Influence of arterial stiffness on cardiovascular outcome in patients without high blood pressure

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☆All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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Abbreviations

PWV: pulse wave velocity

CV: cardiovascular

CKD: chronic kidney disease

LVH: left ventricular hypertrophy

NT-proBNP: N-terminal of the pro-hormone brain natriuretic peptide

CAC: coronary artery calcification

BP: blood pressure

LVEF: left ventricular ejection fraction

eGFR: estimated glomerular filtration rate

baPWV: brachial–ankle pulse wave velocity

HR: heart rate

PP: pulse pressure

LV: left ventricular

LVMI: left ventricular mass index

e′: early diastolic velocity

E/e′ ratio: ratio of mitral velocity to early diastolic velocity of the medial mitral annulus

Hs-cTnT: high-sensitivity cardiac troponin T

ACE-I: angiotensin-converting enzyme inhibitor

ARB: angiotensin receptor blocker

CI: confidence interval

Abstract

Objective: Although blood pressure (BP) is a major determinant of arterial stiffness, whether high pulse wave velocity (PWV) adversely influences cardiac parameters and cardiovascular (CV) outcome in patients without high BP remains unclear.

Methods: Outpatients without high BP (n=320), defined as systolic BP ≥140 mmHg, were enrolled in this retrospective study. At baseline, all patients underwent echocardiography and multidetector computed tomography to determine the coronary artery calcification (CAC) score. Arterial stiffness was assessed based on brachial–ankle PWV (baPWV), from which patients were classified into two groups: those with high (≥18 m/s, n=89) and low baPWV (<18 m/s, n=231). Cardiac parameters and CV event incidence during the follow-up period were compared between these groups.

Results: In multivariable linear regression analysis, baPWV was significantly associated with CAC score and serum N-terminal pro-brain natriuretic peptide hormone level, after adjustment for confounding factors. In multivariable logistic regression analysis, baPWV ≥18 m/s was significantly associated with CAC score ≥400 (odds ratio: 2.466, 95% confidence interval: 1.012–6.009, p=0.0471). Kaplan–Meier analysis showed that the high-baPWV group experienced more CV events during the 575 days of follow-up (20% vs. 6%, p=0.0003).

Conclusions: High baPWV was associated with greater CAC and a high risk of a future CV event, especially coronary artery disease, even in patients without high BP.

Keywords: pulse wave velocity; blood pressure; coronary artery calcification

Key questions

What is already known about this subject?

Arterial stiffness has been proposed as an important predictor of cardiovascular (CV) events in various groups. Although blood pressure (BP) is a major determinant of arterial stiffness, no study has evaluated the prognostic significance of arterial stiffness in patients without high BP.

What does this study add?

In this study, we enrolled 320 outpatients with systolic BP less than 140 mmHg. We performed comprehensive assessment of cardiac parameters including echocardiography and coronary artery calcification (CAC), and evaluated the association of arterial stiffness assessed by brachial–ankle pulse wave velocity (baPWV) with these cardiac parameters in these patients. We also evaluated the association of baPWV with the subsequent development of CV events. The results showed that baPWV ≥18 m/s was significantly associated with CAC score ≥400 and the incidence of future CV events, especially coronary artery disease. Arterial stiffening is a strong determinant of impairment of cardiac parameters as well as future CV events, even in patients without high BP.

How might this impact on clinical practice?

Measurement of PWV is useful in identifying patients at high risk of CV events, even among those without high BP. In patients with high PWV, an intense cardiac evaluation should be scheduled. Furthermore, aggressive treatment with antihypertensive

medication for lowering BP may be effective to reduce or prevent arterial stiffening. Additionally, nonpharmacological treatments such as exercise training and dietary changes may be beneficial for reducing arterial stiffness as well as improving CV outcome in patients with high PWV.

1. Introduction

The measurement of arterial pulse wave velocity (PWV) provides a noninvasive tool to assess arterial stiffness, which increases with aging and is a marker of arterial damage.[1] Previous studies reported the significant association between PWV and cardiovascular (CV) events in the general population,[2] in patients with hypertension,[3] and in patients with chronic kidney disease (CKD).[4] An increase in arterial stiffness is associated with left ventricular hypertrophy (LVH) and increased levels of N-terminal pro-brain natriuretic peptide hormone (NT-proBNP).[5, 6] In addition, a recent report demonstrated the significant association between PWV and coronary artery calcification (CAC) score among healthy middle-aged men.[7]

Blood pressure (BP), which is firmly established as a major risk factor for CV mortality, is one of the most important determinants of arterial stiffness.[8] These two markers are strongly correlated in most cases; however, we occasionally found cases with a discrepancy between BP and PWV, such as patients with “high PWV without high BP” irrespective of antihypertensive medication. Unfortunately, the clinical implication of elevated PWV in patients without high BP remains unknown.

