*Clinical Medicine Research*
2025, Vol. 14, No. 4, pp. 153-163
https://doi.org/10.11648/j.cmr.20251404.17

Research Article

# Prevalence and Factors Associated with Irregular Red Blood Cell Antibodies Among Voluntary Blood Donors at the Northern Zone Blood Transfusion Service Centre in Moshi, Tanzania

**Johnson Jason Matowo[1, 2 *], Sweetness Sospeter Ombura[1], Aaron George Loy[1], Kelvin Kulasaukwa Swai[1], Joyce Hendrich Mwanga[1]**

[1]Department of Medical Parasitology and Entomology, Kilimanjaro Christian Medical University College, Moshi, Tanzania

[2]Pan African Malaria Vector Research Consortium, Kilimanjaro Christian Medical University College, Moshi, Tanzania

## Abstract

Irregular red blood cell antibodies may occur in blood donors and can cause serious complications to the point of endangering patient life if transfused. The rate of detection of irregular red blood cell antibodies among people ranges approximately from 0.2% to 2%. Despite the efforts, donated blood is still not screened for irregular red cell antibodies in many local community hospitals, and there is a scarcity of information about irregular red blood cell antibodies in Tanzania. The present study was carried out to determine the prevalence and factors associated with irregular red blood cell antibodies among voluntary blood donors at the Northern Zone Blood Transfusion Service Centre, Moshi, Kilimanjaro. It was an analytical cross-sectional study conducted in the northern zone blood transfusion center from May to June 2023. The study population was all voluntary blood donors attending the Northern Zone Blood Transfusion Center. Interview-administered questionnaires were used to collect information from study participants. Blood samples were screened for irregular RBC using a fully automated immunohematology system (NEO IRIS, Immucor Inc., Norcross, GA, USA). Data was entered and analyzed using SPSS. Logistic regression analysis determined the factors associated with irregular red blood cell antibodies among voluntary blood donors. Odds ratios and their 95% confidence intervals were reported. The mean age of participants was 29.72 (SD 8.958) years. In rural areas, the prevalence of irregular red cell antibodies was 14.3% while in urban areas it was 2.4%. Among participants with a transfusion history, the prevalence of irregular red cell antibodies was 14.3% compared to 2.4% for those who had never been transfused. We recommend including antibody screening tests in the routine pretransfusion testing protocol, especially for those requiring frequent transfusions and having the risk of alloimmunization.

## Keywords

Alloantibodies, Autoantibodies, Blood Donors, Blood Transfusion, Irregular Red Blood Cell Antibodies, Tanzania

*Corresponding author: johnsonmatowo@gmail.com (Johnson Jason Matowo)

**Received:** 28 July 2025; **Accepted:** 12 August 2025; **Published:** 29 August 2025

# 1. Introduction

Blood transfusion provides blood or blood components following loss of blood due to several reasons, including certain medical conditions, such as infections and which affect blood or its components. Blood loss can also occur following an injury or during surgery. The blood typically comes from donors, and the blood banks and healthcare providers ensure transfusion is safe. Blood transfusion saves many people every year who would otherwise have died [1]. The need for blood varies greatly from one country to another. For Tanzania, the most common reasons for blood transfusion include maternal haemorrhage, anemia as a result of various infectious and sickle-cell disease, malnutrition, and road traffic accidents [2-5].

In many situations, blood transfusion is essential as it prevents loss of life or functional capacity of an individual. However, it is associated with certain inherent risks [6].

Unexpected or irregular red blood cell antibodies can be encountered in healthy blood donors, especially those who have been transfused previously or in multiparous females [7]. These include alloantibodies and or autoantibodies. Alloantibodies occur due to genetic differences between the blood donor and the recipient [8-10]. Auto-antibodies are those produced against one's antigens, primarily when infectious or foreign components are introduced into the body and are able to bind strongly with self-proteins in solution or on the cell surface [11]. Irregular red blood cell antibodies can potentially lead to transfusion reactions or decreased survival of transfused red blood cells. This can cause serious complications to the point of endangering the patient's life if transfused. The published prevalence of irregular red blood cell antibodies varies globally between 0.2% to 2% in different studies [12].

Studies reporting the prevalence of irregular RBC antibodies in Sub-Saharan Africa are scanty, and a previous narrative review that included three studies conducted in two countries revealed that 1-6% of transfused patients displayed clinically irregular RBC antibodies [13, 14]. According to Committee, (2015), irregular red blood cell antibodies are one among the criteria of blood rejection [15] as it may lead to complications such as hemolytic antibody reaction that involves the development of blood clotting disorders, acute kidney injury, disseminated intravascular coagulation, transfusion-associated circulatory overload, blood incompatibility, and adverse reactions, which include allergic reaction [16].

The frequency of blood transfusion, pregnancy in females, geographical location, age, and sex are common factors associated with the presence of irregular red blood cell antibodies. In a previous study by Santos et al. (2024) [17], sex and age were associated with irregular RBC antibodies.

