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THE HAEMORHEOLOGICAL PARAMETERS OF HYPERTENSIVE -- COMPARED WITH NORMOTENSIVES

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Summary: Sex variations in some haemorheological parameters: Haematocrit (Hct), Erythrocyte Sedimentation Rate (ESR), Hemoglobin concentration (Hbc), Fibrinogen concentration (FC), Relative Plasma Viscosity (RPV) and Whole Blood Relative Viscosity (WBRV) were determined in 30 male and 20 female hypertensive subjects without complications, aged between 30 and 70 years. 30 male and 20 female normotensive subjects aged between 29 and 71 years, matched for age, weight and height with the hypertensive group served as control. In both groups all the parameters were determined using methods previously described by various workers (Chien, 1977). Results obtained in normotensives showed a significantly lower systolic blood pressure , mean arterial pressure, haematocrit and whole blood relative viscosity and a significantly higher erythrocyte sedimentation rate in female subjects compared to male subjects , no significant correlation was found between any of the haemorheological parameters and the blood pressure indices in both sexes. In the hypertensives, only whole blood relative viscosity was found to be significantly higher in females compared to males. In male hypertensives significant positive correlations were found between erythrocyte sedimentation rate and all the blood pressure parameters and between relative plasma viscosity and systolic and mean arterial pressures; negative correlations were found between haematocrit and systolic and mean arterial pressures. In female hypertensives there were positive correlations between relative plasma viscosity and all the blood pressure parameters and between whole blood relative viscosity and systolic blood pressure. The present study confirms that significant sex variations occur in the various haemorheological parameters in both normotensive and hypertensive Nigerian subjects.

***Key Words**: fibrinogen, sex variations, blood pressure, viscosity.*

Introduction

It is fairly established that sex variations occur in the various haemorheological parameters in healthy Africans (Ingram, 1961;Dacie and Lewis, 1991; Dapper, 2002) For example, fibrinogen concentration has been reported to be consistently (though not always significantly) higher in the female African compared to the African male. The higher fibrinogen concentration apparently accounts for the elevated erythrocyte sedimentation rates usually seen in African females (Ingram, 1961; Dapper, 2002) In addition, haemoglobin concentration, haematocrit and specific gravity of whole blood have been reported to be significantly lower in healthy Nigerian females compared to males (Ingram, 1961). Perhaps, these variations in both haemorheological and haematological parameters could possibly induce sex variations in blood and plasma viscosity in health and disease.

In Caucasians several studies have reported that haemorheologic changes occur in hypertension. These studies have shown increases in plasma and whole blood viscosity (Korubo-Owiye, *et al*, 1997; Korubo-Owiye, *et al,* 1998), increase in erythrocyte aggregation and decrease in erythrocyte deformability (Korubo-Owiye *et al*, 1998), increase in fibrinogen and globulin concentrations(Lee, 1977) and variable changes in haematocrit concentrationLetcher *et al*). These changes clearly predispose hypertensives to a hyper viscosity state with increased risks of cardiovascular and cerebrovascular morbidity and mortality(Korubo-Owiye, *et al,* 1997). Africans are particularly susceptible to hypertension and its complications (Low *et al,* 1988; Nwosu *et al,* 1992). However, reports on rheologic changes in Nigerian

hypertensives are still relatively scanty. In a recent survey significantly higher fibrinogen concentration, relative plasma viscosity and whole blood relative viscosity were found in Nigerian hypertensives compared to normotensives(Chien, 1977).These changes are attributed mainly to the significantly elevated fibrinogen concentration seen in hypertensive subjects. However, possible sex variations in these haemorheological parameters in hypertensive Nigerians have not been fully studied. Such a study becomes important considering the fact that sex variations in rheological parameters are present in healthy African normotensives(Ingram 1961;Dacie and Lewis, 1991; Dapper, 2002). In addition, in hypertensives, haemorheological changes could influence thrombo-embolic complications with unfavorable prognostic consequences(Korubo-Owiye, 1997). Therefore, any possible sex variations in the pattern of these rheological changes in hypertensives need to be elucidated.

