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WEST AFRICAN JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Association between Height and Blood Pressure in Middle Age and Older Adults in Southeast Nigeria

Association Entre la Taille et la Pression Artérielle chez les Personnes d'Age Moyen Age et plus Agés Adultes du Sud-Est du Nigeria

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ABSTRACT

BACKGROUND: This study was carried out in Abia State, Southeast Nigeria, to determine the association between height and blood pressure in middle age and elderly adults.

MATERIALS AND METHODS: This was a cross-sectional study carried out in Abia State, Southeast Nigeria, between August 2011 and March 2012. The participants were residents in the state and were recruited from the three senatorial zones of the state. The total number of participants that took part in the study was 2,487 adults. The World Health Organisation STEPwise approach to surveillance of chronic disease risk factors was used. Information collected included blood pressure and anthropometric measurements. The association between height and blood pressure was determined.

RESULTS: A total of 1,363 participants that took part in the study were ≥40 years old. Six hundred and fifty-five participants (48.1%) were males and 708 participants (51.9%) were females. There was no significant inverse relationship between height and blood pressure components (Systolic Blood Pressure Diastolic Blood Pressure, and Pulse Pressure) among the males. Among the females there was a high inverse relationship between height and blood pressure components. However, this relationship was not statistically significant. In addition, among the males there was no relationship between height and hypertension. Among the females, there was some degree of inverse relationship between height and hypertension, although multivariate regression analysis showed that this was not significant.

CONCLUSION: There was an inverse but non-significant relationship between height and blood pressure components/ hypertension among males and females in Southeast Nigeria in this study. **WAJM 2022; 39(2): 127–133.**

Keywords: Height, Hypertension, Pulse Pressure, Systolic Blood Pressure, Diastolic Blood Pressure,

RÉSUMÉ

CONTEXTE: Cette étude a été menée dans l'État d'Abia, au sud-est du Nigeria, pour déterminer, pour déterminer l'association entre la taille et la pression artérielle chez les adultes d'âge moyen et les personnes âgées.

MATÉRIEL ET MÉTHODES: Il s'agissait d'une étude transversale réalisée dans l'État d'Abia, au sud-est du Nigeria, entre août 2011 et mars 2012. Les participants étaient des résidents de l'État et ont été recrutés dans les trois zones sénatoriales de l'État. Le nombre total de participants ayant pris part à l'étude était de 2 487 adultes. L'approche STEPwise de l'Organisation mondiale de la santé pour la surveillance des facteurs de risque des maladies chroniques a été utilisée. Les informations recueillies comprenaient la pression artérielle et les mesures anthropométriques. L'association entre la taille et la pression artérielle a été déterminée.

RÉSULTATS: Au total, 1 363 participants à l'étude étaient âgés de plus de 40 ans. Six cent cinquante-cinq participants (48,1%) étaient des hommes et 708 participants (51,9 %) étaient des femmes. Il n'y avait pas de relation inverse significative entre la taille et les composantes de la pression artérielle (pression artérielle systolique, pression artérielle diastolique et pression du pouls) chez les hommes. Chez les femmes, on a constaté une forte relation inverse entre la taille et les composantes de la pression artérielle. Cependant, cette relation n'était pas statistiquement significative. En outre,
Chez les hommes, il n'y a pas de relation entre la taille et l'hypertension. Chez les femmes, on a constaté un certain degré de relation inverse entre la taille et l'hypertension, bien que l'analyse de régression multivariée a montré qu'elle n'était pas significative.

CONCLUSION: Il existe une relation inverse, mais non significative, entre la taille et les composantes de la pression artérielle/ hypertension chez les hommes et les femmes du sud-est du Nigeria. **WAJM 2022; 39(2): 127–133.**

Mots clés: Taille, Hypertension, Pression artérielle, Pression artérielle systolique.

