Elevated Resting Heart Rate Is Associated with Carotid Atherosclerosis in Middle-Aged and Elderly Chinese Population

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Background: Elevated resting heart rate predicts poor cardiovascular and cerebrovascular outcomes. Atherosclerosis may be a mediator linking this relationship. In a Chinese population, we investigated whether resting heart rate was associated with carotid atherosclerosis as indicated by elevated carotid intima–media thickness (CIMT) and presence of carotid plaque. *Methods:* A total of 1557 participants older than 50 years old from a community-based population without known cardiovascular diseases were included. All participants provided detailed lifestyle and medical information, and blood samples for biochemical measurements. The participants were categorized according to resting heart rate quartiles (<67, 67-73, 74-81, >81 beats per minute [bpm]). CIMT and presence of carotid plaque were determined using B-mode ultrasonography. Elevated CIMT was defined as the upper quartile of CIMT. *Results:* We observed positively graded associations between resting heart rate quartiles and carotid atherosclerosis. Participants with resting heart rates higher than 81 bpm had an odds ratio of 2.82 (95% confidence interval 1.92-4.13) for elevated CIMT, and an odds ratio of 2.00 (1.36-2.92) for carotid plaque, compared to participants with resting heart rates lower than 67 bmp. Each 10-bpm increase in resting heart rate was associated with an odds ratio of 1.47 (1.29-1.68) for elevated CIMT and an odds ratio of 1.40 (1.23-1.60) for carotid plaque. The associations were independent of conventional cardiovascular risk factors. *Conclusions:* Elevated resting heart rate was strongly and independently associated with carotid atherosclerosis in the middle-aged and elderly Chinese population. Atherosclerosis may be a potential mediator between resting heart rate and adverse cardiovascular outcomes. **Key Words:** Resting heart rate—carotid atherosclerosis—carotid intima–media thickness—carotid plaque.

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Introduction

Accumulating studies have demonstrated that resting heart rate is a low-tech and useful predictor of coronary heart events and all-cause mortality,[1-3] both among apparently healthy subjects and among those with pre-existing diseases such as diabetes and vascular diseases.[4-6] Recent evidence has suggested that the relationship between resting heart rate and risk of cardiovascular diseases is independent of conventional and novel cardiovascular risk factors such as blood pressure,[4] inflammation markers,[7] and physical fitness,[8] Results in relation to resting heart rate and risk of stroke are generally inconsistent, and some studies suggest a positive association,[9] while others do not.[3]

Atherosclerosis plays a causative role in the development and progression of cardiovascular diseases. It is logical to speculate that atherosclerosis may be implicated in the relation between resting heart rate and cardiovascular risk. Only a few studies have investigated the association between resting heart rate and atherosclerosis.[10-13] In a Black and White young adult population, Chen et al.[10] showed that resting heart rate was independently associated with aorta–femoral pulse wave velocity, but not carotid intima–media thickness (CIMT), whereas in the Multi-Ethnic Study of Atherosclerosis (MESA), resting heart rate demonstrated a stronger association with carotid artery stiffness than with aorta artery stiffness.[13] Those uncertainties warrant a further scrutiny of this topic.

Elevated CIMT and presence of carotid plaque were established predictors and causes of cardiovascular diseases, as well as cerebrovascular events such as ischemic stroke.[14,15] So far, few data were available for the relationship between resting heart rate and carotid atherosclerosis, especially in non-Western populations such as China. We hypothesized that elevated resting heart rate was associated with increased CIMT and presence of carotid plaque in asymptotic populations without known cardiovascular diseases. We aimed to test this hypothesis in a general middle-aged and elderly Chinese population.

Methods

Study Participants

This was a cross-sectional study including 1557 participants from a community-based population aged 50 years or older (age range 51-87). Briefly, during May to August, 2013, we invited all the residents older than 50 years of a local community in Nanjing city, Jiangsu province of China, to attend a medical checkup at the medical service center of the community. The participants were asked to complete a self-administered questionnaire themselves or with assistance from a trained doctor and provided fasting venous blood samples, and underwent a detailed medical examination including carotid B-mode ultrasonography. A total of 1789 participants attended the medical checkup. For the current analysis, we excluded participants with pre-existing atherosclerotic cardiovascular diseases including coronary heart diseases and stroke, cardiac arrhythmia including sinus bradycardia and tachycardia, other cardiac diseases, and thyroid diseases (n = 178). We also excluded participants who reported current use of β-blockers, digoxin, or nondihydropyridine calcium channel blockers (n = 54) because those drugs may affect resting heart rate. Finally, 1557 participants were included in the current analysis.

The study was approved by the ethics committee of the Second Medical School of Nanjing University of Chinese Medicine and all participants signed informed consents accompanying the questionnaire.

Data Collection

All participants were asked to complete a detailed questionnaire themselves if they were educated adequately, or with the assistance of a trained doctor if the participants were illiterate. The questionnaire information included sociodemographic factors (occupation and education level), lifestyle factors (current smoking and drinking status, and physical activity at leisure time), and medical information (current use of medicines and prior history of cardiovascular diseases). Current smoker and drinker were defined as those who had smoked or drunk regularly over the past 3 months. Physical activity at leisure time was assessed using the short form of International Physical Activity Questionnaire and presented as metabolic equivalent hours per week. Cardiovascular diseases included coronary heart disease, myocardial infarction, and stroke over a life span.

Body weight and height were measured with the participants wearing lightweight clothes and no shoes. Body mass index was calculated as body weight in kilogram divided by squared height in meters. Systolic and diastolic blood pressures were taken 3 times with an autonomic device after a 5-minute rest and the second and third readings were averaged for analysis. Resting heart rate was recorded simultaneously with the measurement of blood pressure, and the second and third readings were also averaged.

Fasting venous blood was drawn. Plasma triglyceride, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, fasting glucose, and high-sensitivity C-reactive protein were measured using an automatic biochemical analyzer.

Ultrasound Measurements of CIMT and Carotid Plaque

Carotid ultrasound measurements were performed with B-mode ultrasound systems (GE Logic P5; GE Healthcare, Milwaukee, WI) with 10-MHZ probe. Examination was taken with the participants lying in supine position and with necks extending. CIMT was measured in the diastolic phase as the distance between lumen–intima and