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Vascular Reactivity in Normotensive Male and Female Subjects in a Nigerian Population

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ABSTRACT

Hypertension is a medical condition that does not have specific clinical manifestations until organ damage is set-in and its prevalence is said to be highest in Africa. The objective of this study is to assess and compare vascular reactivity in normotensive male and female Nigerians in order to screen for those at risk of developing hypertension.Thirty-six apparently healthy, young normotensive male and female subjects, aged 18 years – 37 years were exposed to cold pressor test (CPT). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured before and after exposure to the CPT. Blood pressure was determined by auscultatory method. Subjects were instructed to immerse one foot up to the ankle into ice slurry maintained at 4°C for 1 minute[2]. [11]Vascular hyper-reactivity was determined as an increase in the subject's systolic or diastolic blood pressure $\geq$ 15 mmHg after exposure to the CPT. In the parameters measured, SBP and DBP increased significantly ($p< 0.0001$) after exposure to CPT. There were no significant differences ($p> 0.05$) in SBP and DBP responses to the CPT between the male and female subjects. However, Systolic hyper-reactivity was observed in 56% of the male subjects while 50% of them demonstrated diastolic hypereactivity. On the other hand, 50% of the female subjects showed systolic hyper-reactivity while 56% of them demonstrated diastolic hyper-reactivity, indicating vulnerability of these individuals to development of hypertension in the future. Since at least,half (50%) of the study population were hyper-reactive in their SBP or DBP, drastic action on preventive measures should be targeted at those at risk of developing hypertension, so as to stem the rising incidence and prevalence of hypertension in Africa.

Key words: Vascular Reactivity, Cold Pressor test, Hypertension

INTRODUCTION

Globally, the incidence and prevalence of cardiovascular disorders are increasing alarmingly.[1] Hypertension is the single most important risk factor for stroke and coronary artery disease worldwide.[2,3,4] Hypertension, a silent killer, affects more than one billion people in the world and responsible for about 9 million deaths, annually, globally.[1]Africa has been reported to have the highest prevalence of hypertension in the world with the prevalence rate of 46% in adults aged 25 years and above.[5,6]The prevalence is documented to be higher in men than women.[7,8] Women have been reported to have lower systolic blood pressure levels than that of men in early adulthood.[7] After menopause, however, the prevalence of elevated blood pressure is reported to be greater in women than men.[7,9] Essential or fixed hypertension in adulthood may begin in adolescence and one of the basic methods used in search for potentially hypertensive patients is the application of a provocative test (cold pressor test) designed to gauge the response of the blood pressure to the external stimulus and this provocative test, is based on the premise that an excessive response to the external stimulus is indicative of future hypertension[10,11] Vascular reactivity can be simply defined as the magnitude of change in blood pressure or other haemodynamic parameters in response to physical or mental stimuli.[12] It was proposed by Hines and Brown that a hyper-reactive response of blood pressure to an externally applied stimulus was an inherited trait and that a period of vascular hyper-reactivity preceded the development of fixed hypertension.[13,14] Blood pressure and heart rate responses to cold pressure test are well characterized and differential responses have been seen in a variety of clinical populations and conditions.[15,16] Although , vascular reactivity varies with individual characteristics such as genetic predisposition, level of stress that the individual is exposed to at work or from finances, personality factors, emotion as well as racial factor; blacks have been shown to have a higher vascular reactivity to stress than their white counterparts[17,18]

Since, hypertension does not have specific symptoms until organ damage manifests and its prevalence is highest in Africa, there is need for a study to assess vascular reactivity in normotensive Nigerian subjects so as to screen for those at risk of developing hypertension, in order to give room for early interventional measures in the susceptible individuals.