The aim of this study is thus to clarify whether the measurement of PWV is useful for risk stratification in patients without high BP, which was defined as systolic BP ≥140 mmHg. We investigated the association between PWV and cardiac functional and atherosclerotic parameters, including CAC, and the association of elevated PWV with the subsequent development of CV events in these patients.

2. Methods

2.1. Study population

This single-center retrospective study was based on 320 outpatients consecutively enrolled from May 2010 to June 2015. They had no history of CV disease but had at least one coronary risk factor and had been referred to our hospital for the examination of coronary artery disease. We enrolled patients with office systolic BP less than 140 mmHg irrespective of whether they were taking antihypertensive medication. Patients <40 years of age, with diastolic BP ≥90 mmHg, atrial fibrillation, peripheral artery disease defined as ankle–brachial pressure index <0.9, a history of cardiovascular disease, left ventricular ejection fraction (LVEF) <50%, or estimated glomerular filtration rate (eGFR) <15 ml/min/1.73 m^2 were excluded. Hypertension (or a history of it) was defined as systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg, and/or the use of antihypertensive medication. Diabetes mellitus was defined as a fasting blood glucose concentration of ≥126 mg/dl, and/or the use of insulin or oral hypoglycemic medication. Dyslipidemia was defined as LDL cholesterol ≥140 mg/dL, triglyceride ≥150 mg/dL, HDL cholesterol <40 mg/dL, and/or taking antidyslipidemic medication. The study protocol was approved by the Institutional Review Board of the hospital, and all patients enrolled in the study provided written informed consent. This study was conducted in line with the Declaration of Helsinki.

2.2. Measurement of blood pressure and PWV

We measured brachial–ankle PWV (baPWV) using an automatic waveform analyzer (BP-203RPE; Omron Colin, Tokyo, Japan) in all study patients. The measurement was performed after they had rested in a supine position for at least 5 min. The baPWV is automatically calculated as the ratio of transmission distance to the transmission time.[9] The same system was used to collect data on systolic BP and diastolic BP in the

right brachial artery as well as heart rate (HR). Pulse pressure (PP) was defined as the difference between systolic BP and diastolic BP. Based on the results of the J-TOPP trial,[10] baPWV of 18 m/s was previously shown to be an optimal cut-off value for the prediction of CV events. Patients were divided into high- and low-baPWV groups (≥18 m/s and <18 m/s, respectively).

2.3. Assessment of coronary calcification and echocardiographic parameters

We assessed the calcification of the epicardial coronary arteries using 64-slice multidetector computed tomography (Aquilion 64; Toshiba, Tokyo, Japan). Images were acquired in 3.0-mm slices throughout the coronary artery regions using prospective, electrocardiogram-triggered scan acquisition at 75% of the RR interval. CAC score was calculated using an automated computerized system (Ziostation System 1000; Ziosoft, Tokyo, Japan) and the Agatston method.[11]

All patients underwent the echocardiographic examinations. A commercially available system was used to obtain standard images with the patient in the left lateral decubitus position. We measured left ventricular (LV) mass and expressed it as the ratio to body surface area (LV mass index: LVMI). LVH was defined according to the previously established criterion: LVMI >115 g/m^2 for men and LVMI >95 g/m^2 for women.[12] LVEF was measured using the disc summation method. Mitral inflow was measured in the apical four-chamber view. From the mitral inflow velocity profile, the E- and A-wave velocities, deceleration time of the E-wave, and E/A ratio were determined. Tissue Doppler imaging of the mitral annulus was performed from the apical four-chamber view. A sample volume was placed sequentially at the septal mitral annulus and early diastolic velocity (e′) was then measured. The ratio of mitral velocity

to early diastolic velocity of the medial mitral annulus (E/e′), a marker of LV diastolic filling pressure, was calculated.

