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Original Research Article

Distribution of ABO blood group/Rhesus factor in the Eastern Region of Ghana, towards effective blood bank inventory

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Abstract: Knowledge about ABO blood grouping/Rhesus factor has been associated with successful blood transfusions in many emergency medical situations. However, there is limited data on the distribution of ABO blood group phenotypes/Rhesus factor in the Ghanaian population, a situation which may undermine storage of predominant blood group phenotypes in blood banks. This study therefore, sought to investigate distribution of ABO blood groups/Rhesus factor in the Eastern Region of Ghana. Data was retrospectively collected from the records of four major healthcare facilities within the region. The findings indicated that the most prevalent blood group/Rhesus factor was O^+ (6077/11298; 53.8%). The distributions by sex, age and ethnic group, showed that the proportion of females (50%), those aged between 21 and 40 years (44.6%) and the Akan ethnic group (57.6%) were highest. The blood group/Rhesus factor distribution among females, persons between 21 and 40 years and the Akan ethnic group showed predominance for O^+ blood in the proportions of 55.0%, 46.2% and 55.0% respectively, compared with the other blood phenotypes. This study clearly showed that the characteristics of the ABO blood group/Rhesus factor distribution were skewed towards a population of donors rather than recipients, probably due to evolutionary advantage of blood group O in the Eastern Region of Ghana. Healthcare facilities in the region must therefore adopt a policy to stock-pile sufficient O^+ blood for transfusion purposes.
Keywords: Blood group, Ethnic group, Eastern region, Phenotype, Rhesus, Ghana

INTRODUCTION

The distribution of ABO blood groups/Rhesus factor varies globally among different populations of people [1, 2, 3]. The existence of these variations, pertaining to geographical, racial and ethnicity also influence the distribution of blood group phenotypes [4, 5]. The ABO blood group phenotypes arise due to the presence of antigens on the surface of the red blood cells or antibodies in the blood plasma. Individuals have different types and combinations of these molecules [6]. According to ABO blood group/Rhesus factor nomenclature, a person can belong to either of the following eight blood groups: A Rh^+ (A^+), A Rh^- (A^-), B Rh^+ (B^+), B Rh^- (B^-), AB Rh^+ (AB^+), AB Rh^- (AB^-), O Rh^+ (O^+) and O Rh^- (O^-). The discovery of these blood groups system by Karl Landsteiner in 1901 has currently become a landmark in blood banking, transfusion medicine and organ transplantation.

A previous study has shown that blood group O is the most common blood group phenotype found globally [7]. The differential distributions show that Africa has the highest prevalence for blood group O [8], whilst blood group A is predominant in Northern parts of Europe [9] and group B is most frequent in Central Asia [10]. These discrepancies in the distribution of the ABO blood groups among different populations are thought to arise due to natural selection from disease susceptibility to pathogens leading to evolutionary changes or the migration of people across different geographical settings [11, 12].

Conditions requiring blood transfusion may be clinical, such as patients with severe anaemia, cancer, haemophilia, kidney disease, liver disease, severe infection, sickle cell disease, thrombocytopenia, surgery [13, 14], or environmental, such as victims of accidents and physical injuries accompanied with severe loss of

blood [15]. While blood transfusion can be life-saving and provides great clinical benefit to many patients, it is not without risks [16, 17]. These risks however, have been either shown shown to either be immediate or delayed thus making clinical diagnosis and reporting of cases difficult to monitor [17]. One prominent health risk is agglutination resulting from transfusion of incompatible blood to patients, a situation which could be fatal. Improving safety in blood transfusion and reducing transfusion errors requires robust hospital transfusion protocols [16]. The preparedness of health facilities in specified geographic locations for emergency or ordinary blood transfusions has to be precipitated by knowledge of predominant blood types of the community. This can only be achieved through thorough inventory taking or stock piling of dominant blood types in health facilities. Blood donation for stock piling has to then focus on the dominant distribution of blood types in the community. This requires the establishment of reliable blood group/Rhesus factor reports that offer fundamental knowledge to policy makers in the local community in anticipation for future transfusions.

For successful blood transfusion to be carried out in local/regional healthcare facility there is need for the existence of a blood bank having compatible blood stock-piled in adequate quantities. Stock-piling compatible blood requires previous knowledge of dominant blood group phenotype prevailing within a geographical setting. The current status of the distribution of blood group/Rhesus factor at local/regional levels in Ghana is poorly known, which necessitated the current research. The knowledge of the distribution of blood group phenotype/Rhesus factor would help in efficient taking of inventory and delivery of blood transfusion services within the local/regional healthcare facilities in the Eastern region of Ghana.