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INTRODUCTION

Hypertension is an important and preventable cause of cardiovascular events and it is also a major cause of morbidity and mortality worldwide.[1] Globally, the number of people that have hypertension is around one billion.[2] In Nigeria, most cases of stroke, heart failure, ischemic heart disease, and renal failure were related to hypertension.[3]

Height is an established risk factor for cardiovascular diseases. A study carried out in 1951 reported that young men at risk for coronary artery disease were about 5cm shorter than their healthy counterparts. In addition, another study in 1967 extended these observations to the risk of developing a fatal stroke among longitudinally followed university students. The study reported that among the study participants, those that suffered stroke were 2 to 3cm shorter.[4] Some studies have also been carried out on height and cardiovascular diseases since then.[5,6]

The association between height and non-communicable diseases (NCDs) like hypertension,[4] diabetes mellitus[7] and cancer[8] has been explored by some studies carried out in different regions of the world. However, there is a dearth of data emanating from sub-Saharan African countries on the relationship between height and NCDs.[9] This study was, designed to test the hypothesis that height has an inverse relationship to blood pressure/hypertension in middle age and older adults in southeast Nigeria.

MATERIALS AND METHODS

The methodology used in the Abia State, Nigeria, Non Communicable Diseases (NCDs) and NCDs related risk factors survey had been described in an earlier publication.[10] The survey was designed to determine the burden of NCDs and the associated risk factors in Abia State, Southeast Nigeria using the World Health Organisation (WHO) STEPwise – approach to surveillance.[11]

Ethics Statement

Ethics approval for the study was given by the Abia state Ministry of Health Ethics Review Committee.

Study Population

The study was carried out in Abia State, one of the five states in southeast Nigeria: adult males and females of $\geq$18 years old were recruited as participants. Abia State is predominantly inhabited by indigenous Igbo people of Nigeria (Figure 1).[12] It is one of the three major ethnic groups in Nigeria. The study was a population-based cross-sectional observational study. A multistage stratified sampling method was used to randomly select the study participants from the three senatorial zones and 17 LGAs in the state. The three senatorial zones included: Abia North, Abia Central and Abia South. One rural and one urban LGA were randomly selected from each senatorial zone. They were Ohafia and Isuikwuato/Bende for Abia North, Umuahia North and Ikwuano for Abia Central, and Aba South and Ukwa East for Abia South senatorial zones.

Study Design

The study was cross-sectional and the WHO STEPwise approach to surveillance guidelines was used in calculating the sample size. The minimum calculated sample size using the WHO STEPwise questionnaire guideline was 2,880. However, 2,999 participants were interviewed. Complete data were obtained from 2,487. Details on how the sample size was calculated had been published earlier.[10]

Study Questionnaire

The data collection was performed using the WHO-STEPwise approach surveillance questionnaire and these were carried out by trained health workers. A wide range of information was collected using the questionnaire and these included the age of the participants, gender, history of tobacco and alcohol consumption, and dietary information on vegetables and fruits consumption (socio-demographic parameters). Additional information collected included personal history, family history of NCDs such as cancer, diabetes, asthma, hypertension and awareness of common NCDs and physical activities. Anthropometric indices recorded included height and weight. Body mass index (BMI) was calculated using the height and weight of the participants and was categorized using the WHO classification.[13]

The blood pressure measurements were carried out in sitting position in accordance with the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. (JNC 7 guidelines)[14] Participants that had SBP $\geq$140 mmHg and or DBP $\geq$90 mmHg or had normal blood pressure but were pharmacologically being treated for hypertension were classified as hypertensive.

