Original Article

Day and Night Blood Pressure Variability among Older Persons in South-Western Nigeria

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Abstract

Background: Hypertension is the largest contributor to the global burden of disease. Emerging risk factors for cardiovascular disease include blood pressure variability (BPV), but evidence on BPV is lacking among older Nigerians. We reported BPV in a cohort of older persons at the University College Hospital (UCH), Ibadan. **Methods:** We conducted a retrospective cohort study of respondents aged >50 years within the Ibadan Ambulatory Blood Pressure Registry at the UCH, Ibadan, Nigeria. Socio-demographic characteristics, lifestyle habits and anthropometric measurements were obtained. **Results:** Among 639 respondents, 332 (52.0%) were female. The blood pressure (BP) variables were strongly associated with age. Compared with younger age groups, mean diastolic BP (DBP) was less at an older age, whereas mean pulse pressure was greater. During the wake-up and sleep periods, mean DBP and mean arterial BP were less with each increasing age category, whereas mean pulse pressure was larger with each increasing age category. BP dipping, systolic, diastolic and mean arterial BP decreased with age. Overall, timed BPV increased significantly with increasing age. The prevalence of white-coat hypertension was greater among older participants than younger participants. Most respondents in the 50–59 years' age group were non-dippers (55.8%), whereas 33.7% of older respondents were reverse-dippers. **Conclusion:** Older persons experienced a greater abnormal circadian blood variation and greater BPV than younger people. In Nigeria, follow-up data are needed to determine the prognostic significance of these data in this population.

Keywords: Ambulatory blood pressure monitoring, blood pressure, Nigeria, older adults, variability

Introduction

Hypertension is the greatest contributor to the burden of disease.[1,2] In Nigeria, the overall prevalence of hypertension ranges between 8.0% and 46.4% depending on the age group targeted, type of measurement and cutoff value used for defining hypertension.[1,3] The prevalence of hypertension, as measured in the office, rises with age and can be as high as 56.5% in the elderly aged >65 years.[4] It also appears to be increasing over time.[3,5]

One point office blood pressure (BP) measurement, compared with continuous BP monitoring, is less predictive of cardiovascular morbidity and mortality.[6] BP variability (BPV) is an emerging risk factor for cardiovascular disease.[7,8] BP varies in a diurnal manner throughout a 24-h period, being higher during the day and lower at night, and this occurs in people with both normal and high BP.[9] Studies have shown that most people have a dipping BP pattern identified by a nighttime BP that is 10%–20% lower than their daytime BP.[10,11] Most people with a <10% reduction in nighttime BP are described as having a non-dipping BP pattern.[10] Literature has shown that a non-dipping BP pattern is associated with a greater risk of target organ damage among individuals with essential hypertension than those with a dipping pattern.[10] Some evidence suggests that non-dipping BP patterns differ according to age, ethnicity, sex, sleep apnoea and other

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factors.[11] Little is known about BPV in older people in Nigeria, who may be at greater risk of non-dipping patterns than younger people.[12]

While the best method for quantifying BPV remains debatable,[13] there is a need to determine the role of BPV as a risk factor for cardiovascular disease in older people.[14] In addition, BPV has been associated with the development and severity of target organ damage.[14,15] Our objective was to systematically evaluate BPV and related risk factors for cardiovascular disease in an elderly cohort of Nigerians with and without hypertension.

Methods

Ethical approval was obtained from the Joint College of Medicine, University of Ibadan, Ibadan/University College Hospital (UCH), Ibadan ethics review committee (UI/EC/18/029). Ethical approval was granted on 19th March 2018. The confidentiality of data was maintained by excluding participants' names and hospital numbers from the analysis and report leaving only the assigned serial numbers.

Study design

We carried out a retrospective analysis of the data of people aged at least 50 years who were registered in the Ibadan Ambulatory Blood Pressure Registry (IABPR) component of Association between Selected Molecular Biomarkers and Ambulatory Blood Pressure Pattern in African Chronic Kidney Disease and hypertensive patients compared with normotensive **c**ontrols (the symbolic study) at the UCH, Ibadan, Nigeria, between 28th July 2018 and 28th February 2020.

Study site

The UCH, established in 1957, is the premier tertiary hospital in Nigeria and has 1000 beds. The hospital services patients from Nigeria and the West African sub-region.

