Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation

The association of pulse pressure with metabolic syndrome in Korean elderly: A nationwide population-based study

Yu-Jin Kwon [a], Tae-Ha Chung [b], Jae-Yong Shim [a], Yong-Jae Lee [a,*]

[a] Department of Family Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea
[b] Severance Check-up, Severance Hospital, Yonsei University Health System, Seoul, Republic of Korea

ARTICLE INFO

Article history:
Received 2 July 2016
Received in revised form
3 November 2016
Accepted 30 November 2016
Available online 5 December 2016

Keywords:
Pulse pressure
Metabolic syndrome
Arterial stiffness
Insulin resistance
Inflammation

ABSTRACT

Aims: Metabolic syndrome (MetS) is one of the most important issues in elderly people because of its association with ensuing cardiovascular disease (CVD). The components of MetS play a key role in the pathogenesis of arterial thickness and stiffness. Pulse pressure (PP), an easily accessible parameter in a basic health evaluation, has been documented as a marker of arterial stiffness and widespread atherosclerosis. The aim of our study was to assess the association between PP and MetS in Korean elderly people.

Methods: A nationwide cross-sectional study was conducted to examine the relationship between PP and MetS among 6187 participants (2687 men and 3500 women) aged 60 years older Korean people using the Korean National Health and Nutrition Examination Survey. The odds ratios (ORs) and 95% confidence intervals (CIs) for MetS were calculated across PP quartiles using multiple logistic regression analyses.

Results: There was a positive relationship between PP and MetS in a dose-response manner. The prevalence of MetS significantly increased with increasing PP quartile in both men and women ($p < 0.001$). Compared with the lowest PP quartile group, the ORs (95% CIs) for MetS of the highest PP quartile was 2.60 (1.91–3.52) for men and 1.97 (1.48–2.59) for women after adjusting for age, cigarette smoking, alcohol intake, regular exercise and mean arterial blood pressure. These associations remained valid after additionally adjusting for hypertension and diabetes medications.

Conclusion: We found a positive relationship between PP and MetS among Korean elderly men and women.

1. Introduction

Pulse pressure (PP), the difference between systolic blood pressure (SBP) and diastolic blood pressure (DBP), is an easily measurable parameter in a basic health evaluation. Both SBP and DBP increase with age up to the sixth decade of life [1]. Thereafter, SBP continuously increases, whereas DBP remains constant or decreases, resulting in a rise in PP. In the elderly population, SBP rather than DBP is a stronger risk factor for cardiovascular disease (CVD) morbidity and mortality [2]. In

* Corresponding author at: Department of Family Medicine, Yonsei University College of Medicine Gangnam Severance Hospital, 211 Eonju-ro, Gangnam-gu, Seoul 06273, Republic of Korea. Fax: +82 3462 8209.
E-mail address: ukyjhome@yuhs.ac (Y.-J. Lee).

http://dx.doi.org/10.1016/j.diabres.2016.11.027
0168-8227/

addition, a higher PP in older individuals had been documented as a marker of arterial stiffness and widespread atherosclerosis with several adverse cardiac implications such as congestive heart failure and atrial fibrillation [3–5]. Thus, a higher PP is widely recognized as an independent risk factor for CVD in elderly populations [6]. Metabolic syndrome (MetS) is rapidly increasing in prevalence worldwide; it is characterized by a cluster of detrimental cardiometabolic conditions such as abdominal obesity, raised blood pressure, hyperglycemia, and dyslipidemia [7]. MetS has been established as a multiplex risk factor for CVD both in general community population and in the elderly population. A growing body of literature has documented that the prevalence of MetS is age-dependent and tends to rise with increasing age [8,9]. Emerging evidence suggests that MetS and its components accelerate arterial aging with increases in arterial stiffness and thickness [10]. The association between PP and MetS had been investigated in a few previous studies among Greece and Italian hypertensive patients [11,12]. However, the association between PP and MetS had not yet been critically evaluated in the general elderly population. Based on the available literature, we hypothesize that MetS has an influence on arterial stiffness and there is also a positive association between PP and MetS in elderly people. Thus, we examined whether PP was independently associated with MetS in a representative sample of elderly Koreans.

