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Influence of ABO and Rhesus Blood Group on Blood Pressure and Hypertension in Bayelsa State

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Authors' contributions

This work was carried out in collaboration among all authors. Author SOO conceived the study, designed the protocol and coordinated the experiment while the manuscript writing, statistical analysis and data interpretation were performed by authors AME and DVD. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This present study was carried out to ascertain the influences of ABO and Rhesus blood groups on blood pressure and hypertension among normotensive and hypertensive patients attending cardiologic clinic in Niger delta University Teaching Hospital, Okolobiri in Yenagoa Local Government Area of Bayelsa State Nigeria.
Study Design: Cross sectional study design was adopted.
Place and Duration of Study: The study was carried out in the Cardiology Clinics in the Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Bayelsa State, from February 2020 to November 2020.
Methodology: This study was carried out on 800 participants, consisting of 400 each of apparently healthy Normotensive and Hypertensive individuals. The blood pressures were determined using palpatory and auscultatory (stethoscope and sphygmomanometer) method in both control and hypertensive groups and their ABO and Rhesus blood groups were determined using the slide

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haemagglutination technique. Statistical analysis was done using SPSS statistical software to perform Chi-square test.

Results: The frequency of the various blood groups was A-20.0%, B-16.8%, AB-13.3% and O-50.0% for the normotensive individuals and A-12.0%, B-15.5%, AB-17.8% and O-54.8%, for the hypertensive individuals. The frequency of ABO blood groups in both the normotensive and hypertensive group was therefore found to be O>B>A>AB. The prevalence of blood group O and rhesus O^{-ve} was found to be associated with elevated blood pressure and the development of hypertension while prevalence of blood group AB was found to be lowest in the same group, but was not significant statistically ($p>0.05$). There was no significant difference between systolic and diastolic blood pressure of different blood groups.

Conclusion: Blood group O was found to be the most common blood group in our study. Blood group O^- was also found to be more prone to hypertension. However, there was no statistically significant association between ABO blood groups and Hypertension.

Keywords: Hypertension; ABO blood group; Rh blood group; antigens and blood pressure.

1. INTRODUCTION

Hypertension is defined as sustained elevated arterial pressure to a level that places the patient at increased risk of organ damage. Blood pressure above 140/90 mmHg should be considered hypertensive [1,2]. Hypertension is a chronic medical condition and one of the most common non-communicable diseases that threatens life. It contributes about 7.6 million premature deaths, 54% of strokes, 47% of ischemic heart diseases and 13% of deaths worldwide [1]. The prevalence of hypertension is likely to increase in developing countries, due to the adoption of Western lifestyles and urbanization [2]. Hypertension is a non-communicable 'silent killer' and a chronic illness with adverse effects principally involving the central nervous system, the retina, the heart and the kidneys and it constitutes a public health importance. Since hypertension is multifactorial, the ABO and Rhesus antigens may indirectly influence arterial pressure, hence the need to ascertain their influences on blood pressure and hypertension [2,3].

Blood group can be defined as an inherited allogeneic variation detected on the surface of blood cells [3]. It is a system of red blood cell antigens (blood group substances) controlled by a genetic locus having a variable number of alleles A, B, and O in the ABO system [4]. The ABO blood group system was the first to be described among other blood group systems and remains the most important in transfusion medicine [5]. Based on red blood cell agglutination patterns, individuals could be divided into four major groups; A, B, AB, and O [6]. The ABO blood group system is genetically determined and plays a role in the development of certain genetic disorders (Shivayogappa et al,) [7] and has been linked to certain diseases [8,9].

The Rhesus (Rh) blood group is named from the Rhesus monkey and is the most complex of the human blood-group systems with 52 well-defined antigens, the most immunogenic of which is D (RD) [10]. The Rh blood groups rank with ABO groups in clinical importance because of their relation to haemolytic disease of the newborn (HDN) and their importance in blood transfusion [11,12]. In contrast to the ABO group, anti-D antibodies are not normally present in the blood. They form only in Rhesus negative (Rh^-) individuals who are exposed to Rhesus positive (Rh^+) blood [10].

Blood pressure (BP) is a cardiovascular parameter and one of the four most important vital signs regularly assessed by medical professionals and healthcare providers. Several studies have shown that the ABO blood system is linked to various disorders such as hypertension, urinary tract infection and venous thrombosis and due to the fact that hypertension is dependent on a number of factors, ABO antigens can indirectly influence blood pressure [13]. The clinical relevance attached to ABO and Rhesus blood group systems spreads beyond blood transfusion and various studies have suggested that there is sufficient evidence of a relationship between ABO blood groups and the occurrence of heart conditions in patients who have been treated for cancer and other ailments with the tendency to have thrombosis as a result of certain inherited and/or acquired molecular defects [14].