The aim of the present study therefore was to assess any possible sex variations in haemorheological changes in some Nigerian hypertensives. This will provide insight into the effect of sex on the rheologic changes in hypertension.

Materials and Methods

50 known hypertensive subjects consisting of 30 males and 20 females, aged between 30 and 70 years attending the Medical outpatient clinics of the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria were recruited for the study. The subjects were without any complications. Control subjects were 50 healthy normotensives (30 males and 20 females), aged between 29 and 71 years. No control subject had any antecedent history of cardiovascular, endocrine, metabolic, neurologic, nutritional or inflammatory disease known to affect blood rheology and all were staff and students of the University of Port Harcourt, Nigeria. Both control and hypertensive subjects were matched for age, weight and height. Informed consent was sought and obtained from each subject before recruitment into the study.

On arrival to the clinic or laboratory, all subjects were allowed to rest for 30 minutes in a comfortable chair before determination of blood pressure. In all subjects diastolic blood pressure (DBP) and systolic blood pressure (SBP) were measured using the Mercury sphygmomanometer (Chien, 1977).

During each measurement, readings were taken until two consecutive readings were similar. The same observer did all determinations of blood pressure. A standard scale (seca model) was used to determine height and weight. Body mass index(B.M.I) was calculated using the formula of Dubois and Dubois; weight in kg divided by the square of the height in m (kg/m^2).

10mls of venous blood was subsequently collected from an ante cubital vein with minimum stasis and immediately transferred into EDTA specimen bottles and gently mixed. The following haemorheologic parameters were determined by the method indicated: Haematocrit (Hct) was determined by Hawksley micro-capillary centrifugation at 3000 r.p.m. for 10 minutes, the mean of two separate readings was taken as the Hct value; Haemoglobin concentration (Hbc) was determined by the Haemoglobincyanide (cyanmethaemoglobin) method as described by Dacie and Lewis (1991); Fibrinogen Concentration (FC) was determined by the clot-weight method of Ingram (1961); Erythrocyte Sedimentation Rate (ESR) was determined by the Westergren method as described by Dacie and Lewis (1991); while both Relative Plasma Viscosity (RPV) and Whole Blood Relative Viscosity (WBRV) were determined by capillary viscometry as described by Reid and Ugwu (1987) and recently modified by Korubo-Owiye *et al* (1997). All haemorheological parameters were analyzed within 2 hours of blood collection, at a room temperature of $27.0\pm0.5^{o}C$

Results obtained were subjected to statistical analysis using the student's t-test and the Z- test as appropriate. Tests of correlations were determined using the Pearson's correlation coefficient. Attempt was made to determine any sex variations in the various haemorheological parameters between sexes in both normotensive and hypertensive subjects. Results are presented in Tables.

Results

Table I summarizes the clinical data of hypertensive and normotensive male and female subjects involved in this study. Amongst hypertensives, no significant differences were observed in any of the various clinical parameters: age, height, weight, body mass index, systolic blood pressure, diastolic blood pressure and mean arterial pressure between both sexes. However, amongst female normotensives the mean values of systolic blood pressure and mean arterial pressure of 115.25 ± 13.03 mmHg and 92.12 ± 10.15 mmHg respectively were significantly lower than the corresponding value in males which were 127.33 ± 13.24 mm and 95.90 ± 11.08 mmHg respectively.

Table II shows the haemorheologic parameters obtained for hypertensive and normotensive male and female subjects. Amongst hypertensives, only whole blood relative viscosity showed significant differences between both sexes. The mean value of whole blood relative viscosity for female hypertensive subjects found to be 4.48 ± 0.74, was significantly higher than the corresponding mean value for whole blood relative viscosity obtained for male hypertensive subjects which was 4.23 ± 0.93 ($p < 0.05$). There were no significant differences for haematocrit, erythrocyte sedimentation rate, haemoglobin concentration, fibrinogen concentration and relative plasma viscosity between male and female hypertensive subjects. Differences observed in these haemorheological parameters between both sexes among hypertensives were marginal. However, amongst normotensives, haematocrit, erythrocyte sedimentation rate and whole blood relative viscosity showed significant differences between both sexes. The mean erythrocyte sedimentation rate value amongst females of 8.85 ± 2.16 mm/1hr was significantly higher than the corresponding value for males, which was 5.23 ± 2.75 mm/1hr. The mean value of haematocrit and whole blood relative viscosity for females was 42.80 ± 4.60 % and 2.85 ± 0.87 respectively; this was significantly lower than the mean value of these parameters for males which were 52.17 ± 2.80% and 4.15 ± 0.59 respectively.

