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BLOOD GROUPS (ABO/Rh) AND SOCIODEMOGRAPHIC AND CLINICAL PROFILE AMONG PATIENTS WITH LEPROSY IN ANGOLA

Running title: ABO/Rh blood groups among patients with leprosy in Angola

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ABSTRACT

Introduction: Leprosy, caused by *Mycobacterium leprae* is one of the oldest infectious diseases in human history and its eradication is linked to poverty control, lack of basic sanitation, the fragility of health, and education services. **Objective:** To evaluate the frequency of blood groups (ABO/Rh) and the sociodemographic and clinical profile of Angolan patients with Leprosy treated at the Anti-Tuberculosis and Leprosy Dispensary in Luanda, the capital city of Angola. **Methodology:** A descriptive, introspective, cross-sectional study with a quantitative approach was carried out with 102 patients of Luanda, in the second half of 2021. **Results:** Of the 102 patients included in the study, the majority belonged to the ORh+ group (51.9%), followed by the BRh+ group (27.4%) and ARh+ (18.6%), most were under 51 years of age (87.3%), with low education (54.9%), coming from urban areas (44.1%). As for clinical conditions, most had a multibacillary infection (93.1%), diagnosed mainly by smear microscopy (75.5%) without other infection (79.4%), some of them with complications (28.4%) and individuals with non-O blood group showed changes in the blood count. **Conclusion:** Leprosy seems to be common in ORh+ individuals, it continues to affect especially those residing in areas of population

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agglomerations and with low education, presenting itself as a multibacillary infection, where changes in the blood count are greater in non-O individuals.

Keywords: leprosy; ABO/Rh blood group; Clinical; Angola

INTRODUCTION

Leprosy, caused by *Mycobacterium leprae*, is one of the oldest known infectious diseases in human history, which spread throughout the world following human migration paths from the African continent to Asia and Europe, where factors such as wars, anti-hygienic conditions, social and health inequality created conditions for its propagation since prehistoric times, and existing health disparities contributed to uneven morbidity and mortality, before their gradual decline after the Middle Ages due to the emergence of other worse pandemics [1,2].

The relationship between leprosy and poverty, lack of basic sanitation, and fragility of health and education services, especially in developing countries, contribute as a threat to the eradication of the disease, since leprosy, is characterized by an infectious, chronic, endemic disease, of compulsory notification, neglected and considered a serious public health problem [3].

In 2016, the World Health Organization (WHO) prepared a document to describe the global strategy adopted to completely eradicate leprosy worldwide, where it emphasized the importance of integral political and economic coordination and an effort against the cases of leprosy still present in the world, in order to prevent related disabilities and other complications [4]. However, in 2018, 208, 619 new cases of leprosy were diagnosed in 159 countries, which highlights the need to replan strategies linked to public health [5].

According to the Angolan health authorities, about 1,887 cases of leprosy have been treated since 2005, when Angola reached the goal of eliminating the disease, according to data from the WHO, in turn, in 2022, the province of Luanda recorded around 184 new cases of leprosy in 2022 [6].

The ABO system is the most crucial blood group polymorphism related to compatibility and has been linked to infections such as - *E.coli*, *P.vivax*, *P.falciparum*, Candida, *H.pylori*, HIV, V.cholerae, Parvovirus B19 and Influenza Viruses [7] and other

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diseases such as cancer, cardiovascular diseases, hematological disorders, cognitive disorders, circulatory diseases, metabolic diseases and malaria [8,9].

Individuals of blood group AB were considered susceptible to cognitive impairment, disorders such as hypertension, obesity, dyslipidemia, cardiovascular disease and diabetes, smallpox and *E. coli*, and salmonella infection; group O has an increased incidence of cholera, plague, tuberculosis infections, and mumps; blood group A is related to increased incidence of smallpox and *Pseudomonas aeruginosa*; blood type B is also associated with an increased incidence of gonorrhea, tuberculosis, and *Streptococcus pneumoniae, E. coli*, and salmonella infections[10].

