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The relationships between hematogram and metabolic syndrome in elderly subgroups: A Taiwan cohort study

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ABSTRACT

Background: Abnormal hematogram components could predict future metabolic syndrome (MetS) and diabetes. However, there was no study focusing on the subgroups of the elderly. In this ten-year longitudinal study, we investigated the association between hematogram components, future MetS and diabetes in the elderly.
Methods: Subjects above 65 years were divided into three groups by age (young old: ≧65 and <75, old–old: ≧75 and <85 and oldest–old ≧85).By using multiple logistic regression, the hazard ratio (HR) of higher hemoglobin (Hb), white blood cell count (WBCC) and platelet (PLT) to have future MetS and diabetes were evaluated.
Results: There were 15169 subjects in the young-old group, 3536 in the old–old group and 202 in the oldest–old group, respectively. After 10 years follow-up, only higher WBCC and Hb levels (>5.0×10^3, 15 g/dL, respectively) was correlated to future MetS in young–old men (adjusted HR: 1.242, 1.166, respectively). In addition, higher Hb (>13.7 g/dL) was originally associated with future MetS in young–old and old–old women but failed in adjusted HR. Moreover, the PLT did not correlate with any of the endpoints. Finally, higher chances of diabetes could be noted with higher WBCC in both men and women (adjusted HR: 1.404, 1.206, respectively).
Conclusions: The associations between hematogram and future MetS were different in each subgroup of the elderly. Higher WBCC and Hb levels could predict future MetS in young–old men. Moreover, Higher WBCC is positively correlated with future diabetes in both young–old men and women.

1. Introduction

The clustering of hypertension, hyperglycemia and adiposity was found to be related to cardiovascular disease (CVD) and diabetes as early as 1923 (Kylin, 1923). Later, in 1988, Reaven (1988) had coined this phenomenon as syndrome X and suggested that insulin resistance is the core of this syndrome. Due to the increasing incidence of these two diseases in recent decades, World Health Organization formally proposed the term of 'metabolic syndrome' (MetS) in 1998 (Alberti & Zimmet, 1998). The purpose of the MetS was to early detect CVD and diabetes. After this first version, more than 40 definitions were published by different organizations (Pacifico et al., 2011; Zimmet et al., 2007). Among them, the most widely used edition is the one suggested by National Cholesterol Education Program in 2001 (Expert Panel on Detection, 2001). The five criteria were systolic blood pressure (SBP) ≧130 mmHg or diastolic blood pressure (DBP) ≧85 mmHg, triglycerides (TG) ≧150 mg/dL, fasting plasma glucose (FPG)

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≧100 mg/dL, high-density lipoprotein cholesterol (HDL-C) ≦40 and 50 mg/dL in men and women or taking related medications and waist circumference (WC) ≧90 and 80 cm for Chinese men and women (Weng et al., 2012). Subjects had to have at least three criteria to be diagnosed as MetS.

Other than the five 'traditional' MetS components, there are some other risk factors which were also found to be related to CVD and diabetes. For instance, higher white blood cell count (WBCC) has been found in subjects with MetS and can be used to predict the incidence and mortality rates of CVD (Mueller, Neumann, Perruchoud, & Buettner, 2003; Ford, 2003). Furthermore, levels of hemoglobin (Hb) and platelets (PLT) are also positively correlated to more MetS components and higher PLT counts is even associated with increased long-term coronary death (Hamalainen, Saltevo, Kautiainen, Mantyselka, & Vanhala, 2012; Jesri, Okonofua, & Egan, 2005; Thaulow, Erikssen, Sandvik, Stormorken, & Cohn, 1991). Our group has published a 4-year longitudinal study which showed that models using hematogram components including WBCC, Hb and PLT could successfully predict future MetS in the elderly (Fu et al., 2014).

Ever since 1993, Taiwan has become an aged society (Lin, Chen, & Cheng, 2014). At present, 14% of the population is over 65 years old. Because of this, geriatric medicine and long-term care consequently become major issues for the government and health providers. It is therefore important to early detect subjects who are under high risks for CVD and diabetes in this age group. Due to different risk factors and outcomes, previous studies had further classified the elderly into three groups, *i.e.* young-old (≧65 and <75), old–old (≧75 and <85) and oldest-old (≧85) (Hiramatsu et al., 2012; Yoshimura, Yamada, Kajiwara, Nishiguchi, & Aoyama, 2013; Nagata et al., 2012). However, there has been no published study focusing on the roles of hematogram in these three groups.

