrome in Geriatric Taiwanese Women☆

Yen-Lin Chen [1], Chun-Hsien Hsu [2], Chang-Hsung Hseih [3], Kun Wang [4], Chung-Ze Wu [5], Cheng-Yi Wang [4], Jen-Yu Wang [4], Jin-Biou Chang [6], Dee Pei [4]*

[1] *Department of Pathology, Cardinal Tien Hospital, School of Medicine, Fu-Jen Catholic University,* [2] *Department of Family Medicine, Cardinal Tien Hospital, School of Medicine, Fu-Jen Catholic University,* [3] *Department of Internal Medicine, Tri-Service General Hospital, National Defense Medical Center,* [4] *Department of Internal Medicine, Cardinal Tien Hospital, School of Medicine, Fu-Jen Catholic University,* [5] *Division of Endocrinology and Metabolism, Department of Medicine, Shuang Ho Hospital, Taipei Medical University,* [6] *Department of Pathology, National Defense Medical Center, Division of Clinical Pathology, Tri-Service General Hospital, Taipei, Taiwan*

ARTICLE INFO

Article history:
Received 8 November 2010
Received in revised form
23 May 2011
Accepted 10 June 2011
Available online 21 March 2012

Keywords:
body mass index,
low-density lipoprotein-cholesterol,
metabolic syndrome,
platelet count,
triglyceride

SUMMARY

Background: The growing elderly population in Taiwan, as in many other countries, has resulted in increased importance of the metabolic syndrome (MetS). Although it has been reported in different age groups, the relationship between platelets and MetS remains unknown in geriatric patients.
Patients and Methods: We enrolled 1460 women >65 years old. Women with a known history of diabetes, hyperlipidemia or hypertension or those taking medication for these conditions were all excluded. The women were further divided into quartiles arbitrarily according to platelet count (PC) (PC1–PC4, lowest to highest accordingly).
Results: Among the MetS components, body mass index (BMI), total cholesterol, low-density lipoprotein cholesterol (LDL-C) and log transformation triglyceride (Log TG) were all significantly higher in the PC4 group ($p < 0.05$), and they were also positively correlated with PC. However, in multiple regression, BMI became nonsignificant. Both LDL-C and Log TG were the only two factors that remained positively and independently correlated with PC. Compared to PC1, all the other three groups had significantly higher odds ratios for having MetS (2.013, 1.473–2.751; 1.486, 1.081–2.042; 1.537, 1.117–2.114; odds ratios and 95% confidence intervals for PC4, PC3 and PC2, respectively).
Conclusion: Elderly women with MetS had higher PC. Among the five components, TG was positively correlated with PC. There was a positive correlation between PC and LDL-C but not high-density lipoprotein cholesterol. The importance of both lipids might be re-evaluated in the future in older women.

1. Introduction

As early as 1966, the concept of metabolic syndrome (MetS) was first proposed by Avogaro et al[1]. However, the formal definition was not proposed until recently. In 2001, National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP-III) issued the definition of MetS. In short, it is mainly composed of hyperglycemia, central obesity, hypertension and dyslipidemia[2]. Although there have been many other modified definitions proposed since then, by far, the ATP-III version is the one that is most commonly used and discussed[3]. It should be emphasized that the purpose of defining MetS was to enable early detection of individuals at high risk for cardiovascular diseases (CVDs).

Currently, there is evidence to suggest that CVD is fundamentally a disease of inflammation and this perception has been supported by the positive links between inflammatory markers and CVD[4]. MetS is a key predictor of CVD, therefore, higher levels of inflammatory markers can be seen in patients with MetS[2,5]. For example, white blood cell count, considered as one of the inflammatory makers, was the first to be recognized as a risk factor for myocardial infarction[6], and also correlated with MetS[2,5,7–9]. More importantly, Jesri et al also have reported that platelet count (PC), similar to white blood cell count, is higher in MetS patients[10]. Although this phenomenon has already been studied in adults[10,11],

☆ The authors have no conflicts of interest to declare.
* Correspondence to: Dr Dee Pei, 362, Chung Cheng Road, Hsintien, Taipei County 23137, Taiwan.
E-mail address: anthonychen0719@msn.com (D. Pei).