For Tanzania, a centrally organized blood transfusion system, the National Blood Transfusion Service (NBTS) was established by the Government [18], with a network of seven blood centers countrywide, namely, the Lake Zone, Northern Zone, Southern Zone, Eastern, Southern Zone, and Tanzania People's Defence Forces (TPDF). The NBTS laid down the clinical guidelines for the appropriate use of blood and blood products, covering the collection of blood only from voluntary, unpaid blood donors and the screening of irregular red blood cell antibodies from the donated blood [19, 20]. Other achievements include increased total collection of blood units between 2005 and 2016 from 52,0009 to 196,735 units [21] and Quality assurance, where blood samples are being screened for TTIs at the zonal centres [21].

Inspite of the efforts, out of 196,735 blood units that were collected by the NBTS in 2016 [11], 30 297 units (15%) were discarded due to transfusion transmissible infections (TTIs) (14.5%) and non-conformities, including irregular RBC antibodies, which (0.7%) [21, 22]; and there is a paucity of information on the prevalence of the irregular red cell antibodies in whole blood donor population in Tanzania. Therefore, the present study investigated the prevalence and factors associated with irregular red cell antibodies among the blood donors at the Northern Zone Blood Transfusion Center.

# 2. Materials and Methods

## 2.1. Study Area

The study was conducted in the Northern Zone Blood Transfusion Service (NBTS), adjacent to Kilimanjaro Christian Medical Centre (KCMC), in Moshi Municipality, in the Kilimanjaro region. KCMC is one of the four Zonal Referral Consultant hospitals in Tanzania, owned by the Evangelical Lutheran Church in Tanzania (ELCT). It serves patients from the northern, eastern, and central zones of Tanzania, including Arusha, Kilimanjaro, Tanga, Singida, and Dodoma, with a has a catchment population of 15,000,000 persons.


Source: Mauka et al. (2015) [23]

***Figure 1.*** *A map of Tanzania showing the northern zone regions and location of the Northern Blood Transfusion Centre.*

## 2.2. Study Design

The study was an analytical cross-sectional study to assess the prevalence and factors associated with irregular red blood cell antibodies among voluntary blood donors at the Northern Zone Blood Transfusion Service Center, Moshi, Kilimanjaro. A sectional study was the best in this study as the quickest method to assess the prevalence and risk factors associated with irregular red blood cell antibodies at the time, as we intended to do for this study. This study was conducted between May 2023 and June 2023.

## 2.3. Study Population

The study population was voluntary blood donors whose blood samples were sent to the Northern Zone Blood Transfusion Service Centre, Moshi, Kilimanjaro.

## 2.4. Inclusion Criteria and Exclusion Criteria

The inclusion criteria were voluntary blood donors' samples received at the Northern Zone Blood Transfusion service center, Moshi, Kilimanjaro, from May 2023 to June 2023. All voluntary blood donors' samples that were hemolyzed and all voluntary blood donors who did not consent to participate in the study were excluded from the study. There was no bias in the sample since there was no difference between voluntary blood donors who were included and those who were excluded from the study. These were just excluded based on the fact that they did not provide consent, not that they were different from those who were included in the study.

## 2.5. Sampling and Sample Size Estimation

A convenience sampling technique was used in this study, where the study units (voluntary blood donors) that were available at the time of data collection were selected to participate in the study.

The sample size was calculated using the Cochran formula [24].

$$n = \frac{Z^2(1-\alpha/2)pq}{L^2}$$

Where:

n=minimum sample size

$Z^2(1-\alpha/2)$ = value of z corresponding to 95% confidence interval (1.96)

P= prevalence of 6.7% according to Ngoma et al. (2020) [13]

q= 1-p

l= allowable error of 5%

Sample size= $1.96^2 0.067(1-0.067)/0.05^2$

Sample size [n] = 100, adding 10% for non-response bias.

Therefore, a minimum sample size for our study was 110 voluntary blood donors.

## 2.6. Study Variables

The dependent variable of interest was irregular red blood cell antibodies among voluntary blood donors. Participants were defined as having irregular red blood cell antibodies if the antibody screening test was positive. We measured the dependent variable as binary dichotomous, assigning a code of 0 if a participant had an absence of irregular red blood cells and a code of 1 if a participant had the presence of irregular RBC antibodies.

The independent variables of interest were socio-demographic categorical variables, which were measured by assigning codes as follows: Age: 18-35 was coded as 1, 36-45 age was coded as 2, and 46-65 age was coded as 3; Gender: male was coded 1 and female was coded 2. For Transfusion history: ever transfused was coded 1, and never transfused was coded 2; Geographical location: Kilimanjaro was coded 1, Arusha was coded 2, Manyara was coded 3, and Tanga was coded 4. The pregnancy history: Yes was coded 1, while No was coded 2. For the residence, urban was coded 1, and rural was coded 2.

## 2.7. Data Collection Tools and Study Procedure

### 2.7.1. Data Collection Tools

Interview-administered questionnaires were used to collect information from study participants. A questionnaire created in English and Swahili was used to obtain factors associated with irregular red blood cell antibodies, such as sociodemographic factors, for those who met the inclusion criteria. The tool had both open and closed-ended questions. The Neo-Iris Immucor machine was also used as a tool to identify the presence or absence of irregular red blood cell antibodies.

