Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
49(6) 1–9

DOI: 10.1177/03000605211016144
journals.sagepub.com/home/imr
SAGE

Comparing differences and correlation between 24-hour ambulatory blood pressure and office blood pressure monitoring in patients with untreated hypertension

Zhenhong Zhang, Shunyin Wang, Junru Yan, Zhiwen Xu, Dongliang Liang, Baohua Liu, Junjie Liang and Mingjie Chen

Abstract

Objective: We assessed differences and correlations between 24-hour ambulatory blood pressure (ABP) and office blood pressure (OBP) monitoring.

Methods: We conducted an observational study among 85 untreated patients with essential hypertension and measured 24-hour ABP, OBP, target organ damage (TOD) markers, and metabolism indexes. Variance analysis and the Pearson method were used to compare differences and correlation between the two methods. The Spearman or Pearson method was applied to compare the correlation between TOD markers, blood pressure index, and metabolism index. Linear regression analysis was applied to estimate the quantitative relationship between the blood pressure index and TOD markers.

Results: There were significant differences in the mean and variance of systolic blood pressure (SBP) and diastolic blood pressure and a positive correlation between ABP and OBP. Correlations between the left ventricular mass index (LVMI) and average ambulatory SBP, daytime ambulatory SBP, nighttime ambulatory SBP, and fasting blood glucose were significant. Correlations between left intima-media thickness (IMT) and average ambulatory SBP, nighttime ambulatory SBP, right IMT, and nighttime ambulatory SBP were significant. In linear regression analysis of the LVMI (y) and ambulatory SBP (x), the equation was expressed as $y = 0.637^{*}x$.

Conclusion: Nighttime ambulatory SBP may be an optimal predictor of TOD.

Department of Cardiology, The Second People's Hospital of Foshan (The Affiliated Hospital at Foshan, Southern Medical University), Foshan, China

Corresponding author:
Zhenhong Zhang, Department of Cardiology, The Second People's Hospital of Foshan (The Affiliated Hospital at Foshan, Southern Medical University), No. 78, Weiguo Road, Chancheng District, Foshan 528000, China.
Email: zhangzhenhongcn@163.com

Keywords
Ambulatory blood pressure, monitoring, target organ damage, office blood pressure, left ventricular mass index, carotid intima thickness

Date received: 17 August 2020; accepted: 13 April 2021

Introduction

Blood pressure is traditionally monitored in a clinic by a doctor or nurse. The diagnosis and treatment of hypertension are usually based on office blood pressure (OBP) monitoring.[1] With rapid developments in information technology and telecommunications in the medical field, ambulatory blood pressure (ABP) monitoring, first used in 1904,[2] is becoming more frequently used to assess individual blood pressure. ABP monitoring has the potential to improve the control of hypertension. Monitoring of OBP and ABP have specific advantages and disadvantages in clinical practice.[1,37] Studies have investigated these methods, but the study protocols and findings were not homogeneous.[8] There is still no agreement among the various guidelines about the use of ABP monitoring in clinical practice.[9,10] For example, National Institute for Health and Care Excellence (NICE) guidelines[11] and Chinese guidelines[12] recommend that ABP monitoring should be offered to all patients with suspected hypertension. However, European guidelines[10] recommend that ABP monitoring should only be an option in selected cases. Hence, the first aim of this study was to evaluate the relationship between OBP and ABP, especially looking at which blood pressure index is superior in predicting target organ damage (TOD). The second study aim was to elucidate the prognostic significance of TOD assessed using two blood pressure monitoring systems independently. Our study findings may provide valuable information regarding the use of ABP monitoring in clinical practice.

Methods

This was a cross-sectional observational study. Participant recruitment was conducted from 1 August 2018 to 31 December 2018 by five doctors at the Affiliated Hospital of Foshan, Southern Medical University. The sample size was calculated using the correlation module in PASS 11.0 software (NCSS LLC, East Kaysville, UT, USA) ($\alpha = 0.05$, $\beta = 0.90$), according to a 15% refusal rate and participant drop out.

