African Journal of Advanced Pure and Applied Sciences (AJAPAS)
Online ISSN: 2957-644X
Volume 4, Issue 2, April - June 2025
Page No: 212-218
Website: https://aaasjournals.com/index.php/ajapas/index
ISI 2024: 0.877 **SJIFactor 2024: 6.752** **معامل التأثير العربي: 1.62**

Prevalence of ABO and Rh Blood Group Phenotypes Among Pregnant Women

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انتشار النمط الظاهري لفصائل الدم بنظام ABO ونظام Rh بين النساء الحوامل

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Received: March 02, 2025	Accepted: April 20, 2025	Published: April 26, 2025

Abstract:
Knowledge of the ABO and Rh blood group systems is essential to clinical practice. Maternal mortality and morbidity during childbirth remains a significant concern worldwide, with blood loss being the leading cause of death. Health care management during antenatal periods highly relies on the verification of maternal ABO and Rh blood. This is crucial to prevent complications outcomes, like hemolytic disease of newborns (HDN), postpartum hemorrhage, and miscarriage. Details on the prevalence of the ABO and Rh blood groups among pregnant women in Libya are lacking. The Objective of this research is to study the distribution pattern of the ABO and Rh blood groups among pregnant women in the city of Derna, north-eastern Libya. A retrospective, health records-based study was conducted at Al-Wahda Teaching Therapeutic Hospital, Derna from January 2020 to December 2023 and enrolled 5012 women at delivery. Blood samples were collected upon admission and ABO and Rh typing were performed using slide agglutination method. Descriptive statistical results were shown in frequency and percentage. The results revealed that group O positive was the most prevalent blood phenotype (32%), followed by A positive (29.5%), B positive (19.9%), AB positive (6.9%), O negative (4.6%), A negative (3.6%), B negative (2.3%) and AB negative (0.8%). The Conclusion of the study shed light on the prevalence of the ABO and Rh blood phenotypes on large scale basis. Our findings may provide a reliable database to help optimize blood reserves and ensure safe blood transfusion during pregnancy and delivery.

Keywords: ABO blood group, Rh factor, Pregnant Women.

الملخص
معرفة نظام فصائل الدم أي بي أو (ABO) والعامل الرايزيسي (Rh) ضروري في الممارسة السريرية. لا تزال الأمراض والوفيات لدى الأمهات أثناء الولادة مصدر قلق عالمي، حيث يُعد فقدان الدم سببًا رئيسيًا للوفاة. يعتمد التدبير العلاجي خلال فترة الحمل بشكل كبير على التحقق من فصيلة دم الأم بنظامي أي بي أو والعامل الرايزيسي. هذا الأمر مهم لمنع نتائج المضاعفات مثل داء الانحلال الدموي عند حديثي الولادة، والنزيف ما بعد الولادة، والإجهاض. المعلومات حول انتشار فصائل الدم بنظام أي بي والعامل الرايزيسي بين النساء الحوامل في ليبيا نادرة. يهدف هذا البحث إلى دراسة نمط توزيع نظام فصائل الدم أي بي أو والعامل الرايزيسي بين النساء الحوامل في مدينة درنة، شمال شرق ليبيا. تم إجراء الدراسة بتأثير رجعي استنادا على السجلات الطبية بمستشفى الوحدة التعليمي العلاجي بمدينة درنة، وذلك خلال الفترة من يناير 2020 إلى

ديسمبر 2023 وشملت الدراسة 5012 امرأة أثناء الولادة. تم جمع عينات الدم عند إيواء الحالات بالمستشفى، وتم تحديد نظام فصائل الدم أي بي أو والعامل الرايزيسي باستخدام طريقة التراص الدموي على الشريحة. تم عرض النتائج الإحصائية الوصفية من خلال التكرارات والنسب المئوية. أظهرت النتائج بأن فصيلة الدم الأكثر شيوعًا هي أو موجب (32%)، تليها أي موجب (29.5%)، ثم بي موجب (19.9%)، أي بي موجب (6.9%)، أو سالب (4.6%)، أي سالب (3.6%)، بي سالب (2.3%)، وأخيرًا أي بي سالب (0.8%) . تخلص الدراسة إلى تسليط الضوء على معدل انتشار نظام فصائل الدم بين النساء الحوامل على نطاق واسع. قد تساهم هذه النتائج في توفير قاعدة بيانات موثوقة لدعم تحسين مخزون الدم وضمان نقل دم آمن خلال فترتي الحمل والولادة.

