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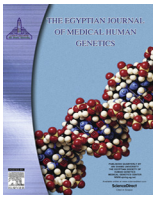

Review

Gene frequencies of ABO and Rh blood groups in Nigeria: A review

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ABSTRACT

Background: ABO and Rhesus factor (Rh) blood type are germane in human life in genetics and clinical studies.
Aim of the study: The review was undertaken with the objective to provide data on the ABO and Rh(D) blood group distribution and gene frequency across Nigeria which is vital for blood transfusion and susceptibility to disease.
Materials and methods: Literature search for ABO/Rh blood distribution in Nigeria was done and allele frequencies of A, B, O, D and d were calculated from the frequency recorded from six geopolitical zones in Nigeria. We reported frequency of ABO and Rhesus blood type from 318,940 and 280,514 individuals respectively. Prevalence were reported as percentage and Hardy-Weinberg equilibrium was tested using Chi square test and p was set at 0.05 unless otherwise stated.
Results: We reported ABO blood group frequencies in the order O > A > B > AB (52.93%, 22.77%, 20.64% and 3.66%) while prevalence of Rh+ was 94.90% from total population studied. Our reported frequencies did not differ from Hardy-Weinberg equilibrium (goodness-of-fit X^2 for ABO = 1.74 df = 3, $p < 0.05$). Allelic frequencies for A(p), B(q) and O(r) are 0.143, 0.130 and 0.728 respectively.
Conclusion: The study provides information on the distribution/frequency of ABO/Rh(D) blood group and their corresponding allelic proportion in a large Nigeria study. It also revealed how the Nigerian populations in the North, South, West and East vary with respect to genetic traits. This vital information will be important for population genetics and anthropology studies and may be helpful in planning for future health strategy and blueprint, particularly planning with regards to disease management and blood transfusion medicine.

Contents

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1. Introduction

Blood transfusion resulted in high mortality before the discovery of ABO blood groups because there was no knowledge of the difference in the blood composition among individuals in human population [1]. Later study by Landsteiner [2] made it possible to type/group blood to ABO class (A, B and O) based on the presence or absence of surface antigens on red blood cell (RBC). The last type (AB) was discovered in 1902 by DesCasterllo and Sturli [3]. These germane discoveries lead to reduced mortality due to blood transfusion. Human ABO type is a classic example of multi-allelism because it has three alleles (A, B and O) and its phenotype could be O, A, B or AB. The composition for an individual ABO blood type is always based on inheritance of gene on chromosome 9(9q34) which encodes glycosyl transferases that transfer some oligosaccharides residues to H antigen, resulting in the formation of group A and B antigens but O individuals lack such activity [4].

Rh blood type (Rhesus) is second to ABO blood group in its importance in blood transfusion biology. It is highly polymorphic because it contains more than forty-four different antigens but the most clinical significant polymorphism is the presence or absence of the Rh (D) antigen on the red blood cell.

Environmental factor does not change individual blood during life except in rare cases of certain diseases like Acute Leukemia [5–7] or bone marrow transplant. Although ABO blood group is determined by inheritance, natural selection may have influenced the current frequencies of ABO types among populations based on susceptibility to particular diseases or disorders [8–10].

A, B and O (H) are determinants for the antigens on ABO blood group respectively which are complex oligosaccharide (carbohydrate) molecules positioned strategically on the extracellular surface of the red blood cell (RBC) membrane [11]. Apart from their expression on the RBC, ABO antigens are also highly expressed on the surface of a variety of human cells and tissues, including the epithelium, sensory neurons, platelets, and the vascular endothelium [12]. Thus, the biological/clinical importance of the ABO blood group system extends beyond transfusion medicine/immunohaematology because there are accumulating evidence that the ABO blood group also plays a key role in various human diseases such as diabetes, cardiovascular, neoplastic, carcinoma and infectious disorders [8,13–14]. From the foregoing, we can deduce that ABO and Rh blood groups polymorphism are valuable and indispensable tools in contemporary medicine, population genetics and anthropology.

