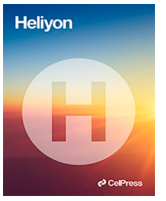
Heliyon 9 (2023) e22313

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



The frequency of ABO and Rhesus(D) blood group antigens among blood transfused patients in Northern Ethiopia, 2023: Retrospective study

Ayenew Berhan [a,*], Yenealem Solomon [a], Birhanu Getie [a], Shewaneh Damtie [a], Biruk Legese [a], Awoke Chanie [b], Andargachew Almaw [a]

[a] Department of Medical Laboratory Science, College of Health Sciences, Debre Tabor University, Debre Tabor, Ethiopia
[b] Dessie Compressive Specialized Hospital Laboratory, Dessie, Ethiopia

ARTICLE INFO

Keywords:
Transfusion
Blood group
Frequency
Ethiopia

ABSTRACT

Background: Data about the distribution of ABO and RhD blood groups is important for effective blood utilization, which is maintained by identifying the most clinically required blood type. However, there is a scarcity of data in Ethiopia about the distribution of ABO and RhD blood groups among blood-transfused patients, particularly in the study area.
Objective: To determine the frequency of ABO and RhD blood groups among blood transfused patients at Dessie Comprehensive Specialized Hospital, Northern Ethiopia, 2023.
Method: A hospital-based retrospective study was conducted from September 1 to September 30, 2022, to determine the frequency of ABO and RhD blood groups among blood-transfused patients at Dessie Comprehensive Specialized Hospital. The study was conducted on data from blood-transfused patients from October 2019 to June 2022. A total of 3762 blood transfused patients' data was collected from the blood transfusion log book records. The data were coded, entered, and cleaned using Epi-data version 4.6 and analyzed for descriptive statistics using Stata version 14.0.
Result: A total of 3762 blood-transfused patients were included in the study. Of those, females made up 57.3 % (2156/3762). Of 3762 blood transfused patients, the majority (33.9 %, 1277/3762) had ABO blood group B, and 81.3 % (3060/3762) of the blood transfused patients were RhD-positive. Eight thousand three hundred fifteen units of whole blood were transfused to 3762 patients, with a mean of 2.2 units of blood transfused per patient. Furthermore, the majority of the study participants 42.82 %, (1611/3762) were given two units of blood, and 8.77 % (330/3762) were given four units of blood.
Conclusion: Most of the study participants had B and RhD-positive blood groups. The majority of the blood transfused patients were females. Most of the blood was transfused in the medical ward, and whole blood was transfused for all patients.

* Corresponding author. Department of Medical Laboratory Science, College of Health Sciences, Debre Tabor University, Debre Tabor, Ethiopia.
E-mail address: ayenewbirhan10@gmail.com (A. Berhan).

https://doi.org/10.1016/j.heliyon.2023.e22313
Received 6 March 2023; Received in revised form 9 November 2023; Accepted 9 November 2023
Available online 13 November 2023
2405-8440/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

1.1. Background

Blood is an indispensable body fluid as it transports nutrients, enzymes, and hormones throughout the body [1,2]. Blood cells (white blood cells (WBCs), red blood cells (RBCs), and platelets) and plasma are the core constituents of blood. The red blood cell membrane is the most complex of the cells, containing numerous antigens made of glycoproteins and glycolipids [1]. Until about a century ago, all blood groups were thought to be identical, and the terrible cost of blood transfusions was unknown. However, after the discovery of the ABO and Rhesus-D (RhD) blood group systems in different populations, genetic polymorphism was discovered [3].

More than 100 different blood group systems have been recognized and characterized before the discovery of the A, B, and O blood groups by Karl Landsteiner in 1901; the AB blood group by Alfred Von Decastello and Adrian Sturli in 1902; and the RhD blood group by Landsteiner and Weiner in 1939, based on the surface of RBC antigens [1,2,4,5]. Clinically, the ABO and RhD blood groups are the most important [4–6]. Because they are critical for the transfusion of whole blood and its components, organ transplantation, genetic studies, and forensic determinations, as well as medico-legal issues such as paternity testing. They are also of great clinical importance due to their relationship with hemolytic diseases of the fetus and newborn. ABO and RhD are produced in the human genome by genes on chromosomes 9 and 1, respectively [1,6].