### 2.7.2. Data Collection Study Procedures

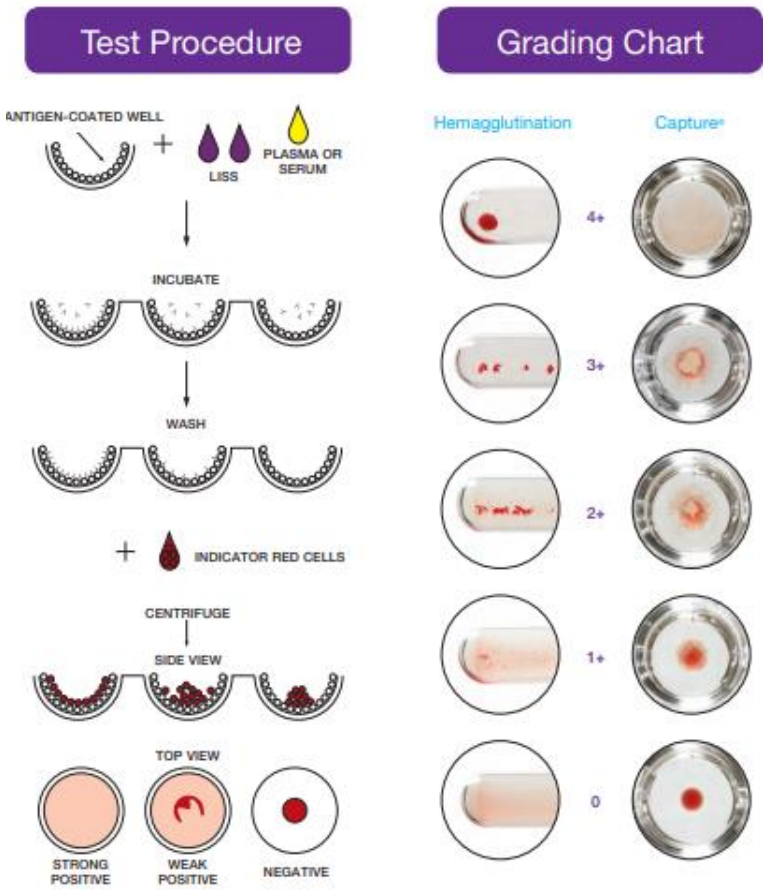


***Figure 2.*** *Neo Iris immucor showing test procedure and grading chart for antibody screening Source: Immucor, 2022 [25].*

Before sample collection, interview-administered questionnaires were used to collect information from participants. During sample collection, a tourniquet was applied just above the venipuncture site, and sterile alcohol swabs were used to clean the area of venipuncture. Blood was then drawn from the antecubital fossa by using a sterile 16-gauge needle.

Blood was transferred into a blood collection bag containing anticoagulant, mixed gently with anticoagulant, and the donor was monitored for a time after donation. The blood sample was stored and delivered appropriately for laboratory testing. Venous blood was collected into 450 mL of blood bags and tested for irregular red blood cell antibodies before transfusion.

In the laboratory, the blood samples were screened for irregular RBC on a fully automated immunohematology system (NEO IRIS, Immucor Inc., Norcross, GA, USA) following the Manufacturer's Instructions [25], where the patient's blood sample and LISS were added to microplates, which were pre-coated with specific antigens. This was then incubated onboard the Neo Iris, followed by a washing step. Indicator red cells were added, and the samples were centrifuged.

The results were read using the camera onboard the Neo Iris, and the results were graded. The results were graded from 0 to 4+ reaction, with 4+ being strongly positive and 0 being strongly negative.

## 2.8. Data Management and Analysis

The questionnaire was reviewed daily in the field after activities to check for errors or mistakes and correct them before the participants left the field site. Data was cleaned and checked for quality assurance and consistency.

Missing values and duplicates were reported, and duplicates were dropped. Variables were clearly labeled and coded for easy interpretation. Categorical variables with levels were identified and coded efficiently according to their levels. The collected questionnaires were checked manually for their completeness and correctly coded. Data was entered into SPSS version 20 for analysis.

Independent and dependent variables were summarized using descriptive statistics, reported as mean and standard deviation for continuous variables and frequencies and proportions for categorical ones. Logistic regression analysis was used to determine the association between the independent variables and the presence of irregular red blood cell antibodies among voluntary blood donors. The variables that showed a possible association with the presence of irregular red cell antibodies ($p<0.05$) were included in a multivariate logistic regression model. The association was expressed through Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR) after adjusting for confounders. A p-value of less than 0.05 at 95% confidence was considered statistically significant.

Numeric variables were summarized using mean The categorical variables were summarized using frequencies and proportions/percentages. Odds Ratio (OR) with their 95% confidence interval and logistic regression analysis were used to determine the factors associated with irregular red blood cell antibodies among voluntary blood donors as a measure of association between dependent and independent variables. The level of significance was set at $p<0.05$.