Procedure

Records of all the 639 participants registered at the IABPR and had complete ambulatory BP monitoring (ABPM) were retrieved (total sampling). The participants were categorised into different age categories (50–59 years, 60–69 years and ≥70 years) based on the provided ages. Information was retrieved on socio-demographic characteristics (i.e. age, sex, marital status, educational attainment and occupation), alcohol and tobacco consumption and anthropometric measures, including height, weight and waist and arm circumferences.

Using a ruler attached to the wall, the participant's height was measured without shoes to the nearest centimetre. Furthermore, an electronic scale was used to measure their weight to the nearest 0.1 kg while wearing light clothing and no shoes. The participants' waist circumference is the minimum circumference between the iliac crest and the rib cage; the narrowest part of the participant's trunk was taken at the end of expiration using an anthropometric measuring tape. Three measurements of the waist circumference were averaged, recorded to the nearest 0.1 cm and used in analyses.

The participants were allowed a 5 min rest in the sitting position with their legs uncrossed before measuring their BP with the standard Omron (HEM711DLX) BP apparatus placed on the left arm at the heart level using appropriate cuff sizes. The average of the last two of three BP measurements taken at the 1-min interval was recorded and used in the present analysis. A 24-h ABPM was carried out on all the participants using the SpaceLabs® ABPM (SpaceLabs Healthcare, Issaquah, WA, USA) with the cuff placed on the non-dominant arm. The selected cuff size for each participant was determined by measuring the circumference of the participant's non-dominant arm. The machine was programmed to read half-hourly from 7 a.m. to 10 p.m. and hourly from 10 p.m. to 7 a.m. The participants were counselled to engage in their routine daily activities, avoid vigorous physical activities and keep motionless at the time of measurement. Measurements were collected during weekdays to allow participants to return to the hospital for disconnection of the ABPM machine. A minimum of 10 daytime and 5 nighttime systolic BP (SBP) and diastolic BP (DBP) measurements was considered complete for an ABPM measurement.

Hypertension was taken as having a SBP ≥140 mmHg or DBP ≥90 mmHg or being on antihypertensive medications. Based on the clinic/office BP and ABPM readings, we evaluated three phenotype domains, namely (1) diurnal BP patterns, (2) elevated mean clinic or daytime BP and (3) a disparity between clinic hypertension and out-of-clinic hypertension. Elevated clinic BP was defined as a mean clinic SBP ≥140 mmHg or DBP ≥90 mmHg. Based on the European Society of Cardiology guideline, an elevated daytime BP was defined as the mean daytime SBP ≥135 mmHg or DBP ≥85 mmHg, while an elevated nighttime BP was taken as the mean nighttime SBP ≥120 mmHg or DBP ≥70 mmHg. We also used the Jackson Heart Study thresholds for African-Americans, 24-h hypertension[16] [Appendix 1].

The diurnal BP patterns included in the present study were nocturnal hypertension, isolated nocturnal hypertension and a non-dipping BP pattern. The mismatches between out-of-clinic clinical hypertension and clinic hypertension included masked hypertension, masked isolated nocturnal hypertension and white coat hypertension.

Data analysis

The data were analysed with the IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, Version 25.0. (Armonk, NY, USA: IBM Corp.). Chi-square tests (categorical variables) or Student's *t*-test or analysis of variance (ANOVA; continuous variables) were used to compare the distribution of variables across age groups. The level of significance was set at $P < 0.05$ (two-sided).

Results

Among 639 participants enrolled, 332 (52.0%) were female. The majority of the respondents (309; 48.4%) were aged 50–59 years and 545 (85.3%) were currently married. With each increasing age category, some fewer respondents were currently married ($P < 0.001$), had no formal education ($P < 0.001$) and were currently engaged in occupational activities ($P < 0.001$) [Table 1].

Twenty four hour blood pressure measurements

A summary of BP measurements by age group is provided in Table 2. With each increasing age category, there was a statistically significant decrease in the mean overall DBP ($P < 0.001$), mean minimum DBP ($P < 0.001$) and mean maximum DBP ($P = 0.01$). In contrast, increasing age category was associated with increasing mean overall pulse pressure ($P < 0.001$), mean minimum pulse pressure ($P < 0.001$), mean maximum pulse pressure ($P < 0.001$) and mean maximum SBP ($P = 0.04$). Moreover, with each increasing age category, BP dipped less overnight for each of mean SBP ($P = 0.01$), mean DBP ($P = 0.05$) and mean arterial BP (MAP; $P = 0.01$).