The distribution of these two blood groups has been repeatedly investigated in various populations all over the world and their frequencies exhibited considerable variation in different geographic locations, reflecting the underlying genetic and ethnic diversity of human populations [15]. A multi race/ethnic study in the United State reported that blood type O is the most prevalent (46.6%) with White non-Hispanic, Hispanic, Black non-Hispanic, Asian and North American Indian having varying percentage of 45.5, 56.5, 50.2, 39.8 and 54.6 respectively [15]. Other studies in Turkey, Mauritania, Iran, Ethiopia, Colombia, Cameroun, Bangladesh, Madagascar, Morocco, Guinea and Northern India have reported varying percentage in ABO and Rh blood types [15–26].

Nigeria is a highly populated country comprising of different ethnic groups. As with many other genetic traits, the gene frequency of ABO and Rh blood group varies significantly within the six geopolitical zones in Nigeria [27–34]. Therefore, this study reviewed the distribution of ABO and Rh blood groups and determined it gene frequency in different parts of Nigeria to serve as a reference/database that contains information on ABO and Rh(D) phenotype for accurate ABO/ Rh(D) phenotype/allelic frequencies for the six geo-political zones in Nigeria.

2. Materials and methods

A search engine for ABO and Rh(D) distribution/prevalence/frequency of different blood type in Nigeria was done and used for our data analysis on frequency and allele distribution of ABO and Rh(D) in Nigeria.

We assigned p, q and r to allele A, B, and O respectively for the allele frequencies of ABO blood group genes. Their frequencies were calculated under Hardy-Weinberg (H-W) assumptions as $[(p + q + r)^2 = p^2 + q^2 + r^2 + 2pq + 2pr + 2pq = 1]$ as p^2 $(I^AI^A) + 2pr$ $(I^AI^O) + q^2$ $(I^BI^B) + 2qr$ $(I^BI^O) + 2pq$ $(I^AI^B) + r^2$ (I^OI^O) while allele D and d in rhesus type were assigned p and q respectively and their frequencies were also calculated using H-W equilibrium $p^2 + 2pq + q^2 = 1$ [35].

Allele frequencies were calculated under the assumption of H-W equilibrium and prevalence were expressed as percentages. Chi-square test was used to compare observed allelic and genotypic frequency distributions of the blood group and Rh antigens to that expected under the H-W equilibrium [35].

3. Results

ABO and Rh phenotype frequencies from different states/locations and geopolitical zones were compared and their corresponding allelic frequencies (A, B, O, D and d) were computed with data compiled from each studies. A total of 318,940 and 280,514 individuals were compared for ABO and Rh(D) respectively in this study. Total data collated from Nigeria showing their distribution and percentages (Table 1) revealed that the ABO blood group frequencies were found in the order O > A > B > AB (52.93%, 22.77%, 20.64% and 3.66%) while prevalence of Rh+ was 94.90% (Table 2). We observed a similar trend when we compared them across six geopolitical zones except that B > A in North-West (Table 1). As shown in Table 1, the frequency of allele A, B and O are 0.143, 0.130 and 0.728 respectively.

As shown in Table 1, we found that the distribution and proportion of individuals having ABO blood antigens did not differ from those expected under Hardy–Weinberg equilibrium for overall total in Nigeria, South-West (SW), North-West (NW), and South-East (SE) (goodness-of-fit X^2 for ABO = 1.74, 1.28, 1.29 and 6.97 respectively df = 3, $p < 0.05$), however; the distribution and proportion of individuals having ABO blood antigens differ from those expected under Hardy–Weinberg equilibrium for North-Central, South-South and North-Eastern part of Nigeria (goodness-of-fit X^2 for ABO = 928.91, 222.00 and 12.05 respectively, df = 3, $p < 0.05$). As expected the frequency of Rh+(D) recorded for overall total in Nigeria from this study was 94.9%. The distribution and proportion of individuals having Rh blood antigens for overall total in Nigeria and all six geopolitical zones did not differ from those expected under Hardy–Weinberg equilibrium at df = 1 and $p < 0.01$ (Table 2).

4. Discussion

This study investigated the distribution and gene frequencies of ABO and Rh (D) blood group systems in most parts of Nigeria with representatives in each of the six geopolitical zones. The data collated revealed that the ABO blood group frequencies were found in the order O > A > B > AB (52.93%, 22.77%, 20.64% and 3.66%) respectively among Nigeria population. Our data is in agreement with other reports from most parts of the world as reported from a study on 3,086,215 individuals belonging to different race/ethnic groups in USA (O;46.6%, A;37.1%, B;12.2% and AB;4.1%) [15]. Also in congruent with studies from Mauritania, Morocco, Cameroun,