Table I: *Clinical data of Hypertensive and Normotensive subjects.*

	Male Hypertensives (n = 30)	Female Hypertensives (n = 20)	Male Normotensives (n = 30)	Female Normotensives (n = 20)
Ages (years)	51.07 ± 11.17	49.05 ± 10.33	40.52 ± 10.12	48.21 ± 9.66
Height (cm)	165.4 ± 7.84	160.3 ± 5.71	163.5 ± 7.52	159.20 ± 5.81
Weight (kg)	63.69 ± 10.38	62.52 ± 10.10	64.50 ± 5.51	61.5 ± 3.51
BMI (kg/m^2)	23.62 ± 4.02	24.44 ± 4.92	22.50 ± 3.72	23.40 ± 4.01
SBP(mm Hg)	172.8 ± 24.66	167.1 ± 25.47	127.33 ± 13.24	115.25± 13.03*
DBP (mm Hg)	101.9 ± 9.69	103.0 ± 15.60	80.17 ± 11.93	80.55 ± 9.83
MAP(mm Hg)	125. 10 ± 13.09	124.35 ± 18.12	95.90 ± 11.08	92.12 ± 10.15*

*All values: Mean ± SD. * = Significant differences at p level of 0.05.*

Table II: *Haemorheological Parameters of Hypertensive and Normotensive Subjects*

	Male Hypertensive (n=30)	Female Hypertensive (n=20)	Male Normotensive (n=30)	Female Normotensive (n=20)
Haematocrit (%)	41.47±8.29	40.80±6.90	52.17±28	42.80±4.60*
ESR (mm/1hr)	9.99± 6.41	11.15± 7.16	5.23± 2.75	8.85± 2.16*
Haemoglobin Conc. (g/dl)	14.10± 10.03	14.02± 0.66	14.15± 2.27	13.67± 0.98
Fibrinogen Conc.(g/dl)	6.63± 0.22	6.61± 0.13	2.24± 0.69	2.54± 0.38
Relative Plasma Viscosity	1.41± 0.09	1.42± 0.11	1.26± 0.022	1.27± 0.083
Whole Blood Relative Viscosity	4.23± 0.93	4.48± 0.74*	4.15± 0.59	2.85± 0.87*

*All values: Mean ± SD, * = Significant differences at p level of 0.05.*

Table III shows the Pearson's correlation coefficient between the various haemorheological parameters and the blood pressure indices in hypertensive male subjects.

Amongst hypertensive males' erythrocyte sedimentation rate showed significant positive correlations with diastolic blood pressure ($r = 0.3619$; $p < 0.01$), systolic blood pressure ($r = 0.6410$; $p < 0.001$) and mean arterial pressure ($r = 0.5896$; $p < 0.001$). In addition, relative plasma viscosity showed significant positive correlations with systolic blood pressure ($r = 0.5344$; $p < 0.01$) and mean arterial pressure ($r = 0.4648$; $p < 0.01$). Negative correlations were found between haematocrit and both systolic blood pressure ($r = -0.6136$; $p < 0.001$) and mean arterial pressure ($r = -0.5057$; $p = 0.01$). In hypertensive male subjects no significant correlations were found between haemoglobin concentration, fibrinogen concentration, and whole blood relative viscosity and any of the blood pressure indices.

Table IV shows the Pearson's correlation coefficient between the various haemorheological parameters and the blood pressure indices in hypertensive female subjects. Significant positive correlations were found only for relative plasma viscosity and whole blood relative plasma viscosity and the blood pressure indices. Relative plasma viscosity showed significant and positive correlations with diastolic blood pressure ($r = 0.5140$; $p < 0.05$), systolic blood pressure ($r = 0.7913$; $p < 0.001$) and mean arterial pressure ($r = 0.6651$; $p < 0.01$). Whole blood relative viscosity only showed significant positive correlation with systolic blood pressure ($r = 0.4575$; $p < 0.05$). In addition, in hypertensive females no significant correlations were found between haematocrit, erythrocyte sedimentation rate, haemoglobin concentration and fibrinogen concentration and any of the blood pressure indices.

