

## Research

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# Evaluation of Cardio-Ankle Vascular Index and Influencing Factors in Natural Population of She Minority in China

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### ABSTRACT

**Objective:** The present study was designed to investigate the influencing factor of cardio-ankle vascular index (CAVI) in natural population of She minority in China.

**Methods:** Five hundred and twenty-four subjects were enrolled into our study (male 227 and female 297). Main analyzing indexes included vascular related markers namely of CAVI and carotid artery intima-media thickness (CIMT) and blood markers.

**Results:** Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were high in the entire population (150.08±23.32 mmHg, 91.15±12.42 mmHg). CAVI, left CIMT and right CIMT were normal. Univariate analysis showed CAVI was positively correlated with age, waist hip ratio (WHR), SBP, DBP, pulse pressure (PP), blood urea nitrogen (BUN), serum creatinine (Cr), fasting plasma glucose (FPG), triglyceride (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), high sensitive C reactive protein (hs-CRP), left CIMT and right CIMT ( $r=0.570, 0.240, 0.512, 0.372, 0.459, 0.231, 0.095, 0.182, 0.158, 0.164, 0.167, 0.169, 0.395, 0.407$ , all  $p<0.05$ ). Multivariate linear regression analysis (selected factors including age, heart rate (HR), body mass index (BMI), WHR, SBP, DBP, PP, blood uric acid (UA), BUN, Cr, FPG, TC, TG, high density lipoprotein cholesterol (HDL-C), LDL-C, hs-CRP, left CIMT and right CIMT) showed that age, SBP, FPG, hs-CRP, TG and Cr were the independent related factors of CAVI (adjusted  $R^2=0.399$ ).

**Conclusion:** Age, systolic blood pressure, fasting plasma glucose, high sensitive C-reactive protein, triglyceride and creatinine levels were independent factors of CAVI in natural populations of She minority in China.

**KEYWORDS:** She minority; Arterial stiffness; Cardio-ankle vascular index (CAVI).

**ABBREVIATIONS:** CAVI: Cardio-ankle vascular index; CIMT: Carotid artery intima-media thickness; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; PP: Pulse Pressure; HR: Heart Rate; WHR: Waist Hip Ratio; BMI: Body Mass Index; FPG: Fasting Plasma Glucose; TG: Triglyceride; TC: Total Cholesterol; LDL-C: Low Density Lipoprotein Cholesterol; HDL-C: High Density Lipoprotein Cholesterol; hs-CRP: high sensitive C-reactive protein; BUN: Blood Urea Nitrogen; Cr: Serum Creatinine; UA: Blood uric acid.

### INTRODUCTION

Arterial stiffness has been considered as a surrogating indicator of atherosclerosis progression and degree of vascular injury.<sup>1</sup> In addition, arterial stiffness is an independent risk factor and predictor of cardiovascular disease. There were many evaluation methods of arterial stiffness, cardio-ankle vascular index (CAVI) was a new marker reflecting the whole arterial stiffness from aortic to ankle and independently of immediate blood pressure during measurement.<sup>2</sup> Therefore, CAVI was used as a reliable evaluation of early vascular injury. It has been considered as a quantitative assessment of disease progression and therapeutic efficacy.<sup>3,4</sup> Recent

years, many studies about CAVI found that it was closely related to vascular injuries in patients with hypertension, diabetes mellitus and dyslipidemia, and was regarded as a useful tool for screening of vascular health in patients with metabolic syndrome.<sup>3,5-11</sup> Furthermore, the new vascular health classification also included CAVI as an evaluation index of vascular health.<sup>12</sup> However, few study assessed CAVI in a minority population of China. People of the minority lived in a natural mountain area without known vascular related diseases and with little interference from modern society. Therefore, the present study was to evaluate the vascular status using CAVI and assess its influencing factors.

## SUBJECTS

A total of 524 subjects from 6 natural minority villages using a cluster sampling method were enrolled into the present study, including male 227 and female 297 with 14-85 years old. Subjects with ankle brachial index equal or below 0.9, serious liver and kidney dysfunction, systematic inflammatory disease, infectious disease and cancer were excluded the study.

The ethics committee of Mindong Hospital in China approved the study. And all participants completed informed consent.