The surface of red blood cells contains various sugars and proteins that make up the blood group antigens. The ABO blood group antigens are synthesized well before birth and remain active throughout life. On the other hand, the fetus passively acquires ABO antibodies from its mother, and by three months of age, infants begin to prepare their specific antibodies [7]. Now the International Society of Blood Transfusion has recognized approximately 700 red-cell antigens. These antigens are organized into 30 different human blood group systems, and each person has a unique spectrum of blood groups, except for identical twins or triplets, who have similar blood groups [5]. The ABO system is comprised of four major blood groups (A, AB, B, and O), which are ascertained either by the presence or absence of A and B antigens. These antigens are controlled by three allelic genes, A, B, and O, located on the long arm of chromosome 9 (9q) and are primarily responsible for RBC membrane structural integrity and molecule transport through membranes [1,7]. These blood groups are encoded with N-acetyl D-galactose amine, D-galactose amine, and both N-acetyl D-galactose amine and D-galactose amine and no active enzyme, respectively. However, blood plasma contains reverse antibodies that are directed against specific antigens. A and B antigens are highly antigenic, with naturally occurring antibodies in human plasma that are antigen-free and can cause hemolysis in vivo [8].

In terms of transfusion, the RhD blood group system is the second most clinically significant blood group. It is also useful in the context of genetic studies, identifying medico-legal issues, and tracing family history [2]. This blood group is a multiantigen system with over 50 antigens expressed by three pairs of closely linked allelic genes on chromosome 1. However, the most medically essential RhD antigens are D, C, E, c, and e [9]. Based on the presence or absence of RhD antigens on the red cell surface, the RhD blood group can be RhD-positive or RhD-negative, respectively [2,5].

Antisera (anti-A, anti-B, and anti-D) are used to detect the presence of A, B, and D antigens on the surface of the red blood cell membrane to determine the ABO and RhD blood groups. Furthermore, known red cell antigens can be used to detect anti-A and anti-B in plasma, a process known as a revers grouping. As a result, ABO and RhD phenotypes, alleles, and gene frequencies vary significantly across races and geographical borders [10]. It is critical to identify the RhD system to avoid erythroblastosis fetalis. It occurs frequently when an RhD-negative person receives RhD-positive blood or an RhD-negative mother carries an RhD-positive fetus. On such occasions, the immune system recognizes the antigen as a foreign particle and produces an antibody, resulting in a hemolytic transfusion reaction and hemolytic disease in the fetus and the newborn [2,10].

The distribution of ABO and RhD blood groups varies in different populations (races, ethnic groups, and socio-economic classes). According to a few studies conducted on blood transfused patients about ABO and RhD distribution in Ethiopia, the "O RhD positive" blood group was the most dominant [11,12].

To ensure an adequate supply of the most medically useful blood types, blood banks require timely information on the distribution and frequency of blood group antigens among transfused patients. Furthermore, the information is critical for effective blood bank inventory management at the national and regional levels, as well as for local blood transfusion services. However, data on the frequency and distribution of ABO and RhD blood groups among blood-transfused patients in the study area are lacking. As a result, this study aimed to reveal the distribution of ABO and RhD blood group antigens among blood-transfused patients at Dessie Comprehensive Specialized Hospital, Northern Ethiopia.

2. Methods and materials

2.1. Study design, area, and period

A hospital-based retrospective study was carried out at Dessie Compressive Specialized Hospital, Northern Ethiopia from September 1, 2022 to 30, 2022 on the data of blood transfused patients from October 2019 to June 2022. Dessie Compressive Specialized Hospital is located in Dessie Town, which is 400 km to the north of the capital city of Ethiopia, Addis Ababa. Dessie town is located in the South Wollo Zone of the Amhara Regional national state, with a latitude and longitude of 11°8′ N and 39°38′ E and an elevation between 2470 and 2550 m above sea level. The hospital is the only referral hospital in the South Wollo administration zone and provides various services, including blood transfusion services around 10 million people in South Wollo and neighboring districts.

