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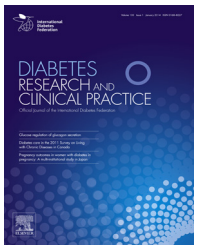

Differential patterns of effects of age and sex on metabolic syndrome in Taiwan: Implication for the inadequate internal consistency of the current criteria

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ABSTRACT

Aims: Current criteria of metabolic syndrome (MetS) give equal weight to each component and apply mostly the same cut-off values to all ages. The contribution of each component to MetS and the effects of age and sex on each component and MetS were explored.

Methods: We carried out a survey on residents aged 40–74 years of the northern coastal area of Taiwan. The prevalent rates of MetS in 646 males and 961 females were 32.4% and 27.8%, respectively. Logistic regression analyses were used to assess the main and interactive effects of age and sex. The Cronbach's α coefficient was calculated as the indicator of internal consistency of MetS components.

Results: There were significant age trends for MetS components, except for low HDL-C in both sexes and high fasting triglyceride in males. Logistic regression analyses showed that the effects of age and sex on MetS and its component were all different. The age-sex-specific Cronbach's α coefficients for MetS ranged from 0.43 to 0.61. The age trends of the coefficients in males and females were opposite. The exclusion of some components from the MetS resulted in an increase of the coefficients.

Conclusions: Our results indicate that the internal consistency of MetS was questionable. It seems that the currently defined MetS components of MetS did not formulate a single pathophysiological entity. Given equal weight to each component and used the same cut-off values for the subjects of all age groups in both sexes need to be reconsidered.

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Abbreviations: BP, blood pressure; CVD, cardiovascular diseases; DBP, diastolic blood pressure; FPG, fasting plasma glucose; FTG, fasting triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; MetS, metabolic syndrome; SBP, systolic blood pressure; TG, triglycerides.

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1. Introduction

Metabolic syndrome (MetS) is a combination of risk factors that increase the risk for cardiovascular diseases (CVD), stroke, and type 2 diabetes mellitus [1–6]. The most frequently used clinical criteria were recommended by the International Diabetes Federation (IDF), the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III), and the American Heart Association/National Heart, Lung, and Blood Institute recommendation (AHA/NHLBI) [7–9]. These criteria include central obesity, high blood pressure, high blood sugar, low high-density lipoprotein cholesterol (HDL-C), and high triglycerides. MetS and its components also contribute to CVD-related and all-cause mortality and post a global threat and burden to public health [8,10–15].

Plenty of human studies showed that the prevalence of MetS components differ in age, sex, and ethnicity [15–19]. Aging is a decline of physiological function over a long period of time after an organism has reached its maximal reproduction potential. The aging process shows a sexual dimorphism [20]. The most apparent difference in aging between men and women lies in the reproductive organs. Female experiences a rapid decline of sex hormones while the decline process in male is slow and prolonged. Changes of sex hormones level have also been connected to MetS [21,22] and CVD [23–25] in both males and females.

The different effects of age and sex on MetS and its components were demonstrated by a ''cross-over'', a phenomenon of interaction, of the prevalence between sexes [18,26–29]. Males have higher prevalence before certain ages and females experience higher MetS prevalence afterward.

The prevalence of MetS and its components differ in age, sex, and ethnicity, which have been known for decades. However, in the same MetS criteria, cut-off values of each component for all ages were almost the same [7–9]. Only slight modifications of the definitions and cut-off values for some components of MetS were made for the application in different regions or populations [7,9]. In the present study, we analyzed the patterns of effects of age and sex on MetS and its components in a community-based cohort in Northern Taiwan suburban areas. We also assessed the contribution of each component to MetS in different age-sex strata. We found that given equal weight to each MetS component and used the same cut-off values for the subjects of different age groups in both sexes seem questionable.

2. Materials and methods

2.1. Ethics statement and study population

The study subjects were from a community-based cohort enrolled by the Mitochondria-Aging in Northern Taiwan (MAGNET) study during September 2010 and May 2012 [30]. The protocol of this study was reviewed and approved by the Institution Review Board of Mackay Medicine College (No. P990001). The MAGNET study recruited residents, aged 40–74, from northern coastal areas in New Taipei City, Taiwan. A well-informed invitation letter describing the objective and protocols of the study was distributed to potential participants. Written consents had been obtained from all participants before they received extensive health examinations. A total of 646 males and 961 females enrolled in the study.

2.2. Measurements and definition of metabolic syndrome

Body height, weight, waist and hip circumference were measured in the standing position wearing indoor clothing and no shoes. Blood pressure (BP) was measured three times by well-trained nurses in the morning after 10 min rest of subjects on their upper right arms in the sitting position. The averages of the results of three measurements of systolic BP (SBP) and diastolic BP (DBP) were used for analysis. Venous blood samples were collected after at least 8 h of fasting for assays of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), fasting triglycerides (FTG), and fasting plasma glucose (FPG).

In this study, MetS was defined as the AHA/NHLBI recommendation [9] and the NCEP-ATP III and with the modification of waist circumference cutoff points for Asians [10]. The components include central obesity (waist circumference, >90 cm in male or >80 cm in female); high BP (SBP $\geqq$ 130 mmHg, DBP $\geqq$ 85 mmHg, or self-reported treatment with antihypertensive medications); high FPG (fasting plasma glucose $\geqq$ 100 mg/dl, or the use of insulin or other hypoglycemic agents); low HDL-C level (<40 mg/100 ml in males or <50 mg/100 ml in females); and high FTG level ($\geqq$150 mg/100 ml). Participants with at least 3 of these 5 components were defined as having MetS.

2.3. Statistical analysis

Age-sex-specific mean and standard deviation (SD) of each risk factor of MetS and CVDs were calculated. Student's *t*-tests were used to compare whether there was significant difference in the mean levels of risk factor of MetS and CVDs between male and female subjects. Mantel's trend test was also performed to assess whether there is a linear relationship between age and prevalence of each metabolic component factor. Logistic regression analyses coupled with Wald Chi-square test were used to assess the main and interactive effects of age and sex on each component and MetS. The Cronbach's α coefficients were calculated as an index of internal consistency of each component with MetS. All statistical analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA). $p < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline clinical characteristics of study subjects

A total of 1607 residents aged 40–74 years were recruited in this study, and 40.2% were men. The clinical characteristics of study subjects are summarized in Table 1. The mean (SD) age of enrolled subjects was 53.5 (9.5) for male and 52.6 (8.6) for female subjects ($p = 0.061$). No statistical difference between sexes was detected in LDL-C. HDL-C and total cholesterol in blood were significantly higher in females. All other variables were significantly higher in males.

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