## METHODS

### The Detection of CAVI

According to the guideline of early vascular detection system (the second report),<sup>1</sup> CAVI was detected by the vascular measurement apparatus VS-1000 (Fukuda Denshi Co. Ltd, Japan) automatically. Subjects were asked to rest for 10 minutes with a supine position. Electrodes were placed on the wrists to collect the ECG waveform, and micro heart sound recorder was placed in the fourth intercostal space of left sternal to capture the heart sounds, and a blood pressure cuff was attached to the double arm and double ankle with appropriate tightness, and then the value of CAVI and blood pressure were measured automatically. In the study, we used the right CAVI to analyze.

### The Measurement of CIMT

According to the proposal of series studies on arterial stiffness in China, carotid artery detection for CIMT was conducted by color Doppler ultra sound apparatus (Mylab 70 CV) by a linear probe LA523 and with frequency of 5-13 MHz. It was installed with automatic analysis software of quality intima-media thickness (QIMT). Subjects were detected with a supine position. Bilateral carotid sinus 1.5 cm was the CIMT examination site and the QIMT automatic analysis system will get the value of CIMT during 6 cardiac cycles.

### Laboratory Examination

All subjects were drawn the fasting venous blood and using

EDTA anticoagulant, and TC, TG, LDL-C, HDL-C, FPG, UA, BUN, Cr and hs-CRP were measured by automatic analyzer.

## General Medical History Collection

People were asked to complete a questionnaire for the collection of age, gender, history of diseases (such as hypertension, diabetes mellitus, coronary artery disease, cerebral infarction and peripheral artery disease) and life habits.

## STATISTICAL ANALYSIS

SPSS V.20.0 was used as statistical software in the study. Continuous variables were showed as mean±standard deviation ( $\bar{x}\pm s$ ) and categorical variables were showed as percentage and frequency. Pearson correlation analysis was used to quantitatively describe the degree and direction of the relationship between variables. Multiple linear regression analysis was used to screen influencing factors of CAVI.  $P<0.05$  (bilateral) was considered of statistical significance.

## RESULTS

Eventually 524 subjects were enrolled into our study (male 227 and female 297, age  $47.95\pm 13.48$  year). From Table 1, we can see that SBP and DBP were high. CAVI and CIMT were both in the mean normal level. Pearson correlation analysis showed CAVI were positively correlated with age, WHR, SBP, DBP, PP, BUN, Cr, FPG, TG, TC, LDL-C, hs-CRP, left CIMT and right CIMT, with age showed the highest correlation. However, it didn't show negative or positive correlation between CAVI and HDL-C (Table 2). In the further linear regression analysis, we included age, HR, BMI, WHR, SBP, DBP, PP, UA, BUN, Cr, FPG, TG, HDL-C, LDL-C, hs-CRP, left CIMT and right CIMT as independent variables and CAVI as dependent variable. The final model indicated age, SBP, FPG, hs-CRP, TG and Cr were independent influencing factors of CAVI (Table 3).

## DISCUSSION

In the present study, we found the mean level of both SBP and DBP were high, but the mean CAVI and CIMT were in a normal level in the She minority population in China, which indicated some other factors may influence vascular function and structure. Therefore, further analysis showed age, SBP, FPG, hs-CRP, TG and Cr were independently positively correlated with CAVI in the special population.

CAVI has been put forward as a new evaluation index of vascular health for about ten years. It is independent of immediate blood pressure during measurement and has become a hot field of research.<sup>2</sup> Our previous studies indicated that the influencing factors of CAVI were different for different populations. We compared population between Chinese and Japanese and found that CAVI was both increased by age. However, CAVI level was significantly lower in Chinese than that of Japanese.

Variables (N=524)	Mean±standard deviation ( $\bar{x}\pm s$ )
Age (year)	47.95±13.48
Male/Female	227/297
BUN (mmol/L)	5.09±1.73
Cr ( $\mu\text{mol/L}$ )	65.02±18.54
UA ( $\mu\text{mol/L}$ )	284.48±83.34
FPG (mmol/L)	5.42±1.35
TC (mmol/L)	5.15±1.37
TG (mmol/L)	1.25±1.04
HDL-C (mmol/L)	1.59±0.49
LDL-C (mmol/L)	2.93±0.89
hsCRP (mg/L)	3.87±6.46
BMI ( $\text{kg/m}^2$ )	24.1±3.33
HR (beats/minutes)	71.4±13.23
WHR	0.90±0.05
CAVI	7.32±1.30
SBP (mmHg)	150.08±23.32
DBP (mmHg)	91.15±12.42
PP (mmHg)	58.93±15.99
Left CIMT ( $\mu\text{m}$ )	557.55±134.15
Right CIMT ( $\mu\text{m}$ )	541.01±132.86

Table 1: General clinical characteristics of all subjects.