MATERIALS AND METHODS

Thirty-six apparently healthy, normotensive male and female Nigerians, aged18years – 37years were exposed to cold pressor test (CPT) after they had been fully informed about the study and informed consent was obtained. The selection of subjects was primarily based on their health status. From their medical history taken, they were not hypertensive or diabetic and none of them was suffering from any psychological disease as any of these disease conditions, could adversely affect the outcome of our findings. The subjects were capable of performing CPT. Volunteers were excluded from participating, if there was any history of smoking, use of hypoglycaemic, oral contraceptive, antihypertensive, vasoactive, phenothiazine or tricylic antidepressant drugs that could affect autonomic nervous system. Subjects' ages were taken to their nearest birthdays. Body weight was determined with a weighing scale and measured to the the nearest 0.01 kg and height was measured to the nearest 0.01m by means of a wall-mounted stadiometer. BMI was determined by dividing the subject's weight in kilogrammes by his or her in metres. SBP and DBP were measured before and after exposure to the CPT. Blood pressure was determined by auscultatory method using Accuson mercury sphygmomanometer model as per described instructions of America Heart Association.[19,20]

The subjects were allowed to sit comfortably. A blood pressure reading was obtained at the beginning of the test after a period of 10 minutes rest. This was the casual blood pressure, taken from the right hand. Serial blood pressure readings were then taken at 10-minute intervals until three almost identical readings were obtained. The last of these measurements was designated the basal blood pressure.[11]Each of the subjects was then instructed to immerse one foot up to the ankle into ice slurry maintained at 4°C for 1 minute.[21] After 1 minute of foot immersion, blood pressure readings were taken in the right arm thrice at 15-second intervals; the highest of these readings was designated the peak blood pressure[10,11] Vascular reactivity was determined from the differences in the peak and basal blood pressure.[10,11]Vascular hyper-reactivity was determined as an increase in the subject's systolic or diastolic blood pressure $\geq$ 15 mmHg after exposure to the CPT.[11]Subjects whose blood pressure showed a rise < 15 mmHg be it systolic or diastolic, were designated normoreactive ones.

Data Analysis

Data were analyzed using GraphPad Statistical Software, Version 5 for Windows (GraphPad Software, San Diego, California, USA). Data are expressed as mean ± SEM. Changes in SBP and DBP in the subjects were analyzed using paired student's t- test and variations between the male and female subjects were determined using unpaired student's t- test and $p < 0.05$ was considered statistically significant.

RESULTS

The baseline characteristics of the subjects

The baseline characteristics of the study subjects are shown in Table 1. Although, there was a significant difference ($p < 0.05$) in the mean ages of male and female subjects, there were no significant differences ($p > 0.05$) in the means of their body weights and body mass indices (BMI) between the male and female subjects. Besides, the subjects were young; the females were still in their reproductive age group. There was significant difference in the baseline systolic blood pressure between the male and females subject, the SBP being significantly lower ($p < 0.05$) in females than males (Table 1).

Vascular reactivity in the subjects

Table 2 shows the vascular reactivity in the study subjects. After exposure to cold pressor test, the mean systolic blood pressure of all the subjects increased significantly ($p < 0.0001$) from 113.60 ± 1.76 mmHg to 132 ± 2.81 mmHg. Their diastolic blood pressure also increased significantly ($P < 0.0001$) from 75.86 ± 1.56 mmHg to 93.64 ± 2.22 mmHg, after exposure to cold pressor test. When considering the effect of gender on vascular reactivity in the study subjects by assessing the effect of cold pressor test on their blood pressure, there were no significant differences ($p > 0.05$) in the systolic and diastolic blood pressure between the male and female subjects even though, there were differences in the mean changes of their systolic and diastolic blood pressure (Table 3).