The aim of this study was therefore to determine the influence of the ABO and Rhesus blood groups on blood pressure and hypertension in a

cohort of apparently healthy Normotensives and amongst known Hypertensives in Yenagoa, Bayelsa State Nigeria.

2. MATERIALS AND METHODS

The study was carried out in the Cardiology Clinics where blood pressure checks and care for hypertension cases are provided routinely in the Niger Delta University Teaching Hospital (NDUTH), Okolobiri. The NDUTH is a 200-bed Bayelsa state government-owned teaching hospital established in 2007 and situated in Okolobiri, a semi-urban city in Yenagoa local government area (YELGA) of Bayelsa State. The sub-specialties of the hospital consist of Internal Medicine, Surgery, Obstetrics and Gynaecology and Paediatrics.

The target population for this study consists of all the staff, students and patients attending the cardiologic clinics for medical care and routine check-up. Two groups of individuals including those with normal blood pressure (Normotensives) and those with elevated blood pressure (Hypertensives) were randomized for the study and the blood of both groups were collected to determine the influence of blood group on blood pressure and hypertension.

The sample size for this study was obtained using the formula as described by a group of researchers [15]:

$$N = \frac{\mathrm{Z}^2 Pq}{\mathrm{d}^2}$$

Where;
N is the minimum sample size
Z is a constant at 95% confidence level for 2-tailed study (1.96≈2.0) and significance level is 0.05
P is the immunization coverage for Bayelsa state (51.5%)
Q is 1-p
D is the absolute precision required in percentage points between the population and the sample rate, at 95%CI, which we set as 5%
Substituting;

$$N = \frac{(1.96)^2 \, x \, 0.515 \, x \, (1 - 0.515)}{0.05^2}$$

$N = (2.0)^2 (0.5)(0.5)/(0.05)^2 = 400$

Eight hundred (800) subjects (Hypertensive n=400 and Normotensive n=400) were randomly selected.

The group 1 subjects were Staff and students of Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Bayelsa State.

Group 2 subjects were hypertensive patients attending the Cardiology Clinic of Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Bayelsa State. Exclusion Criteria includes all staff and students with history of hypertension, elevated blood pressure or cardiovascular disease.

Data was collected based on a checklist (proforma) that collects socio-demographic information of patients and then a record of the blood group which was determined in the laboratory using standard techniques.

Blood pressure parameters were measured manually using stethoscope (Littmann, England) and standard mercury sphygmomanometer (Fisher Scientific, England). The Blood Pressure Parameters measured include: Diastolic blood pressure, Systolic Blood Pressure, Pulse pressure and Mean Arterial pressure [16].

The blood group system was determined using the tile method which is based on antigen-antibody reaction between the blood anti-body of the individual and the antigen from the anti-sera (A and B). The obtained blood was grouped into A^-, A^+, B^-, B^+, AB^-, AB^+, O^- and O^+ based on the result [17].

The generated data were analysed using Statistical Package for Social Sciences (SPSS) version 22. Parametric test (Pearson's correlation) was used on ordinal data and non-parametric tests (Z-test and ANOVA) were used to test the hypotheses at 0.05 level of significance.

3. RESULTS AND DISCUSSION

3.1 Results

Table 3 shows the mean values for cardiovascular parameters of the different ABO and Rhesus Blood group for normotensive subjects in the study population. There was no significant difference in the systolic, diastolic, mean arterial and pulse pressures in the different blood groups ($p>0.05$).

Table 4 shows the mean values for cardiovascular parameters of the different ABO/Rhesus Blood groups for hypertensive

subjects in the study population. There was no significant difference in the systolic, diastolic, mean arterial and pulse pressures in the different blood groups (p>0.05).

3.2 Discussion

3.2.1 Distribution of ABO and Rhesus (Rh) blood group

Our research showed that the Rhesus positive phenotype (Rh^+) was detected in 678 (84.75%) subjects while the Rhesus negative phenotype (Rh^-) was found in 122 (15.25%) subjects in the total sample size of 800 studied (Table 1). This finding is in collaboration with existing studies [18,19]. Also, this finding is in agreement with that of other researchers [20,21], who reported Rhesus positive to be the highest with 96.68% while Rhesus Negative was the lowest with 3.30% .Rhesus negative was common to the blood group O, 52 (6.50%) of all the blood groups as compared to blood group AB of only 18 (2.25%). The Rh group negativity for blood groups A and B were close; 22 (2.75%) and 30 (3.75%) respectively. This is in agreement with the result of a similar study carried out in Benin [22]. For the distribution of subjects according to blood group, Rhesus factors and hypertension, the most common blood group and Rhesus factor observed for both hypertensive and normotensive subjects was O positive (O^+) 366 (53.98%) and the least was B positive (B^+) 100(14.74%). When compared amongst the normotensive and hypertensive groups, similar incidence of Rhesus positive and negative groups were noticed i.e. $O^+ > A^+ > B^+ > AB^+$. For the negative groups, $O^- > A^- > B^- > AB^-$ .For the hypertensive groups only, there were disparities as indicated: $O^+ > AB^+ > B^+ > A^+$. For the negative groups, $O^- > B^- > AB^- > A^-$. O-positive and O-negative blood group were found to be more frequent in both groups, while there is an interchange between AB^+ and B^- in the hypertensive groups.