Recent studies carried out by our research team in Angola, to assess the frequency of blood groups in patients with Arterial Hypertension, showed that the most frequent blood group was group B 36.4% (36/99), in the study to assess the frequency of groups in patients with chronic kidney disease, most individuals belonged to group O 56.4% (79/140) and in patients with Nephrotic Syndrome (NS) and Sickle Cell Anemia (SC), most of the population belonged to the group ORh+, followed by patients in the ABRh+ group [11,12,13].

Although several studies demonstrate the association between blood groups (ABO) and infectious diseases, no studies were found that correlate leprosy disease with the classification of blood groups. From this perspective, the present study aimed to evaluate the frequency of blood groups (ABO/Rh) and the sociodemographic and clinical profile of patients with leprosy treated at the Anti-Tuberculosis and Leprosy Dispensary in Luanda, the capital city of Angola.

METHODOLOGY

Study design

This was an analytical, prospective study, with a quantitative approach, where the blood group (ABO System) and Rhesus factor were determined in patients with leprosy (leprosy) treated at the Anti-Tuberculosis and Leprosy Dispensary of Luanda in the second half of 2021. In the database, the population consisted of 250 patients, from which a sample of 150 patients with leprosy was extracted, regardless of sex and age.

Ethics statement

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The study was reviewed and approved by the Ethics Committee for Research on Human Beings of the Instituto Superior de Ciências da Saúde, Universidade Agostinho Neto (nr. 904/GD/ISCISA/UAN/2021) and by the Pedagogical and Scientific Department of the Anti-tuberculosis and Leprosy (nr. 55/DPC/DATL/2021). All patients gave their informed consent before being included in the study.

Variables studied

Variables such as ABO/Rh blood group, age, sex, education, place of residence, type of infection, number of lesions, methods used in diagnosis, associated diseases, complications results of the erythrocyte, leukocyte, and platelet count were obtained.

Analysis of blood groups

A blood sample estimated at 2 mL was collected for each patient by the venipuncture technique and the samples were placed in test tubes containing ethylenediaminetetraacetic acid (EDTA). The samples were placed in three wells and the latter was associated with anti-A, Anti-B, and Anti-D reagents (Immucor, Portugal). Blood group determination was performed using the microplate technique according to the manufacturer's instructions, which is an agglutination test between the patient's serum and the anti-A, Anti-B, and Anti-D reagents from each well for phenotypic identification of the blood. groups (ABO and Rh).

Statistical analysis

The data obtained in this study were analyzed using SPSS v20 (IBM SPSS Statistics, USA). Absolute and relative frequencies were determined in the descriptive analysis. Normally data distribution was expressed as mean and standard deviation (SD). Chi-square (X^2) test was used to assess the relationship between categorical variables. All reported p-values are two-tailed and deemed significant when $p<0.05$.

RESULTS

Socio-demographic data

The sociodemographic data (Table 1) found in patients with leprosy show that the majority of the population consisted of young people aged between 21 and 40 years, representing about 55.9% of the entire population studied; with a predominance of males

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(63.7%); except for illiterate people, who represented only 7.8% of individuals affected by leprosy, as the level of education increases, the incidence of cases decreases; Regarding housing, it was found that the majority resided in the municipality of Luanda, followed by Viana, and Belas. Of the 102 patients included in the study, most belonged to the ORh(+) group, which represented 51.9% of the entire population studied, followed by the BRh+(27.4%) and ARh+(18.6%) groups. Only one ABRh+ and BRh- individual was found in the present study. In all the variables of the ABO system studied, most individuals were in the ORh+ group. There was no significant relationship between sociodemographic data and blood groups of patients with leprosy (p>0.05).