METHODOLOGY

Study site and design

The study adopted the retrospective approach to collect data on the ABO/Rhesus blood group distribution of donors and recipients recorded in four major healthcare facilities (hospitals, clinics and blood banks) in the Eastern Region of Ghana. The healthcare facilities which were purposefully selected were the Koforidua Regional Hospital, Atua Government Hospital, Tetteh Quarshie Memorial Hospital and the Akosombo Hospital.

Data management and analysis

All available data on blood group/Rhesus factor collected from the healthcare facilities over a three year period (between 2012 and 2015) were used in the study. This yielded an overall sample size of eleven thousand, two hundred and ninety eight (11, 298). Since the data were already available in the healthcare facilities, no laboratory test was carried out to determine the blood group phenotype of participants. The data was first recorded in Microsoft excel for Windows 10 software and later imported to SPSS Version 20 (Chicago, IL, USA) for quantitative analysis to determine the distribution of the blood types.

Ethics statement

Permission was sought from the directors/administrators of all the health facilities used in the study. Ethical clearance was obtained from the Institutional Review Board of the Central University before commencement of the study.

RESULTS

The findings of this study revealed that the most prevalent blood group/Rhesus factor in the Eastern Region of Ghana was O^+ (53.8%). Blood group B^+ was however found to be somewhat prevalent (18.3%) and second to blood group O^+, followed by A^+ (17.6%) (Table 1). Even though the male female ratio was almost one, the proportion of females with blood group O^+ was higher (55%) compared with males (52.8%) as shown in Table 1.

Table 1: Distribution of blood group/Rhesus factor by sex in the Eastern Region

Characteristic	Blood group/Rhesus factor								
Sex	A^+ n (%)	A^- n (%)	B^+ n (%)	B^- n (%)	AB^+ n (%)	AB^- n (%)	O^+ n (%)	O^- n (%)	Total (%)
Male	937 (16.7)	80 (1.4)	975 (17.3)	75 (1.3)	169 (3.0)	5 (0.1)	2968 (52.8)	417 (7.4)	5626 (49.8)
Female	1055 (18.7)	66 (1.2)	1093 (19.4)	70 (1.2)	144 (2.6)	21 (0.4)	3109 (55.0)	91 (1.6)	5649 (50.0)
Overall (N/%)	1992 (17.6)	146 (1.3)	2068 (18.3)	145 (1.3)	313 (2.8)	26 (0.2)	6077 (53.8)	508 (4.5)	**11298**

The results of the study again showed that the Eastern region of Ghana is characterized predominantly by a middle-aged population (between 21 and 40 years), having blood group O^+ as the most prevalent blood phenotype (46.2%) (Table 2). Even though the population of the infants/youth (0 to 20 years) was second (24.1%), the proportion of persons with blood group AB^+ and O^- found in both the infant/youth and middle-aged groups were the same (2.9%) (5.4%) respectively, as shown in Table 2.

Table 2: Distribution of blood group/Rhesus factor by age in the Eastern Region

Characteristic	Blood group/Rhesus factor								Total N (%)
Age group	A^+ n (%)	A^- n (%)	B^+ n (%)	B^- n (%)	AB^+ n (%)	AB^- n (%)	O^+ n (%)	O^- n (%)	
0-20	413 (15.1)	39 (1.4)	488 (17.9)	34 (1.3)	79 (2.9)	3 (0.1)	1526 (55.9)	146 (5.4)	2728 (24.1)
21-40	1114 (22.1)	69 (1.4)	1014 (20.1)	81 (1.6)	146 (2.9)	14 (0.3)	2327 (46.2)	271 (5.4)	5036 (44.6)
41-60	341 (16.5)	22 (1.1)	343 (16.6)	19 (0.9)	54 (2.6)	7 (0.3)	1221 (59.1)	59 (2.7)	2066 (18.3)
Above 60	124 (8.6)	16 (1.1)	223 (15.4)	11 (0.8)	34 (2.4)	3 (0.2)	1002 (69.3)	32 (2.2)	1445 (12.8)

Table 3 shows the distribution of blood group/Rhesus factor based on ethnic groups within the Eastern Region of Ghana. The finding clearly showed that the Eastern region is dominant with the indigenous Akan ethnic group forming about 58% of the population with a leading proportion of 55% blood group O^+ phenotype. The second predominant blood groups/Rhesus factors recorded among the Akan ethnic group were B^+ and A^+ with similar percentage distributions of 18%. The second largest ethnic representation of the Eastern Region, the Ga Adangmes (22.8%) also had the highest proportion of persons with O^+ blood phenotype (56.1%). There were no blood groups AB^- and O^- for ethnic minority groups from other countries in the shown in Table 3.