Since hematogram which includes WBCC, Hb, PLT is a routine, simple and low-cost test done in daily practice, it is an appropriate tool for predicting MetS, CVD and diabetes. In this longitudinal study, we enrolled 18907 subjects and they were followed up for 10 years. Our purpose was to evaluate the relationships between hematogram components and further MetS and type 2 diabetes (T2DM) among young–old, old–old and oldest–old subjects.

1.1. Subjects

1.1.1. Study population

MJ Health Screening Centers are a privately owned chain of clinics located throughout Taiwan, and provide regular health examinations to their members. The participants in this study were entirely enrolled from this clinic. All study participants were included in this study anonymously, and informed consents were obtained. The study protocol was approved by the institutional review board of MJ Health Screening Center, and the Data were used for research purposes only.

We randomly selected 36,169 subjects who were over 65 years old during the sampling time- from 1999 May to 2008 April. We excluded 3347 subjects visited only once during this periods. Subjects with past history of hypertension, diabetes, cardiovascular event and were taking medications known to affect MetS components were all excluded (n = 11,562) in order to enrolled the newly diagnosed subjects. In addition, we excluded the subjects with missing data of MetS components, hematogram and other related data (n = 2353). Finally, 18,907 subjects were eligible for further analysis. Subjects without baseline MetS were followed for median 4.7 years. Since it is well documented that the changes of MetS are not the same in different age groups, even in the old people, we further grouped the participants into young–old (≥65 and <75), old–old (≥75 and <85), and oldest-old (≥85) (Expert Panel on Detection, 2001).

There are two parts of this study. The first one is a cross-sectional-designed observation. The relationships between hematogram and MetS components were studied. The cutoff values of hematogram to predict the future development of MetS were identified by using the receiver operation curve (ROC), which will be further detailed in the statistic method section. In the second longitudinal part of the study, 7750 subjects were excluded because of having MetS at baseline. Therefore, only 11,157 subjects were remained in this part of this study. The purpose of this part was to confirm the predictability of the cutoff values derived from the first part. In other words, we hope that this study could validate our hypothesis whether the higher hematogram accompany with the more development of MetS, hypertension and T2D in the future.

1.2. Definition of metabolic syndrome

We used the latest harmonized criteria of MetS in 2009 with some modification which is the lower WC for Chinese (≧90 for men and 80 cm for women) (Weng et al., 2012; Alberti et al., 2009). The details of the criteria are stated in the introduction.

2. Methods

2.1. Clinical methods

A standard protocol of the checkup was followed in the MJ clinic. The senior nursing staffs in the clinic used a questionnaire to obtain the subject's medical history, including any current medications. Then, complete physical examinations were performed. WC was measured horizontally at the level of the natural waist, which was identified as the level at the hollow molding of the trunk when the trunk was laterally concave. Body mass index (BMI) was calculated as the subject's body weight (kg) divided by the square of the subject's height (m). Both SBP and DBP were measured by the nursing staff using a standard mercury sphygmomanometer fitted on the right arm of each subject when seated.

2.2. Laboratory methods

Laboratory measurements after the subject fasted for 10 h, blood samples were drawn from the antecubital vein for biochemical analysis. Plasma was separated from blood within 1 h and stored at −30 °C and analyzed for FPG and lipid profiles. The FPG was detected using a glucose oxidase method (YSI 203 glucose analyzer, Scientific Division, Yellow Springs Instruments, Yellow Springs, OH). Total cholesterol and TG were measured using the dry, multilayer analytical slide method in the Fuji Dri-Chem 3000 analyzer (Fuji Photo Film, Minato-Ku, Tokyo, Japan). Serum HDL-C and low-density lipoprotein cholesterol (LDL-C) concentration were analyzed using an enzymatic cholesterol assay following dextran sulfate precipitation., WBCC, Hb and PLT were measured with an Abbott Cell Dyn 3000 hematology analyzer (Abbott Laboratories, Abbott Park, IL, USA).

2.3. Statistical analysis

The data in this study are presented as mean ± standard deviation ($x \pm$ SD). All data were tested for normal distribution, median or interquartile range with Kolmogorov–Smirnov test and homogeneity of variances with Levene's test. The t-test (for normal distribution) and Mann–Whitney test (for asymmetric distribution) was used to evaluate the differences between the two groups.

As aforementioned, there are two parts of the study. The first one is a cross-sectional designed observation. The purpose of this