	BLOOD GROUP (n/%)					Total	Ages	
	ABRh +	ARh +	BRh –	BRh +	ORh +	N (%)	P-Value	
AGE GROUP	**(n=1/)**	**(n=19)**	**(n=1)**	**(n=28)**	**(n=53)**	**(n=102)**	**(X^2)**	**Mean/SD**
≤20	0(0,0)	5(33,3)	0(0,0)	3(20)	7(46,7)	15 (14,7)		16,7±1,7
21-30	1(3,8)	4(15,3)	0(0,0)	5(19,3)	16(61,6)	26 (25,5)	0,647	25,1±2,0
31-40	0(0,0)	5(16,1)	0(0,0)	12(38,7)	14(45,2)	31 (30,4)		35,0±2,9
41-50	0(0,0)	3(17,6)	1(5,8)	4(23,5)	9(52,9)	17 (16,7)		44,3±3,4
≥51	0(0,0)	2(15,4)	0(0,0)	4(30,8)	7(53,8)	13 (12,7)		63,2±6,2
GENDER								
Female	0(0,0)	8(21,6)	0(0,0)	11(29,7)	18(48,7)	37 (36,3)	0,800	36,5±15,4
Male	1(1,5)	11(16,2)	1(1,5)	17(26,2)	35(53,8)	65 (63,7)		34,0±13,6
EDUCATION								
Basic education	0(0,0)	6(12,5)	0(0,0)	18(37,5)	24(50)	48 (47,1)	0,229	37,0±15,6
High school	0(0,0)	10(30,3)	1(3,0)	5(15,2)	17(51,5)	33 (32,4)		31,2±11,9
University education	1(7,6)	2(15,4)	0(0,0)	2((15,4)	8((61,5)	13 (12,7)		29,5±6,2
Illiterate	0(0,0)	1(12,5)	0(0,0)	3(37,5)	4(50,0)	8 (7,8)		46,6±16,4
Residence								
Belas	0(0,0)	3(18,7)	0(0,0)	4(25)	9(56,3)	16 (15,7)	0,118	32,5±10,9
Cacuaco	1(14,3)	1(14,3)	0(0,0)	2(28,6)	3(42,8)	7 (6,9)		37,3±13,6
Cazenga	0(0,0)	1(7,6)	0(0,0)	6(46,2)	6(46,2)	13 (12,7)		33,8±17,2
Icolo e Bengo	0(0,0)	0(0,0)	0(0,0)	0(0,0)	1(100)	1 (1,0)		32,0±0,0
Luanda	0(0,0)	11(24,4)	1(2,2)	10(22,2)	23(51,2)	45 (44,1)		35,4,±14,9
Viana	0(0,0)	3(15,0)	0(0,0)	6(30,0)	11(55,0)	20 (19,6)		35,9±14,7

Table 1. Sociodemographic data and blood groups of patients with leprosy.

When evaluating the blood groups in relation to the clinical condition and complications resulting from leprosy (Table 2), we found that most patients were classified as new cases of the disease (66.7%), however, the lowest mean age (29 .8 years, SD=10.3) was found in patients who were considered to be reentry cases. It was found

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that most patients included in the study had multibacillary infections (93.1%) and were mostly diagnosed with smear microscopy (75.5%). In the evaluation of pre-existing diseases to leprosy infection, we found that most individuals had no previous disease (79.4%), however, diseases such as Arterial Hypertension, Hepatitis B, and Tuberculosis were cited as a condition prior to leprosy in some patients, where he noticed that individuals with pre-existing diseases had a higher average age than individuals without any other pathology. As for the complications resulting from leprosy, we noticed that ulcers (11.8%), visual problems (8.8%), mutilations, and claws (3.9%) were the complications most cited by patients. With the exception of the clinical diagnosis, Hypertension and mutilations, where there was a majority of individuals in the ARh+ group, in all other clinical situations and complications, it was found that the individuals in the ORh+ group were the most affected. There was a significant relationship between disease classification by the number of lesions as well as diseases associated with blood groups ($p<0.05$).