Study participants

Patients with untreated hypertension (including those taking medication or receiving life guidance therapy) were eligible to participate in the study. Exclusion criteria were patients with: 1) cardiac function grade IV and acute left heart failure, according to New York Heart Association classification; 2) secondary hypertension; 3) primary cardiomyopathy; 4) acute cerebral vascular accident; 5) chronic renal insufficiency; 6) chronic respiratory disease; 6) cirrhosis and acute or chronic hepatitis; 7) diabetes, hyperthyroidism, and other endocrine and metabolic diseases; 8) anemia owing to heart disease; 9) mild to moderate anemia; 10) congenital heart disease and valvular heart disease; and 11) patients

who did not agree to provide informed consent.

Blood pressure measurements

OBP was monitored in the clinic using the same device (HEM-6111; Omron, Kyoto, Japan) and calculated as the average of three consecutive measurements. ABP was recorded using an automatic electronic device (Oscar 2; SunTech Medical Inc., Morrisville, NC, USA) during the daytime (6.00 a.m. to 10.00 p.m.) at 30-minute intervals and during the night (10.00 p.m. to 6.00 a.m.) at 60-minute intervals. The average was taken over 24 hours; daytime and nighttime blood pressure were calculated using hourly data. These measurements were taken prior to the administration of antihypertensive medication.

Target-organ damage (TOD) marker measurements

The left ventricular mass index (LVMI), carotid intima-media thickness (IMT), and urinary albumin–creatinine ratio (UACR) are recognized markers of heart, vascular, and kidney damage caused by hypertension, respectively. Therefore, as markers of TOD, we measured these in our study. The LVMI and IMT measurements were performed under quiet and warm conditions. The right and left carotid arteries were imaged using a high-resolution color Doppler ultrasound imaging instrument (Philips iE33; Netherlands) by an experienced ultrasonographer. Values of the LVMI and IMT were computed and outputted automatically by the instrument. Urine samples were collected when patients enrolled in the study. The UACR was measured using a turbidimetric immunoassay (Beckman AO5421 fully automatic biochemistry analyzer; Abbott, Chicago, IL, USA).

Metabolism index

Blood lipids, glycated hemoglobin (HbA1C), and fasting plasma glucose (FPG) were measured as metabolism indexes. Blood samples were collected when patients enrolled in the study. High-density lipoprotein cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c), and FPG were measured using the Beckman AO5421 biochemistry analyzer. HbA1C was measured with a TOSOH HLC 723GB automatic glycohemoglobin analyzer (Abon, Japan).

Statistical analysis

The data were analyzed using IBM SPSS 21.0 software (IBM Corp., Armonk, NY, USA). Data are expressed as mean $\pm$ standard deviation or median and interquartile range. First, we used the Kolmogorov–Smirnov method to perform normality tests for values of the various indicators. Second, analysis of variance or a nonparametric Kruskal–Wallis test was performed to detect differences between the two blood pressure monitoring methods. Third, Pearson or Spearman correlation coefficients were determined to assess a possible relationship between the two monitoring methods. Fourth, Spearman or Pearson methods were applied to identify correlations between TOD and the values of blood pressure indexes (OBP, average ABP, daytime ABP, nighttime ABP) and metabolism indexes (blood lipids, HbA1C, FPG), respectively. Furthermore, linear regression analysis was used to search for linear and quantitative dependence between values of blood pressure indexes and TOD. All tests were two-sided and a P-value less than 0.05 indicated statistical significance.

Ethics

The ethics committee of the Affiliated Hospital at Foshan, Southern Medical

University approved the protocol. Patients who agreed to participate in this study signed informed consent forms and were registered in a Chinese clinical trial registry (http: //www.chictr.org.cn, Registry NO: ChiCTR-OOC-16008944).

Results

Patient characteristics

Eighty-five patients with untreated hypertension agreed to participate and provided an informed consent form; all participants were older than 18 years of age. The characteristics of the study population are reported in Table 1.

Table 1. Participant characteristics.

	N	Value
Age	85	67.32 ± 10.6 years
OBP		
SBP	85	148.13 ± 18.75 mmHg
DBP	85	79.01 ± 14.14 mmHg
Average BP		
SBP	85	132.61 ± 14.04 mmHg
DBP	85	73.92 ± 10.03 mmHg
Daytime ABP		
SBP	85	134.54 ± 14.50 mmHg
DBP	85	75.42 ± 10.70 mmHg
Nighttime ABP		
SBP	85	125.53 ± 17.59 mmHg
DBP	85	69.20 ± 10.32 mmHg
LVMI	84	84.88 ± 22.15 g/m^2
IMT (left)	70	0.98 mm
IMT (right)	70	0.98 mm
UACR	82	1.90 mg/mmol
LDL-c	83	2.73 ± 0.82 mmol/L
HDL-c	83	1.46 ± 0.47 mmol/L
FBG	83	5.34 mmol/L
HbA1C	81	5.71 ± 0.40%