Table 1: Baseline characteristics of the study subjects

Parameters	Males (N = 18)	Females (N = 18)	P value
Age (yr)	27.11±1.06	23.56 ± 1.47	0.029*
Body Weight (kg)	79.67 ± 2.98	70. 56 ± 3.84	0.069 NS
Height (m)	1.72 ± 0.02	1.60 ± 0.02	0.0001***
BMI (kg/m^2)	26.74 ± 0.95	27.32 ± 1.10	0.693 NS
SBP (mmHg)	120.4 ± 2.35	110.7 ± 2.38	0.0061**
DBP (mmHg)	79.72 ± 2.13	74.28 ± 2.38	0.097 NS

Values are expressed in mean ± SEM

KEY:
BMI – Body mass index
SBP – Systolic blood pressure
DBP – Diastolic blood pressure
SEM – Standard error of mean
NS – Not significant

Table 2: Vascular reactivity in the study subjects

		(N = 36)		
Parameters	**Basal Value**	**Peak Value**	**Δ: (P – B)**	**p value**
SBP (mmHg)	113.00 ± 1.76	132.60 ± 2.81	15.58 ± 3.31	< 0.0001*
DBP (mmHg)	75.86 ± 1.57	93.64 ± 2.22	17.78 ± 2.72	< 0.0001*

Values are in Mean ± Standard error of mean

KEY:
SBP = Systolic blood pressure
DBP = Diastolic blood pressure
P = Peak value
B = Basal value
N = Number of subjects

Hyperreactivity in the study Subjects
On hyprereactivity in the study subjects, 56% of the male subjects demonstrated systolic hyper-reactivity while 50% of them showed diastolic hyper-reactivity (Table 4). On the other hand, 50% of the female subjects observed, showed hyper-reactivity in their systolic blood pressure while 56% demonstrated diastolic hyper-reactivity (Table 4). However, when comparing the percentages of hyperreactors in systolic and diastolic blood pressure between the male and female subjects, there were no significant differences ($p > 0.05$) in their hyperactivity (Table 4).

Table 3: Effect of gender on the vascular reactivity in the study subjects

Parameters	Males (N= 18)	Females (N= 18)	p Value
Δ SBP: (Peak SBP – Basal SBP) (mmHg)	20.11 ± 3.01	19.06 ± 3.44	0.819 NS
Δ DBP: (Peak DBP – Basal DBP) (mmHg)	15.33 ± 2.67	19.67 ± 2.62	0.255 NS

Values are in Mean ± SEM

KEY
Δ SBP = Change in systolic blood pressure
Δ DBP = Change in diastolic blood pressure
N = Number of subjects
NS = Not significant

Table 4: Hyper-reactivity in the study subjects

Hyperreactors	Males (N = 18) frequency (%)	Females (N =18) frequency (%)	p value
Systolic blood pressure	10 (55.56)	8 (44.44)	0.519 NS
Diastolic blood pressure	9 (50.00)	10 (55.56)	0.747 NS

KEY:
N = Number of subjects
NS = Not significant

DISCUSSION

The lower baseline systolic blood pressure seen in the female subjects is in agreement with what has been been previously reported by researchers that premenopausal women have lower systolic blood pressure than their counterpart men.[7]This difference may be due to the effect of oestogen on cardiovascular function in premenopausal women as it has been documented that oestrogen plays a protective role on cardiac function and enhances endothelium -dependent vasodilatation in women in their reproductive age group[22,23,24] This may explain the lower prevalence of hypertension reported in women of this age group[7,9]. There were subjects significant increases in the subjects' systolic and diastolic blood pressure after exposure to cold pressor test. These Findings are consistent with what hs been earlier reported by other investigators[11,16]The cardiovascular responses to cold pressor test have beenattributed to sympathetic activation which evokes marked vasoconstriction.[15] Although, it has been reported that oesrogen plays a vital role in cardiovasualr function, this role seems not to be evident in the female subjects that were studied as there were no significant differences in their systolic and diastolic blood pressure responses to cold pressor test when compared with their male counterparts.

No fewer than half (50%) of this study population demonstrated hyper-reactivity either in their systolic blood pressure or diastolic blood pressure or both, after exposure to cold pressor test, indicating the susceptibility of these individuals to the development of hypertension in the future.[10]

CONCLUSION

From our findings, since at least half (50%) of the study subjects, showed systolic or diastolic hyperreactivity, urgent preventive measures targeted at those at risk of developing hypertension, should be taken, in order to stem the rising incidence and prevalence of hypertension in Nigeria and Africa at large.

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