1873-9598/$ – see front matter
doi:10.1016/j.ijge.2012.01.015

this relationship has not been examined in geriatric patients. In Taiwan, the proportion of aged people is growing, as in other countries. Early detection of MetS among these patients has become an important societal issue. In this study, we examined the correlations between PC and MetS in women aged >65 years.

2. Methods

2.1. Study subjects

In this cross-sectional study, we enrolled women >65 years old from individuals receiving an annual health examination at the M J Life Clinic in Taiwan. The M J Life Clinic is a large institute that carries out health examinations in North, Central and South Taiwan and China. This study was approved by the Institutional Review Board of the M J Life Clinic. All participants gave their informed consent.

Patients with major medical diseases, known diabetics, or those taking medication for hyperlipidemia, hypertension or diabetes were all excluded. We wanted to evaluate the relationships between PC and MetS more concisely, therefore, we only included individuals with normal platelet levels. In this way, the relationships between them could be defined more clearly. After the preliminary screening, there were 1503 women enrolled. We further excluded one individual with an abnormal PC of 835 ($10^3/\mu L$) and 42 individuals with other missing data. Finally, 1460 women were analyzed. In order to evaluate the components of MetS in different PC level, the women were further divided into quartiles, PC1−PC4, according to PC from lowest to highest level.

The NCEP ATP III definition of MetS was used in this study[3]. However, according to the study by Lee et al[12], we used the criteria of body mass index (BMI) ≧ 26.4 instead of waist circumference ≧ 80 cm in Chinese women.

Participants visited the clinic at 08:00 hours after at least 10 hours fasting. Senior nursing staff obtained information about medical history, lifestyle, alcohol intake, smoking and physical exercise. A complete physical examination was done and BMI was calculated as weight/height^2 (kg/m^2). For measuring blood pressure (BP), the participants were required to rest for at least 5 minutes. BP was measured by nursing staff using standard mercury sphygmomanometers on the right arm, with the patient in the seated position. Blood samples were drawn from the antecubital vein for biochemistry studies.

2.2. Laboratory measurement

The plasma was separated from the blood within 1 hour of being drawn, and stored at −30°C until analysis. The samples were analyzed for plasma glucose and lipid levels. Plasma glucose was measured with a glucose oxidase method (YSI 203 glucose analyzer; Yellow Spring Instrument Company, Yellow Spring, OH, USA). Triglyceride (TG) and total cholesterol (TC) were measured with the dry, multilayer analytical slide method in the Fuji Dri-Chem 3000 analyzer (Fuji Photo Film; Minato-Ku, Tokyo, Japan). Serum concentration of high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) was measured using an enzymatic cholesterol assay following dextran sulfate precipitation. PC was measured with an Abbott Cell Dyn 3000 hematology analyzer (Abbott Laboratories, Abbott Park, IL, USA).

2.3. Statistical analysis

The data were analyzed with SPSS version 13.0 (SPSS, Chicago, IL, USA). All data were tested for normal distribution with the Kolmogorov−Smirnov test and for homogeneity of variances with Levene's test. Continuous variables were expressed as mean ± standard deviation. The *t* test was used to evaluate the differences between the two groups. When comparing the differences between the three groups, one-way analysis of variance was used. For *post hoc* comparison, the Bonferroni test was applied. To observe the correlation between different parameters, simple correlation and multivariate linear regression were used. Finally, the odds ratio (OR) was calculated to compare the possibility of having MetS in different groups. Among all the parameters, TG was not normally distributed; log transformation (Log TG) was performed before further analysis. All statistical tests were two-sided and considered statistically significant at $p < 0.05$.

