



Persistence of blood pressure phenotypes defined by office and ambulatory measurements in youth of 5 to 15 years of age

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Keywords Ambulatory blood pressure monitoring · Children · Masked hypertension · White-coat hypertension · Persistence

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Blood pressure fluctuates over time. For accurate assessment, blood pressure has to be repeatedly measured on several occasions in the clinic, over 24 h on ambulatory basis or for 5 to 7 consecutive days at home [1]. Among these guideline recommended office and out-of-office blood pressure measurements, ambulatory blood pressure monitoring is the most efficient and can be completed within a day for the diagnosis of hypertension and therapeutic monitoring. It is also the only technique that may evaluate the circadian rhythm of blood pressure, including the nighttime dipping status and morning surge, both of which are predictive of cardiovascular events and mortality. Ambulatory blood pressure measurement is performed with automated devices. It therefore allows blood pressure measurement during daily life, such as mild physical activities and nighttime sleeping hours, and is devoid of observers' bias and white-coat effect. By comparing the out-of-office ambulatory with office blood pressure, white-coat hypertension and masked hypertension can be differentiated from sustained hypertension and true normotension, respectively. These special forms of hypertension are of particular clinical significance, because they are different not only in the associated cardiovascular risk but also in the management. However, it has also been criticized that these blood pressure phenotypes have unsatisfactory reproducibility and low persistence [2, 3].

Several previous studies in adults investigated the persistence of white-coat and masked hypertension or white-coat and masked uncontrolled hypertension defined by

ambulatory blood pressure monitoring in untreated [4–10], treated [2, 3, 11, 12] or mixed untreated and treated adults (Table 1) [13]. These studies often had a moderate or small number of participants. Nonetheless, two studies did have a sample size that exceeded 1000 participants [2, 5]. These two large studies reported relatively low persistence of masked hypertension. Other studies reported high or moderate persistence of masked or white-coat hypertension, regardless of the antihypertensive treatment status. Time length between repeated measurements probably matters. Short-term studies within months often reported high persistence. The two large studies that reported low persistence had a long time-length up to 48 to 60 months [2, 5]. During long-term follow-up, the blood pressure phenotype, like blood pressure itself, may change for various reasons. In the long-term follow-up study with the largest number of participants ($n = 1669$) and two timepoints of blood pressure measurements, the persistence rate of masked hypertension decreased from 38.0% at three years to 18.5% at five years [5]. One of the major reasons for the decreasing persistence was that a sizable proportion of participants with masked hypertension progressed to sustained hypertension [5].

Few studies addressed this research question of reproducibility and persistence of white-coat and masked hypertension in children and adolescents. Nonetheless, two previous studies of moderate sample size reported moderate persistence of 38.2% [14] and 33.3% [15] for masked hypertension, respectively, in untreated and mixed untreated and treated children and adolescents (Table 1). One of the two studies also reported no persistence for white-coat hypertension in only less than a dozen of patients with this phenotype [15]. Both of the two studies had a relatively long time length between repeated measurements [14, 15].

In this issue of the Journal, Martinez F, et al investigated the persistence of blood pressure phenotypes in a relatively large number of children and adolescents ($n = 582$) [16]. The mean age of the study participants was 9.4 years. The

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Table 1 Persistence of white-coat and masked hypertension or white-coat and masked uncontrolled hypertension