Wake-up period blood pressure measurements

There were some patterns between age groups in BP variables during the wake-up period [Table 3]. With each increased age group, there was a significant decline in the mean DBP ($P < 0.001$), mean minimum DBP ($P < 0.001$), mean maximum DBP ($P = 0.01$), MAP ($P = 0.04$) and mean minimum arterial BP ($P = 0.01$). In contrast, with each increasing age category, there was a greater mean pulse pressure ($P < 0.001$), mean minimum pulse pressure ($P < 0.001$) and mean maximum pulse pressure ($P < 0.001$).

Sleep period blood pressure measurements

During the sleep period, with each increasing age group, there was a reduction in mean DBP ($P < 0.001$), mean minimum DBP ($P < 0.001$) and mean maximum DBP ($P = 0.01$) [Table 4]. In contrast, the mean pulse pressure ($P < 0.001$) and mean maximum pulse pressure ($P < 0.001$) increased significantly with increasing age. In addition, there was a statistical association between the mean minimum arterial BP ($P = 0.02$), mean minimum pulse pressure ($P < 0.001$) and age. Timed BPV showed increased SBP, DBP, MAP and pulse pressure variability with increasing age during 24-h, sleep and wake-up periods [Tables 2-4].

Ambulatory blood pressure phenotypes thresholds/ hypertension diagnoses

Using the Jackson guide, the proportion of respondents diagnosed with daytime hypertension ($P = 0.01$) and whitecoat hypertension ($P < 0.001$) increased significantly across age groups [Table 5]. Using the European guide, only the proportion of participants with whitecoat hypertension rose with increasing age ($P = 0.01$).

Blood pressure dipping status

Most people in the 50–59 years' age group were non-dippers (55.8%) [Figure 1]. Most reverse dippers (33.7%) were in the 50–59 years and 60–69 years' age groups. There was no extreme dipper in the age group ≥70 years. With each increasing age category, there was a decrease in overall summary DBP, overall summary MAP, wake period DBP, wake period MAP, sleep period DBP, sleep period pulse pressure [Figure 2a-f], all of which decreased with increasing age except sleep period MAP which increased with age.

Discussion

This study comprehensively evaluates ambulatory pressure profiles among pre-old (50–59 years) and old persons (60 years

Table 1: Sociodemographic characteristics and lifestyle habits of participants by age group

Variable	50-59 years (n=309), n (%)	60-69 years (n=210), n (%)	≥70 years (n=120), n (%)	Total (n=639), n (%)	P
Sex					
Males	147 (47.6)	96 (45.7)	64 (53.3)	307 (48.0)	0.40
Females	162 (52.4)	114 (54.3)	56 (46.7)	332 (52.0)	
Mean age (years)	54.3±2.9	63.7±2.9	75.9±4.9		
Marital status					
Not currently married	26 (8.4)	35 (16.7)	33 (27.5)	94 (14.7)	<0.001*
Currently married	283 (91.6)	175 (83.3)	87 (72.5)	545 (85.3)	
Educational level (n=620)†					
No formal education	19 (6.3)	25 (12.2)	30 (26.1)	74 (11.9)	<0.001*
Had formal education	281 (93.7)	180 (87.8)	85 (73.9)	546 (88.1)	
Occupational status (n=629)†					
Currently employed	281 (92.1)	130 (63.4)	59 (49.6)	470 (74.7)	<0.001*
Unemployed	24 (7.9)	75 (36.6)	60 (50.4)	159 (25.3)	
Tobacco smoking (n=156)†					
Current smokers	26 (40.6)	20 (33.3)	11 (34.4)	57 (36.5)	0.67
Past smokers	38 (59.4)	40 (66.7)	21 (65.6)	99 (63.5)	
Alcohol consumption (n=320)†					
Current consumers	146 (87.4)	89 (86.4)	46 (92.0)	281 (87.8)	0.60
Past consumers	21 (12.6)	14 (13.6)	4 (8.0)	39 (12.2)	