3. Results

Among the 1460 women, 500 had MetS. The anthropometric variables, BP, blood biochemistry and PC are shown in Table 1. There was no significant difference between age in women with and without MetS. However, other parameters such as BMI, systolic BP, diastolic BP, fasting plasma glucose (FPG), TC, HDL-C, LDL-C, Log TG, hemoglobin, white blood cell count and PC were all significantly higher in the MetS group ($p < 0.01$).

The MetS components in the four groups of PC1−PC4 are shown in Table 2. BMI, TC, LDL-C and Log TG were all significantly higher in the PC4 group ($p < 0.05$). When simple correlation was used to examine their relationship, they were also positively correlated with PC as expected (Table 3). However, when all these components were analyzed by multiple regression, BMI became nonsignificant (Table 4). LDL-C and Log TG were the only two factors that remained positively and independently correlated with PC. Compared to PC1, all the other three groups had significantly higher ORs for MetS (2.013, 1.473−2.751; 1.486, 1.081−2.042; 1.537, 1.117−2.114; ORs and 95% confidence intervals for PC4, PC3 and PC2, respectively; Fig. 1). Finally, to demonstrate further their relationship graphically, Fig. 2 shows that higher PCs were seen when women had more MetS components. The PCs were 202.6 ± 59.3 × $10^3/\mu L$, 224.8 ± 60.7 × $10^3/\mu L$, 221.8 ± 61.3× $10^3/\mu L$, 229.0 ± 55.8 × $10^3/\mu L$ and 240.8 ± 54.6 × $10^3/\mu L$ for 0, 1, 2, 3 and >4 MetS components, respectively. This trend reached statistical significance ($r = 0.922$, $p = 0.026$). In contrast, Fig. 3 shows the opposite relationship, that is, the numbers of MetS components in different PC groups (1.82 ± 1.07, 2.08 ± 1.16, 2.04 ± 1.08 and

Table 1
Anthropometric and metabolic variables of subjects with or without MetS.

	MetS(−)	MetS(+)	*p*
N	960	500	
Age (y)	69.6 ± 4.3	69.8 ± 4.4	0.335
BMI (kg/m^2)	17.8 ± 2.8	19.3 ± 2.7	0.000
Systolic BP (mmHg)	138 ± 22.0	150 ± 20.9	0.000
Diastolic BP (mmHg)	76 ± 12.0	80 ± 11.7	0.000
FPG (mg/dL)	103.6 ± 29.3	113.1 ± 35.1	0.000
TC (mg/dL)	217.4 ± 39.7	223.6 ± 40.9	0.005
HDL-C (mg/dL)	56.9 ± 14.2	42.3 ± 11.3	0.000
LDL-C (mg/dL)	138.4 ± 35.2	143.9 ± 35.6	0.006
TG (mg/dL)	110.0 ± 46.6	187.5 ± 70.6	0.000
Log TG	2.0 ± 0.16	2.2 ± 0.16	0.000
Hemoglobin (g/dL)	13.0 ± 1.1	13.2 ± 1.2	0.000
WBC count ($\times 10^3/\mu L$)	6.1 ± 1.9	6.7 ± 1.8	0.000
PC ($\times 10^3/\mu L$)	220.8 ± 61.1	232.9 ± 55.6	0.000

Data are shown as mean ± standard deviation. BMI = body mass index; BP = blood pressure; FPG = fasting plasma glucose; HDL-C = high-density lipoprotein cholesterol; LDL-C, Low-density lipoprotein cholesterol; Log TG, log transformation of triglyceride; MetS = metabolic syndrome; PC = platelet count; TC = total cholesterol; WBC = white blood cell.

Table 2
Components of MetS in patients with different PC.