Data Analysis

The data collected were first entered into Epidata software using double entry technique. They were cleaned and exported to Statistical Package for Social Sciences (SPSS), IBM Corp, US, version 21 for analysis. A subset of the data comprising adults aged $\geq$40 years was analyzed. Descriptive statistics was done to estimate mean age, height, body mass index (BMI) and physical activity, proportion of each sex, marital status, educational status, use of tobacco, alcohol use, consumption of vegetables and fruits, family history of hypertension and age-adjusted prevalence of hypertension and diabetes among the subjects. One-way ANOVA was done to compare differences in mean blood pressure (systolic blood pressure, diastolic blood pressure and pulse pressure) among the subjects categorized by height quartiles. Multiple linear regression analysis was done to estimate the relationship between height and blood pressure components. The association between height and hypertension was determined using chi-square test and multiple logistic regression analysis. The level of statistical significance was assumed to be <0.05. Regression analysis of association between height, blood pressure components and hypertension were done using three models, which included age adjusted model 1, age and BMI adjusted model 2 and Model 3 adjusted for age, BMI, education, physical activity, marital status, current smoking status, current drinking status, dietary intake frequency categories (including vegetables and fruits), diabetes, and family history of hypertension.

RESULTS

One thousand three hundred and sixty three of the participants in the study were ≥40 years old, comprising 655 (48.1%) males and 708 (51.9%) females. The mean ages were 58.6+13.5 years, 58.5+12.9 years and 58.5+13.2 years for the males, females and all the participants respectively. The mean height was 165.98+8.28cm for males, 155.65+8.04cm for females and 160.66+9.65cm for both males and females. The prevalence of hypertension was 59.1%. The prevalence of hypertension for males and females were 59.2% and 59.0% respectively (Table 1).

There was consistent inverse relationship between height and SBP/PP for males; but this was not statistically significant. The mean difference of SBP and PP observed was also not statistically significant. However, among females, there was consistent decline in SBP and PP with increasing height. In females also, the DBP declined consistently with increasing height, but, it increased in the Q4 (highest) group (Table 2 and Figure 2a, and Figure 2b). Post hoc analysis showed significant difference in mean SBP and mean PP among females (Q3 vs. Q1, $p<0.01$ for SBP, and Q3 vs. Q1 $p<0.01$ for PP).

The multivariate linear regression analyses were used to explore the association between height and blood pressure components (Table 3). For the males, there was no inverse relationship between height and blood pressure (SBP, DBP, PP) for model 1 (age adjusted), model 2 (age and BMI adjusted) and Model 3 (adjusted for age, BMI, education, physical activity, marital status, current smoking status, current drinking status, dietary consumption including vegetables and fruits), diabetes, and family history of hypertension. While for females, an inverse relationship was observed between height and blood pressure (SBP, DBP and PP) for all the models, however these relationships were not statistically significant.

Table 4 shows age adjusted prevalence of hypertension according to the height quartiles. Among the males, there was a consistent decline in the prevalence of hypertension with increasing height, even though this was not statistically significant. However, among the females, there was a consistent decline in the prevalence of hypertension (except for Q4) with increasing height and the association was statistically significant.

Table 5 displays the age-adjusted and multivariate-adjusted odds ratios (ORs) and 95% CIs for hypertension according to quartiles of height. In the age-adjusted analysis (model 1), increased height was associated with

Table 1: Age-adjusted Characteristics of the Participants according to Height Quartiles