Table 1. ABO and rhesus blood group distribution of the study population of normotensive subjects

Blood group	Number	Percentage
A	80	20.0
B	67	16.8
AB	53	13.3
O	200	50
A+	68	17.0
A^-	12	3.0
B+	57	14.3
B^-	11	2.8
AB+	47	11.8
AB^-	6	1.5
O+	184	46.0
O^-	15	3.8

Table 2. ABO and rhesus blood group distribution of the study population of hypertensive subjects

Blood group	Number	Percentage (%)
A	48	12.0
B	62	15.5
AB	71	17.8
O	219	54.8
A+	38	9.5
A^-	10	2.5
B+	43	10.8
B^-	19	4.8
AB+	59	14.8
AB^-	12	3.0
O+	182	45.5
O^-	37	9.3

Table 3. Cardiovascular characteristics of the different ABO and rhesus blood group among normotensive subjects in Yenagoa, Bayelsa State

Blood group and rhesus factor	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Mean arterial pressure (mmHg)	Pulse pressure (mmHg)
A+	118.38±8.37	75.02±6.06	89.4±5.23	43.35±9.61
B+	120.05±7.94	75.12±6.26	90.09±6.16	44.92±6.43
AB+	116.46±11.24	73.36±7.21	87.73±7.65	43.10±9.04
O+	120.07±7.73	75.58±6.04	90.41±5.68	44.48±7.34
A-	115.16±11.76	72.00±7.67	86.38±6.88	43.16±13.08
B-	120.90±7.06	77.54±5.00	92.00±4.76	43.36±6.93
AB-	122.33±6.97	71.00-10.09	88.11±7.84	51.33±10.09
O-	117.73±8.68	73.93±6.87	88.53±6.99	43.80±5.88
ANOVA	P=0.09	P=0.11	P=0.52	P=0.39

Table 4. Cardiovascular characteristics of the different abo/rhesus blood groups among hypertensive subjects in Yenagoa, Bayelsa State

Blood group and rhesus factor	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Mean arterial pressure (mmHg)	Pulse pressure (mmHg)
A+	135.31±20.96	82.76±11.43	100.28±13.38	52.55±15.64
B+	136.11±13.70	86.04±10.18	102.73±10.16	50.06±11.31
AB+	130.23±14.21	83.96±9.82	99.38±10.32	46.27±10.62
O+	134.22±15.42	84.88±12.76	101.33±12.64	49.34±11.20
A-	136.70±14.71	83.80±13.04	101.43±13.00	52.90±8.59
B-	136.36±15.24	85.21±13.34	102.26±12.67	51.15±12.65
AB-	130.00±13.48	80.50±8.66	97.00±8.86	49.50±12.00
O-	133.78±15.11	86.40±10.79	102.19±10.68	47.37±13.39
ANOVA	P=0.53	P=0.75	P=0.75	P=0.24

Globally, the ABO and Rhesus (Rh) genes and phenotypes have been investigated and findings have shown that they are not equally distributed [23,24]. The analysis of distribution of blood groups is significant as it performs a critical role in genetics, blood transfusion, organ transplantation, genetic research and human evolution [25]. Forensic pathologists and some other groups have shown their associations with diseases, for instance, duodenal ulcer,[26] diabetes mellitus, and Rh and ABO incompatibilities of the newborn [27]. In addition, the Forensic application of blood group studies is of unlimited importance in uncovering crime [28].

Results obtained from this study showed that the distribution of ABO and Rh-D blood groups among the participants are in the order of ABO percentage frequencies of O>B>A>AB (Table 1). The group O with 419 (52.38%) is the most frequently encountered phenotype. This observation is in accordance with previous reports from other parts of Nigeria [12,29]. With regard to the other phenotypes of ABO blood groups, the frequency of blood group B was 129 (16.13%) which is very close to the reported frequency of 17.10% by a researcher in Port Harcourt [30]. However, different dissimilarities have been reported in these frequencies and the reasons have been attributed to the ethnic difference among the study population and sample size [31]. Blood group B (16.13%) was slightly more prevalent than blood group A (16.00%) in the present study. This closely support earlier report of 24.6% in Port Harcourt, 20.5% in Lagos and 20.7% in Kano where blood group B was also found to be the second most prevalent in the population [21]. From the findings of the research, it is evident that the proportion and gene frequencies of individuals belonging to blood group O in the studied population was most predominant and this might imply that blood type O is the most readily available blood group in the Bayelsan population which is more advantageous for the population in the event of blood transfusion.