Amongst normotensive subjects no significant correlation was found between the haemorheological parameters and the blood pressure indices.

Table III: *Correlation coefficients between haemorheologic parameters and blood pressure indices in male hypertensives.*

	Diastolic Blood Pressure (mmHg)	Systolic Blood Pressure (mmHg)	Mean Arterial Pressure (mmHg)
Haematocrit (%)	-0.2351	-0.6136***	-0.5057**
ESR (mmHg)	0.3619**	0.6410***	0.5896***
Haemoglobin Conc.(g/dl)	-0.2395	-0.1226	-0.2010
Fibrinogen Conc.(g/dl)	0.1961	0.3256	0.3055
Relative Plasma Viscosity	0.2581	0.5344**	0.4684**
Whole Blood Relative Viscosity	-0.0592	0.2756	0.1418

** = Significant differences at p level of 0.05, ** = Significant differences at p level of 0.01, *** = Significant differences at p level of 0.001*

***Table IV**: Correlation coefficients between haemorheologic parameters and blood pressure indices in female hypertensives.*

	Diastolic Blood Pressure (mmHg)	Systolic Blood Pressure (mmHg)	Mean Arterial Pressure (mmHg)
Haematocrit (%)	-0.1042	-0.1319	-0.1212
ESR (mmHg)	0.1513	0.2668	0.2110
Haemoglobin Conc.(g/dl)	0.0726	-0.1083	-0.0084
Fibrinogen Conc.(g/dl)	0.0948	0.0077	0.0582
Relative Plasma Viscosity	0.5140*	0.7913***	0.6651**
Whole Blood Relative Viscosity	0.3394	0.4575*	0.4086

** = Significant differences at p level of 0.05, ** = Significant differences at p level of 0.01,*
*** = Significant differences at p level of 0.001

Discussions

The results of the present study clearly indicate that sex variations occur in some haemorheological parameters in both healthy normotensive and hypertensive Nigerians. The higher erythrocyte sedimentation rate and the lower haematocrit found in female normotensive compared to males is consistent with earlier reports in this regard (Korubo-Owiye *et al,* 1998; Reid, 1982). However in addition, we report that in normotensive Nigerian females' whole blood relative viscosity is apparently lower. Reasons for this is presently unclear since there were no significant sex differences in the fibrinogen concentration of normotensive subjects studied; though female normotensive subjects had marginally higher values of fibrinogen concentration compared to male normotensives. However, amongst hypertensive subjects the higher whole blood relative viscosity seen in normotensive males reverses; female hypertensives had significantly higher whole blood relative viscosity compared to male hypertensives. Reason for this is also unclear; no significant sex differences were observed for any of the other haemorheological parameters studied in hypertensive subjects.

The correlations between the various haemorheological parameters and the blood pressure indices in hypertensive subjects also show sex variations. In hypertensive males haematocrit showed significant negative correlations with both systolic blood pressure and mean arterial pressure, while erythrocyte sedimentation rate showed positive correlation with all blood pressure indices. No similar correlations were found for both haematocrit and erythrocyte sedimentation rate in hypertensive females. However, in both sexes relative plasma viscosity showed significant positive correlation with all the blood pressure indices except with diastolic blood pressure in male hypertensives. Apparently, relative plasma viscosity is an important haemorheological parameter in hypertensive Nigerians; showing positive correlations with most blood pressure indices in both sexes. Female hypertensive subjects showed significant positive correlation between whole blood relative viscosity and systolic blood pressure. This was however not observed in male hypertensives. We were unable to

demonstrate significant correlations between any of the haemorheological parameters and the blood pressure indices in the normotensive subjects under study.

The result of the present study confirms that sex variations in haemorheological parameters exist in healthy Nigerian subjects and that these sex variations are also present in Nigerian hypertensives.

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