Variables (N=524)	r	p
Age (year)	0.570	<0.05
BMI ( $\text{kg/m}^2$ )	-0.060	0.183
WHR	0.240	<0.05
HR (beats/minutes)	0.034	0.447
SBP (mmHg)	0.512	<0.05
DBP (mmHg)	0.372	<0.05
PP (mmHg)	0.459	<0.05
BUN (mmol/L)	0.231	<0.05
Cr ( $\mu\text{mol/L}$ )	0.095	<0.05
UA ( $\mu\text{mol/L}$ )	0.086	0.079
FPG (mmol/L)	0.182	<0.05
TG (mmol/L)	0.158	<0.05
TC (mmol/L)	0.164	<0.05
LDL-C (mmol/L)	0.167	<0.05
HDL-C (mmol/L)	0.025	0.610
hs-CRP (mg/L)	0.169	<0.05
Left CIMT ( $\mu\text{m}$ )	0.395	<0.05
Right CIMT ( $\mu\text{m}$ )	0.407	<0.05

Table 2: Pearson correlation between CAVI and other variables.

Final entered variables (Adjusted R <sup>2</sup> =0.399)	Adjusted $\beta$	p
Age (year)	0.346	<0.05
SBP (mmHg)	0.202	<0.05
FPG (mmol/L)	0.179	<0.05
hs-CRP (mg/L)	0.157	<0.05
TG (mmol/L)	0.146	<0.05
Cr ( $\mu\text{mol/L}$ )	0.138	<0.05

Table 3: Multiple linear regression analysis between CAVI and other variables (adjusted R<sup>2</sup>=0.399).

Age, SBP, FPG, Cr were independent influencing factors of CAVI in Chinese; age, SBP, HDL-C, Cr, BMI, FPG were independent influencing factors of Japanese population.<sup>11</sup> CAVI were both correlated with age, SBP, BMI in healthy women of Chinese and Japanese.<sup>13</sup> In addition, CAVI were independently related to age, BMI, HbA1c, HDL-C in patients with hypertension and diabetes mellitus and community residents.<sup>5,10,14,15</sup> In addition, CAVI level was different between the northern and southern area which was higher in the south region in China.<sup>16</sup> Other studies also indicated CAVI were independently related to Cr and homocysteine.<sup>9,17,18</sup> Study on another minority in China namely Miao minority showed that age, SBP, uric acid, BMI were independent influencing factors of CAVI.<sup>19</sup> Therefore, the above studies informed us that the influencing factors of CAVI were different in different populations. Thus, the present study added some more information on CAVI in a She minority population in China. The results will provide special intervention for different populations and it was also the embodiment of precision medicine.

#### MERITS AND LIMITATIONS

The subjects enrolled into the study were from natural mountain areas of China. In these areas, people lived with farming works and far away from the cities. People there were influenced little by the modern society and lived with less mental stress. They also ate natural homemade foods. In addition, the participants were almost farmers, thus they knew little about their health or disease condition, therefore few of them were taking drugs which would have little influence on CAVI. Therefore, the results can reflect the natural relationship between CAVI and other markers. In addition, few studies in the China have assessed the influencing factors of She minority. The present study provided a reference for the related factors of CAVI in She minority and some clues for the following-up studies.

However, the above merits may also be the limitations of the study. We could not evaluate the difference between different diseases status in CAVI because of the limited medical knowledge of the local people. Finally, the study was observational and can only provide limited information about CAVI. We have conducted follow-up study for this population and further research results will add more information on CAVI and its influencing factors.

#### CONCLUSION

The mean level of blood pressure was high but the mean CAVI and CIMT were at the normal level in the natural population of She minority in China. Furthermore, age, systolic blood pressure, fasting plasma glucose, high sensitive C-reactive protein, triglyceride and creatinine levels were independent factors of CAVI in the minority in China. Therefore, in the She minority population, we should focus more on the above influencing factors on CAVI and carry out some early intervention strategies for prevention.

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Beijing Vascular Disease Patients Evaluation Study (BEST) has been registered in Clinical Trial (<https://clinicaltrials.gov>), and ClinicalTrials.gov Identifier is NCT02569268.

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#### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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