*Significant at 5% level of significance. †Incomplete due to non-response

Table 2: Ambulatory blood pressure measurements according to age group

Variable	Mean±SD			*P*
	50-59 years (*n*=309)	60-69 years (*n*=210)	≥70 years (*n*=120)	
Overall summary of BP measurements (mmHg)				
SBP	125.9±18.3	129.1±19.7	127.4±14.9	0.17
DBP	78.9±11.7	76.2±10.6	72.9±9.8	<0.001*
MAP	95.1±13.3	94.9±13.3	92.0±11.6	0.08
Pulse pressure	47.1±10.8	53.0±13.6	54.4±10.3	<0.001*
Minimum SBP	103.7±17.9	105.8±17.6	103.4±15.3	0.36
Minimum DBP	59.1±13.0	56.9±10.8	54.3±10.1	<0.001*
Minimum MAP	75.0±13.9	74.8±12.6	71.7±11.3	0.06
Minimum pulse pressure	29.2±9.1	33.4±12.1	33.4±9.5	<0.001*
Maximum SBP	150.7±22.5	155.3±24.7	156.0±19.0	0.04*
Maximum DBP	100.2±14.5	99.08±14.95	95.31±12.42	0.01*
Maximum MAP	116.6±18.3	118.8±18.1	116.5±15.0	0.35
Maximum pulse pressure	65.9±15.2	71.2±17.0	74.8±14.1	<0.001
Office BP measurements (mmHg)				
SBP				
Left arm	138.1±21.4	147.5±24.4	142.3±20.1	<0.001*
Right arm	137.4±21.4	146.9±24.8	142.0±20.9	<0.001*
DBP				
Left arm	88.4±13.8	85.0±13.9	79.3±13.7	<0.001*
Right arm	86.8±13.6	85.6±14.5	78.6±13.7	<0.001*
BPV (24 h BP)	9.0±3.3	9.2±2.4	9.4±2.5	0.381
Overall summary of BP dipping (mmHg)				
SBP	4.5±6.8	2.7±7.5	2.6±6.6	0.01*
DBP	8.1±8.7	6.1±9.9	6.1±8.5	0.05*
MAP	6.4±7.5	4.2±8.9	3.8±7.2	0.01*

*Significant at 5% level of significance. BP: Blood pressure, SBP: Systolic BP, DBP: Diastolic BP, MAP: Mean arterial BP, SD: Standard deviation, BPV: BP variability

and above) in Nigeria. It demonstrated that office and 24-h ambulatory DBP decreased while pulse pressure increased with increasing ageing. It highlighted abnormal circadian BPV among this population. Whitecoat and clinic hypertension increased while mean SBP, DBP and MAP dipping decreased with increasing ageing. BPV (DBP) and early morning surge increased with ageing. Finally, it showed that this study population has a high proportion of non-dippers.

Vascular changes are associated with ageing, which reduces the vascular impedance and cardiac output, with an increase in peripheral vascular resistance. These changes result in lower or statistic DBP while the SBP increases, culminating in isolated systolic hypertension (ISH).[16,17] Our findings in this study showed a decreasing DBP across the age groups, whether for ABPM or office BP measurements. The lifetime peak of DBP of 50 years was the lower cut-off of our study participants. Qin *et al*. reported similar findings in their study of 513 elderly Chinese population.[18] ISH is associated with substantial cardiovascular morbidity and mortality, especially cognition impairment and stroke.[16] With the global challenges in the management, it may be inferred that our cohort is not immune against the long-term sequelae of ISH and earlier intervention should focus on lowering SBP and PP to reduce risk whether among in hypertensive.[16]

While sustained hypertension is an independent risk factor for major cardiovascular events, wide short term or visit to visit fluctuation of BP parameters (BPV) potentiates the risk of cerebrovascular diseases.[14,19,20] Emerging risk factors for cardiovascular disease include BPV in a diurnal manner throughout 24 h.[11] The current study showed an increasing BPV of DBP during the daytime and a 24-h summary with ageing. Contrary to our findings, Qin *et al*. found a significant increment in SBP with ageing.[18] There have been unabated controversies on the prognostic implication of BPV. While some studies in various populations have indicated that short-term BPV might have independent prognostic significance for cardiovascular events in the elderly, not all studies have found this association.[5,6] However, Hansen *et al*., in the study of 8938 participants from 11 populations, confirmed that DBP variability tended to be a stronger predictor of cardiovascular morbidity and mortality outcome than SBP variability.[21] The effect of either SBP or DBP variation in the older populations of Nigeria needs further exploration.

