



# Impact of different blood pressure measurement on the cardiovascular risk assessment

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Cardiovascular risk assessment plays a very important role in hypertension management. Initiation of antihypertensive treatment is recommended to be based on the estimation of cardiovascular risk instead of blood pressure (BP) level alone, especially for subjects with a high-normal or elevated BP. Meta-analyses of randomized controlled trials demonstrated that BP reduction was beneficial across almost the entire BP range [1], however, the effect might differ according to the patients' baseline cardiovascular risk. While the relative risk reduction of cardiovascular events was similar across the risk strata, absolute risk reduction was significantly greater in patients with higher cardiovascular risk [2].

Several scores [3–7] have been proposed for the estimation of cardiovascular risk in various populations (Table 1). Although office systolic BP has been used in all these score calculations, there is widespread concern about the quality and accuracy of the office BP measurement. In real-world clinical practice, office BP measurement with unstandardized preparation, invalid device or inappropriate schedule may lead to inaccurate BP estimations. Automated office BP measurement may overcome these limitations by taking multiple BP readings with a validated electronic device in the presence or absence of a medical staff. It has been shown that the automated office BP measurement can partially reduce the white-coat effect by decreasing alerting reaction to the medical environment and is similar to the

level of daytime ambulatory BP. Another limitation of office BP measurement is that it cannot reflect BP during daily activities and sleep. A large amount of studies have demonstrated that out-of-office BP, especially the 24-h and nighttime ambulatory BP, was more closely associated with cardiovascular mortality and morbidity than office BP [8]. However, it remained to be investigated how the estimated absolute cardiovascular risk would differ if using the automated office and ambulatory BP instead of the real-world office BP.

In this issue of *Hypertension Research* [9], Niamh and colleagues determined the difference in the Framingham risk score using the real-world office BP compared to the automated office BP and ambulatory BP in 226 hypertensive patients, with 20% having white-coat hypertension. They found that the real-world office systolic BP was on average 18 mm Hg higher than the automated office BP and daytime BP and 22 mm Hg higher than 24-h BP. As a result, the real-world office BP classified twice as many participants at high cardiovascular risk compared with the automated office BP, daytime and 24-h BP. One of the strengths of the study is that multiple BP measurements were applied within one study, and the office BP measurement by referring general practitioners reflected the real-world condition. The observation of a higher real-world office BP than the automated measurement and ambulatory BP in the current study was consistent with previous investigations. In a meta-analysis of subjects with a systolic automated office BP of 130 mm Hg or more [10], routine office and research systolic BPs were substantially higher than the automated office BP with a pooled mean difference of 14.5 mm Hg and 7.0 mm Hg, respectively. Even though the research office BP might be more accurate than the real-world measurement, the cardiovascular risk estimates may still differ from that based on ambulatory or home BP. A previous study [11] compared differences in the

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**Table 1** Cardiovascular risk scores

Risk scores	Framingham risk score [3]	ACC/AHA pooled cohort equations [4]	SCORE2 [5]	QRISK2 [6]	China-PAR equation [7]
Risk estimation	10-year CVD risk	10-year ASCVD risk	10-year fatal and nonfatal CVD risk	10-year CVD risk	10-year ASCVD risk
Derivation cohort	Framingham Heart Study	U.S. adults aged 45 to 79 years in the absence of concurrent statin therapy	Europe individuals without previous CVD or diabetes aged 40 to 69 years	England and Wales patients aged 35 to 74 years	A nationally representative sample aged 35 to 74 years in China
Risk variables	Age Sex SBP Total cholesterol HDL cholesterol History of diabetes Smoking On antihypertensive treatment	Age Sex Race SBP Total cholesterol HDL cholesterol History of diabetes Smoking On antihypertensive treatment	Age Sex Region SBP Non-HDL cholesterol Smoking	Age Sex Ethnicity SBP Body mass index Total/HDL cholesterol ratio Family history of coronary heart disease in first degree relative under 60 years Townsend deprivation score On antihypertensive treatment Rheumatoid arthritis Chronic renal disease Type 2 diabetes Smoking Atrial fibrillation	Age Sex SBP Total cholesterol HDL cholesterol Waist circumference History of diabetes Smoking On antihypertensive treatment Geographic region Urbanization Family history of ASCVD

CVD cardiovascular disease, ASCVD atherosclerotic cardiovascular disease, SBP systolic blood pressure, HDL high density lipoprotein

Framingham risk score calculated using ambulatory or home BP measurements instead of office readings, the scores were similar using different BPs, but nearly 10% of participants were reclassified into a different risk category. Nevertheless, it remained to be investigated if these differences in the predicted risk would be confirmed in terms of the incidence of cardiovascular events.

Overall, the previous and the current Niamh's study highlight that it should be better if a more standardized and accurate BP, such as the automated office BP or out-of-office ambulatory or home BP, can be used in the cardiovascular risk assessment. Emerging evidence showed that artificial intelligence may help to develop novel prediction models and improve the risk prediction using office or out-of-office BP. In the Spanish Ambulatory BP Monitoring registry, the machine-learning-derived prediction of cardiovascular mortality with ambulatory BP instead of office BP significantly increased the area under the curve, accuracy, and specificity [12]. The potential superiority of the out-of-office BP to office BP in risk assessment is encouraging and merits further investigation.

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## Compliance with ethical standards

**Conflict of interest** YL reports having received research grants from A&D, Bayer, Omron, Salubris, and Shyndec and lecture fees from A&D, Omron, Servier, and Salubris.

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