Table 2. Blood groups and clinical condition and complications in patients with leprosy

	BLOOD GROUP					Total		Ages
INFECTION	**ABRh+**	**ARh+**	**BRh –**	**BRh +**	**ORh +**	**N (%)**	**P-Value**	
	(n=1/)	**(n=19)**	**(n=1)**	**(n=28)**	**(n=53)**	**(n=102)**	**(X2)**	**Mean/SD**
New Cases	0(0,0)	13(19,1)	1(1,4)	19(27,9)	35(51,4)	68 (66,7)	0,635	37,5±15,3
Re-infection	1(2,9)	6(17,7)	0(0,0)	9(26,5)	18(52,9)	34 (33,3)		29,8±10,3
CLASSIFICATION (NUMBER OF INJURIES)								
Multibacillary (MB)	0(0,0)	18(18,9)	1(1,1)	27(28,4)	49(51,6)	95 (93,1)	**0,007**	35,3±14,6
Paucibacilary (PB)	1(14,3)	1(14,3)	0(0,0)	1(14,3)	4(57,1)	7 (6,9)		30,4±8,2
DIAGNOSIS METHOD								
Bacilloscopy	0(0,0)	15(19,5)	1(1,2)	20(25,9)	41(53,4)	77 (75,5)	0,109	36,6±14,8
Histol/Bacilloscopy	0(0,0)	1(16,7)	0(0,0)	1(16,7)	4(66,6)	6 (5,9)		32,3±14,7
Clinical	0(0,0)	1(11,1)	0(0,0)	6(66,7)	2(22,2)	9 (8,8)		30,7±12,0
Histology	1(10,0)	2(20,0)	0(0,0)	1(10,0)	6(60,0)	10 (9,8)		27,5±8,6
ASSOCIATED DISEASES								
Hepatitis B	0(0,0)	0(0,0)	0(0,0)	0(0,0)	3(100,0)	3 (2,9)	**<0,001**	33,7±5,5
Arterial hypertension	0(0,0)	2(20,0)	0(0,0)	5(50,0)	3(30,0)	10 (9,8)		56,8±12,2
None	0(0,0)	15(18,5)	1(1,2)	22(27,2)	43(53,1)	81 (79,4)		31,3±11,5
Others	1(14,3)	1(14,3)	0(0,0)	1(14,3)	4(57,1)	7 (6,9)		45,4±17,4
Tuberculosis	0(0,0)	1(100,0)	0(0,0)	0(0,0)	0(0,0)	1 (1,0)		39,0±0,0
CLINICAL COMPLICATIONS								
Claws	0(0,0)	1(33,3)	0(0,0)	1(33,3)	1(33,3)	3 (3,9)	0,982	24,0±5,2

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Mutilation	0(0,0)	1(25,0)	0(0,0)	2(50,0)	1(25,0)	4 (3,9)	34,3±5,1
None	1(1,3)	14(18,9)	1(1,3)	21(28,5)	37(50,0)	74 (72,5)	34,5±14,7
Visual problems	0(0,0)	2(22,2)	0(0,0)	0(0,0)	7(77,8)	9 (8,8)	38,2±14,9
Ulcers	0(0,0)	1(8,3)	0(0,0)	4(33,3)	7(58,4)	12 (11,8)	37,9±14,5

In the evaluation of the hemogram (Table 3) in patients with leprosy according to blood groups, we noticed that in the erythrogram only the mean number of erythrocytes (RBC) was normal in all groups. However, ABRh+ patients had mean Hemoglobin (HBG), Hematocrit (HCT), Mean Corpuscular Volume (MCV), and Mean Corpuscular Hemoglobin (MCM) slightly below the reference values and Red Blood Cell Distribution Range (RDW) slightly above the reference values. Individuals in the ARh+ group presented the mean Hemoglobin (HBG) and Hematocrit (HCT) values slightly below the reference values. Individuals from the BRh- group presented the average Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) slightly below the reference values.