Circadian BP patterns measured by ABPM are better predictive value for cardiovascular events than one-point clinic BP checks. Using ABPM, different BP phenotypes such as daytime hypertension, nocturnal hypertension, white-coat hypertension, masked hypertension and early morning BP surge are

Table 3: Blood pressure measurements during the wake-up period according to age groups

Variable (mmHg)	Mean±SD			P
	50-59 years (*n*=309)	60-69 years (*n*=210)	≥70 years (*n*=120)	
SBP	127.7±18.2	130.3±19.1	128.5±148.0	0.31
DBP	81.1±11.6	77.8±10.4	74.6±9.9	<0.001*
MAP	97.1±13.2	96.3±12.9	93.5±11.1	0.04*
Pulse pressure	46.7±10.9	52.6±13.4	54.1±10.3	<0.001*
Minimum SBP	106.5±18.0	108.2±17.6	105.3±15.3	0.33
Minimum DBP	62.2±13.0	59.3±10.8	56.1±10.4	<0.001*
Minimum MAP	77.9±14.1	77.1±12.6	73.2±11.3	0.01*
Minimum pulse pressure	29.9±9.8	33.9±12.2	33.8±9.9	<0.001*
Maximum SBP	150.1±22.8	154.4±24.5	154.1±19.0	0.08
Maximum DBP	99.5±13.8	98.3±15.3	94.3±12.5	0.01*
Maximum MAP	116.8±16.1	118.0±18.0	114.8±14.6	0.27
Maximum pulse pressure	65.2±15.4	70.4±16.5	74.1±13.8	<0.001*

*Significant at 5% level of significance. BP: Blood pressure, SBP: Systolic BP, DBP: Diastolic BP, MAP: Mean arterial BP, SD: Standard deviation

Table 4: Blood pressure measurements during sleep period according to the age group

Variable (mmHg)	Mean±SD			P
	50-59 years (*n*=309)	60-69 years (*n*=210)	≥70 years (*n*=120)	
SBP	121.1±18.9	125.3±24.9	120.8±25.8	0.11
DBP	74.1±12.2	72.1±14.4	67.2±15.3	<0.001*
MAP	90.3±15.0	91.3±17.9	86.6±18.8	0.06
Pulse pressure	47.4±11.2	53.2±15.3	53.8±14.0	<0.001*
Minimum SBP	109.1±19.2	113.0±23.4	105.9±24.3	0.02*
Minimum DBP	62.6±13.5	61.4±14.6	55.5±14.0	<0.001*
Minimum MAP	79.2±14.9	80.0±17.2	74.1±17.3	0.01*
Minimum pulse pressure	38.5±10.8	43.7±14.3	42.2±12.0	<0.001*
Maximum SBP	134.0±21.6	139.5±28.5	136.2±30.8	0.10
Maximum DBP	86.1±14.3	83.8±16.4	80.5±19.3	0.01*
Maximum MAP	102.5±16.2	103.5±20.4	101.2±23.1	0.60
Maximum pulse pressure	55.8±13.0	63.0±18.6	64.8±17.3	<0.001*

*Significant at 5% level of significance. BP: Blood pressure, SBP: Systolic BP, DBP: Diastolic BP, MAP: Mean arterial BP, SD: Standard deviation

described.[19] Ageing, among other factors, is a strong indicator of these abnormal circadian BP which have been associated with increased carotid intima thickness, left ventricular hypertrophy and cerebrovascular angiogenesis culminating in mild cognitive impairment and eventual vascular dementia.[11] In the current study, white-coat hypertension, clinic hypertension, blunted nocturnal BP dipping increased with ageing, worse in people older than 70 years. These findings were similarly reported in many other studies on the older population. However, little empirical data exist in older Nigerians.