2.4. Laboratory measures and data collection

In addition to standard laboratory parameters, the plasma levels of the cardiac markers NT-proBNP and high-sensitivity cardiac troponin T (hs-cTnT) were measured in all patients. A commercially available Elecsys proBNP sandwich immunoassay on an Elecsys 2010 (Roche Diagnosis, Mannheim, Germany) was used to determine NT-proBNP levels, and a high-sensitivity hs-cTnT assay (Elecsys troponin T high-sensitive assay; Roche Diagnostics, Mannheim, Germany) to measure hs-cTnT levels. CKD was defined as eGFR <60 ml/min/1.73 m^2. The urinary albumin-to-creatinine ratio (UACR) was determined from a spot urine sample using a turbidimetric immunoassay (SRL, Tokyo, Japan).

2.5. Outcome data

After the measurement of baseline parameters, we performed a follow-up study to assess the incidence of CV events, including cardiac death and coronary artery disease; the latter was defined as myocardial infarction or coronary revascularization, admission due to heart failure, and stroke. This follow-up study was performed by medical record review, and was completed in 100% of the eligible patients.

2.6. Statistical analysis

Continuous variables are expressed as the mean ± standard deviation or the median with the interquartile range. Dichotomous variables are expressed as a number and

percentage. Differences in the continuous variables between the two groups were analyzed by Student's t-test and the Mann–Whitney U-test as appropriate. Categorical data were compared by χ^2 analysis and Fisher's test as appropriate. In a subsequent analysis, the NT-proBNP and hs-cTnT data were log-transformed because they did not exhibit a normal distribution. Similarly, because the distribution of the Agatston score data was also highly skewed, the CAC score was logarithmically transformed and a value of 1 was added to all calcium scores to manage values of 0 (log CAC+1). Univariable and multivariable linear regression analyses were performed to examine the association of baPWV and cardiac parameters, with adjustments for variables related to increased PWV, including age, gender, hypertension, diabetes mellitus, dyslipidemia, CKD, systolic BP, HR, and use of a Ca channel blocker, angiotensin-converting enzyme inhibitor (ACE-I), angiotensin receptor blocker (ARB), or statin. Univariable and multivariable logistic regression analyses were also performed to evaluate the association of baPWV with NT-proBNP ≥125 pg/ml and CAC score ≥400.[13, 14] In multivariable logistic regression analysis, the associations were adjusted for the variables described above. Cumulative survival estimates were calculated using the Kaplan–Meier method and the data from the two baPWV groups were compared using the log-rank test. Statistical analyses were performed using SPSS statistical software (Version 24; IBM Corp., Armonk, NY, USA).

3. Results

3.1. Comparison of baseline characteristics

This study population consisted of 320 outpatients, 132 (41%) of whom were male. The age ranged from 40 to 84 years old (mean age: 67). Eighty-nine (28%) patients had

baPWV of ≥18 m/s and were defined as the high-baPWV group. The baseline patient characteristics of the high- and low-baPWV groups are described in Table 1. The high-baPWV group was older and had higher prevalence rates of a history of hypertension, diabetes mellitus, dyslipidemia, and CKD. There was no difference in smoking status between the two groups. Antihypertensive drugs and statin were more frequently used in the high-baPWV group. There were also higher levels of HR, systolic BP, PP, and prevalence of systolic BP ≥120 mmHg in the high-baPWV group. The eGFR was lower in the high-baPWV group, whereas UACR was comparable between the two groups. Regarding cardiac parameters, NT-proBNP, hs-cTnT, and CAC score were higher in the high-baPWV group. LVMI and the prevalence of LVH were also higher in the high-baPWV group. Moreover, the high-baPWV group had lower e′ velocity and higher E/e′ ratio (Table 2).

3.2. Association of higher baPWV value with cardiac parameters

In univariable linear regression analysis, baPWV correlated with Ln NT-proBNP, Ln (CAC+1), Ln hs-cTnT, E/e′, e′, and LVMI. However, in multivariable analysis, only Ln NT-proBNP and Ln (CAC+1) were still associated with baPWV (Table 3). The associations of baPWV with CAC score and NT-proBNP level were also examined in logistic regression analysis. In univariable logistic regression analysis, baPWV was associated with a serum NT-proBNP level of ≥125 pg/ml and CAC score ≥400. In multivariable logistic regression analysis, baPWV ≥18 m/s was significantly associated with CAC score ≥400 with an odds ratio of 2.466 (95% CI: 1.012–6.009, p=0.0471) (Table 4).