In the leukogram evaluation, individuals of the ABRh+ group presented the mean of Leukocytes (WCB) and Lymphocytes (LYM) slightly below the reference values, while the mean of Monocytes (MONO) was slightly increased. Individuals in the BRh- group presented mean Neutrophils (NEUT) and Eosinophils (EOS) slightly below the reference values, while the mean Lymphocytes (LYM) were slightly increased.

In the plateletogram, only individuals in the ABRh+ group had a mean Platelet (PLT) far below the references, the other groups had a normal mean Platelet value. All patient groups, with the exception of the BRh+ group, had a decreased mean platelet volume (MPV) value, which indicates that the production of platelets in the bone marrow is slightly below the reference values.

Table 3. Blood groups and changes in the blood count of patients with leprosy

	BLOOD GROUP				
	ABRh + (n=1/)	**ARh + (n=19)**	**BRh – (n=1)**	**BRh + (n=28)**	**ORh + (n=53**
BLOOD COUNT	Mean/SD	Mean/SD	Mean/SD	Mean/SD	Mean/SD
ERYTHROGRAM					
RBC 10 e3/uL(3,9-5,9)	3,8±0,0	3,9±0,9	5,6±0,0	4,09±0,7	4,21±0,7
HBG g/dl(12-18)	9,5±0,0	10,6±2,1	12,6±0,0	10,9±1,3	11,2±1,6
HCT %(35-52)	31,0±0,0	32,8±6,1	42,2±0,0	34,7±4,9	35,1±5,7

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MCV fl(80-100)	80,7±0,0	83,7±10,9	75,5±0,0	86,0±11,4	84,3±12,7
MCH pg(27-32)	24,8±0,0	27,0±3,1	22,5±0,0	27,1±3,1	26,8±3,4
MCHC g/dl(31-36)	30,8±0,0	32,5±3,1	29,9±0,0	31,7±2,9	32,1±2,9
RDW %(10-16)	18,6±0,0	9,9±9,3	15,1±0,0	14,6±5,7	14,6±6,2
LEUCOGRAM					
WCB 10 e3/uL(4-11)	2,77±0,2	7,1±4,8	3,8±0,0	5,9±2,4	6,5±2,7
NEUT %(40-70)	61,4±0,3	53,0±15,9	32,0±0,0	54,4±13,2	52,1±16,1
LYM %(20-50)	15,3±0,2	32,2±12,2	58,2±0,0	32,2±11,1	34,6±12,7
MONO %(2-10)	14,8±0,2	9,2±5,4	8,5±0,0	7,0±4,2	6,5±4,1
EOS %(1-7)	7,4±0,2	5,3±5,7	0,51±0,0	2,5±3,3	3,5±5,6
BASO %(0-3)	1,1±0,1	1,4±1,0	0,75±0,0	1,2±0,9	0,89±0,6
PLACHETOGRAM					
PLT 10 e3/uL(140-450)	27,7±0,0	199,5±53,5	149,0±0,0	199,0±71,8	196,2±63,4
MPV fl(8,8-12,6)	5,7±0,0	7,6±2,1	5,7±0,0	9,44±12,8	7,5±1,7

DISCUSSION

Based on the absolute number of cases analyzed in the present study, it was clear that the ORh+ group prevails among individuals. This prevalence among the ABO System (ORh+) was also found in a study with patients undergoing hemodialysis [14], in nephrotic syndrome and sickle cell anemia[13]. Although we have not found recent studies on the correlation between blood groups (ABO/Rh) and leprosy, several studies point to the correlation between ABO/Rh blood groups and infectious clinical conditions, such as its association with infection by the hepatitis B virus in China[15], were found that among 3,827,125 participants, the proportion of participants belonged to blood group A (30.54%), followed by group O (30.37%), B (29.42%) and AB (9.66%) and a total of 38,907 (1.02%) were Rh-D negative.