# 3. Results

## 3.1. Response Rate

A total of 110 voluntary blood donors from the Northern Zone Blood Transfusion Centre were enrolled. All donors who were approached agreed to participate, giving a response rate of 100%. Out of the 110 donors, 104(94.5%) were able to give the blood sample, while 6 participants refused to participate in blood collection due to fear of a needle during phlebotomy. The analysis and results presented were for 104 donors.

## 3.2. Socio-demographic Characteristics of the Participants

Out of 110 voluntary blood donors selected conveniently, 104 (94.5%) fully participated in the study by filling out questionnaires and providing a blood sample. The largest number of donors, 76 (73.1%), were from the age group of 18-35 years, followed by the age group of 36-45, which was 22(21.2%), and the smallest number of donors, 6(5.8%), were from the age group between 46-65 years. The study participants consisted of 80(76.9%) males and 24(23.1%) females. About 26 (25.0%), 33(31.7%), 14(13.5%), and 31(29.8%) were from Kilimanjaro, Arusha, Manyara, and Tanga regions, respectively. Concerning transfusion history ever transfused were 21(20.2%) and never transfused were 83(79.8%) (Table 1).

***Table 1.*** *Social demographic characteristics of the participants (n=104).*

| Characteristics | Frequency (N) | % |
|---|---|---|
| Age | | |
| Mean (SD) | 29.72(8.958) | |
| 18-35 | 76 | 73.1 |
| 36-45 | 22 | 21.2 |
| 46-65 | 6 | 5.8 |
| Sex | | |
| Male | 80 | 76.9 |

| Characteristics | Frequency (N) | % |
|---|---|---|
| Female | 24 | 23.1 |
| Education level | | |
| Primary level | 14 | 13.5 |
| Secondary level | 23 | 22.1 |
| College level | 37 | 35.6 |
| University level | 20 | 19.2 |
| No formal education | 10 | 09.6 |
| Residence | | |
| Rural | 21 | 20.3 |
| Urban | 83 | 79.8 |
| Geographical location | | |
| Kilimanjaro | 26 | 25.0 |
| Arusha | 33 | 31.7 |
| Manyara | 14 | 13.5 |
| Tanga | 31 | 29.8 |
| Transfusion history | | |
| Ever transfused | 21 | 20.2 |
| Never transfused | 83 | 79.8 |
| Pregnancy history | | |
| YES | 14 | 58.3 |
| NO | 10 | 41.7 |

SD=Standard Deviation

## 3.3. Prevalence of Irregular Red Blood Cell Antibodies

***Table 2.*** *Prevalence of irregular red blood cell antibodies (n=104).*

| | Frequency (N) | Irregular RBC antibodies | |
|---|---|---|---|
| | | Positive | Negative |
| Age | | | |
| 18-35 | 76 | 03(3.9%) | 73(96.1%) |
| 36-45 | 22 | 01(4.5%) | 21(95.5%) |
| 46-65 | 6 | 01(16.7%) | 05(83.3%) |
| Gender | | | |
| Male | 80 | 04(5.0%) | 76(95.0%) |
| Female | 24 | 01(4.2%) | 23(95.8%) |
| Level of education | | | |
| Primary level | 14 | 01(7.1%) | 13(92.9%) |
| Secondary level | 23 | 00(0.0%) | 23(100%) |
| College level | 37 | 03(8.1%) | 34(91.9%) |
| University level | 20 | 01(05.0%) | 19(95.0%) |
| No formal education | 10 | 00(0.0%) | 10(100%) |
| Geographical location | | | |
| Kilimanjaro | 26 | 01(3.8%) | 25(96.2%) |
| Arusha | 33 | 0(0.0%) | 33(100%) |
| Manyara | 14 | 0(0.0%) | 14(100%) |
| Tanga | 31 | 04(12.9%) | 27(87.1%) |
| Residence | | | |
| Rural | 21 | 03(14.3%) | 18(85.7%) |
| Urban | 83 | 02(2.4%) | 81(97.6%) |
| Transfusion history | | | |
| Ever transfused | 21 | 03(14.3%) | 18(85.7%) |
| Never transfused | 83 | 02(2.4%) | 81(97.6%) |
| Pregnancy history | | | |
| Yes | 14 | 01(7.1%) | 13(92.9%) |
| No | 10 | 10(100%) | 0(0.0%) |

N=number of donors screened for irregular antibodies

Overall, 104 blood samples were examined for irregular red blood cell antibodies; thus, the prevalence of irregular red blood cell antibodies was 4.8% (N=5). Prevalence of irregular red blood cell antibodies in participants aged 18-35 was 3.9%, for those aged 36-45 was 4.5% and for the last group aged 46-65 was 16.7%. In males, the prevalence of irregular red blood cell antibodies was 5%, which was higher compared to females, 4.2%. The prevalence of irregular red blood cell antibodies in participants with primary school education was 7.1%, while the prevalence of irregular red blood cell antibodies in participants with secondary school education was 0%.