2.2. Source and study population

The source population consisted of all admitted patients at Dessie Compressive Specialized Hospital during the study period. The study population was blood transfused individuals who had records of blood transfusion: blood recipient ABO and RhD type, units of blood transfused, name of ward admitted, date of transfusion, Medical Registration Number (MRN), age, and sex of the patient.

2.3. Inclusion criteria

Blood transfused individuals who have a full record of blood recipient ABO and RhD type, units of blood transfused, name of ward admitted, age and sex of the patient were included in the study.

2.4. Sample size and sampling technique

Data from all patients who had a blood transfusion at Dessie Compressive Specialized Hospital from 2019 to 2022 and fulfilled the inclusion criteria were included in the study. A survey was applied to collect the data on blood transfused individuals, and the total number of blood transfused individuals was 3762.

2.5. Laboratory tests

The slide method was used for ABO and RhD phenotyping, and blood grouping was determined using commercially available blood grouping antisera: anti-A, anti-B, and anti-D monoclonal antibodies. A drop of blood from a patient was placed in three locations on a clean slide, and an equal volume of anti-sera was added to each drop of blood. The antiserum was then mixed with each drop of blood using an applicator stick. After 2 min of incubation at room temperature, the results were recorded by looking for agglutination with the naked eye and a microscope. Agglutination indicates the presence of the corresponding blood group antigen, while absence indicates the absence of the corresponding blood group antigen. To ensure the accuracy of each anti-sera, known A-cell, B-cell, and RhD positive and negative cells were used as controls to ensure the quality of the results.

2.6. Data collection

The structured data extraction sheet was used to obtain blood transfused patients' data from transfused blood tracking logbooks. Training was given to the data collectors on how to collect the data with the data extraction tool. The data was also collected by trained data collectors under the supervision of a principal investigator from September 1 to September 30, 2022. Moreover, to improve the quality of the data, the questionnaires were pre-tested at Debre Tabor Comprehensive Specialized Hospital before starting the study.

2.7. Data entry and analysis

The data were coded, entered, and cleaned in Epi-data version 4.6. Then, it was exported to STATA version 14.0 software for analysis. The Shapiro-Wilk test was used to determine the age distribution of the study participants. The mean and standard deviation were used for normally distributed data, while the median and interquartile range (IQR) were used for skewed data. Categorical variables were described using frequency, percentages, and charts based on the objective of the study.

2.8. Ethical approval

The study was conducted after obtaining an ethical clearance letter from the research and ethical review board of the College of Health Sciences, Debre Tabor University with reference No.: CHS/RCC/121/2022. A permission letter was also obtained from Dessie Comprehensive Specialized Hospital. The data was accessed and complied with relevant data protection and privacy regulations by using codes. In addition, the study was conducted as per the Declaration of Helsinki. The study design was retrospective. As a result, data was extracted from the blood transfusion record log books, and due to the retrospective nature of the study and the research

Table 1
Socio-demographic characteristics of blood transfused patients(N = 3762) at Dessie Comprehensive Specialized Hospital, Northern Ethiopia, 2023.

Variables	Category	Number	Percent (%)
Age in years	0–14	762	20.3
	15–24	277	7.4
	25–54	1975	52.5
	55–64	509	13.5
	≥65	239	6.3
Sex	Male	1606	42.7
	Female	2156	57.3

ABO and RhD blood group distribution of blood transfused patients.

ethical review board of the College of Health Sciences, Debre Tabor University has waived informed consent for the study. Therefore, informed consent from the study participants was not obtained.

3. Results

3.1. Socio-demographic characteristics of study participants

A total of 3762 blood transfused patients were retrospectively included in this study. Approximately 57.3 % (2156/3762) of blood transfused patients were females. Among the total transfused females, 57 % (1240/2156) were in the reproductive age group. The median age of the transfused patients was 37 years (IQR = 23–52 years), and 52.5 % (1975/3762) of the transfused patients were in the age group of 25–54 years (Table 1).