Variable	Height Quartile				P value
	Q1	Q2	Q3	Q4	for Trend
Men					
Age (years)	65.97±13.81	61.93±14.31	56.75±12.06	54.74±12.74	<0.001
BMI (kg/m2)	23.84±3.85	23.98±3.90	25.30±4.07	24.48±3.89	0.018
Married (%)	85.3	94.6	87.9	94.2	0.206
Education Status (%)					
≥Secondary)	29.3	39.2	48.3	64.5	<0.001
<Secondary	70.7	60.8	51.7	35.5	
Physical Activity (MET, h/wk)	871±827	1043±867	1134±938	1126±962	0.224
Current smoker (%)	4.0	8.5	11.1	8.7	0.166
Current alcohol intake (%)	64.0	60.0	72.1	70.0	0.224
Diabetes mellitus (%)	2.2	5.9	8.5	6.6	0.324
Family history of hypertension (%)	10.7	17.1	22.7	31.8	0.001
Dietary intake (%)					
Vegetable consumption	67.8	71.9	74.4	73.3	0.405
Fruit Consumption	18.6	28.0	29.2	34.9	0.018
Women					
Age (years)	61.71±13.62	55.68±16.37	56.04±10.93	53.08±13.15	<0.003
BMI (kg/m2)	25.16±5.19	25.89±4.64	24.52±4.55	26.18±5.95	0.333
Married (%)	70.2	76.5	77.3	76.0	0.113
Education Status (%)					
≥Secondary	21.9	38.3	44.2	58.3	<0.001
<Secondary	78.1	61.7	55.8	41.7	
Physical Activity (MET, min/wk)	825±773	817±791	1024±808	1641±1679	0.005
Current smoker (%)	0.3	0.0	0.0	0.0	0.426
Current alcohol intake (%)	25.8	26.1	26.1	50.0	0.331
Diabetes mellitus (%)	4.8	5.4	3.5	14.3	0.811
Family history of hypertension (%)	15.5	20.7	19.5	8.3	0.416
Dietary intake (%)					
Vegetable Consumption	71.7	69.1	61.6	50.0	0.032
Fruit Consumption	29.7	32.9	40.7	25.0	0.145

Table 2: Age-adjusted Mean Blood Pressure according to Height Quartiles by Sex

Blood Pressure	Height Quartile				P Value
	Q1N=	Q2	Q3	Q4	for Trend
Men					
SBP	146.54±26.67	146.02±26.41	145.73±25.88	142.52±20.10	0.517
DBP	81.57±11.59	82.33±14.27	84.04±14.26	82.96±12.46	0.527
PP	65.63±21.35	64.09±19.74	61.68±17.93	59.37±13.75	0.051
Women					
SBP	147.62±27.81	140.71±27.59	135.69±22.35	135.68±15.90	0.001
DBP	83.29±13.57	81.27±12.61	79.90±12.26	81.33±8.13	0.148
PP	64.78±20.55	60.12±19.40	56.10±14.58	57.76±14.03	0.002

SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; PP, Pulse Pressure.

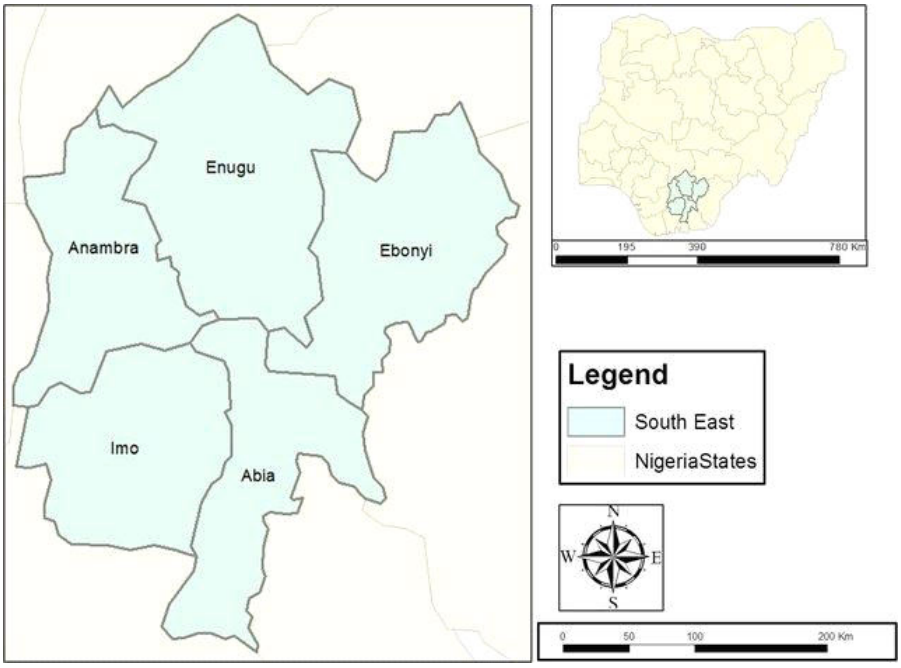

Fig. 1: Map of the South East Region of Nigeria showing the Five Component States. Map of Nigeria is inset. Reference Anejionu, *et al.* [11]