For participants with College and University education, the prevalence of irregular red blood cell antibody levels was 8.1% and 5% respectively. Participants without formal education had a prevalence 0%. For the regions, Tanga had the highest prevalence of irregular red blood cell antibodies (12.9%), followed by Kilimanjaro, 3.8%. In Arusha and Manyara, the prevalence of irregular red blood cell antibodies was 0%. The percentage of those who were ever transfused was 14.3%, and for those who were never transfused was 2.4%. For females

with a pregnancy history, the prevalence of irregular red blood cell antibodies was 7.1%, while for those females with no pregnancy history, the prevalence of irregular red blood cell antibodies was 0% (Table 2).

### 3.4. Factors Associated with Irregular Red Blood Cell Antibodies Among Voluntary Blood Donors

The socio-demographic characteristics, including age, sex, education level, geographical location, and pregnancy history in females, were not associated with irregular red blood cell antibodies (p>0.05). Only residence and transfusion history were statistically significant with irregular red blood cells (p<0.05).

In univariate logistic regression, the sex of the participants was not statistically significant, whereas males were 0.826 times more likely to have irregular red blood cell antibodies compared to females (COR=0.826; 95% CI: 0.08-7.76; p>0.05). The females with a pregnancy history were 0.929 times more likely to have irregular red blood cell antibodies compared to females with no pregnancy history (COR=0.929; 95% CI: 0.803-1.074; p>0.05).

Blood transfusion history was found to be associated with irregular red blood cell antibodies (p < 0.023), where blood donors with a blood transfusion history were 1.148 times more likely to have irregular red blood cell antibodies compared to those who were never transfused (COR=1.148; 95% CI: 0.23-0.95; p< 0.05). Residence of the participants was also statistically significant (p < 0.023), where the rural residents were 6.750 times more likely to have irregular red blood cell antibodies compared to residents of urban areas (COR=6.750; 95% CI: 1.05-43.39; p<0.05). Surprisingly, all 21 voluntary blood donors with a transfusion history came from Rural areas, where 3 (14.3%) had irregular red blood cell antibodies, while all 83 voluntary blood donors who had no transfusion history came from Urban areas, and of these, 2 (2.4%) had irregular red blood cell antibodies (Table 3).

***Table 3.*** *Factors associated with irregular red blood cell antibodies among voluntary blood donors at Northern Zone Blood Transfusion Centre. (N=104).*

| Variables | Red irregular blood cell antibodies | | COR | 95% CI | p-value |
|---|---|---|---|---|---|
| | Positive (P) | Negative (N) | | | |
| Age (Years) | | | | | |
| 18-35 | 03(3.9%) | 73(96.1%) | 1 | 1 | |
| 36-45 | 01(4.5%) | 21(95.5%) | 1.159 | 0.11-11.73 | 0.901 |
| 46-65 | 01(16.7%) | 05(83.3%) | 4.867 | 0.43-55.71 | 0.203 |
| Gender | | | | | |
| Male | 04(5.0%) | 76(95.0%) | 1 | 1 | |
| Female | 01(4.2%) | 23(95.8%) | 0.826 | 0.09-7.76 | 0.867 |
| Residence | | | | | |
| Rural | 03(14.3%) | 18(85.7%) | 1 | 1 | |
| Urban | 02(2.4%) | 81(97.6%) | 6.750 | 1.05-43.39 | 0.023 |
| Pregnancy history | | | | | |
| YES | 01(7.1%) | 13(92.9%) | 1 | 1 | |
| NO | 10(100%) | 0(0.0%) | 0.929 | 0.803-1.074 | 0.38 |
| Transfusion history | | | | | |
| ever transfused | 03(14.3%) | 18(85.7%) | 1 | 1 | |
| never transfused | 02(2.4%) | 81(97.6%) | 1.148 | 0.23-0.95 | 0.023 |

COR=Crude Odds Ratio; CI-Confidence Interval

Factors with a p-value less than 0.05 (p<0.05) in the univariate analysis were entered in the multivariable logistic regression model; residence and blood transfusion history

remained statistically significantly associated with irregular red blood cell antibodies. Whereas according to residence, participants in urban areas were 8.730 times more likely to have irregular RBC compared to rural areas (AOR=8.730; 95%CI: 1.15-61.12; p<0.05), and participants with a transfusion history were 0.119 times more likely to have irregular RBC antibodies compared to those who never transfused (Table 4).

***Table 4.*** *Multivariable Logistic Regression Analysis for Factors Associated with Irregular Red Blood Cell Antibodies.*

| Variable | Adjusted OR (95% CI) | p- value |
|---|---|---|
| Residence | | |
| Rural | 1 | |
| Urban | 8.370(1.15-61.12) | 0.036 |
| Transfusion history | | |
| Ever transfused | 1 | |
| Never transfused | 0.119(0.02-0.87) | 0.036 |

CI=Confidence Interval

## 4. Discussion

The frequency and type of irregular antibodies found during screening depend on several factors, including the research subjects, blood type, genotypic frequency, screening method, and ability of the decoder [26]. While the prevalence of irregular antibodies in nonexposed as well as multitransfused patients has been studied by many Indian researchers, there is limited information on their prevalence in healthy donors. Therefore, the present study was undertaken to assess the prevalence and factors associated with irregular red blood cell antibodies among voluntary blood donors in the Northern Zone Blood Transfusion Centre, north-eastern Tanzania.