Note: Data are expressed as mean ± standard deviation or median.
OBP, office blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; ABP, ambulatory blood pressure; LVMI, left ventricular mass index; IMT, intima-media thickness; UACR, urinary albumin–creatinine ratio; LDL-c, low-density lipoprotein cholesterol; HDL-c, high-density lipoprotein cholesterol; FBG, fasting blood glucose; HbA1C, glycated hemoglobin.

Normality tests for various indicator values

The values of blood pressure, LVMI, HDL-c, LDL-c, and HbA1C had a normal distribution whereas those of the IMT (right), IMT (left), UACR, and FBG had a non-normal distribution. Variance analysis was used to compare the difference between blood pressure monitoring methods, and Pearson correlation coefficients were determined to assess possible relationships between the two methods. The Pearson method was applied to find the correlation between the LVMI and values of blood pressure indexes HDL-c, LDL-c, and HbA1C, respectively. Alternatively, the Spearman method was applied to find the correlation between the IMT or UACR and the value of blood pressure index, FBG.

Office blood pressure (OBP) monitoring versus ambulatory blood pressure (ABP) monitoring

The mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) were higher using OBP than ABP (148.13 ± 18.75 mmHg vs. 132.61 ± 14.04 mmHg; 79.01 ± 14.14 mmHg vs. 73.92 ± 10.03 mmHg, respectively; $P < 0.01$ for both). The mean SBP and DBP of OBP were also higher than those of daytime ABP (148.13 ± 18.75 mmHg vs. 134.54 ± 14.50 mmHg; 79.01 ± 14.14 mmHg vs. 75.42 ± 10.70 mmHg, respectively; $P < 0.05$ for both). Blood pressure measurements were highly correlated between the two methods (Pearson correlation coefficients between the two methods were $r = 0.561$ and 0.675 for SBP and DBP, respectively; $P < 0.001$ for both).

Correlation analysis of TOD, blood pressure monitoring systems, and metabolism indexes

First, we assessed possible correlations between the LVMI and values of the two blood pressure monitoring systems, HDL-c, LDL-c, FPG, and HbA1C. The average ambulatory SBP (Pearson correlation coefficient $r = 0.527$, $P = 0.013$), daytime ambulatory SBP (Pearson's $r = 0.559$, $P = 0.014$), nighttime ambulatory SBP (Pearson's $r = 0.239$, $P = 0.032$), and FPG (Spearman's $r = 0.224$, $P = 0.042$) were significantly positively correlated with the LVMI. Correlation analysis of blood pressure and the LVMI are shown in Table 2. The correlation between the LVMI and other indicators was not significant (data not shown).

Second, we assessed possible correlations between the IMT, blood pressure, and metabolism indexes. The average ambulatory SBP (Spearman's $r = 0.244$, $P = 0.042$) and nighttime ambulatory SBP (Spearman's $r = 0.377$, $P = 0.001$) were significantly positively correlated with left IMT. Correlation analysis of blood pressure and the left IMT are shown in Table 3. Similarly, nighttime ambulatory SBP (Spearman's $r = 0.312$, $P = 0.009$) was significantly positively correlated with right IMT. Results of correlation analysis for blood pressure and right IMT are shown in Table 4.

Third, we assessed possible correlations between the UACR, blood pressure, and metabolism indexes. There were no statistical correlations between the UACR and all indicators.

Linear regression analysis

From the above results, we deemed that the average ambulatory SBP, daytime

Table 2. Correlation analysis of blood pressure and LVMI.

LVMI	r (N = 84)	P-value
OBP (SBP)	0.145	0.1894
OBP (DBP)	−0.065	0.556
ABP (SBP)	0.527	0.013
ABP (DBP)	0.113	0.306
ABP (D-SBP)	0.559	0.014
ABP (D-DBP)	0.119	0.280
ABP (N-SBP)	0.239	0.032
ABP (N-DBP)	0.106	0.339

Note: Pearson's correlation coefficients.
LVMI, left ventricular mass index; OBP, office blood pressure; ABP, ambulatory blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; D-, daytime; N-. nighttime.