In addition higher proportion of blood group O in the studied population is also an advantage because Nigeria is a malaria endemic country and therefore individuals belonging to blood group O have been found to be protected from severe malaria attack due to the mechanism of reduced resetting [32].

The low frequency of blood groups AB and O^- reported in the present study (Table 1) and other studies among Nigerian population indicate the high risk individuals in that category of blood groups are likely to be encountered should they require blood transfusion as scarcity of it may be experienced. Hence individuals of blood groups AB and O^- should be willing donors to blood banks across the state and Nigeria at large so as to make available blood to others in that category when in need.

3.2.2 Distribution of ABO/Rhesus blood groups and hypertension

Findings from this study (Table 1) revealed that hypertension was more common in blood group O, n=219 (54.8%) and least common in the blood group A, n=48 (12.0%). From Table 3, the relationship between ABO blood group and blood pressure was statistically insignificant (P>0.05). Those who had blood group O were found to be more prone to hypertension as compared to AB and A blood groups. Thus, the findings of this study indicate that those with less chance of getting hypertension are those of blood group A. This indicates that blood group O might be genetically more prone to hypertension as compared to other groups. Many other previous studies have shown a significant association of Hypertension with blood group B [33] [34] [35] and blood group O [36] [37]. Again, a researcher

found a positive association of hypertension with ABO blood group, [33] while the study conducted in Nigeria found that AB blood group children had less chances of getting hypertension than the O blood group [38].

3.2.3 Relationship of the ABO/Rhesus blood group with blood pressure and other cardiovascular parameters among the hypertensive subjects

Among the hypertensive individuals, blood group A^- had the highest systolic blood pressure (136.70±14.71 mmHg) while blood group AB^- had the lowest systolic blood pressure (130.70±13.48 mmHg).This means that blood group AB^- tends to have the least systolic blood pressure among the various blood groups. Blood group O^- had the highest diastolic blood pressure (86.40±10.79 mmHg) while blood group AB^- had the lowest diastolic pressure (80.50±8.66mmHg). Systolic blood pressure measures the force that the heart exerts on the walls of the arteries each time it beats. The diastolic blood pressure on the other hand, is a measure of the force the heart exerts on the walls of the arteries in between beats. Blood group B^+ was found to have the highest mean arterial pressure (102.73±10.16 mmHg) while blood group AB^- had the lowest mean arterial pressure (97.00±8.86mmHg). The mean arterial pressure is the average pressure in a patient's arteries during one cardiac cycle. It measures the pressure necessary for the adequate perfusion of the organs of the body. It is considered a better indicator of perfusion to vital organs, than systolic blood pressure. The pulse pressure was found to be highest in the blood group A^- and lowest among blood group AB^+. The pulse pressure is the difference between the systolic and diastolic blood pressures. It represents the force that the heart generates each time it contracts. It is an indicator of how well the heart is working

In our study it was found that there was no significant difference in mean Systolic blood pressure in between the different blood groups ($p=0.53$). A Study done by other groups of researchers also found similar result [39] [40]. The current study outcome also showed that there was no significant difference in mean Diastolic blood pressure between the different blood groups ($p=0.75$). However in some other studies, a significant association was found between the blood group B and O and diastolic blood pressure [41] [42]. The findings of another research also showed that there is significant evidence of ABO antigen indirectly influencing blood pressure [13].

4. CONCLUSION

This study has shown that Blood group O is the most prevalent blood group in Bayelsa studied population with prevalence rate of 52.38% followed by B, A and AB in that order. Most of the subjects were found to be Rhesus positive (84.75%) while only minority were Rhesus negative 15.25%. The study has also shown that Rhesus negative blood group were found to be few. This study has also shown that individuals with blood group O and Rhesus O-negative that is O^- individuals have the highest values of blood pressure indices and may be predisposed to hypertension, while the lowest is blood group AB and Rhesus A^-, though the results were not statistically significant. These findings could be useful in health care planning, genetic counselling and running of an organised, efficient and safe blood transfusion services. Institution of blood donor registry is also suggested for easy accessibility to rhesus negative blood for transfusion especially in cases of emergency and also to prevent haemolytic disease of the newborn. Despite all these associations, there is need for caution in tagging a particular blood group as being prone to hypertension as suggested by a researcher, [39] who established that despite the high figures recorded among different blood groups, there is no statistical significant correlation between tendencies for developing hypertension with a particular blood group.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

All the authors hereby declare that this experiment has been examined and approved by the appropriate ethics committee of the Niger Delta University, Bayelsa State and have therefore been performed in accordance with the ethical standards laid down by the University.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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