	PC1	PC2	PC3	PC4	*p*
N	365	359	367	369	
PC ($\times 10^3$ /μL)	155.2 ± 28.5[2,3,4]	203.6 ± 9.4[1,3,4]	238.2 ± 11.4[1,2,4]	301.4 ± 41.8[1,2,3]	0.000
Age (y)	69.9 ± 4.4	70.0 ± 4.5	69.4 ± 4.3	69.4 ± 4.1	0.088
BMI (kg/m^2)	17.9 ± 2.9[1,2,3]	8.4 ± 2.8	18.5 ± 2.7[1,2,3]	8.4 ± 2.8	0.024
SBP (mmHg)	140 ± 23.0	143 ± 22.7[3]	143 ± 21.8	141 ± 21.6	0.077
DBP (mmHg)	76 ± 12.0[1,2,3]	77 ± 12.0[1,2,3]	78 ± 11.7[1,2,3]	77 ± 12.1[2,3]	0.079
FPG (mg/dl)	106.1 ± 35.6[1,2,3]	108.1 ± 34.3[2,3]	107.4 ± 29.9[1,3]	105.9 ± 26.5[1,2,3]	0.747
TC (mg/dl)	206.9 ± 37.9[2,3,4]	215.8 ± 38.2[1,3,4]	224.3 ± 39.1[1,2,3]	230.8 ± 41.8[1,2,3]	0.000
HDL-C (mg/dl)	53.0 ± 15.4[1,2,3]	50.3 ± 14.4[1,2,3]	52.3 ± 14.6[1,2,3]	51.9 ± 15.3[1,2,3]	0.097
LDL-C (mg/dl)	130.7 ± 33.6[2,3,4]	138.8 ± 34.4[1,2,4]	143.7 ± 36.0[1,4]	147.9 ± 35.5[1,2,3]	0.000
TG (mg/dl)	116.7 ± 57.9[2,3,4]	133.8 ± 64.0[1,2,4]	141.1 ± 65.5[1,4]	154.2 ± 74.1[1,2,3]	0.000
Log TG	2.02 ± .189[2,3,4]	2.08 ± .189[1,2,4]	2.11 ± .187[1,2]	2.14 ± .207[1,2,3]	0.000

Data are shown as mean ± standard deviation. BMI = body mass index; DBP = diastolic blood pressure; FPG = fasting plasma glucose; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; Log TG = log transformation of triglyceride; MetS = metabolic syndrome; PC = platelet count; SBP = systolic blood pressure; TC = total cholesterol; TG = triglyceride.

2.23 ± 1.13 for PC1, PC2, PC3 and PC4, respectively). However, the trend was not significant ($r = 0.907$, $p = 0.093$).

4. Discussion

The purpose of our study was to investigate the relationships between PC and components of MetS in geriatric Taiwanese women. Patients with major medical diseases, known diabetics, or those taking medication for hyperlipidemia, hypertension or diabetics were all excluded. Therefore, our results should be interpreted with caution. However, our design ensured that the relationships that we evaluated between PC and MetS should become more concisely because we removed all these confounding factors. It is worth noting that our study is believed to be the first in this field. In general, the findings in this study were similar to others done in different cohorts[10,11]. However, there were still some novel and interesting results that are worthy of note.

The relationship between PC and adiposity has been reported previously[13–15]. The fact that both PC and adiposity are positively correlated with inflammatory markers indicates that inflammatory markers might be the crucial mediators between them. For example, Yudkin et al have indicated that interleukin (IL)-6 levels were correlated with adiposity in a group of Caucasians[16]. IL-6 is also known to be the main inflammatory marker that is correlated with PC[17,18]. Our results showed that women with higher PC (group PC4) had higher BMI, which is similar to other studies[13–15]. This relationship was confirmed by their significant positive Pearson correlation (Table 3). However, there are two major differences that should be pointed out in our study. First, the BMI was much lower than in the other three studies, partly because the other study cohorts were Caucasian and Jews. Second, after adjustment for the other significant parameters (LDL-C and TG) in the multiple regression, the significance between BMI and PC disappeared. This result indicated that the relationship between BMI and PC was actually mediated through TG and/or LDL-C. This paradoxical finding could be easily explained by the well-documented correlations between adiposity and higher TG and LDL-C[19]. Thus, we propose that the elevation of these two lipids might elevate PC in elderly individuals, rather than BMI itself. Our finding is not unique because several other studies have shown that individuals with either hypertriglyceridemia or high LDL-C have higher platelet activity[20–23]. Again, although a more sophisticated method was used in those studies (platelet activity), their cohorts were small.