In this study, the prevalence of irregular RBC antibodies among 104 voluntary blood donors was 4.8%. These results are considerably higher than those observed in South Korea, where the prevalence was 1.52% [27]. The study by Makroo et al.(2018) in India [28] showed a low prevalence of 0.27% among 82,153 blood donors, while another study that was carried out in a tertiary care hospital in North India, by Yadav et al.(2022) seropositivity rate among healthy blood donors was 0.3% [29].

In India, the study of Pahuja et al. (2012) found a prevalence of 0.05% among 7756 whole blood donors [30], while Garg et al. (2014) reported a prevalence of 0.09% among 47,450 whole blood donors [31]. On the contrary, Ngoma et al. (2020) reported a prevalence of 6.7% in blood donors [13].

In our study, the prevalence of irregular antibodies in healthy donors is comparable to the study by Ngoma et al. [13], although the prevalence of irregular Red Cell antibodies in this study was lower than that reported in the study by Ngoma et al. [13]. This can be because the study of Ngoma et al. [13] involved transfused patients who were most likely exposed.

In this study, the prevalence of irregular Red Blood Cell antibodies in healthy blood donors is higher compared to the other studies [27-31]. This might be due to the screening methods used. We used the Neo Iris Immucor machine, which is a highly sensitive and specific method compared to the manual tube and gel method, which was done by other studies, including that of Makroo et al. (2018) [28]. Moreover, a significant proportion of voluntary blood donors who tested positive for irregular RBC antibodies, in this study, had a transfusion history. However, a small sample size was used in our study (N=104); therefore, more studies are needed with a bigger sample size to determine the actual prevalence of irregular RBC antibodies in blood donors.

Several factors were assessed for association with irregular Red Blood Cell antibodies. However, only residence and transfusion history were found to be associated with the presence of irregular Red Blood Cell antibodies in the blood donors in the study area.

Irregular RBC antibodies were found to be associated with residence, whereby the blood donors from rural areas were 8.370 times more likely to have irregular antibodies compared to those living in urban areas. Blood donors with a transfusion history were 1.148 times more likely to have irregular antibodies compared to those without a transfusion history.

In northern India, where a study was undertaken with the aim of detecting the prevalence and type of irregular antibodies among donors as well as transfusion recipients, the nonexposed group showed a seropositivity of 0.36%, while the exposed group (transfused showed a seropositivity of 9.4% [29].

In this study, pregnancy history in females was not associated with the presence of irregular antibodies, probably because male gender was most represented, with 76.9% (80 men) against the female 23.1% (24 females). Of the 24 females, 58.3% had a pregnancy history, and 41.7% had no pregnancy history. However, only one female with a pregnancy history was found positive for irregular RBC antibodies. Elsewhere in the Netherlands (Koelewijn et al. (2008) [32]), Saudi Arabia (Al-Ibrahim et al. (2008) [33]), and the United Kingdom (Howard et al. (1998) [34]), the total alloimmunization rates in pregnant women were 1.2%, 2.0% and 1.0% respectively. In India [29], the overall seropositivity rate was 4.5% most likely because a significant proportion (575 of the total 1538 females) had a history of multiple exposures due to pregnancy or transfusion.

It is necessary to find matched blood when alloantibodies and autoantibodies co-exist, but there is almost no need to find matched blood when only autoantibodies exist [10]. Therefore, most blood banks transfuse red blood cells that show the lowest degree of response in cross-matching tests for patients

with only autoantibodies. For individuals with both auto- and alloantibodies, red blood cells negative for the relevant antigen that show the smallest response are transfused. However, it can be difficult to promptly find matched blood, so the existence of unexpected antibodies must be identified before surgery to ensure prompt and safe transfusion.

## 5. Limitations of the Study

The study involved only voluntary healthy blood donors and hence does not represent the general population. In this study, we did not differentiate autoantibodies from alloantibodies because most red blood cells and autoantibodies react. However, it is difficult to differentiate autoantibodies from alloantibodies because most red blood cells and autoantibodies react.

## 6. Conclusions

This study has revealed a high prevalence of irregular RBC antibodies among voluntary blood donors at the Northern Zone Blood Transfusion Centre, with factors associated being the area of residence and the transfusion history of the participant, which were statistically significant. The risk of alloimmunization is more common in multi-transfused patients; therefore, it is advisable to screen at least those cases for irregular antibodies. We recommend including antibody screening tests in the routine pretransfusion testing protocol, especially for those requiring frequent transfusions and having the risk of alloimmunization.

## Abbreviations

| | |
|---|---|
| CI | Confident Interval |
| COR | Crude Odds Ratio |
| KCMC | Kilimanjaro Christian Medical Centre |
| LISS | Low Ionic Strength Solution |
| NBTS | National Blood Transfusion Service |
| OR | Odds Ratio |
| RBC | Red Blood Cell |
| SPSS | Statistical Package for the Social Sciences |
| WHO | World Health Organization |

## Acknowledgments

The authors acknowledge all the voluntary blood donors who participated in this study.