3.3. Prognostic implication of baPWV level

During the 575 days of follow-up, CV events occurred in 15 patients in the low-baPWV group (12 cases of coronary artery disease, 2 of heart failure, 1 of stroke, with no cardiac deaths) and in 18 patients in the high-baPWV group (15 cases of coronary artery disease, 3 of heart failure, with no cardiac deaths). Kaplan–Meier analysis showed that the high-baPWV group experienced more CV events during the follow-up period (20% vs. 6%, $p<0.0001$, Figure).

4. Discussion

In this study, we comprehensively evaluated the association of baPWV with cardiac parameters to clarify the clinical implication and prognostic impact of baPWV in patients with systolic BP less than 140 mmHg and with no history of CV disease. An increase in baPWV was associated with increased CAC score. Furthermore, the patients with baPWV ≥18 m/s were associated with a higher incidence of future CV events, especially coronary artery disease, than those with baPWV <18 m/s. Our results suggested that evaluating arterial stiffness by baPWV aids in identifying patients at high risk of CV disease, even among those without high BP.

Previous studies reported the association between PWV and the incidence of CV events.[3] In this study, we enrolled patients limited to those with systolic BP less than 140 mmHg to clarify more precisely the effect of baPWV on future CV outcome. Patients in the high-baPWV group had higher CV mortality, especially owing to coronary artery disease. Several factors may be associated with the incidence of coronary artery disease in patients with high baPWV. The higher CAC related to arterial stiffening is associated with a greater plaque burden in the coronary artery tree, and may

be involved in the higher risk of coronary events. Additionally, arterial stiffening may contribute to coronary plaque development and plaque rupture,[15] and the induction of myocardial ischemia.

We showed the significant association of high PWV with higher CAC. To date, only limited information on this association has been reported. For example, Vishnu et al. examined 1131 healthy middle-aged men (40–49 years) without cardiovascular disease and found that those with high baPWV had a higher CAC score [7]. There are several possible mechanisms linking high baPWV to high CAC. Increases in arterial stiffness as well as CAC score occur in the development of atherosclerosis, and several risk factors, including hypertension, diabetes mellitus, and aging, are commonly involved in these two pathologies. Actually, in this study, systolic BP was higher in the high-baPWV group, which is supposed to be responsible for the association of arterial stiffening and CAC, both of which develop as a result of high BP. In addition, the mechanical stress on the arterial wall imposed by arterial stiffening may lead to microvascular remodeling and arterial calcification.[16, 17]

The subjects in this study were limited to patients with systolic BP less than 140 mmHg, and 30% of them had high baPWV. There are several factors potentially involved in arterial stiffening in the absence of high BP, such as cardiovascular risk factors including age, diabetes mellitus, dyslipidemia, and CKD other than hypertension. Furthermore, vascular inflammation caused by these risk factors promotes alterations in arterial function and structure through the promotion of endothelial dysfunction and abnormal collagen deposition in the arterial wall,[18, 19] which have been implicated in arterial stiffening. Recently, frailty as well as sarcopenia has emerged as a factor related to arterial stiffening.[20] In addition, the high-baPWV group had higher systolic BP and

HR than the low-baPWV group, which at least to some extent may be involved in the arterial stiffening in these patients.

In this study, we found that the patients with high baPWV had a higher prevalence of LVH as well as a higher level of NT-proBNP than those with low baPWV. Previous studies reported an association between arterial stiffness and BNP levels,[6] LVH,[5] and LV diastolic dysfunction.[21, 22] In our study, we also found a weak but significant association between baPWV and e′ as well as E/e′, which are parameters of LV diastolic dysfunction. Our results indicated that the rapid reflection of pulse waves might augment LV afterload to impair LV diastolic function irrespective of BP.