Lower HDL-C level, but not high LDL-C level, is considered to be a component of MetS. In our study, the negative relation between PC and HDL-C was observed as expected, but it was not statistically significant. On the contrary, both TC and LDL-C were all higher in the PC4 group, and they were significantly positively correlated with PC. This positive correlation continued even in the multiple regression after BMI and TG were taken into consideration. Before trying to find the underlying link between LDL-C and PC, it should be noted that LDL-C level is correlated with both vascular inflammation[24,25] and platelet activity[22,23]. The increased platelet reactivity may be due to inhibition of the Na^+/H^+ antiport through receptor-independent mechanisms[26]. Also, a low-grade inflammatory process is associated with PC[17,18]. Thus, similar to adiposity, inflammation is one possible key connection between PC and LDL-C. Oda et al also have found that LDL-C is associated with MetS in Japanese individuals, which supports our findings indirectly[27]. The role of LDL-C in MetS should be re-evaluated in different populations in the future.

Our study suggests that TG is the last component of MetS found to be correlated with PC. If MetS is considered to be a state of low-grade inflammation, then it would be reasonable to find this correlation between TG and PC[28,29]. Concerning the common association of low grade inflammation, the first substantial evidence came from studies of Clarke et al and Kaser et al[17,18]. They have shown that IL-6 is associated with PC by stimulating thrombopoiesis with thrombopoietin[17,18]. Other inflammatory markers,

Table 3
Simple correlation between PC and each MetS component.

	r	*p*
BMI	0.061	0.020
Systolic BP	0.021	0.421
Diastolic BP	0.030	0.258
FPG	−0.012	0.657
TC	0.230	0.000
HDL-C	−0.003	0.921
LDL-C	0.190	0.000
Log TG	0.185	0.000

BMI = body mass index; BP = blood pressure; FPG = fasting plasma glucose; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; Log TG = log transformation of triglyceride; MetS = metabolic syndrome; PC = platelet count; TC = total cholesterol.

Table 4
Multiple regression of PC and MetS components.

	r	*p*
BMI	−0.005	0.862
LDL-C	0.173	0.000
Log TG	0.189	0.000

BMI = body mass index; LDL-C = low-density lipoprotein cholesterol; Log TG = log transformation of triglyceride; MetS = metabolic syndrome; PC = platelet count.

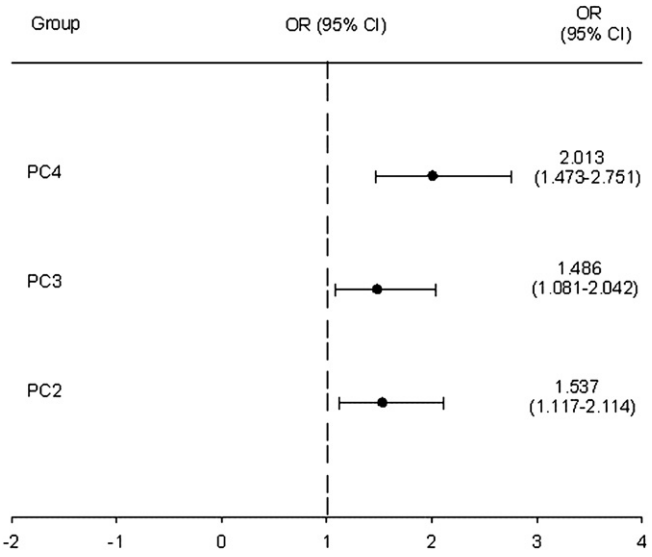

Fig. 1. OR for subjects in different PC groups of having metabolic syndrome. All the three groups (PC2−PC4) had significant odds ratio than PC1. OR = odds ratio; PC = platelet count.

especially tumor necrosis factor α, have also been found to be associated with TG both *in vivo* and *in vitro*[30,31]. These studies strongly support our findings. Still, it should be noted that our study is believed to be the first to show this relationship in elderly women.