females. However, even though the DBP declined consistently with height, it increased in the Q4 (highest) group. Post hoc analysis showed significant difference in mean SBP and mean PP among females. In males, there was consistently inverse relationship between height and SBP/PP, however, this was more profound in the females. The multivariate linear regression analyses showed that for females there was an inverse relationship between height and blood pressure components, however this relationship was not statistically significant, same goes for the males. Olatunbosun, *et al*[9] in a study carried out in southwest Nigeria involving 998 participants reported that there was no association between height and blood pressure. However, multivariate logistic regression analysis was not carried out; in addition, separate analysis for males and females was also not reported in their study.

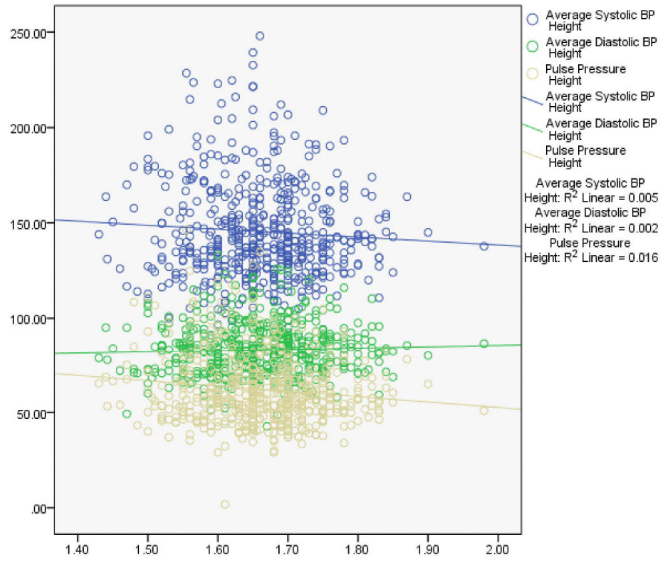

Fig. 2a: Correlation between Blood Pressure Components and Height in Males.

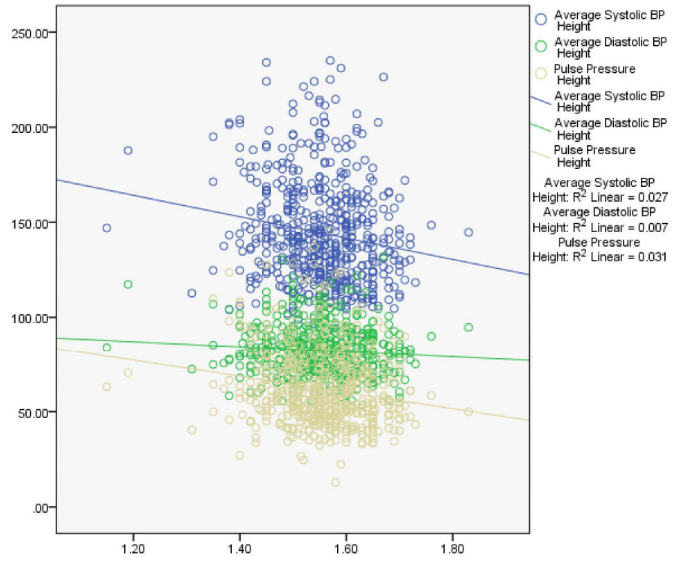

Fig. 2b: The Correlation between Blood Pressure Components and Height in Females.

slightly increased likelihood of hypertension in males though not statistically significant (the highest vs. shortest quartile: OR, 0.89; 95% CI, 0.577–1.372) P for trend <0.384). Among the females, there was a slightly -increased odd of hypertension for increased height though not statistically significant OR, 0.707; 95% CI, 0.203–2,592, P for trend <0.719). After adjustment for BMI (model 2), the inverse association between height and hypertension showed no significant trend and same observation was made in model 3 among males and females.