Although carotid–femoral PWV has been considered to be the gold standard marker for central arterial stiffness,[23] baPWV is currently used routinely, especially in East Asia, because it is simpler and does not require complicated equipment or a high level of expertise.[9] Moreover, a significant association between baPWV and carotid–femoral PWV has been reported,[24] and the comparable utility of these measurements in predicting cardiovascular mortality has been demonstrated.[25]

Study limitations

Several limitations should be considered when interpreting our results. First, this was a single-center study and the number of patients was relatively small. It is thus unclear whether the findings of this study can be extrapolated to other populations, and further large multicenter studies are needed to validate these results. Second, patients taking antihypertensive medication as well as statin were included in this study, which may have influenced BP, arterial stiffness, and CAC. Nonetheless, the associations between baPWV and both CAC score and CV outcome did not change when the use of

antihypertensive medication was included in the multivariable analysis. In addition, only a small proportion of the patients were being administered more than two antihypertensive medications. Thus, these medications should not have significantly influenced our results. Third, in this study, BP was measured in an outpatient clinic, so patients with masked hypertension may have been included among our subjects. Masked hypertension is a common condition,[26] although it is difficult to identify in an outpatient setting. The measurement of BP at home and the use of 24-h ambulatory BP monitoring may aid in identifying those with masked hypertension.[27, 28] Fourth, longitudinal information about changing medication, compliance, and risk factor control during the follow-up period was not available. It was the general physician's decision to start or change antihypertensive medication. However, regarding the antihypertensive agent used, it is unlikely that any changes to a markedly different type or dose occurred because no patients had high BP at inclusion. Fifth, the rates of CV events in both groups were low in this study, probably because only patients without high BP and a history of CV disease were enrolled. The prognostic significance of these data should be confirmed in larger studies with a longer follow-up period.

Clinical implications

The clinical characteristics of our patients with high PWV included a higher CAC score and a higher incidence of future CV events. Therefore, the measurement of baPWV is useful in identifying patients at high risk of CV events, and in patients with high baPWV, and intense cardiac evaluation should be performed even if they do not have systolic BP ≥140 mmHg. Although we examined patients with systolic BP <140 mmHg, there was a significant difference in the prevalence of patients with systolic BP ≥120 mmHg

between the high- and low-baPWV groups. Aggressive treatment with antihypertensive medication targeting systolic BP <120 mmHg might be effective to reduce or prevent arterial stiffening.[29] In addition, nonpharmacological treatments such as exercise training, dietary changes including weight loss, sodium restriction, and consuming fish oil are effective for relieving arterial stiffening.[30] Further studies are required to evaluate whether these efforts to reduce PWV will attenuate the progression of adverse cardiac parameters, such as CAC score, and improve the CV outcome of patients with high PWV but without high BP.

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Competing interests

The authors declare no conflicts of interest directly relevant to the content of this article.

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Figure legend

Figure. Kaplan–Meier curve showing freedom from a cardiovascular event according to baPWV group

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Table 1: Patient characteristics according to baPWV

	Low baPWV	High baPWV	p-value
n	231	89	
Age, years	64 ± 10	75 ± 6	<0.0001
Male gender, N (%)	96 (41)	37 (42)	0.965
Hypertension, N (%)	99 (43)	67 (75)	<0.0001
Diabetes, N (%)	25 (11)	19 (21)	0.014
Dyslipidemia, N (%)	69 (30)	40 (45)	0.0107
CKD, N (%)	42 (18)	38 (43)	<0.0001
Smoking, N (%)	62 (27)	26 (29)	0.677
Beta blocker, N (%)	27 (12)	12 (13)	0.6601
Ca channel blocker, N (%)	59 (26)	45 (51)	<0.0001
ACE-I or ARB, N (%)	50 (22)	32 (36)	0.0006
Diuretics, N (%)	10 (4)	9 (10)	0.064
Statin, N (%)	42 (18)	27 (30)	0.0188
Number of anti-hypertensive medications	0.6 ± 0.9	1.1 ± 1.0	<0.0001
More than two anti-hypertensive medications, N (%)	48 (21)	29 (33)	0.027
Body mass index, kg/m^2	23 ± 3	23 ± 3	0.9894
HR, bpm	65 ± 11	71 ± 15	<0.0001
Systolic BP, mmHg	123 ± 10	129 ± 8	<0.0001
Systolic BP ≥120mmHg, N (%)	157 (68)	80 (90)	<0.0001

