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THE RELATIONSHIP BETWEEN PLASMA VISCOSITY AND BODY MASS INDEX IN NORMAL YOUNG NIGERIAN ADULTS

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ABSTRACT

Plasma viscosity is one of the most important rheological parameters for assessing the health status of an individual. It is influenced by diseases with alteration in plasma protein composition and previous studies have shown that the viscosity of plasma is affected by various factors which includes body weight, fibrinogen concentration, lipoprotein content, etc. The goal of this study was to obtain a relationship between body mass index and relative plasma viscosity in normal young Nigerian adults. A total of 22 normal undergraduate students (8 male and 14 females) of both sexes and between the ages of 18 and 27 years participated in the study. The age, weight and height of each subject was obtained and BMI was estimated by the universal BMI formula (w/h^2). Blood pressure was measured and relative plasma viscosity (RPV) was determined by methods described previously by various researchers. Results obtained showed a positive statistical significance between BMI and RPV in all subjects and in both sexes. However, there was no statistical significance between the blood pressure indices with relative plasma viscosity in all subjects and in both sexes.

INTRODUCTION

The study of haemorheology, the science of blood flow and deformation of blood, has been of great interest in the biomedical field for many years. Haemorheological properties of blood include whole blood viscosity, plasma viscosity, hematocrit, red blood cell (RBC) deformability and aggregation, and fibrinogen concentration in plasma. It has been well established that plasma behaves like a Newtonian fluid and its viscosity is determined by its macromolecular contents. It has been demonstrated from previous comparative studies that the relative plasma viscosity and other factors (Reid and Ugwu, 1987) such as body weight, body mass index, fibrinogen concentration, systolic and diastolic blood pressure were all significantly more in hypertensive diabetic than normotensive diabetics and healthy control subjects (Muhammad Khan et al., 2005). It was also discovered that the Body mass index (BMI), systolic and diastolic blood pressures and plasma viscosity were significantly higher in the hypertensive Nigerian diabetics than their normotensive counterparts and it was therefore suggested that high levels of body weight, fibrinogen concentration and plasma viscosity could contribute to the development of hypertension in diabetic Nigerians (Memeh, 1990).

There are several existing literatures on the subject of plasma viscosity and most of these reports, discussed the significance of plasma viscosity measurements in the diagnosis of cardiovascular and coronary

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heart diseases, its comparison between that of hypertensive and normotensive subjects as well as suggesting it as a marker of all cause mortality in middle-aged men. These studies were performed at different geographical locations, mostly Europe and on different races. However, not much work has been done in this respect in our own geographical location here in Nigeria and on the population of the young adults who make up a greater percentage of the citizenry. This study therefore aims at obtaining a relationship between plasma viscosity measurements and body mass index in both sexes of young Nigerian adults between the ages of 18 and 27 years.

This study is however limited by sample number and geographical location, as only 8 selected male and 14 female subjects from the undergraduate student community of the University of Benin were used in carrying out the research.

MATERIALS AND METHODS

A total of 22 normal subjects consisting of 8 males and 14 females, aged between 18 and 27 years, who are undergraduate students of the University of Benin, Benin City, were recruited for the study after their informed consent was sought and obtained.

In all subjects, systolic blood pressure (SBP) and diastolic blood pressure (DBP) was measured by the auscultatory method using a stethoscope and mercury sphygmomanometer (Chien, 1977) at an interval of 5 minutes and readings were taken until two consecutive readings were similar. The pulse of each subject was also taken and recorded in same manner.

Anthropometric data for the estimation of body mass index (BMI) was obtained from each subject using a metre rule and a digital weighing scale and the BMI was calculated using the universal BMI formula (WHO, 2011), that is; the weight of each subject in kg divided by the square of the height in m (kg/m^2).

A total of 5mls of venous blood was drawn from the ante cubital vein from most subjects or dorsum of the hand in a few subjects when it was difficult to obtain blood from the former, with minimum stasis by applying a tourniquet and immediately transferred into sequestered tripotassium EDTA bottles and gently mixed. Relative plasma viscosity (RPV) of each blood sample was determined immediately after collecting the blood sample by the Reid and Ugwu capillary viscometer method (Reid and Ugwu, 1987) at laboratory temperature of 27.0 ± 0.5°C. Statistical analysis was done using OriginPro7.5 and MS Excel 2007 PC application for Windows. The Student's t-test was used to test for significance in means and tests of correlations were determined using the Pearson's correlation coefficient (r) where $p \leq 0.05$ is considered significant. The results obtained are presented in tables.