2. Methods

2.1. Study population

This study was based on data obtained in the 2010–2012 Korean National Health and Nutrition Examination Survey (KNHANES V), which was a complex, stratified, multi-stage probability-cluster survey of a representative sample of the noninstitutionalized civilian population. The survey was performed by the Korea Centers for Disease Control and Prevention (KCDC) and had four components: The Health Interview Survey, Health Behavior Survey, Health Examination Survey, and Nutrition Survey. The health interview and health examination surveys were performed in specially designed and equipped mobile centers that traveled to locations throughout the country. The health examinations comprised a medical history, physical examination, health behaviors, and anthropometric and biochemical measurements. A total of 31,596 participants were recruited and 25,533 of them completed the KNHANES V. This study included data from 6855 participants aged 60 years or more. Of these, we excluded 668 participants because they met at least one of the following criteria: missing data; a history of cancer, respiratory, renal, hepatobiliary, or rheumatologic disease; and lack of a 12-h fasting period. After these exclusions, 6187 participants (2687 men and 3500 women) were included in final analysis. The KNHANES received ethical approval by the Institutional Review Board of the KCDC (IRB No: 2010-02-CON-04-P, 2011-04EXP-01-C, 2012-01CON-03-2C), and written consent was obtained from all of the participants. In addition, the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

2.2. Data collection

For the 2010–2012 KNHANES, citizens were informed that they had been randomly selected as a household to voluntarily participate in a nationwide representative survey conducted by Korea Centers for Disease Control and Prevention, and that they had the right to refuse to participate in accordance with the National Health Enhancement Act supported by the National Statistics Law of Korea. Information on age, household income, and residence was collected through the health interview. Health-related behavior, such as physical activity, smoking, and drinking status, were obtained from a self-reported questionnaire completed during the interview period. Smoking status was categorized as "current smoker" or "not current smoker." In regard to alcohol drinking, a "current drinker" was defined as a person who drinks any alcohol, even only once a month. Participants performed the International Physical Activity Questionnaire (IPAQ) to estimate the frequency of physical activity. A subject who exercised with moderate to vigorous intensity at least three days per week was classified as a regular exerciser. Anthropometric measurements were conducted by trained medical staff following a standardized procedure. Height and weight were obtained with participants wearing light indoor clothing and no shoes to the nearest 0.1 cm (Seca 225, Seca, Germany) and 0.1 kg, respectively (GL-6000-20, G-tech, Korea). Waist circumference was measured at the midway between the costal margin and the iliac crest at the end stage of a normal expiration (Seca 200, Seca, Germany). Systolic and diastolic blood pressure were measured three times in a seated position after a 5-min rest time using a standard mercury sphygmomanometer (Baumanometer, W.A. Baum Co., Inc., Copiague, NY, USA), with the average of the second and third results used for analysis. PP was calculated as SBP minus DBP [13]. As the mean arterial blood pressure is constant component of blood pressure and widely used as estimate of vascular resistance [14], the mean arterial blood pressure was calculated by the formula: mean arterial blood pressure = 1/3(SBP) + 2/3(DBP). Type2 diabetes mellitus was diagnosed as having fasting plasma glucose $\geqslant$126 mg/dl or currently medication for diabetes. Hypertension was defined as SBP $\geqslant$140 or DBP $\geqslant$90 or taking antihypertensive medication. Coronary artery disease (CAD) was defined who was diagnosed as myocardial infarction and currently treated for myocardial infarction or who was diagnosed as angina or having treatment for angina.

After a 12-h overnight fast, blood samples were obtained from an antecubital vein. Samples were immediately sent to a central certified laboratory and plasma was separated by centrifugation. Fasting plasma glucose, total cholesterol, triglyceride, and HDL cholesterol levels were analyzed using a Hitachi 700-110 Chemistry Analyzer (Hitachi Co., Tokyo, Japan). Fasting serum insulin was measured by immunoradiometric assay (1470 WIZARD gamma-counter, PerkinElmer, Finland). The homeostasis model assessment estimate of insulin resistance (HOMA-IR) was calculated using the following formula: fasting plasma glucose (mg/dL) $\times$ fasting insulin (μIU/mL)/405. Leukocyte counts were quantified by Laserflow cytometry (XE-2100D, Sysmex, Japan).