We also discovered that there was no positive correlation between PC and FPG or BP, as expected. Theoretically, a positive correlation should be found between FPG and BP because it is well known that they are related to inflammation[32,33]. With regard to PC and hypertension, there have been few studies that have specifically focused on the relationship between PC and BP. Indirect information can be drawn from the study of Spencer et al, which showed that PC was not increased in patients with hypertension[34]. Other studies in this field have only examined the relationship between BP and platelet activity, which is not the same as PC[35]. Our study is believed to be the first to examine this relationship in a large cohort of elderly patients. With regard to the relationship between FPG and PC, the information is also insufficient. Although PC has been shown to be related to insulin resistance, this relationship does not suggest directly that FPG should be higher with

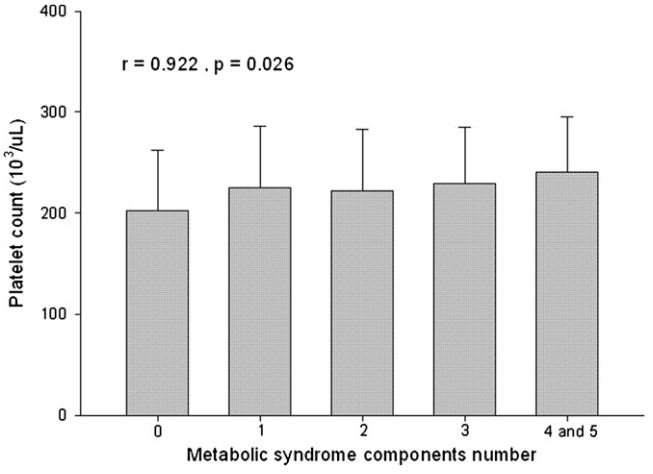

Fig. 2. Metabolic syndrome components and platelet counts.

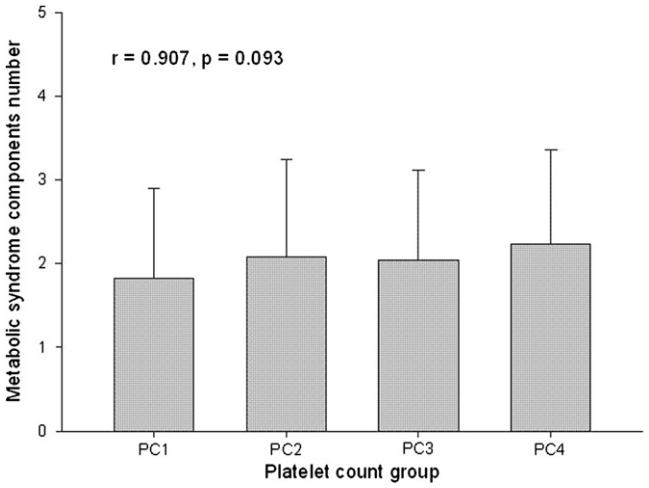

Fig. 3. PC groups and metabolic syndrome components. PC1−PC4: groups of subjects with different PCs from the lowest quartile to highest. PC = platelet count.

PC[36]. The reason is that the level of FPG is determined by insulin resistance and secretion. Therefore, when only insulin resistance is taken into consideration, one would expect to miss the significant correlation between PC and FPG. This finding is similar to the results obtained by Soogarun et al, who have found that there is no relationship between PC and FPG[37]. From the above evidence, we suggest that whether BP or FPG is related to PC warrants further investigation in different age or ethnic groups.

There were two limitations in our study. First, this was only a cross-sectional study, which provides less information than a longitudinal observation. Second, if we could have measured plasma insulin level, we could have carried out homeostasis model assessment. This is considered to be the core of MetS and could have allowed us to learn more about the interaction between insulin resistance and PC.