1st author and year of publication	Number of participants	Mean age (years)	Female sex (%)	BMI (kg/m ²)	Office SBP/DBP (mmHg)	Time length between repeated measurements (months)	Masked or masked uncontrolled hypertension		White-coat or white-coat uncontrolled hypertension		Kappa
							Prevalence (%)	Persistence (%)	Prevalence (%)	Persistence (%)	
Children and adolescents											
<i>Untreated participants</i>											
Lurbe E [14] (2005)	234	10.2	55.7	–	–	34–37	14.5	38.2	–	–	–
Martinez F [16] (2022)	582	9.4	51.0	24.0	104.7/61.2	19.5	12.5	13.7	5.0	17.2	0.20
<i>Mixed untreated and treated participants</i>											
Hamdami G [15] (2017)	123	16.9	32.5	–	118.0/68.0	27.6	36.6	33.3	6.5	0	–
Adults											
<i>Untreated participants</i>											
Viera AJ [4] (2010)	50	49.0	56.0	–	137.0/83.0	0.25	54.2	73.3	–	–	0.47
Trudel X [5] (2013)	1669	–	57.4	–	–	36	13.9	38.0	–	–	–
						60	13.9	18.5	–	–	–
Abdalla M [6] (2016)	282	39.4	58.2	27.0	116.0/75.6	1.2	26.4	–	–	–	0.67
de la Sierra A [7] (2016)	839	53.0	44.2	29.0	145.5/88.2	3	9.3	47.4	24.4	55.6	0.50
Wei FF [8] (2016)	45	52.2	37.8	25.0	129.0/80.6	1	100	62.2	–	–	–
Husain A [9] (2017)	404	47.9	56.4	29.3	129.6/81.0	0.25	48.1–51.1	67.0–69.0	–	–	0.34–0.38
Cohen LP [10] (2020)	254	38.0	65.7	26.6	109.4/71.3	1	27.6	83.1	–	–	0.57
<i>Treated participants</i>											
Agarwal R [11] (2016)	333	69.4	1.8	30.7	–	1	32.8	76.5	–	–	0.47
Ghazi L [12] (2019)	203	71.8	32.0	29.3	126.4/69.1	10.5	28.1	49.1	3.0	50.0	0.38
Mancia G [2] (2020)	1664	55.8	55.1	–	163.1/101.1	48	17.8	34.0	21.1	39.0	–
Mancia G [3] (2022)	363	58.2	58.9	–	160.2/98.5	31.2	16.2	50.0	25.4	39.0	–
<i>Mixed untreated and treated participants</i>											
Ben-Dov IZ [13] (2007)	196	58.0	59.0	27.0	150.0/84.0	18	12.8	44.0	15.8	45.2	0.26

BMI body mass index, *SBP* systolic blood pressure, *DBP* diastolic blood pressure

mean body mass index was 24.0 kg/m². The mean office systolic/diastolic blood pressure was 104.7/61.2 mm Hg. The time length between repeated measurements was 19.5 months. The prevalence of masked and white-coat hypertension was 12.5% and 5.0%, respectively. The corresponding persistence rate was 13.7% and 17.2%, respectively, with a Kappa coefficient of 0.20. The authors of the article concluded that the persistence of ambulatory blood pressure phenotypes, either masked or white-coat hypertension, was low.

The study provided rather unique and important evidence on the use of ambulatory blood pressure for the diagnosis of masked and white-coat hypertension. The observation on the low persistence of both masked and white-coat hypertension does not necessarily challenge the measurement accuracy of the ambulatory blood pressure monitoring technique or the clinical relevance of these blood pressure phenotypes in children and adolescents. It does corroborate frequent or regular blood pressure measurement already in this age range.

As the authors also alluded, several possible reasons might explain the change in blood pressure phenotypes in the young age period. First, blood pressure changes with the growth in body height rather rapidly in children [17]. The blood pressure change could be different in various measurement settings, which may lead to a low persistence of blood pressure phenotypes when office and out-of-office blood pressures are both taken into account. Second, lifestyle modification might also play a role in the changes in blood pressure phenotypes, especially in those with overweight and obesity during a longer-term follow-up. In this cohort, the overall prevalence of overweight and obesity at baseline was 87.7% [16]. The study showed a role of waist circumference in the determination of changes in blood pressure phenotypes, and regression of various forms of hypertension to normotension in a high proportion of participants (22.7%) probably as a consequence of lifestyle modifications. In addition, there is evidence that overweight and obesity is associated with the prevalence of masked hypertension [18]. Third, similar to the results of the studies in adults [2–13], the close to 20 months of time length might also be important in the changes of blood pressure phenotypes.

Although the overall prevalence of masked hypertension and white-coat hypertension was not that high in these children and adolescents, 29 (49.2%) of the 59 participants with office hypertension at baseline had white-coat hypertension, and 73 (14.0%) of the 523 participants with office normotension at baseline had masked hypertension [16]. If only office blood pressure was measured in these children and adolescents, many of them would be misclassified and miss the opportunity of appropriate risk management. This study provided new evidence in supporting the current guideline recommendations on the mandatory use of ambulatory blood pressure monitoring for the diagnosis of hypertension in children and adolescents [19].

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Compliance with ethical standards

Conflict of interest J-GW reports receiving lecture and consulting fees from Novartis and Viatrix. The other authors declared no conflicts of interest.

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