

Original Article

Seasonal Blood Pressure Variations in Persons with Hypertension Seen in the Medical Out-Patients Department of Benue State University Teaching Hospital Makurdi, North Central, Nigeria

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ABSTRACT

Seasonal variation in blood pressure in hypertensive and healthy individuals has been reported in the context of winter and summer seasons in western countries. Cold temperatures in winter are associated with higher blood pressure levels while warm temperatures in summer have been associated with lower blood pressure levels. This is significant because (ambient cold temperature) has been linked to increased risk of cardiovascular disease (CVD) morbidity and mortality. The equivalent seasons for winter and summer in West Africa are the Rain and Dry seasons respectively. Not much has been done in terms of evaluating the impact of variations in seasons on blood pressure levels in our environment. Hence this study to determine the seasonal variation of blood pressure among hypertensives accessing care in Benue State University Teaching Hospital (BSUTH), Makurdi was carried out. This was a retrospective study involving hypertensive patients seen in the medical outpatients' department of the hospital between 1st November, 2018 and 31st October, 2019 in which patients' hospital records were reviewed. The systolic, diastolic Mean Arterial Blood Pressure (MAP), and weight readings were retrieved from the case notes and recorded. The dry season was taken as the period between 1st November, and 31st March, while the rainy season was taken as the period between 1st April and 31st October. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 21. There was a statistically significant increment in all mean systolic, diastolic, and MAP readings obtained during the rainy season compared to the dry season. Mean systolic blood pressure was 112.57 ± 18.7 in the rainy season compared to 100.70 ± 55.0 in the dry season ($p < 0.05$). In conclusion, it was observed that seasonal variation in blood pressure exists in hypertensive patients seen at BSUTH with higher values during the rainy season. Further studies are needed to evaluate the impact of seasonal variation on the adjustment of anti-hypertensive medications and on CVD morbidity and mortality.

Keywords: Blood pressure, Seasonal variation, Temperature.

INTRODUCTION

Blood pressure exhibits seasonal variation in various disease states. This has been observed in hypertensive patients (both treated and untreated).^{1,2,3} in haemodialysis patient.^{4,5} and after physical exercises⁶. Several reports from studies show that both systolic and diastolic blood pressure are highest

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in cold seasons.^{7,8} Seasonal variation in blood pressure in human is well documented in several studies. An earlier work done by Kauffman noted that systolic blood pressure (SBP) was 20-30mmHg higher on cool days than at other times⁹. Over time, other reports show that SBP and diastolic blood pressure (DBP) readings are higher in cold seasons^{7,8}. Rose¹⁰ in early 1960s found a clear seasonal trend in blood pressure readings with a peak in spring (late winter) and a trough in late summer¹⁰.

The causes of seasonal variation in blood pressure are not clear but several studies show inverse relationship between blood pressure level and environmental temperature.¹¹ Experimental work has shown that capillary vascular spasms occur in the cold season and are likely to contribute to elevated blood pressure.⁹ This phenomenon now viewed as part of human thermoregulation, consists of constriction of the peripheral vessels of the body under the cold conditions and subsequent increase in vascular resistance thus leading to rise in blood pressure.¹²

The first large scale population based study focusing on seasonal variation was published by Sega et al¹³ in late 1990s. It further contributed to knowledge that systolic blood pressure and diastolic blood pressures were higher in winter and lower in summer.

In the northern hemisphere mortality from cardiovascular disorders including ischaemic heart disease and stroke are higher in winter than summer.^{14,15} In patients undergoing chronic haemodialysis, cardiovascular disease is associated with increased morbidity and mortality in winter when compared to summer¹⁶

Few studies have been reported on the seasonal changes in blood pressure levels in Nigeria and the Sub-Region⁵. There are primarily two seasons in Nigeria. Dry season (November to March), and rain season (April, to October). Ambient temperature is generally higher during the dry season compared with the rainy season which is akin to summer and winter seasons respectively⁵. Hence our study sought to determine the seasonal variation in blood pressure in persons with hypertension receiving care in Benue State University Teaching Hospital, Makurdi.