In conclusion, geriatric women with MetS had higher PC than subjects without MetS. Among the five components, BMI and TG were positively correlated with PC. There was a positive correlation between PC and LDL-C but not HDL-C. The importance of both lipids should be re-evaluated in the future in older women.

Acknowledgments

The authors sincerely thank M J Life Clinic in Taiwan for providing the anonymous data for the present study.

References

1. Avogaro P, Crepaldi G. Associazione di iperlipemia, diabete mellito e obesita di medio grado. *Acta Diabetologica Lata*. 1967;4:572−590.
2. Nagasawa N, Tamakoshi K, Yatsuya H, et al. Association of white blood cell count and clustered components of metabolic syndrome in Japanese men. *Circ J*. 2004;68:892−897.
3. Stone NJ, Bilek S, Rosenbaum S. Recent National Cholesterol Education Program Adult Treatment Panel III update: adjustments and options. *Am J Cardiol*. 2005;96:53E−59E.
4. Fearon WF, Fearon DT. Inflammation and cardiovascular disease: role of the interleukin-1 receptor antagonist. *Circulation*. 2008;117:2577−2579.
5. Kim JA, Choi YS, Hong JI, et al. Association of metabolic syndrome with white blood cell subtype and red blood cells. *Endocr J*. 2006;53:133−139.
6. Friedman GD, Klatsky AL, Siegelaub AB. The leukocyte count as a predictor of myocardial infarction. *N Engl J Med*. 1974;290:1275−1278.
7. Ford ES. The metabolic syndrome and C-reactive protein, fibrinogen, and leukocyte count: findings from the Third National Health and Nutrition Examination Survey. *Atherosclerosis*. 2003;168:351−358.
8. Ohshita K, Yamane K, Hanafusa M, et al. Elevated white blood cell count in subjects with impaired glucose tolerance. *Diabetes Care*. 2004;27:491−496.