Special thanks are extended to the staff of the Northern Zone Blood Transfusion Service Centre for their cooperation and invaluable support. Their willingness to facilitate access to essential resources, data, and expertise greatly enhanced our data collection.

## Author Contributions

**Johnson Jason Matowo:** Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft

**Sweetness Sospeter Ombura:** Conceptualization, Data curation, Investigation, Methodology, Supervision

**Aaron George Loy:** Data curation, Investigation, Methodology

**Kelvin Kulasaukwa Swai:** Data curation, Investigation, Methodology

**Joyce Hendrich Mwanga:** Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing

## Ethical Approval and Consent to Participate

Ethical approval was obtained from the KCMC University Research Ethics Review Committee before the commencement of the study, certificate number UG 34 /2023. Confidentiality was maintained where participants were assigned unique identification numbers instead of their names. Written informed consent was sought from participants before study initiation. The authors declare that they have no competing interests.

## Funding

We did not receive any funding for this study.

## Data Availability Statement

The data is available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest.

## References

[1] Stokx J, Gillet P, De Weggheleire A, Casas EC, Maendaenda R, Beulane AJ, Jani IV, Kidane S, Mosse CD, Jacobs J, Bottieau E. Seroprevalence of transfusion-transmissible infections and evaluation of the pre-donation screening performance at the Provincial Hospital of Tete, Mozambique. *BMC Infect Dis*, 2011 May 23; 11: 141.

[2] WHO. Global Status Report on Blood Safety and Availability. World Heal Geneva. 2017.

[3] Hamilton AK, Hayton JC, Maternal mortality in sub-Saharan Africa: The contribution of ineffective blood transfusion services, *Int J Obstet Gynaecol*, 2009, 116(5): 736-737. https://doi.org/10.1111/j.1471-0528.2008.02090.x

[4] Mumtaz Z, Bowen S, Mumtaz R. Meanings of blood, bleeding and blood donations in Pakistan: Implications for national vs global safe blood supply policies, *Health Policy Plan* 2012, 27(2): 147-155. https://doi.org/10.1093/heapol/czr016

[5] Barro L, Drew VJ, Poda GG, Tagny CT, El-Ekiaby M, Owusu-Ofori S, Burnouf T, Blood transfusion in sub-Saharan Africa: Understanding the missing gap and responding to present and future challenges, *Vox Sang*, 2018, 113(8): 726-736. https://doi.org/10.1111/vox.12705

[6] RK, Bhasin R, Chatterjee K, Ramalingam V, Narayamswamy R. Adverse effects of blood transfusion. In: Saran RK, editor. Transfusion Medicine Technical Manual. Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India. 2nd ed. India: National Government Publication; 2003. pp. 127-42.

[7] Harmening DM, Modern Blood Banking and Transfusion (6-7) Practices. 6th ed. United States of America: F. A Davis Company Publications, 2012.

[8] Tormey CA, Hendrickson JE, Transfusion-related red blood cell alloantibodies: induction and consequences, *Blood.* 2019, Apr 25; 133(17): 1821-1830. https://doi.org/10.1182/blood-2018-08-833962 Epub 2019 Feb 26.

[9] Walker RH, Lin DT, Hartrick MB, Alloimmunization following blood transfusion. *Arch Pathol Lab Med*, 1989, 113: 254-61.

[10] Han KS, Park MH, Kim SI, Transfusion medicine. 3rd ed. Seoul, Korea Medical Publisher. 2006, pp 153-287.

[11] Rojas M, Restrepo-Jiménez P, Monsalve DM, Pacheco Y, Acosta-Ampudia Y, Ramírez-Santana C, Leung PSC, Ansari AA, Gershwin ME, Anaya JM, Molecular mimicry and autoimmunity. *J Autoimmunity*, 2018, 95: 100-23. https://doi.org/10.1016/j.jaut.2018.10.012 Epub 2018 Oct 26.

[12] Françoise N, Zanga E, Justin G, Bernard C, Ikomey G, Pauline N, Claude T, Prevalence of irregular antibodies in blood donors at Yaoundé Central Hospital, Cameroun,. *The J Med Res*, 2021, 7(6): 172-174 ISSN: 2395-7565.

[13] Ngoma AM, Mutombo PB, Ikeda K, Nollet EK, Natukunda B, Ohto H, Red blood cell alloimmunization in transfused patients in sub-Saharan Africa: A systematic review and meta-analysis, *Transfus Apher Sci*, 2020, Elsevier Ltd. Available at: https://doi.org/10.1016/j.transci.2015.10.017

[14] Nathani K, Patel J, Modi PY, Pandya AN, Wadhwani S, Jarag M, Prevalence of Red Cell AlloAntibodies & AutoAntibodies in Patient & Donor attending a Tertiary Care Hospital in South Gujarat. *Int J Contemp Med Res*, 2022, 8(3): C1-C5 https://doi.org/10.21276/ijcmr.2021.8.3.13

[15] Committee, L. Criteria for Blood Donor Selection. 2015, 7(23), pp 25-30.