DISCUSSION

In this study, we found that there was a better consistent decline in SBP and PP with increasing height among the

Song, *et al*[15] reported that age-adjusted mean SBP decreased linearly with increasing height among males and females, and added that PP showed the same trends as SBP for height in both males and females. Post hoc analyses showed that taller individuals had lower SBP and PP than those with short height in both males and females. The multivariate regression analyses showed

inverse associations between height and SBP/PP among males and females. In model 3, a linear change in SBP was found to be "0.163 mmHg (95% confidence intervals (CI), "0.242, "0.084) for males and "0.248 mmHg (95% CI, "0.317, "0.179) for females, lower for every centimeter increase in height. Each centimeter increase in height was associated with a reduction of 0.216 mmHg for males and 0.272 mmHg for females in PP. No association was found between height and DBP after adjustment for potential factors among males and females. The association in our study was not significant, probably because of the much smaller sample size 1,363 compared to the much larger sample size in Song et al study 33,197. The difference in geographical region and culture may also have contributed to the differences observed. Bourgeois, *et al*[4] in a multiracial study carried out in United States reported that prior to age 30 years, the height effect on SBP was positive and relatively small, while beginning in the 4th decade, the height effect was increasingly negative with greater age among both gender. The study further noted that the association between height and PP/DBP depends on potential confounders like BMI, age and race/ethnicity for both gender. Schooling, *et al*[16] reported that height was inversely associated with increased blood pressure but only after adjustment for central obesity. However, in our study, the relationship between height and blood pressure components did not depend on potential cofounders. Landenberg, *et al*[17] reported that shorter height and leg length but not trunk length, were associated with higher blood pressure

Table 3: Regression Coefficients (95% CIs) of Blood Pressure Components for each Centimeter increase in Height by Gender

	SBP		DBP		PP	
	Coefficient (95% CI)	**P value**	**Coefficient (95% CI)**	**P value**	**Coefficient (95% CI)**	**P value**
Men						
Model 1	0.042 (–0.203–0.288)	0.735	0.095 (–0.051–0.241)	0.203	–0.090 (–0.271–0.090)	0.327
Model 2	0.052 (–0.194–0.297)	0.678	0.090 (–0.052-0.239)	0.209	–0.078 (–0.260–0.103)	0.397
Model 3	0.100 (–0.244–0.445)	0.566	0.083 (–0.154-0.319)	0.490	0.022 (–0.218–0.262)	0.855
Women						
Model 1	–0.244 (–0.512–0.024)	0.074	–0.128 (–0.272–0.014)	0.077	–0.105 (–0.298–0.086)	0.286
Model 2	–0.198 (–0.470–0.075)	0.155	–0.084 (–0.228–0.061)	0.255	–0.107 (–0.304–0.090)	0.287
Model 3	–0.239 (–0.610–0.135)	0.210	–0.155 (–0.315–0.085)	0.257	–0.122 (–0.391–0.147)	0.372

SBP, systolic blood pressure; DBP, diastolic blood pressure; PP, pulse pressure; CI, confidence interval Model 1: adjusted for age. Model 2: adjusted for age, body mass index. Model 3: adjusted for age, body mass index, education, physical activity, marital status, current smoking status, current drinking status, dietary intake frequency categories (including vegetables and fruits), diabetes, and family history of hypertension.