RESULTS

Table 1 below summarises the experimental parameters of all subjects and that of the male and female sexes involved in the study. No significant difference was observed in the age, weight and height between both sexes but was observed between the BMI of both sexes ($p < 0.05$). However, amongst the females, the mean values of systolic blood pressure, diastolic blood pressure and mean arterial pressure of 107.36 ± 2.24 mmHg, 73.00 ± 1.40 mmHg and 84.45 ± 1.56 mmHg respectively were significantly lower than the corresponding values in the males which were 115.63 ± 2.78 mmHg, 78.38 ± 2.26 mmHg and 90.79 ± 1.77 mmHg respectively.

Tables 2 below shows the Pearson's correlation coefficient (r) between body weight and RPV, and between BMI and RPV in all subjects and in the different sexes. Significant positive correlations were found for both body weight and BMI with relative plasma viscosity in all subjects and in both sexes. Relative plasma viscosity showed significant and positive correlations with body weight ($r = 0.4296$; $p < 0.05$) and BMI ($r = 0.6278$; $p < 0.01$) in all subjects, and body weight (0.6734; $p < 0.10$) and BMI (0.8489; $p < 0.01$) in the male subjects, and body weight (0.5533; $p < 0.05$) and BMI (0.6966; $p < 0.01$) in the female subjects.

Table 3 below shows the Pearson's correlation coefficient (r) between blood pressure indices and RPV in all subjects and in the different sexes. Although, negative correlations were observed; between diastolic blood pressure and relative plasma viscosity, and between mean arterial pressure and relative plasma viscosity in all subjects, no statistically significant positive correlations were however found between any of the blood pressure indices and relative plasma viscosity in all subjects and in both sexes (at $p < 0.01$ to < 0.05).

Table 1: Mean± S.E.M (standard error of mean) of the ages, weight, height, BMI, BP indices and the Relative Plasma Viscosity of subjects.

Parameter	All Subjects (n = 40)	Male Subjects (n = 18)	Female Subjects (n = 22)
Age (years)	21.82 ± 0.46	23.00 ± 0.76	21.14 ± 0.52 (ns)
Weight (kg)	62.11 ± 2.73	6769 ± 4.77	58.92 ± 3.13 (ns)
Height (m)	1.68 ± 0.01	172 ± 0.02	1.66 ± 0.02 (ns)
BMI (kg/m^2)	21.93 ± 0.86	22.87 ± 1.64(*)	21.39 ± 1.00 (*)
SBP (mmHg)	110.36 ± 1.92	115.63 ± 2.78	107.36 ± 2.24 (ns)
DBP (mmHg)	74.95 ± 1.31	78.38± 2.26	73.00 ± 1.40 (ns)
MAP (mmHg)	83.76 ± 1.34	90.79± 1.77	84.45 ± 1.56 (ns)
RPV	1.61 ± 0.02	1.58 ± 0.02	1.63 ± 0.03 (ns)

All values: Mean ± S.E.M;* (*) = *significant difference at p < 0.05;* (*ns*) = *not significant.
BMI=Body Mass Index; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure.

Table 2: Pearson's correlation coefficient between body weight (kg) and RPV, and BMI (kg/m^2) and RPV in both subjects and in the different sexes.

Parameter	Body Weight (kg)	Body Mass Index (kg/m^2)
	All Subjects	
RPV	**0.4296****	**0.6278*****
	Male Subjects	
RPV	**0.6734***	**0.8489*****
	Female Subjects	
RPV	**0.5533****	**0.6966*****

**** = significant differences at p level of 0.10, ** = significant differences at p level of 0.05, and *** = significant differences at p level of 0.01.***

Table 3: Pearson's correlation coefficient (r) between RPV and BP indices in all subjects and in the different sexes.

Parameter	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	Mean Arterial Pressure (mmHg)
		All Subjects	
RPV	**0.0831†**	**-0.0774†**	**-0.0100†**
		Male Subjects	
RPV	**0.2568†**	**0.1214†**	**0.1801†**
		Female Subjects	
RPV	**0.2233†**	**0.0034†**	**0.1092†**

† = no significant difference at p < 0.01 to 0.05.

DISCUSSION

Plasma viscosity is one of the most important rheological parameters for assessing the health status of an individual. It is influenced by diseases with alteration in plasma protein composition (Kiesewetter et al., 1991) and it is determined by various macromolecules, such as; fibrinogen, immunoglobulins, and lipoproteins and may therefore reflect several aspects involved in cardiovascular diseases, including the effects of classic risk factors, haemostatic disturbances and inflammation with considerable potential to identify subjects at risk for these cardiovascular disease events (Koenig et al., 1998).

The results presented above depicts that there is elevated plasma viscosity in normal young individuals with a high body mass index. It was shown that body weight and body mass index were significantly positively correlated with relative plasma viscosity in the subjects under study. These were observed as significant positive correlations between body weight and relative plasma viscosity in all subjects for both the males and the female. In addition, there was observed significant positive correlations between body mass index and relative plasma viscosity in all subjects which shows that the present study has demonstrated the association between body weight and relative plasma viscosity as well as the association between body mass index and relative plasma viscosity, in these subjects.