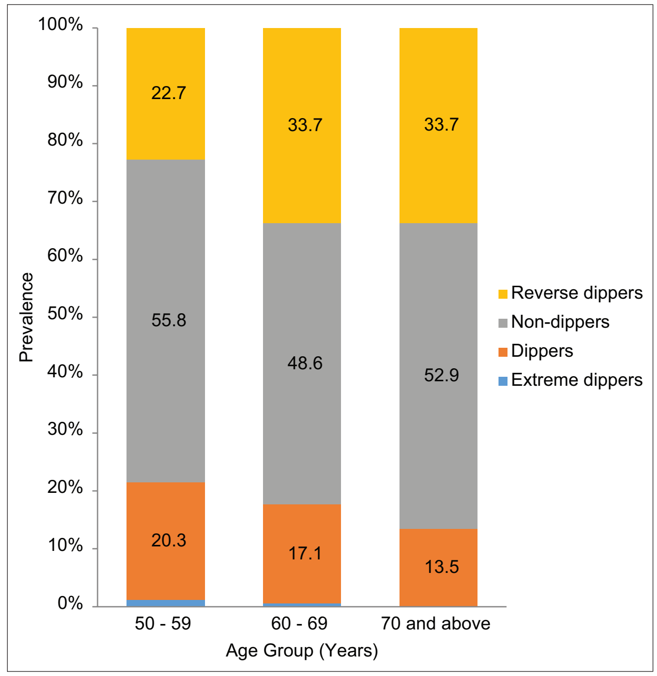

Figure 1: Prevalence of dipping status by age group

Both Jackson and European guidelines for assessing ABPM showed the highest proportion with most day time and masked hypertensive among 50–59 years, nocturnal hypertension among 60–69 years and white-coat hypertension among above 70 years. This suggests and calls for more profiling of BP phenotype using ABPM considering the high risk of cardiovascular outcome among these phenotypes.[20,22] However, this also highlights the previous worry that European guidelines may underestimate nocturnal hypertension.[12]

Limitations

Few limitations exist in this study. The study was limited to one centre, and it is difficult to generalise its findings to other settings in Nigeria. Furthermore, establishing causal relationships is difficult because of the descriptive nature of the study.

Conclusion

Our study showed a significant abnormal circadian BPV among people over 50 years. The finding that most of the respondents were non-dippers, including a significant proportion of older respondents being reversed dippers, was worrisome. Our findings of a significant increase in whitecoat and masked hypertension using both the Jackson's and European guides were in tandem with the reports from the literature. There is a need