Table 4: Age Adjusted Prevalence of Hypertension according to Height Quartiles by Sex

Blood Pressure	Height Quartile				P Value
	Q1	**Q2**	**Q3**	**Q4**	**for trend**
Men	75	130	208	156	
Hypertension (%)	62.7	61.5	58.2	59.0	0.496
Women	330	180	88	12	
Hypertension (%)	63.0	54.4	51.1	58.3	0.030

Table 5: Age-adjusted and Multivariate Adjusted ORs (95% CIs) of Hypertension according to Height Quartiles by Sex

	Height Quartile				
	Q1 (Shortest)	**Q2**	**Q3**	**Q4 (Highest)**	**P value for Trend**
Men					
No of Cases	**75**	**130**	**208**	**156**	
Model 1	1.00 (reference)	0.765 (0.419–1.398)	0.852 (0.517–1.404)	0.890 (0.577–1.372)	0.384
Model 2	1.00 (reference)	0.729 (0.396–1.343)	0.836 (0.505–1.389)	0.818 (0.526–1.273)	0.311
Model 3	1.00 (reference)	0.530 (0.199–1.413)	0.816 (0.305–1.254)	0.619 (0.305–1.234)	0.795
Women					
No of Cases	**330**	**180**	**88**	**12**	
Model 1	1.00 (reference)	0.901 (0.271–2.987)	0.767 (0.229–2.572)	0.707 (0.203–2.592)	0.719
Model 2	1.00 (reference)	0.876 (0.261–2.938)	0.714 (0.210–2.421)	0.705 (0.200–2.485)	0.676
Model 3	1.00 (reference)	1.548 (0.239–10.03)	1.304 (0.199–8.564)	0.927 (0.133–6.455)	0.682

(SBP and PP) in males and females. In their prospective birth cohort study, they found strong evidence that the inverse associations between both height and leg length, and pulse pressure and systolic blood pressure were amplified with age, independent of potential confounders. The mechanism responsible for the reported inverse association between height and blood pressure/hypertension is unclear. It is suggested that it may be a reflection of the dynamic properties of the arterial tree. Usually, reflected waves arrive at the central aorta in late systole or early diastole at normal wave velocity. The shorter the atrial tree length as in short people, the earlier the reflected waves arrive in the central aorta, augmenting the central pressure and PP in late systole.[15]

We found also in our study that age adjusted prevalence of hypertension was consistent with a decline in prevalence of hypertension with increasing height in males even though this was not statistically significant. In addition, among the females, there was consistent decline in prevalence of hypertension with increasing height and the association was more profound than that observed among the males. However, the multivariate analysis showed that there was no significant association between height and hypertension in both males and females. A household survey involving representative adults in Rio involving 2,802 participants suggested that short women but not men were associated with prevalence of hypertension after adjustment for potential confounders.[16] There is a dearth of data from Africa to compare our study with. Although a number of studies regarding association between height and blood pressure components and hypertension in adults had been carried out globally, the reports are often inconsistent. Bourgeois, *et al,*[4] Song, *et al,*[15], Sichieri, *et al*[18] and EL-Bikaia, *et al*[19] reported that in middle age and older subjects there was a strong inverse association between height and hypertension in both males and females. The reasons for the differences are not known but may include difference in race, cultural habits and possibly sample size. However, findings from different regions of the world are not consistent as earlier stated.

CONCLUSION

There were some levels of inverse relationships between height and blood pressure component/hypertension in both genders, more so among females. However, these were not significant among males and females in Southeast Nigeria.

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Limitation

The sample size for the study was small when compared with the sample sizes of the studies that reported a significant inverse relationship between height and blood pressure/hypertension.

What is known about this Topic

A Blood pressure tends to increase with increasing body mass index

B Height is a component for the measurement of body mass index

C The relationship between height and blood pressure has not been completely evaluated.

What this Study adds to knowledge

A The association between height and blood pressure in adults in middle and older age group should not be ignored in clinical practice.

B In adult males in middle and older age groups, there was no significant relationship between height and blood pressure (across the 3 blood pressure components – SBP, DBP and pulse pressure).

C In females in middle and older age groups, there was a greater inverse relationship between height and blood pressure. However, this also was not significant.

Disclosure

There were no conflicts of interest in this survey by any of the authors.

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