الكلمات المفتاحية: فصائل الدم بنظام ABO ، عامل الرايزيسي، النساء الحوامل.

Introduction

Karl Landsteiner was credited in 1900 for discovering the A, B, and O blood types. Alfred Von Decastello and Adriano Sturli discovered the AB blood type two years later. It was until 1940 that Karl Landsteiner and Alexander Weiner uncovered the Rh blood type. [1] The International Society of Blood Transfusion (ISBT) Working Party for Red Cell Immunogenetics and Blood Group Terminology (ISBT WP) maintains an official record of all identified blood group systems. Today, 47 blood group systems are established, representing 366 red blood cell membrane antigens (October 2024). [2] The antigens may be entire proteins where polymorphisms reside in the variation of amino acid sequence as in the case of the Rh system, glycoproteins or glycolipids as in the case of the ABO system. [3]

Although many blood group systems have been recognized, yet, the ABO (with blood types A, B, AB, and O) and rhesus (with blood type Rh D-positive or Rh-D negative) systems essentially hold paramount value in clinical practice. [3-5] This is because of their utility in determining the compatibility of blood transfusions and tissue grafts, resolving particular forensic medicine issues, providing reliable geographical information, and studying community demography, inheritance patterns, and population and evolution genetics. Their clinical importance additionally comes from their link to the risk of developing many pathologies, including some cancers, duodenal ulcers, diabetes mellitus, urinary tract infections, chronic hepatitis, Von Willebrand disease, thrombotic events, and cardiovascular disorders. [4, 6-10]

Along with transfusion transmissible contagions, ABO and Rh incompatibility conditions remain a key source of morbidity and mortality in community health centres [11, 12]. Hemolytic disease of the newborn, a serious red blood cell mismatch between mother and fetus, affects 3/100 000 to 80/100 000 cases annually, with high incidence in African countries. [13, 14]

Despite the fact that pregnancy is a natural life phenomenon desired and expected by all women, it is occasionally associated with complications demanding blood transfusion. [15, 16] Cesarean delivery because of excessive bleeding, hypertension and anaemia in pregnancy, and spontaneous abortions all boost the necessity for blood and blood derivatives needed to maintain the power of life during pregnancy, delivery, and lactation. [15, 17]

Though extensive studies were conducted during the last four decades to determine the frequency distribution of the ABO and Rh blood groups in different populations and geographical areas, however, so far, only few research has been carried out to explore the prevalence of the ABO and Rh blood groups among the population of Libya. Moreover, almost no data are available concerning the spectrum of these blood groups among pregnant women in Libya, including at least the province of Derna. [15]

Information obtained recently from Al Wahda Teaching Therapeutic Hospital, Derna, Libya, infers that significant proportion of pregnant women attending the obstetrics and gynecology ward entails safe blood transfusion to control pregnancy or delivery related complications. The is a vision to establish a blood bank centre in the near future with a reliable database to help serve the city of Derna and its suburbs. [15] This, together with the reports indicating that blood groups can act as markers for diverse human derangements [18, 19] have led us to formulate this research work.

Material and methods

Study Area

The current study was conducted at obstetrics and gynecology ward, Al Wahda Teaching Therapeutic Hospital, Derna, Eastern Libya. Al Wahda Hospital is the main governmental hospital in Derna. It serves to provide health and curative care to the city of Derna and its suburbs in several medical fields, including obstetrics and gynecology and laboratory medicine.

Sample Size

The sample population in the present study consisted of 5012 pregnant women. They were from the city of Derna and its suburbs. The cases attended to the obstetrics and gynecology ward, Al Wahda Teaching Therapeutic Hospital, Derna for normal and caesarean deliveries.

Study Design and Data Collection

This was a descriptive retrospective study on large scale basis. The study covered the period extending from January 2020 until December 2023. Data were collected from medical records extracted mainly from patient files, registration manual books at the delivery room, and laboratory information.