Of 3762 blood transfused patients, the majority study participants, 33.9 % (1277/3762), had an ABO blood group B, and 81.3 % (3060/3762) of the blood transfused patients were RhD positive. The majority, 27.9 % (1048/3762) of blood transfused patients, had B RhD-positive blood groups (Table 2).

Eight thousand three hundred fifteen units of blood were transfused to 3762 patients, with a mean of 2.2 units of blood transfused per patient. Furthermore, the majority of the study participants, 42.82 % (1611/3762) were given two units of blood, and 8.77 % (330/3762) were given four units of blood (Fig. 1).

Transfused blood consumption showed that the majority of blood, 26.4 % (995/3762) was transfused (utilized) in the medical ward, followed by the surgical ward, 21 % (791/3762) (Table 3).

4. Discussion

In Ethiopia, many patients required blood transfusion due to different reasons However, blood and blood component supplies are in short to meet this demand. In addition, ABO and RhD blood group antigens play an important role during organ transplantation and blood transfusion. A small error in matching the donor and recipients blood type can be fatal for recipients. Therefore, data about the distribution of blood group antigens among blood transfused patients is essential to avail medically necessary and safe blood types for the patient. Thus, this study aimed to determine the distribution pattern of ABO and RhD blood group antigens among blood recipient patients at Dessie Comprehensive Specialized Hospital, Northern Ethiopia. In this study 3762 study participants were involved and the result of the study showed that most of the blood recipients (57.3 %) were females. This might be due to the fact that women have a higher bleeding tendency during delivery and are more likely to be transfused than men. This finding is similar to the finding of studies done at Gondar University Hospital, Northwest Ethiopia [13], Jimma Medical Center, Ethiopia [11], Kenya [14], Zimbabwe [15], Mulago Hospital Complex in Kampala, Uganda [16], Southern Nigeria [17], and Saudi Arabia [18]. This might be due to the fact that women have different medical grounds such as low hemoglobin level, low body weight, pregnancy, breast feeding and high bleeding tendency during delivery. Therefore, women are more likely to be transfused than men. However, this finding is contrary to a study done at Yekatit-12 Specialized Hospital, Addis Ababa, Ethiopia [12]. This difference might be due to variations like the study design and sample size. The study design at Yekatit-12 Specialized Hospital, Addis Ababa, Ethiopia, was prospective cross-sectional, and the sample size was 615 study participants. According to this study, the most common ABO blood group among the blood transfused patients was the B blood group. This study showed a contrary result to the studies done at St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia [19], Yekatit-12 Specialized Hospital, Addis Ababa, Ethiopia [12], and Jimma Medical Center, Ethiopia [11]. This might be due to the fact that, the association of blood group B with some chronic diseases like Diabetes mellitus (type 2).

In the RhD distribution, the most common was RhD positive. This finding is similar to studies conducted at Jimma Medical Center, Ethiopia [11] and Yekatit-12 Specialized Hospital, Addis Ababa, Ethiopia [12]. Furthermore, the frequency of AB RhD negative and O RhD negative is significantly low in both the general population and the findings of this study [11].

A total of 8315 blood units were transfused for 3762 patients from different wards in Dessie Compressive Specialized Hospital from October 1, 2019, to June 30, 2022, with a mean of 2.2 blood units transfused per recipient. This finding was relatively in line with the results of studies conducted in Gondar Hospital, Northwest Ethiopia [13], and Yekatit-12 Hospital, Addis Ababa, Ethiopia [12], but relatively higher than studies conducted in Jimma, Ethiopia [11], and Southern Nigeria [17]. In addition, the majority of transfused blood was given to female patients. This is because, naturally, females are more susceptible to anemia and other conditions due to

Table 2
ABO and RhD Phenotype blood group distribution of blood transfused patients (N = 3762). at Dessie Comprehensive Specialized Hospital, Northern Ethiopia, 2023.