Table 3. Correlation analysis of blood pressure and left IMT.

left IMT	r (N = 70)	P-value
OBP (SBP)	0.146	0.228
OBP (DBP)	−0.153	0.207
ABP (SBP)	0.244	0.042
ABP (DBP)	−0.095	0.436
ABP (D-SBP)	0.206	0.088
ABP (D-DBP)	−0.123	0.310
ABP (N-SBP)	0.377	0.001
ABP (N-DBP)	0.091	0.454

Note: Spearman's correlation coefficients.
IMT, intima-media thickness; OBP, office blood pressure; ABP, ambulatory blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; D-, daytime; N-. nighttime.

Table 4. Correlation analysis of blood pressure and right IMT.

right IMT	r (N = 70)	P-value
OBP (SBP)	0.085	0.484
OBP (DBP)	−0.156	0.196
ABP (SBP)	0.189	0.117
ABP (DBP)	−0.130	0.285
ABP (D-SBP)	0.146	0.227
ABP (D-DBP)	−0.163	0.178
ABP (N-SBP)	0.312	0.009
ABP (N-DBP)	0.031	0.797

Note: Spearman's correlation coefficients.
IMT, intima-media thickness; OBP, office blood pressure; ABP, ambulatory blood pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; D-, daytime; N-. nighttime.

ambulatory SBP, and nighttime ambulatory SBP are associated with TOD. Furthermore, to estimate quantitative relationships between various blood pressure indexes and TOD, we used linear regression analysis (standard method). There was a significant linear and quantitative relationship between average ambulatory SBP and the LVMI ($P < 0.05$). This statistical relationship also existed between nighttime ambulatory SBP and IMT ($P < 0.05$). When linear regression analysis was applied to the LVMI (y) and average ambulatory SBP (x), the equation was expressed as $y = 0.637*x$. When linear regression analysis was applied to IMT (y) and nighttime ambulatory SBP (x), the equations were expressed as y (left) $= 0.460 + 0.004*x$ and y (right) $= 0.471 + 0.004*x$. The other blood pressure index could not be introduced into the equation.

Discussion

A main finding of this study revealed that OBP was significantly higher than ABP in a number of untreated patients with hypertension. The primary reason for this is that ABP responds to 24-hour blood pressure, including nocturnal blood pressure troughs, rather than instantaneous blood pressure. OBP was also higher than daytime ABP. Intrinsic characteristics of OBP, such as patient anxiety in the office setting, may explain the above finding. Classic OBP is the gold standard for screening, diagnosing, and managing hypertension, but it is constrained by several factors including white-coat hypertension and nocturnal hypertension. In contrast to OBP, ABP monitoring is a useful tool in diagnosing masked hypertension, nocturnal hypertension, and white-coat hypertension.[13–18] In our study, the proportion of patients with nocturnal hypertension was as high as 78% (58/85) and isolated nocturnal hypertension was 8.2% (7/85). However, ABP is also constrained by factors such as sleep disturbance in many patients.[19–21] Our results provide useful information for the management of hypertension in terms of understanding the characteristics of the two blood pressure monitoring methods. There is a highly positive correlation between these methods, and our results indicate that they are closely related but not identical. OBP monitoring forms the basis for the treatment and management of hypertension. Monitoring of ABP can supplement, rather than replace, OBP monitoring. Use of ABP has several advantages,[1] especially because multiple blood pressure measurements are taken in one day so the data are more detailed, enabling treatment to be adjusted based on the individual's blood pressure fluctuations over a day.

The information revealed in this analysis is that ABP is more closely associated with indices of subclinical TOD than OBP in untreated patients with hypertension. To compare the predictive effect of the two blood pressure measurement methods on TOD, we monitored the correlation coefficient between markers of TOD and these methods. We found that (1) the average SBP, daytime ambulatory SBP, and nighttime ambulatory SBP were significantly positively correlated with the LVMI; (2) the average ambulatory SBP and nighttime ambulatory SBP were significantly positively correlated with left IMT; and (3) nighttime ambulatory SBP was significantly positively correlated with right IMT. Additionally, linear regression analysis showed a linear and quantitative relationship between the LVMI and average ambulatory SBP and the IMT and ambulatory nighttime SBP. Unfortunately, we found no statistical correlations between the UACR and values of the two blood pressure measurement methods. We cannot provide a convincing explanation for this unexpected finding. However, we concluded that ABP has a superior ability to predict hypertensive TOD in comparison with