MATERIALS AND METHODS

This was a retrospective study where records of 108 hypertensive patients on routine care at the medical outpatient department of Benue State University Teaching Hospital between 1st November, 2018 and 31st October, 2019, were retrieved and reviewed. Ethical clearance for this study was obtained from the Health, Research and Ethics Committee of Benue State University Teaching Hospital, Makurdi.

Information obtained were age, sex, dates of visit, systolic blood pressure, diastolic blood pressures, body weight in Kg, and height in metre, calculated body mass index (BMI). Dry season visits were recorded for those seen between 1st November to 31st March and rain season visits from 1st April to 31st October. Mean arterial blood pressure was calculated as 1/3 pulse pressure (Systolic BP – Diastolic BP) plus diastolic blood pressure¹⁷.

Statistical Analysis

The statistical package for social sciences SPSS Inc. Chicago (II) version 21.0 statistical software was used for data analysis. Quantitative variables were expressed as mean \pm standard deviation while categorical variables were expressed as proportions.

The t-test and the chi-square test were used in the comparison of means and proportions respectively. P-value < 0.05 was considered statistically significant.

RESULTS

The study population comprised 108 subjects who had hypertension, 53(49.1%) were males while 55(50.9%) were females. The age and sex distribution of patients is shown in Table 1. The mean SBP and DBP were 151.5 ± 26.3 mmHg and 93.4 ± 16.6 mmHg in the rainy season and 131.9 ± 34.1 mmHg and 81.2 ± 14.4 in the dry seasons respectively and the result was statistically significant at $P < 0.05$. The mean arterial blood pressure was significantly higher (112.53 ± 13.6) in the rain season compared to dry season (100.70 ± 55.97). There was no statistically significant difference in the BMI of the subjects between the two seasons $P > 0.05$. Table 2.

Table 1 Sex and Age Distribution of Patients

Gender	Frequency	Percent age
Male	53	49.1
Female	55	50.9
Total	108	100
Age		
0-30	4	3.7
31-39	12	11.1
40-49	23	21.3
50-59	40	37.0
<60	29	26.9
Total	108	100

Table 2: Seasonal Variation of Blood Pressure (mmHg)

	APRIL TO OCTOBER (RAINY SEASON)	NOVEMBER TO MARCH (DRY SEASON)	
	Mean	Mean	P value
SYSTOLIC	151.57±26.3	131.92±34.1	<0.05
DIASTOLIC	93.44±16.6	81.28±14.4	<0.05
MAP	112.56±13.6	100.70±56.0	<0.05
Weight	75.45±16.8	75.42±16.6	>0.05

Table 3: Monthly Mean Blood Pressure (mmHg) by measurement

MONTH	SYSTOLIC BP	DIASTOLIC BP	MAP
NOVEMBER	140.41±64.56	82.14±15.63	107.60±79.69
DECEMBER	130.10±23.91	81.33±14.72	97.37±16.76
JANUARY	131.51±21.48	81.30±13.69	97.10±15.32
FEBRUARY	129.09±21.17	80.55±12.81	104.75±93.36
MARCH	133.92±23.32	84.75±18.42	100.99±1765
APRIL	153.56±22.34	97.69±14.7	115.40±15.55
MAY	152.66±23.32	94.64±15.47	114.00±17.08
JUNE	152.19±28.25	90.94±18.35	110.70±19.77
JULY	146.42±23.59	90.55±17.36	108.40±19.24
AUGUST	152.32±28.56	93.44±15.15	112.62±19.06
SEPTEMBER	150.34±30.56	92.62±17.15	112.17±20.60
OCTOBER	154.51±27.02	93.51±15.08	114.79±18.47

Table 3 showing the mean SBP and DBP in mmHg by month. P value was <0.05

DISCUSSION

A higher mean systolic blood pressure, diastolic blood and mean arterial blood pressure was recorded during the rainy season as compared to the dry season, 151.57±26.3, 93.44±16.6 and 112.56±13.6 and 131.92±34.07, 81.28±14.40 and 100.70±55.97 respectively. These findings are similar with other studies done in other regions of the world^{10,15,18}.