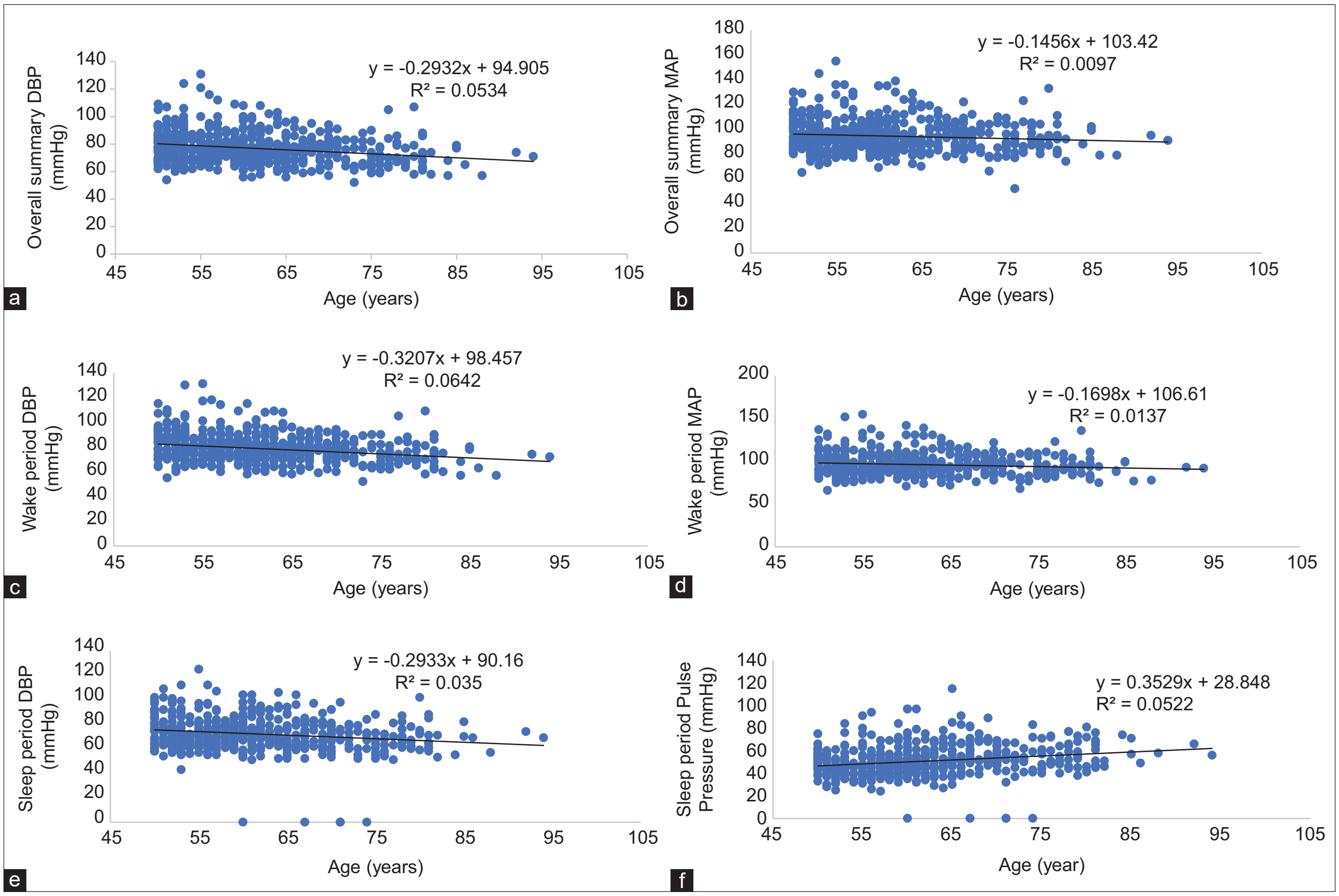

Figure 2: Linear relationship between age and overall summary DBP (a), Overall summary MAP (b), Wake period DBP (c), Wake period MAP (d), Sleep period DBP (e), Sleep period Pulse pressure (F). DBP: Diastolic blood pressure, MAP: Mean arterial blood pressure

Table 5: Hypertension diagnoses according to the age group

Variable	50-59 years (*n*=309), *n* (%)	60-69 years (*n*=210), *n* (%)	≥70 years (*n*=120), *n* (%)	*P*
Jackson guide				
Daytime hypertension	104 (39.2)	64 (32.8)	26 (23.0)	0.01*
Nocturnal hypertension	121 (48.0)	89 (48.1)	43 (39.8)	0.31
Masked hypertension	2 (0.8)	0	1 (0.9)	-
White-coat hypertension	74 (28.7)	87 (45.1)	60 (54.1)	<0.001*
European guide				
Daytime hypertension	107 (40.4)	72 (36.9)	35 (31.0)	0.22
Nocturnal hypertension	161 (63.9)	121 (65.4)	68 (63.0)	0.91
Masked hypertension	2 (0.8)	0	1 (0.9)	-
White-coat hypertension	71 (27.5)	79 (40.9)	52 (46.8)	0.01*

*Significant at 5% level of significance. Multiple diagnoses in individuals

for further longitudinal research on the prognostic significance of these data in the Nigerian pre-older and older populations. Therefore, we recommend routine screening and identification of BPV at first contact with pre-older and older persons in the clinic.

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Conflicts of interest

There are no conflicts of interest.

References

1. Ogah OS, Okpechi I, Chukwuonye II, Akinyemi JO, Onwubere BJ, Falase AO, *et al.* Blood pressure, prevalence of hypertension and hypertension related complications in Nigerian Africans: A review. World J Cardiol 2012;4:327-40.
2. Adeloye D, Basquill C, Aderemi AV, Thompson JY, Obi FA. An estimate of the prevalence of hypertension in Nigeria: A systematic review and meta-analysis. J Hypertens 2015;33:230-42.