Diastolic BP, mmHg	73 ± 9	74 ± 7	0.2516
Pulse pressure, mmHg	50 ± 8	54 ± 8	<0.0001
baPWV, m/sec	14.7 ± 1.7	21.0 ± 3.1	<0.0001
Creatinine, mg/dl	0.74 ± 0.19	0.82 ± 0.20	0.0030
eGFR, ml/min/1.73m^2	72 ± 16	62 ± 14	<0.0001
UACR, mg/g	24 ± 64	23 ± 24	0.8617
Total cholesterol, mg/dl	206 ± 50	191 ± 33	0.0100
LDL cholesterol, mg/dl	124 ± 31	113 ± 30	0.0085
HDL cholesterol, mg/dl	65 ± 18	61 ± 18	0.1311
Non-HDL cholesterol, mg/dl	142 ± 55	130 ± 31	0.0530
Triglyceride, mg/dl	136 ± 130	141 ± 99	0.7492
HBA1c, %	5.74 ± 0.65	5.86 ± 0.64	0.1265

All data are presented as mean ± standard deviation (SD) or median with interquartile range (IQR), or as number (percentage) for dichotomous variables. CKD, chronic kidney disease; ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; HR, heart rate; BP, blood pressure; baPWV, brachial–ankle pulse wave velocity; eGFR, estimated glomerular filtration rate; UACR, urine albumin–creatinine ratio.

Table 2: Cardiac parameters according to baPWV

	Low baPWV	High baPWV	p-value
NT-pro BNP, pg/ml	51 (27, 112)	109 (59, 172)	<0.0001
hs-cTnT, ng/ml	0.006 (0.004, 0.006)	0.008 (0.006, 0.012)	0.0428
CAC score	0 (0, 78)	101 (9,526)	<0.0001
LVEDVI, ml/m^2	57 ± 14	53 ± 15	0.0180
LVESVI, ml/m^2	18 ± 7	16 ± 6	0.0128
LVMI, g/m^2	95 ± 27	102 ± 28	0.0364
LVH, N (%)	71 (32)	38 (45)	0.0326
e′, cm/sec	7.8 ± 2.6	6.4 ± 1.6	<0.0001
E/e′	9.0 ± 2.8	10.3 ± 3.5	0.001

LVEDVI, left ventricular end-diastolic volume index; LVESVI, left ventricular end-systolic volume index; LVMI, left ventricular mass index; LVH, left ventricular hypertrophy; e′, early diastolic velocity of the medial mitral annulus.

Table 3: Association of baPWV with cardiac parameters.

	Univariable		Multivariable*		
Dependent variables	r	p-value	beta	95% CI	p-value
Ln NT-proBNP	0.304	<0.0001	0.05	0.002, 0.098	0.0399
Ln (hs-cTnT)	0.3	<0.0001	0.007	-0.023, 0.038	0.8322
Ln (CACs+1)	0.454	<0.0001	0.139	0.044, 0.234	0.0042
E/ e′	0.25	<0.0001	0.008	-0.116, 0.132	0.8983
e′	-0.329	<0.0001	-0.037	-0.130, 0.056	0.4308
LVMI	0.199	0.0004	0.275	-0.789, 1.339	0.6114

*Adjustment for age, gender, hypertension, diabetes mellitus, dyslipidemia, CKD, systolic BP, HR, use of Ca channel blocker, ACE-I/ARB, or statin.

Table 4: Odds ratios for CAC score ≥400 and NT-probNP ≥125 pg/ml

Dependent variable: CAC score ≥400

	Univariable			Multivariable*		
	odds ratio	95% CI	p-value	odds ratio	95% CI	p-value
baPWV (continuous)	1.195	1.104, 1.295	<0.0001	1.101	0.976, 1.241	0.1163
baPWV <18 m/sec	reference			reference		
baPWV ≥18 m/sec	3.968	2.076, 7.586	<0.0001	2.466	1.012, 6.009	0.0471

Dependent variable: NT-proBNP ≥125 pg/ml

	Univariable			Multivariable*		
	odds ratio	95% CI	p-value	odds ratio	95% CI	p-value
baPWV (continuous)	1.156	1.078, 1.239	<0.0001	1.074	0.970, 1.189	0.1694
baPWV <18 m/sec	reference			reference		
baPWV ≥18 m/sec	2.559	1.498, 4.371	0.0006	1.26	0.628, 2.526	0.5155

*Adjustment for age, gender, hypertension, diabetes mellitus, dyslipidemia, CKD, systolic BP, HR, use of Ca channel blocker, ACE-I/ARB, or statin.