OBP, based on the above findings. Several clinical studies[22–25] have shown that ABP values predict cardiovascular risk better than OBP. Additionally, a consistent finding in this study was that ABP was more closely associated with indices of subclinical TOD in untreated patients with hypertension. In short, the findings of this study may provide objective evidence regarding the value of ABP in the prediction of hypertension-induced TOD.[26–28]

In our study, nighttime ambulatory SBP was a superior predictor in terms of its association with TOD. This conclusion is supported by previous studies.[27,29,31] When examining the correlation between specific components of 24-hour blood pressure and TOD, we found that nighttime ambulatory SBP was closely correlated to the LVMI, left IMT, and right IMT. Recently there have been many reports that cardiovascular risk and TOD in patients with nocturnal hypertension are greater than in those with normotensive blood pressure at night and that good control of nighttime blood pressure is important for preventing cardiovascular disease and protecting against TOD.[30] The present study adds to the evidence showing that nighttime ambulatory SBP has a strong prognostic value for TOD.

A main limitation in this study was that OBP monitoring was done casually, without multiple measurements taken on the same day, thereby reducing the conclusiveness of our research results. Moreover, this study failed to prove the blood pressure predictive value of the UACR, which might weaken the conclusions. Finally, the study design was cross-sectional and observational; therefore, some inherent bias could not be completely excluded.

Conclusion

Our study findings provide a small but valuable contribution to the practice of ABP monitoring in a clinical setting. We offer further support for the usefulness of assessing specific components of ABP monitoring in clinical practice. Second, our findings allow for a better understanding of preferred therapies for controlling nighttime blood pressure and reducing the risk of TOD. Finally, the present results provide hints as to further research involving patients with treated or refractory hypertension, to reach more comprehensive conclusions.

Acknowledgments

We would like to acknowledge the hard and dedicated work of all the staff that implemented the intervention and evaluation components of the study.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This study was supported by the Medical Science and Technology Research Foundation of Guangdong Province, China (A2017550); Medical Science Technology Project of Foshan, China (2016AB003021); and 135 Medical Key Specialty Construction Project of Foshan, China (Cardiovascular Internal Medicine, FSZDZK 135027).

ORCID iD

Zhenhong Zhang https://orcid.org/0000-0001-9141-9621

References

1. Parati G, Stergiou G, O'Brien E, et al. European Society of Hypertension guidelines for blood pressure monitoring at home: a summary report of the Second International Consensus Conference on Home Blood Pressure Monitoring. *J Hypertens* 2014; 32: 1359–1366.
2. Vischer AS and Burkard T. Principles of Blood Pressure Measurement – Current Techniques, Office vs Ambulatory Blood