Variables	Category	Number	Percent (%)
ABO and RhD blood groups	A+	677	18.00
	A-	365	9.70
	B+	1048	27.86
	B-	229	6.09
	AB+	393	10.45
	AB-	14	0.37
	O+	942	25.03
	O-	94	2.50

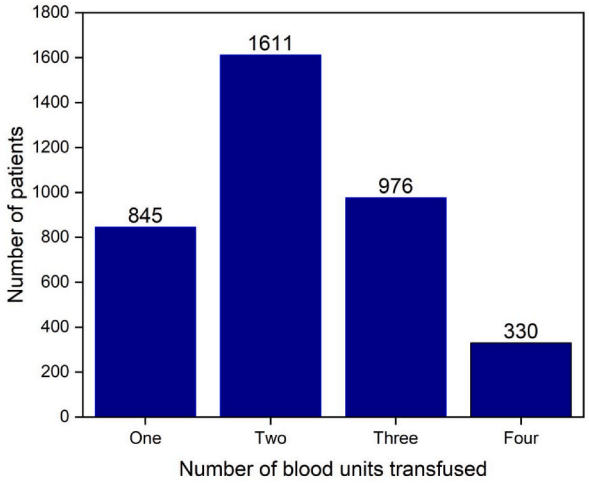


Fig. 1. Number of ABO and RhD blood group units transfused to patients (N = 3762) at Dessie Comprehensive Specialized Hospital, Northern Ethiopia, 2023.

Table 3
Number of blood units transfused to patients(N = 3762) in different wards at Dessie Comprehensive Specialized Hospital, Northern Ethiopia, 2023.

Name of Ward	Unit of blood transfused	Percent (%)
Medical	995	26.45
NICU[¥]	67	1.78
Obstetric	787	20.92
Oncology	28	0.74
Surgical	791	21.03
Orthopedics	415	11.03
Pediatric	679	18.05

NICU[¥]: Neonatal Intensive Care Unit.

difference is their medical physiology and require more blood transfusion than men.

Most of the patients were from the medical ward, which accounted for 995 (26.45 %), followed by the surgical ward, which had 791 (21.03 %). This finding is comparatively in line with the results of a study conducted at Yekatit-12 Specialized Hospital, Addis Ababa, Ethiopia [12], Kenya [14], and Southern Nigeria [17]. This might be due to the fact that ABO blood antigens and RhD antigens previously have been shown to be associated with the risk of chronic disease like strok, coronary heart disease and diabetes millitus [20]. In addition, the median age of the blood transfused patients was 37 years. The majority of blood was used mainly by the younger population, 25–54 years (N = 1975; 52.5 %), followed by the age group of 0–14 years (N = 762; 20.3 %). This result is supported by a study done in Southern Nigeria [17], Kenya [14], and Zimbabwe [15]. However, it varies from a study conducted in Spain [21]. This could be attributed to differences in the age distribution of transfused patients in these countries. In developing countries like Ethiopia, most transfusions are utilized by younger patients, while in developed countries, the elderly (65 years and older) are mostly transfused [14].

This study showed that blood transfusion requests were for whole-blood transfusions. This finding is relatively similar to studies done at Black Lion Specialized Hospital, Ethiopia [22], Jimma Medical Center, Ethiopia [11], Southern Nigeria [17], Jigawa, Nigeria [23], and Kenya [14]. This is due to the use of whole blood as the sole component for transfusion in resource-limited areas, making whole blood seldom used as a component for blood transfusion rather than its therapeutic products due to the non-availability of facilities to practice blood component separation [17,23].

4.1. Limitations of the study

In this study, secondary data was used retrospectively from the transfused blood registration log books. Therefore, it was not possible to include the data such as whether the blood was ordered for elective or emergency cases. In addition, variables were also limited.

5. Conclusions and recommendations

Data about the blood type distribution among transfused patients is essential for planning, efficiently utilizing blood, and avoiding

critical blood shortages. In this study, the most common ABO and RhD blood groups among blood transfused patients were B and RhD positive. Most transfused patients were relatively young and female, most of whom were in the reproductive age group. The majority of blood was transfused to medical ward patients. Whole blood was the major blood component recorded in this study. This shows a lag in healthcare improvement and an unnecessary waste of blood. Furthermore, prospective studies or continued research are needed to identify whether the blood was ordered for routine or emergency.