[16] Lima PR, Destefani AC, Irregular Antibodies Identified Previously In Blood Transfusions: A Review Of The 21st Century. *Open Sci J*, 2017, 2(1) https://doi.org/10.23954/osj.v2i1.807

[17] Santos LDS, Fernandes SES, Sant'Anna ALO, Amorim FFP, Amorim FFP, Amorim FF. Irregular red blood cell antibodies, abnormal hemoglobin and dangerous universal blood donor insights from a public blood center in a Brazilian metropolitan area. *Transfus Apher Sci*, 2024 Aug; 63(4): 103963. https://doi.org/10.1016/j.transci.2024.103963 Epub 2024 Jun 21.

[18] National Blood Transfusion Services, Tanzania, Presentation: Status of Implementation of Quality Management System. In Evidence for Action National Blood Transfusion Service Regional Exchange and Learning Visit, September 16-20 2013. Dar es Salaam, Tanzania.

[19] Ministry of Health, Community Development, Gender, Elderly and Children [United Republic of Tanzania], Clinical Guideline for Appropriate Use of Blood and Blood Products. Nairobi: Ministry of Health, Community Development, Gender, Elderly and Children, 2015.

[20] Ministry of Health [Tanzania], Tanzania National Blood Transfusion Service Policy Guidelines. Dar es Salaam: MoH, 2005.

[21] Juma A, National Blood Transfusion Services Tanzania, Personal Communication, 24 May 2017.

[22] Ministry of Health, Community Development, Gender, Elderly and Children [United Republic of Tanzania]. (n.d.). National Blood Transfusion Service Blood Collection Report: Dar es Salaam: Ministry of Health, Community Development, Gender, Elderly and Children, 2016.

[23] Mauka WI, Mahande MJ, Msuya SE, Philemon RN, Factors associated with repeated blood donation at the northern zone blood transfusion centre in Tanzania. *J Blood Transfus*, 2015: 717653 https://doi.org/10.1155/2015/717653

[24] Cochran WG, Sampling Techniques. 3rd Edition, John Wiley & Sons, New York, 1977.

[25] Immucor. NEO Iris, Operator Manual. Norcross. GA: Immucor; 2017. Available from: https://www.scribd.com/document/437855305/NEO-Iris-OperatorManual-JUNE2017

[26] Brecher ME, Technical manual. 14th ed. Bethesda, Maryland, American Association of Blood Banks. 2002, pp 315-97.

[27] Ko KH. Yo BH, Kim, KM, Lee WY, Yon JH, Hong KH, Han TH, Frequency of unexpected antibody and consideration during transfusion. *Korean J Anesth*, 2012, 62(5): 412-7. https://doi.org/10.4097/kjae.2012.62.5.412

[28] Makroo RN, Rajput S, Agarwal S, Chowdhry M, Prakash B, Karna P, Prevalence of irregular red cell antibody in healthy blood donors attending a tertiary care hospital in North India. *Asian J Transfus Sci*, 2018, Jan-Jun; 12(1): 17-20. https://doi.org/10.4103/ajts.AJTS_4_17

[29] Yadav A, Raturi G, Aparna B, Prevalence of irregular red cell antibody in transfusion recipients vis-a-vis healthy blood donors attending a tertiary care hospital in North India. *Asian J Tranfus Sci*. 2022, 16(1): 73-77. https://doi.org/10.4103/ajts.AJTS_118_19 Epub 2022 May 26.

[30] Pahuja S, Kushwaha S, Sethi N, Pujani M, Jain M. Screening of blood donors for erythrocyte alloantibodies. *Hematology*, 2012, 17: 302-5. https://doi.org/10.1179/1607845412Y.0000000020

[31] Garg N, Sharma T, Singh B. Prevalence of irregular red blood cell antibodies among healthyblood donors in Delhi population. *Transfus Apher Sci*, 2014, 50: 415-7. https://doi.org/10.1016/j.transci.2014.03.004

[32] Koelewijn JM, Vrijkotte TG, van der Schoot CE, Bonsel GJ, de Haas M, Effect of screening for red cell antibodies, other than anti-D, to detect hemolytic disease of the fetus and newborn: A population study in the Netherlands. *Transfusion*, 2008, 48: 941 52. https://doi.org/10.1111/j.1537-2995.2007.01625.x

[33] Al-Ibrahim NA, Al Saeed AH. Red blood cell alloimmunisation among Saudi pregnant women in the central province of Saudi Arabia. *Kuwait Med J*, 2008, 40: 116-23.

[34] Howard H, Martlew V, McFadyen L, Clarke C, Duguid J, Bromilow I, Eggington J, Consequences for fetus and neonate of maternal red cell alloimmunisation. *Arch Dis Child Fetal Neonatal Ed*, 1998, 78: F62-6. https://doi.org/10.1136/fn.78.1f62