In table 1, we found a prevalence in individuals under 50 years of age, male, regardless of schooling and region of residence. These data are similar to a literature review study on leprosy in several countries, where they found that the mean age was 46.1 years, with the lowest ages observed in the cases of Australia, Germany, Libya, and Malta (average age below 40 years) and that nearly two-thirds of all cases were male (65.2%), with only Taiwan and Thailand recording a female percentage above 50%[16]. A study with 801 leprosy cases diagnosed in Morocco between 2000 and 2017, found 48 children diagnosed with leprosy and most cases (72.4%) resided in rural areas of the country[10].

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Data related to the place of residence and schooling (Table 1) are similar to those were identified that individuals living in the most impoverished regions of the country had a risk of leprosy incidence of five to eight times greater than those other individuals, in addition to the fact that reduced levels of income, education, and factors that reflect unfavorable living conditions are associated with up to a two-fold increase in the incidence of leprosy[17].

It was found in the present study that most leprosy patients were recent cases of the disease (Table 2), as it is similar to those reported by the Health Organization in the Dominican Republic of Congo, which is one of the 23 priority countries WHO's global efforts to combat leprosy, 3,032 new leprosy cases were reported in 2019, which assumes that given the recent political and economic instability in the country, the transmission of leprosy and other neglected tropical diseases largely reflects the importance of socioeconomic status as a predictive factor [18]. Regarding the classification, table 2 shows that more than 90% of the cases were Multibacillary, which is similar to the findings when of the 3,950 records of leprosy cases collected in 22 low-endemic countries, 48.3% were suspected of being imported and most cases were multibacillary (64.4%) and confirmed regularly by skin biopsy, with 122 cases of suspected recurrence of previous treatment for leprosy [16].

In the present study, it was found that only a small number of individuals with leprosy had some pre-existing disease (Table 2), data that are similar to those presented in the review where the pathological history was mentioned by 14 (77.8%) patients; three (7.1%) reported HIV/AIDS, three (16.6%) tuberculosis, seven (38.9%) participants reported vaccination with Bacillus Calmette-Guérin and all cases had multibacillary leprosy, these co-infections in leprosy can modify host immunity, so as to increase inflammation and tissue damage, leading to reactions and neuritis, or depress defense mechanisms, resulting in increased bacterial load or relapses[19].

We also see in table 2 that about 26% of individuals with leprosy developed complications resulting from the disease, as described in a study, that individuals with leprosy develop dermatoneurological complications, causing cranial nerve paralysis, along with corneal insensitivity and lagophthalmos, which can lead to trauma, infection, as well as corneal ulcerations and opacities, in addition to blindness in third world countries is correlated with the number of positive leprosy cases [19].

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Blood count data were altered (Table 3) for some individuals depending on the blood group, this data differs from the study, which revealed a marked decrease in hemoglobin concentration, platelet count, mean platelet volume, hematocrit, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration [20].

CONCLUSION

Our results indicate that leprosy is still a public health problem in Angola. The ORh+ group is the most frequent among patients with leprosy, followed by the BRh+ and ARh+ groups. Men are the most affected by the disease and the most common diagnostic method is smear microscopy, where most patients are multibacillary and present complications in the peripheral nervous system. The patients do not seem to be the ones with the most changes in the blood count.

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Interest conflicts

The authors declare that there is no conflict of interest.

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Authors' contributions

Conceptualization: TOM, ENMS. Data curation: ENMS, EKC, ATT, SRS, MC, CAPS, CSS, EEV. Formal analysis: ENMS, EKC, SRS, ATT, MC, CAPS, CSS, EEV. Investigation: ENMS, TOM Project administration: ENMS, EKC, SRS, MC, CAPS, CSS, EEV. Supervision: ENMS. Validation: ENMS, EKC, ATT, SRS, MC, CAPS, CSS, EEV,

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