Ethical consideration

The study was conducted after obtaining an ethical clearance letter from the research and ethical review board of the College of Health Sciences, Debre Tabor University with reference No.: CHS/RCC/121/2022. A permission letter was also obtained from Dessie Specialized Comprehensive Hospital. The data was accessed and complied with relevant data protection and privacy regulations by using codes. In addition, the study was conducted as per the Declaration of Helsinki. The study design was retrospective. As a result, data was extracted from the blood transfusion registration log books, and due to the retrospective nature of the study/research ethical review board of the College of Health Sciences, Debre Tabor University has waived informed consent for the study. Therefore, informed consent from the study participants was not obtained.

Consent for publication

Not applicable.

Funding

There was no funding source for this study.

Availability of data and materials

The data associated with our study are not deposited into a publicly available repository. The datasets used and/or analyzed during the current study are available from the corresponding author and will be accessible upon reasonable request.

CRediT authorship contribution statement

Ayenew Berhan: Methodology, Investigation, Formal analysis, Conceptualization, Data curation, Software, Visualization, Writing - original draft, Writing - review & editing. **Yenealem Solomon:** Formal analysis, Investigation, Methodology, Software, Writing - original draft, Writing - review & editing. **Birhanu Getie:** Software, Writing - original draft, Writing - review & editing. **Shewaneh Damtie:** Data curation, Formal analysis, Methodology, Software, Writing - review & editing. **Biruk Legese:** Data curation, Formal analysis, Software, Visualization, Writing - review & editing. **Awoke Chanie:** Data curation, Formal analysis, Investigation, Validation, Writing - review & editing. **Andargachew Almaw:** Formal analysis, Data curation, Methodology, Software, Validation, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to acknowledge the Dessie Comprehensive Specialized Hospital laboratory staff.

References

[1] B. Enawgaw, M. Aynalem, M. Melku, Distribution of ABO and Rh-D blood group antigens among blood donors in the Amhara regional state, Ethiopia, J. Blood Med. 13 (2022) 97.
[2] B. Woldu, M. Melku, E. Shiferaw, B. Biadgo, M. Abebe, Y. Gelaw, Phenotype, Allele and genotype frequency of ABO and Rhesus D blood groups of blood donors at the North Gondar district blood bank, Northwest Ethiopia, J. Blood Med. 13 (2022) 11.
[3] B.A. Silamlak, ABO and Rh (D) blood group distribution among blood donors: a study of natural and computational science faculty graduating class students at Woldia University, Ethiopia, IJGMB 13 (1) (2021) 21–30.
[4] M.H.T. Mohamud, A.D.H. Aweis, A.S.E. Adam, F.A. Mohamed, S.Q. Fidow, L.M. Mohamed, Distribution and frequency of ABO and Rhesus (D) blood groups in Somalia: a retrospective study on students of jazeera university, mogadishu-Somalia, BioMed Res. Int. (2022) 2022.
[5] R.O. Apecu, E.M. Mulogo, F. Bagenda, A. Byamungu, ABO and Rhesus (D) blood group distribution among blood donors in rural south-western Uganda: a retrospective study, BMC Res. Notes 9 (1) (2016) 1–4.
[6] A. Sabir, A. Iftikhar, M.U. Ijaz, G. Hussain, A. Rasul, R.K. Iqbal, et al., Retrospective study of the frequency of ABO and Rhesus blood group among population of Safdarabad and Faisalabad cities of Pakistan, BMC Res. Notes 14 (1) (2021) 1–5.
[7] T. Eastlund, The histo-blood group ABO system and tissue transplantation, JAABB.Trans. 38 (10) (1998) 975–988.