9. Tong PC, Lee KF, So WY, et al. White blood cell count is associated with macro- and microvascular complications in Chinese patients with type 2 diabetes. *Diabetes Care*. 2004;27:216–222.
10. Jesri A, Okonofua EC, Egan BM. Platelet and white blood cell counts are elevated in patients with the metabolic syndrome. *J Clin Hypertens (Greenwich)*. 2005;7:705–711.
11. Kotani K, Sakane N, Saiga K, et al. Clustered components of the metabolic syndrome and platelet counts in Japanese females. *Clin Chem Lab Med*. 2007;45:376–379.
12. Lee J, Heng D, Ma S, et al. The metabolic syndrome and mortality: the Singapore Cardiovascular Cohort Study. *Clin Endocrinol*. 2008;69:225–230.
13. Charles LE, Fekedulegn D, McCall T, et al. Obesity, white blood cell counts, and platelet counts among police officers. *Obesity (Silver Spring)*. 2007;15:2846–2854.
14. Foschini D, Santos RV, Prado WL, et al. Platelet and leptin in obese adolescents. *J Pediatr (Rio J)*. 2008;84:516–521.
15. Samocha-Bonet D, Justo D, Rogowski O, et al. Platelet counts and platelet activation markers in obese subjects. *Mediators Inflamm*. 2008;8:834153.
16. Yudkin JS, Stehouwer CD, Emeis JJ, et al. C-reactive protein in healthy subjects: associations with obesity, insulin resistance, and endothelial dysfunction: a potential role for cytokines originating from adipose tissue? *Arterioscler Thromb Vasc Biol*. 1999;19:972–978.
17. Clarke D, Johnson PW, Banks RE, et al. Effects of interleukin 6 administration on platelets and haemopoietic progenitor cells in peripheral blood. *Cytokine*. 1996;8:717–723.
18. Kaser A, Brandacher G, Steurer W, et al. Interleukin-6 stimulates thrombopoiesis through thrombopoietin: role in inflammatory thrombocytosis. *Blood*. 2001;98:2720–2725.
19. Lamarche B, Desroches S. Metabolic syndrome and effects of conjugated linoleic acid in obesity and lipoprotein disorders: the Quebec experience. *Am J Clin Nutr*. 2004;79(Suppl. 6):1149S–1152S.
20. Doggen CJ, Smith NL, Lemaitre RN, et al. Serum lipid levels and the risk of venous thrombosis. *Arterioscler Thromb Vasc Biol*. 2004;24:1970–1975.
21. de Man FH, Nieuwland R, van der Laarse A, et al. Activated platelets in patients with severe hypertriglyceridemia: effects of triglyceride-lowering therapy. *Atherosclerosis*. 2000;152:407–414.
22. Korporaal SJA, Akkerman JWN. Platelet activation by low density lipoprotein and high density lipoprotein. *Pathophysiol Haemost Thromb*. 2006;35:270–280.
23. Akkerman JW. From low-density lipoprotein to platelet activation. *Int J Biochem Cell Biol*. 2008;40:2374–2378.
24. Pentikäinen MO, Oörni K, Ala-Korpela M, et al. Modified LDL – trigger of atherosclerosis and inflammation in the arterial intima. *J Intern Med*. 2000;247:359–370.
25. Zamaklar M, Lalic K, Lalic N. Vascular inflammation: effect of proatherogenic dyslipidemic trio or quartet. *Med Pregl*. 2009;62(Suppl. 3):37–42.
26. Nofer JR, Tepel M, Kehrel B, et al. Low-density lipoproteins inhibit the Na+/H+ antiport in human platelets. A novel mechanism enhancing platelet activity in hypercholesterolemia. *Circulation*. 1997;95:1370–1377.
27. Oda E, Kawai R, Sukumaran V, et al. LDL cholesterol is more strongly associated with metabolic syndrome in Japanese women than in men. *Intern Med*. 2009;48:1607–1614.
28. Piché ME, Lemieux S, Weisnagel SJ, et al. Relation of high-sensitivity C-reactive protein, interleukin-6, tumor necrosis factor-alpha, and fibrinogen to abdominal adipose tissue, blood pressure, and cholesterol and triglyceride levels in healthy postmenopausal women. *Am J Cardiol*. 2005;96:92–97.
29. Wang L, Gill R, Pedersen TL, et al. Triglyceride-rich lipoprotein lipolysis releases neutral and oxidized FFAs that induce endothelial cell inflammation. *J Lipid Res*. 2009;50:204–213.
30. Grunfeld C, Dinarello CA, Feingold KR. Tumor necrosis factor-alpha, interleukin-1, and interferon alpha stimulate triglyceride synthesis in HepG2 cells. *Metabolism*. 1991;40:894–898.
31. Jovinge S, Hamsten A, Tornvall P, et al. Evidence for a role of tumor necrosis factor alpha in disturbances of triglyceride and glucose metabolism predisposing to coronary heart disease. *Metabolism*. 1998;47:113–118.
32. Haffner SM. Insulin resistance, inflammation, and the prediabetic state. *Am J Cardiol*. 2003;92:18J–26J.
33. Grundy SM. Inflammation, hypertension, and the metabolic syndrome. *JAMA*. 2003;290:3000–3002.
34. Spencer CG, Gurney D, Blann AD, et al. Von Willebrand factor, soluble P-selectin, and target organ damage in hypertension: a substudy of the Anglo-Scandinavian Cardiac Outcomes Trial (ASCOT). *Hypertension*. 2002; 40:61–66.
35. El Haouari M, Rosado JA. Platelet function in hypertension. *Blood Cells Mol Dis*. 2009;42:38–43.
36. Taniguchi A, Fukushima M, Seino Y, et al. Platelet count is independently associated with insulin resistance in non-obese Japanese type 2 diabetic patients. *Metabolism*. 2003;52:1246–1249.
37. Soogarun S, Wiwanitkit V, Suwansaksri J. Platelet count neither decreases nor relates to blood glucose level. *Clin Appl Thromb Hemost*. 2004;10:187–188.