3. Osunkwo D, Mohammed A, Kamateeka M, Nguku P, Umeokonkwo C, Abolade O, *et al.* Populationbased prevalence and associated risk factors of hypertension among adults in Benue State, Nigeria. Niger J Clin Pract 2020;23:944-9.
4. Shen C, Zhou Z, Lai S, Tao X, Zhao D, Dong W, *et al.* Urban-rural-specific trend in prevalence of general and central obesity, and association with hypertension in Chinese adults, aged 18-65 years. BMC Public Health 2019;19:661.
5. Oladapo O, Salako L, Sodiq O, Shoyinka K, Adedapo K, Falase A. A prevalence of cardiometabolic risk factors among a rural Yoruba southwestern Nigerian population: A population-based survey: Cardiovascular topics. Cardiovasc J Afr 2010;21:26-31.
6. Verdecchia P, Porcellati C, Schillaci G, Borgioni C, Ciucci A, Battistelli M, *et al.* Ambulatory blood pressure. An independent predictor of prognosis in essential hypertension. Hypertension 1994;24:793-801.
7. Floras JS. Blood pressure variability: A novel and important risk factor. Can J Cardiol 2013;29:557-63.
8. Rothwell PM. Does blood pressure variability modulate cardiovascular risk? Curr Hypertens Rep 2011;13:177-86.
9. McGrath BP, National Blood Pressure Advisory Committee of the National Heart Foundation of Australia. Ambulatory blood pressure monitoring. Med J Aust 2002;176:588-92.
10. Mancia G, Parati G. Ambulatory blood pressure monitoring and organ damage. Hypertension 2000;36:894-900.
11. Routledge F, McFetridge-Durdle J. Nondipping blood pressure patterns among individuals with essential hypertension: A review of the literature. Eur J Cardiovasc Nurs 2007;6:9-26.
12. Adeoye AM, Tayo BO, Owolabi MO, Adebiyi AA, Lackland DT, Cooper R, *et al.* Ambulatory blood pressure threshold for black Africans: More questions than answers. J Clin Hypertens (Greenwich) 2018;20:847-9.
13. Del Giorno R, Balestra L, Heiniger PS, Gabutti L. Blood pressure variability with different measurement methods: Reliability and predictors. A proof of concept cross sectional study in elderly hypertensive hospitalized patients. Medicine (Baltimore) 2019;98:e16347.
14. Li CL, Liu R, Wang JR, Yang J. Relationship between blood pressure variability and target organ damage in elderly patients. Eur Rev Med Pharmacol Sci 2017;21:5451-5.
15. Sega R, Corrao G, Bombelli M, Beltrame L, Facchetti R, Grassi G, *et al.* Blood pressure variability and organ damage in a general population: Results from the PAMELA study (Pressioni Arteriose Monitorate E Loro Associazioni). Hypertension 2002;39:710-4.
16. Pinto E. Blood pressure and ageing. Postgrad Med J 2007;83:109-14.
17. Dart AM, Kingwell BA. Pulse pressure – A review of mechanisms and clinical relevance. J Am Coll Cardiol 2001;37:975-84.
18. Qin X, Zhang Q, Yang S, Sun Z, Chen X, Huang H. Blood pressure variability and morning blood pressure surge in elderly Chinese hypertensive patients. J Clin Hypertens (Greenwich) 2014;16:511-7.
19. Pickering TG, Shimbo D, Haas D. Ambulatory blood-pressure monitoring. N Engl J Med 2006;354:2368-74.
20. Ravenell J, Shimbo D, Booth JN, Sarpong DF, Agyemang C, Moody DL, *et al.* Thresholds for ambulatory blood pressure among African Americans in the Jackson Heart Study. Circulation 2017;135:2470-80.
21. Hansen TW, Thijs L, Li Y, Boggia J, Kikuya M, Björklund-Bodegård K, *et al.* Prognostic value of reading-to-reading blood pressure variability over 24 hours in 8938 subjects from 11 populations. Hypertension 2010;55:1049-57.
22. Booth JN 3rd, Diaz KM, Seals SR, Sims M, Ravenell J, Muntner P, *et al.* Masked hypertension and cardiovascular disease events in a prospective cohort of blacks: The Jackson Heart Study. Hypertension 2016;68:501-10.

Appendix 1: Ambulatory blood pressure thresholds proposed for hypertension diagnosis Criteria

Criteria	Jackson Heart Study (mmHg)	IDACO (mmHg)	ESC/ESH guideline (mmHg)
24-h hypertension	≥135/80	≥130/80	≥130/80
Daytime hypertension	≥140/85	≥140/85	≥135/85
Night-time hypertension	≥130/75	≥120/70	≥120/70

Jackson Heart Study

Source: Ravenell J, Shimbo D, Booth JN 3rd, Sarpong DF, Agyemang C, Beatty Moody DL, *et al*. Thresholds for ambulatory blood pressure among African Americans in the Jackson Heart Study. Circulation 2017;135:2470-80

The IDACO

Source: Asayama K, Thijs L, Li Y, Gu YM, Hara A, Liu YP, *et al*. Setting thresholds to varying blood pressure monitoring intervals differentially affects risk estimates associated with white-coat and masked hypertension in the population. Hypertension 2014;64:935-42

The ESC/ESH guideline

Source: Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, *et al*. 2018 Practice Guidelines for the management of arterial hypertension of the European Society of Cardiology and the European Society of Hypertension. Blood Press 2018;27:314-40

IDACO: International Database of Ambulatory Blood Pressure in relation to Cardiovascular Outcome, ESC: European Society of Cardiology, ESH: European Society of Hypertension