[8] S. Rawat, H.R. BhagoraR, A. Mane, P. Kapoor, A. Patil, Frequency and distribution of ABO and Rhesus blood group of blood donors, JMSCR 7 (11) (2019) 148–152.
[9] O. Jahanpour, J.J. Pyuza, E.O. Ntiyakunze, A. Mremi, E.R. Shao, ABO and Rhesus blood group distribution and frequency among blood donors at Kilimanjaro Christian Medical Center, Moshi, Tanzania, BMC Res. Notes 10 (1) (2017) 1–5.
[10] M.E. Enosolease, G.N. Bazuaye, Distribution of ABO and Rh-D blood groups in the Benin area of Niger-Delta: implication for regional blood transfusion, AJTS 2 (1) (2008) 3.
[11] T. Feyisa, G. Tesfaye Kiya, W.A. Maleko, Assessment of recipients' characteristics, transfusion appropriateness, and utilization pattern of blood and blood products in Jimma Medical Center, Jimma, Ethiopia, PLoS One 16 (4) (2021), e0250623.
[12] H. Tewabe, A. Mitiku, H. Worku, Assessment of blood transfusion utilization and patient outcomes at yekatit-12 hospital, Addis Ababa, Ethiopia, J. Blood Med. 13 (2022) 171.
[13] T. Belayneh, G. Messele, Z. Abdissa, B. Tegene, Blood requisition and utilization practice in surgical patients at university of Gondar hospital, northwest Ethiopia, J. Blood Transfus. 2013 (2013).
[14] J.C. Kipkulei, N. Buziba, S. Mining, H. Jepngetich, Demographic and clinical profiles of blood transfusion recipients at a teaching and Referral Hospital in Kenya, J. Blood Disord. 9 (1) (2019).
[15] N. Mafirakureva, S. Khoza, O. Hassall, B.E. Faragher, I. Kajja, D.A. Mvere, et al., Profiles of blood and blood component transfusion recipients in Zimbabwe, J. Blood Transfus. 13 (4) (2015) 600.
[16] E.K. Butler, H. Hume, I. Birungi, B. Ainomugisha, R. Namazzi, H. Ddungu, et al., Blood utilization at a national referral hospital in sub-Saharan Africa, OR Trans. 55 (5) (2015) 1058–1066.
[17] H.U. Okoroiwu, I.M. Okafor, Demographic characteristics of blood and blood components transfusion recipients and pattern of blood utilization in a tertiary health institution in southern Nigeria, BMC Hematol 18 (1) (2018) 1–6.
[18] H. Shash, R. Alabdulqader, L. Alshehri, N. Alkathery, R. Al-Abdulrahman, S. Alahmed, et al., Blood utilization and quality indicators at a university hospital in the Eastern Province of Saudi Arabia, PLoS One 17 (4) (2022), e0267449.
[19] M.B. Muleta, E.H. Yisak, H.A. Gebreselassie, T. Tefera, E. Berhanu, A.L. Mekonnen, et al., A cross-sectional study to analyze blood and blood component transfusion practice at tertiary Care hospital of Ethiopia, Clin. Audit. 13 (2021) 29–35.
[20] M.P.Q. Farshori, I.H. Al-Wakid, I.K. AL-Ibrahim, A.F. AL-Shammari, M. Alduejieman, A.M. Almhanaa, et al., Distribution of ABO and Rhesus (Rh) blood group antigens in male type 2 diabetes mellitus patients in Hail region of Saudi Arabia: high incidences of diabetes mellitus in males with B+ blood type, Integr Obesity Diabetes 2 (3) (2016) 233–238.
[21] M.A. Bosch, E. Contreras, P. Madoz, P. Ortiz, A. Pereira, M.M. Pujol, et al., The epidemiology of blood component transfusion in Catalonia, Northeastern Spain, OR Trans. 51 (1) (2011) 105–116.
[22] M. Tamene, A. Tsegaye, A. Birhanu, B. Taye, M. Birhaneselassie, Assessment of transfusion utilization and patient outcomes at the largest referral and university hospital in Addis Ababa, Ethiopia, ISBT Sci. Ser. 11 (1) (2016) 7–13.
[23] I. Aliyu, G. Michael, H. Ibrahim, Z.F. Ibrahim, G. Aliyu, A.T. Isaiah, Blood transfusion request pattern in a medical center in Northwestern Nigeria, Glob. J. Transfus. Med. 2 (1) (2017) 52.