Table 3: Distribution of blood group/Rhesus factor by ethnic groups in the Eastern Region

Characteristic	Blood group/Rhesus factor								Total N (%)
Ethnic group	A^+ n (%)	A^- n (%)	B^+ n (%)	B^- n (%)	AB^+ n (%)	AB^- n (%)	O^+ n (%)	O^- n (%)	
Ga Adangbe	384 (14.9)	40 (1.6)	435 (16.9)	39 (1.5)	70 (2.7)	7 (0.3)	1448 (56.1)	156 (6.1)	2579 (22.8)
Akan	1164 (18.0)	76 (1.2)	1183 (18.2)	64 (1.0)	162 (2.5)	13 (0.2)	3577 (55.0)	264 (4.1)	6503 (57.6)
Ewe	254 (17.8)	18 (1.3)	277 (19.4)	26 (1.8)	55 (3.8)	4 (0.3)	751 (52.5)	46 (3.2)	1431 (12.7)
Northern	189 (25.4)	11 (1.5)	170 (22.9)	14 (1.9)	25 (3.4)	2 (0.3)	290 (39.0)	42 (5.7)	743 (6.6)
Non-Ghanaian	1 (5.3)	1 (5.3)	3 (15.8)	2 (10.5)	1 (5.3)	0 (0.0)	11 (57.9)	0 (0.0)	19 (0.2)

DISCUSSION

Knowledge about the distribution of blood group phenotypes/Rhesus factor is critical for clinical studies (for example disease association), as well as for population studies at the local/regional level. The findings of this study indicated that the most prevalent blood group/Rhesus factor in the Eastern Region of Ghana was O^+ (53.8%). This is comparable to findings by Mukinda *et al.;* in Uganda [18], who reported 53.2% for blood group O^+ among undergraduate students of Kampala University. Other researchers have also shown that blood group O is most prevalent among black populations globally [19, 7, 20]. The result of the current study however contrasts that of a study conducted in India by Garg (2014), which reported blood group B^+ as the predominant blood group with an overall prevalence of 32.1% [21]. The variations in the distribution of blood group/Rhesus factor in the study population may be due to the influence of genetic and environmental factors.

The ABO blood group system is of critical importance in blood transfusion. It originates from the presence of two sugar antigens (A and B) on the surface of red blood cells, to which most transfusion recipients have naturally occurring haemolytic antibodies. Persons with blood group O express neither the A nor B antigens on red blood cells. Consequently, blood group O are often able to transfuse to patients of other ABO blood groups and thus, controversially known as universal donors. Blood group O donors are always in demand. The reported shortages of blood at blood banks often arise due to insufficiency of group O blood [22]. The current study therefore suggests that health facilities within the Eastern Region of Ghana ought to store enough blood group O phenotype in their blood banks to cater for recipients of blood and to forestall possible crisis to patients likely to arise due to the shortage of same.

Previous researchers have suggested numerous associations existing between ABO blood group

phenotypes and susceptibility to disease. These associations may predict susceptibility to or protection from disease among the current study population and influence the survival and distribution of the blood groups among future populations in the study area. For example, the susceptibility to arterial and venous thromboembolism (VTE) is reported to be less for persons with blood group O compared with group A, B or AB phenotypes, because of the lower levels of the blood clotting protein, von Willebrand factor (vWF) expressed by group O phenotypes [23, 24]. Blood group O also provides a selective advantage against severe malaria [25, 26], a condition endemic in Ghana [27] and Africa [28]. Other published data from large cohort studies suggest lower incidence of malignancies [29], lower incidence of growth and spread of tumors and longer survival times in cancer patients [30] in group O compared with other ABO blood group phenotypes.