Pressure Measurement. *Adv Exp Med Biol* 2017; 956: 85–96.
3. Little P, Barnett J, Barnsley L, et al. Comparison of acceptability of and preferences for different methods of measuring blood pressure in primary care. *BMJ* 2002; 325: 258–259.
4. Gelfer M, Dawes M, Kaczorowski J, et al. Diagnosing hypertension: Evidence supporting the 2015 recommendations of the Canadian Hypertension Education Program. *Can Fam Physician* 2015; 61: 957–961.
5. Argyris AA, Weber T and Protogerou AD. Aortic Ambulatory Blood Pressure Monitoring and Target Organ Damage: Are the Data Really Conflicting? *Am J Hypertens* 2018; 31: 1260–1262.
6. Viera AJ and Shimbo D. Ambulatory blood pressure phenotypes and the risk for hypertension. *Curr Hypertens Rep* 2014; 16: 481.
7. Vongpatanasin W. Accurate Blood Pressure in the Office. *Circulation* 2018; 138: 1771–1773.
8. Hodgkinson J, Mant J, Martin U, et al. Relative effectiveness of clinic and home blood pressure monitoring compared with ambulatory blood pressure monitoring in diagnosis of hypertension: systematic review. *BMJ* 2011; 342: d3621.
9. Gijón Conde T and Banegas JR. Ambulatory blood pressure monitoring for hypertension diagnosis? *Hipertens Riesgo Vasc* 2017; 34: 4–9.
10. O'Brien E, Parati G, Stergiou G, et al. European Society of Hypertension position paper on ambulatory blood pressure monitoring. *J Hypertens* 2013; 31: 1731–1768.
11. Jaques H; National Institute for Health and Clinical Excellence (NICE). NICE guideline on hypertension. *Eur Heart J* 2013; 34: 406–408.
12. Chinese Hypertension League. Chinese Guidelines on Ambulatory Blood Pressure Monitoring. *Chinese Journal of the Frontiers of Medical Science* 2021; 13: 34–51.
13. Islam MS. Ambulatory Blood Pressure Monitoring in the Diagnosis and Treatment of Hypertension. *Adv Exp Med Biol* 2017; 956: 109–116.
14. Gorostidi M, Vinyoles E, Banegas JR, et al. Prevalence of white-coat and masked hypertension in national and international registries. *Hypertens Res* 2015; 38: 1–7.
15. Jardim TV, Carneiro CS, Morais P, et al. White-coat, masked and sustained hypertension detected by home blood pressure monitoring in adolescents: prevalence and associated factors. *Blood Press* 2018; 27: 151–157.
16. White WB and Gulati V. Managing Hypertension with Ambulatory Blood Pressure Monitoring. *Curr Cardiol Rep* 2015; 17: 2.
17. Ahmed J, Ozorio V, Farrant M, et al. Ambulatory vs Office Blood Pressure Monitoring in Renal Transplant Recipients. *J Clin Hypertens (Greenwich)* 2015; 17: 46–50.
18. Andrade H, Pires A, Noronha N, et al. Importance of ambulatory blood pressure monitoring in the diagnosis and prognosis of pediatric hypertension. *Rev Port Cardiol* 2018; 37: 783–789.
19. Staessen JA, Fagard R, Thijs L, et al. A consensus view on the technique of ambulatory blood pressure monitoring. The Fourth International Consensus Conference on 24-Hour Ambulatory Blood Pressure Monitoring. *Hypertension* 1995; 26: 912–918.
20. Mancia G and Zanchetti A. Value of echocardiographic and ambulatory blood pressure monitoring in hypertension. *Clin Exp Hypertens A* 1989; 11: 869–886.
21. Parati G, Mutti E, Ravogli A, et al. Advantages and disadvantages of noninvasive ambulatory blood pressure monitoring. *J Hypertens Suppl* 1990; 8: S33–S38.
22. Clement DL, De Buyzere ML, De Bacquer DA, et al. Prognostic value of ambulatory blood-pressure recordings in patients with treated hypertension. *N Engl J Med* 2003; 348: 2407–2415.
23. Bliziotis IA, Destounis A and Stergiou GS. Home versus ambulatory and office blood pressure in predicting target organ damage in hypertension: a systematic review and meta-analysis. *J Hypertens* 2012; 30: 1289–1299.
24. Niiranen TJ, Mäki J, Puukka P, et al. Office, Home, and Ambulatory Blood Pressures as Predictors of Cardiovascular Risk. *Hypertension* 2014; 64: 281–286.
25. Imai Y, Hozawa A, Ohkubo T, et al. Predictive values of automated blood

pressure measurement: what can we learn from the Japanese population? The Ohasama study. *Blood Press Monit* 2001; 6: 335–339.
26. Flynn JT, Daniels SR, Hayman LL, et al. Update: ambulatory blood pressure monitoring in children and adolescents: a scientific statement from the American Heart Association. *Hypertension* 2014; 65: 1116–1135.
27. Minutolo R, Agarwal R, Borrelli S, et al. Prognostic role of ambulatory blood pressure measurement in patients with nondialysis chronic kidney disease. *Arch Intern Med* 2011; 171: 1090–1098.
28. Agarwal R, Peixoto AJ, Santos SF, et al. Out-of-office blood pressure monitoring in chronic kidney disease. *Blood Press Monit* 2009; 14: 2–11.
29. Li Y and Wang JG. Isolated nocturnal hypertension: a disease masked in the dark. *Hypertension* 2013; 61: 278–283.
30. Sharma AP, Mohammed J, Thomas B, et al. Nighttime blood pressure, systolic blood pressure variability, and left ventricular mass index in children with hypertension. *Pediatr Nephrol* 2013; 28: 1275–1282.
31. Yang Y, Xu JZ, Wang Y, et al. Ambulatory versus clinic blood pressure in predicting overall subclinical target organ damage progression in essential hypertensive patients: a 3-year follow-up study. *Blood Press Monit* 2016; 21: 319–326.