Individuals with a high body mass index (BMI $\geq$ 25.00) chiefly due to body fat content, usually presents with high concentration of lipoproteins, total cholesterol and other lipids in their blood as well as high amount of adipose tissue deposits in almost every part of the body (Guyton and Hall, 2006). These persons are usually overweight or obese and the high concentrations of lipoproteins, total cholesterol and other lipids in their blood have been shown to be a contributor to the viscosity of plasma. Previous studies have demonstrated that plasma viscosity is strongly correlated with total cholesterol in both male and female sexes (Lee et al., 1998) and it has also been found from results of previous researches, that a positive relationship between plasma viscosity and LDL (low density lipoprotein) cholesterol, as well as between plasma viscosity and triglycerides existed, which may be further explained by the rheological effects of molecules of high molecular mass (Lowe et al., 1991; Jung et al., 1992). These altogether, may thus serve as a contribution to the underlying cause of the elevated plasma viscosity measurements observed in these overweight and obese individuals.

However, individuals with a high body mass index (BMI $\geq$ 25.00) that is not due to high amount of body fat but to a large muscle mass or high bone density, usually do not present with elevated plasma viscosity for they normally do not have high concentrations of lipoproteins, total cholesterol or other lipids in their blood. This category of individuals constitutes the "outliers" whom may have a high BMI but a relatively lower plasma viscosity.

Blood pressure indices (i.e., systolic blood pressure, diastolic blood pressure and mean arterial pressure) all showed no significant differences with relative plasma viscosity in the subjects under study and as such, this study was unable to demonstrate statistically significant correlations between relative plasma viscosity and the blood pressure indices in these subjects.

CONCLUSION

In conclusion, body weight and body mass index are positively correlated with relative

plasma viscosity measurements in normal young Nigerian adults and as such, this finding may serve as an additional valuable tool in assessing the health status of an individual in addition to other haemorheologic functions of plasma viscosity measurements.

REFERENCES

1. Chien S. Blood rheology in hypertension and cardiovascular diseases. Cardiovasc. Med. 1977; 2: 236-360.

2. Kiesewetter H., Jung F., Wenzel E. and Müller G. Variance, factors of influence and clinical relevance of plasma viscosity. Biomed. Tech. (Berl). 1991; 36(10): 241-247.

3. Memeh C. U. The relationship between body weight and plasma viscosity in hypertensive diabetic Nigerians. J. Hypertens. 1990; 8: 711-714.

4. Reid H. L. and Ugwu A. C. A simple technique for rapid determination of plasma viscosity. Nig. J. Physiol. Sci. 1987; 3: 45 – 48.

5. Muhammad Khan T., Marwat M. A. and Rehman H. Comparison of plasma viscosity and fibrinogen concentration in hypertensive and normotensive diabetics. J. Ayub Med. Col. Abbottabad. 2005; 17(4): 1-3.

6. Ighoroje A. D. A. and Dapper D. V. The haemorheological parameters of hypertensive-compared with normotensives. Nig. J. Physiol. Sci. 2005; 20(1-2): 33-38.

7. World Health Organization. Body Mass Index Classification.2011;(http://www.who.int/bmi/index.jsp?introPage=intro_3.html).

8. Koenig W., Sund M., Filipiak B., Döring A., Löwel H. and Ernst E. Plasma Viscosity and the Risk of Coronary Heart Disease: Results From the MONICA-Augsburg Cohort Follow-up Study, 1984/85 to 1992. Arteriosclerosis, Thrombosis and Vascular Biology. 1998;18: 768 - 772.

9. Guyton A. C. and Hall J. E. Textbook of medical physiology. 11th ed. Elsevier Saunders, New Delhi, India. 2006; Pg. 291-297, 872-873.

10. Lee A. J., Mowbray P. I., Lowe G. D. O., Rumley A., Gerald F., Fowkes R. and Allan P. L. Blood Viscosity and Elevated Carotid Intima-Media Thickness in Men and Women : The Edinburgh Artery Study. Circulation. 1998; 97: 1467-1473.

11. Lowe G. D. O., Wood D. A., Douglas J. T., Riemersma R. A., Macintyre C. C., Takase T., Tuddenham E. G., Forbes C. D., Elton R. A. and Oliver M. F. Relationships of plasma viscosity, coagulation and fibrinolysis to coronary risk factors and angina. Thromb. Haemost. 1991; 65: 339 –343.

12. Jung F., Pindur G. and Kiesewetter H. Plasma viscosity dependence on proteins and lipoproteins: results of the Aachen Study. Clin. Hemorheol. 1992; 12: 557–571.