Persons with blood group O are however more susceptible to infection by *Helicobacter pylori*, the causative agent for peptic ulceration and gastric cancer [31], as well as intestinal infections from Gram-negative bacteria [32]. For instance, persons with blood group O are reported to experience greater likelihood of severe infections with cholera (*Vibrio cholerae* strains O1 El Tor and O139) compared with the other ABO blood group phenotypes [33]. Again, blood group O are more susceptible in outbreaks of gastrointestinal infections caused by *Escherichia coli* O157 with higher mortality compared with the other ABO blood group phenotypes [34]. Indeed recent epidemiological reports on morbidity and mortality associated with outbreaks of cholera in Ghana have been worrying. According to the weekly epidemiological bulletin of the Ghana Health Service [35], a total of 28,922 cases including 243 deaths (case fatality rate of 0.8%) had been reported from 130 out of the 216 districts (60%) in all the ten regions, including the Eastern region of Ghana, as of 4th January 2015.

The current study reported a slightly higher proportion of females with higher distribution of blood group O^+ (55%) compared with males (52.8%) as shown in Table 1, even though the male female ratio was almost one. This finding is comparable to that reported by the Ghana Population and Housing Census of 2010, indicating that the number of males was approximately equal to the number of females in the Western region. The Eastern and Western regions of Ghana are both dominated by the Akan ethnic group. According to a demographic study conducted by Sen, (1992) and Sen (2003), [36, 37] females have greater resistance to disease throughout life and greater overall longevity; hence in situations where they have the same nutrition and access to healthcare as males, females have lower mortalities across all age groups. The situation for males is however compounded by their greater tendency to engage in risk behaviors and violence, thus increasing their risk of premature mortality, with subsequent inability to transmit their ABO blood groups to future generations, compared with females [38].

As indicated in Table 2, majority (44.6%) of the study participants were between the ages of 21 and 40 years. The highest distribution of the ABO blood group/Rhesus factor among this age group was O^+ (46.2%). This finding was similar to that of Garg et al., 2014, who reported predominant donor age group between 18 and 35 years [21]. Previous studies have explained that the main work force of any society is between 18 and 40 years and are thus likely to be the most common age group donating blood at health facilities [39, 40]. The age group with the least counts of ABO blood/Rhesus factor in this study were those who were 60 years and above. According to the labour laws of Ghana, this group of persons are expected to have retired from active employment. Their frequency of accessing healthcare facilities is low and they often suffer age-related diseases such as hypertension, diabetes mellitus, low hemoglobin and ischemic heart diseases. Persons in this age group are more likely to abstain from donating blood, a situation which may have accounted for the low frequencies recorded except for blood group/Rhesus factor O^+ in the proportion of about 69%.

The results on the distribution of the ABO blood/Rhesus factor by ethnic groups in the Eastern region of Ghana clearly showed a region with diverse ethnic dichotomy (Table 3). Even though the region is dominant with the Akan speaking ethnic group (about 58%), the Ga Adangbe and Ewe speaking groups also have a fair representation. The proportion of Akan speaking ethnic group with highest prevalent blood group/Rhesus factor was O^+ (55%). A similar study conducted in Nigeria also showed variations in ABO blood/Rhesus factor among different ethnic groups and revealed that blood group O^+ was the most common blood group in all three major tribes studied in Kogi State, representing 54.5% [41].

Limitations of study

Retrospective studies are designed to analyze pre-existing data, and are subject to numerous biases as a result. The statistical analysis did not allow interpretation of associations between demographic factors and distribution of blood groups in the current study. These limitations, notwithstanding, the study adds to the existing knowledge about prevailing blood group phenotype/Rhesus factor among the Ghanaian population and could influence policy decisions about blood banking in health facilities within the Eastern region of Ghana.

CONCLUSION AND RECOMMENDATION

The overall sequence of distribution of ABO blood group/Rhesus factor in the Eastern region of

Ghana was found to be represented by the formula $O^+ > B^+ > A^+ > O^- > AB^+ > A^- > B^- > AB^-$. Healthcare facilities in the region should therefore take appropriate inventory and stock-pile blood samples at their respective blood banks based on the prevalence sequence described for effective blood banking at the local/regional level. This would be of tremendous use to alleviate crisis situations associated with blood transfusion services, especially during healthcare emergencies. The study recommends similar but well-designed studies to be conducted in the other nine regions of Ghana to determine the prevailing blood group/Rhesus factor distributions in these localities of the country and to possibly collate a national blood/group Rhesus factor database for policy purposes. Future studies must also include serological and genetic investigation of the prevailing ABO blood group antigens/Rhesus factor in the population, using cross-sectional design.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest to the content of this article.

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