Woodhouse PR et al¹⁸ in a study done in Cambridge in 1992 reported greater systolic blood pressure and diastolic blood pressure during winter across the whole distribution of blood pressure.

Rose¹⁰ and Curwen¹⁵ also reported higher blood pressure and increased cardiovascular mortality during winter (cold temperature).

Heller et al¹⁹ also reported similar seasonal variation in arterial blood pressure where ambient temperature

was found to have an inverse relationship with blood pressure.

Additionally Hopman and Remen²⁰ showed that blood pressure is higher in the cold months of the year than in the warm months.

Angel Argiles et al²¹ in their study carried out in Montpellier France in patient with end stage renal disease on maintenance haemodialysis also observed that blood pressure varies seasonally with higher values in the winter and lower values in the summer.

Ayiyan OP et al⁵ also observed from their study done in Lagos Nigeria that seasonal variation in BP exists in our environment with higher values during the rainy season compared with the dry season.

The cause of seasonal variation on blood pressure in humans is yet to be fully understood but numerous hypotheses have been put forth.

Exposure to winter (cold) weather conditions has been hypothesized to induce physiological and clinical changes including sympathetic activation, reflex coronary and sympathetic vasoconstriction.

This phenomenon is now viewed as part of human thermoregulation consisting of constriction of the peripheral vessels of the body under the cold conditions and subsequent increase in vascular resistance and blood pressure.^{12,22}

A study conducted in Japan reported an increase in blood pressure in winter associated with increased urinary catecholamine excretion. This might buttress the assumption that seasonal variation in blood pressure is due to activation of the sympathetic nervous system.²³ Another mechanism is through modification of the extracellular fluid since insensible fluid loss (via perspiration, transpiration) increases with higher temperatures²³.

Decreasing environmental temperatures may affect BP regulation through several mechanisms, first alterations in skin vasomotor tone resulting in a marked increase in vascular peripheral resistance and second activation of the sympathetic nervous system accompanied by secretion of catecholamines as well

as substances involved in heat production is considered to play a central role, as it produces arteriolar constriction and a subsequent increase in peripheral vascular resistance. In due course this may decrease sweating and therefore salt loss increasing the load of sodium on the kidney thus further contribution to the increase in blood pressure.^{1,2,3}

Evidence that an increased sympathetic activation may contribute to the rise in BP during winter time has been provided by several studies both in normotensive and essential hypertensive individuals showing an increased norepinephrine and epinephrine concentrations in plasma and urine accompanying the BP increase in cold season.^{24,25}

Also marked seasonal variation in loss of fluids and electrolytes through sweating and breathing accompanying seasonal BP changes have also been observed by some studies in which 24 hours urinary volume was shown to be significantly higher and inversely correlated in the mean ambient temperature during the winter season.²⁵

Additionally cold temperature may also increase erythrocyte deformability and blood viscosity, a major determinant of systemic vascular resistances²⁶. It has also been postulated that reduced intensity in ultraviolet light during winter leads to a reduction in the epidermal photosynthesis of vitamin D3 and parathyroid hormone which was shown in turn to be associated with elevated BP levels²⁶. As vitamin D is a negative regulator of the renin-angiotensin system, decrements of its blood levels in the winter period may lead to BP increments via an activation of the renin-angiotensin system.²⁷

The high temperature noted in summer and dry season result in vasodilatation, which in turn is thought to decrease peripheral vascular resistance and blood pressure.²⁸

The blood pressure associated with warm temperature is due to cutaneous vasodilatation, which in turn reduces the peripheral vascular resistance and BP.²⁹

Conclusion and recommendations

This study reveals that seasonal variation of blood pressure exists in hypertensives accessing care in our environment just as reported in other regions of the world. It is desirable to carry out similar studies in other parts of Nigeria and Africa as well as investigate the impact of variation of blood pressure on the morbidity and mortality in patients with elevated blood pressure.

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