Laboratory Phenotyping of ABO and Rh Blood Groups

3 mL blood was collected from labour women into tubes containing ethylene diamine tetra acetic acid (EDTA) as anticoagulant. The ABO and Rh blood groups phenotypes were determined by erythrocytes cell-slide method according to the Association for the Advancement of Blood and Biotherapies (AABB) Technical Manual, 21st edition, consistent with the clinical significance of ABO incompatibility associated with blood and organ transfusion [1]. This analytical work was executed in the Hospital's clinical laboratory as a part of routine practice.

Statistical Analysis

The data were analyzed utilizing Statistical Package for Social Sciences (SPSS), version 29. Descriptive statistical results were presented as frequency (number) and percentage distribution of categorical variables.

Results and discussion

A total of 5012 pregnant women were included in the current study. Table 1 and Figure 1 show the prevalence patterns of the ABO blood groups among the studied population. Groups O was found to be the most predominant ABO blood group accounting for the majority of the population (n = 1859, 37%), followed by group A (n = 1657, 33%), group B (n = 1112), 22.18%) and group AB (n = 384, 7.66%).

Table 1 Prevalence of ABO blood groups among study population (n = 5012)

ABO blood group	A	B	AB	O
Frequency (n)	1657	1112	384	1859
Percentage (%)	33.0606	22.18657	7.6616	37.0909

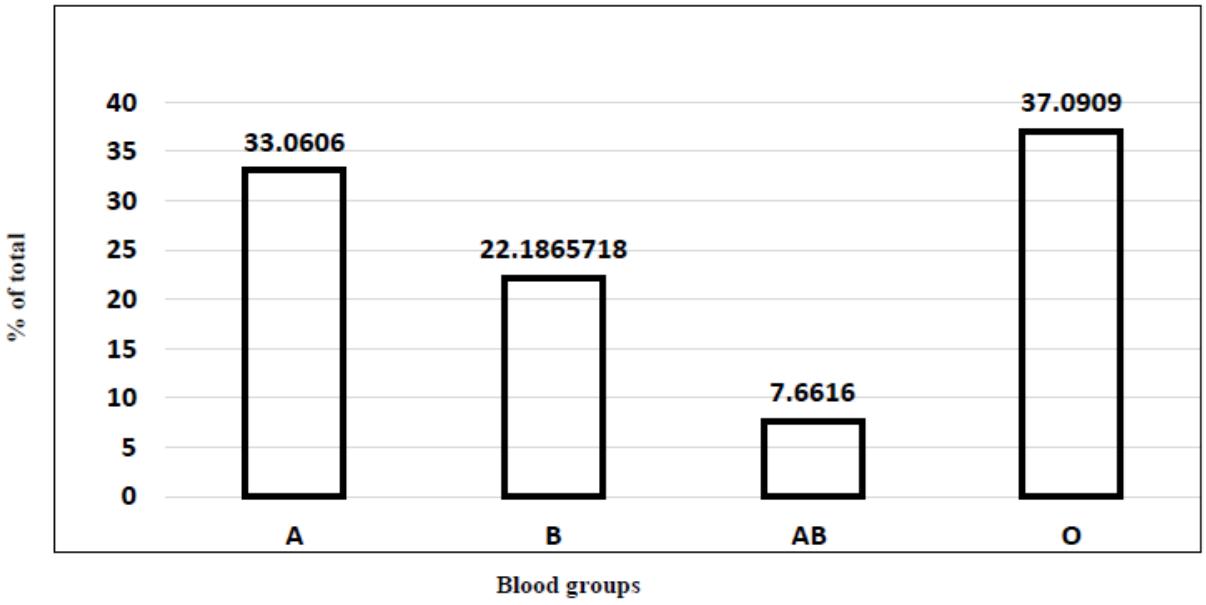

Figure 1 Distribution of ABO blood groups among studied population.

Table 2 and Figure 2 show the prevalence pattern of the Rh blood groups among the studied population. The majority of the population had their blood belonged to the Rh-positive phenotype.

Table 2 Prevalence of Rh blood groups among study population (n = 5012)

Rh blood group	Positive	Negative
Frequency (n)	4447	565
Percentage (%)	88.72705507	11.27294493

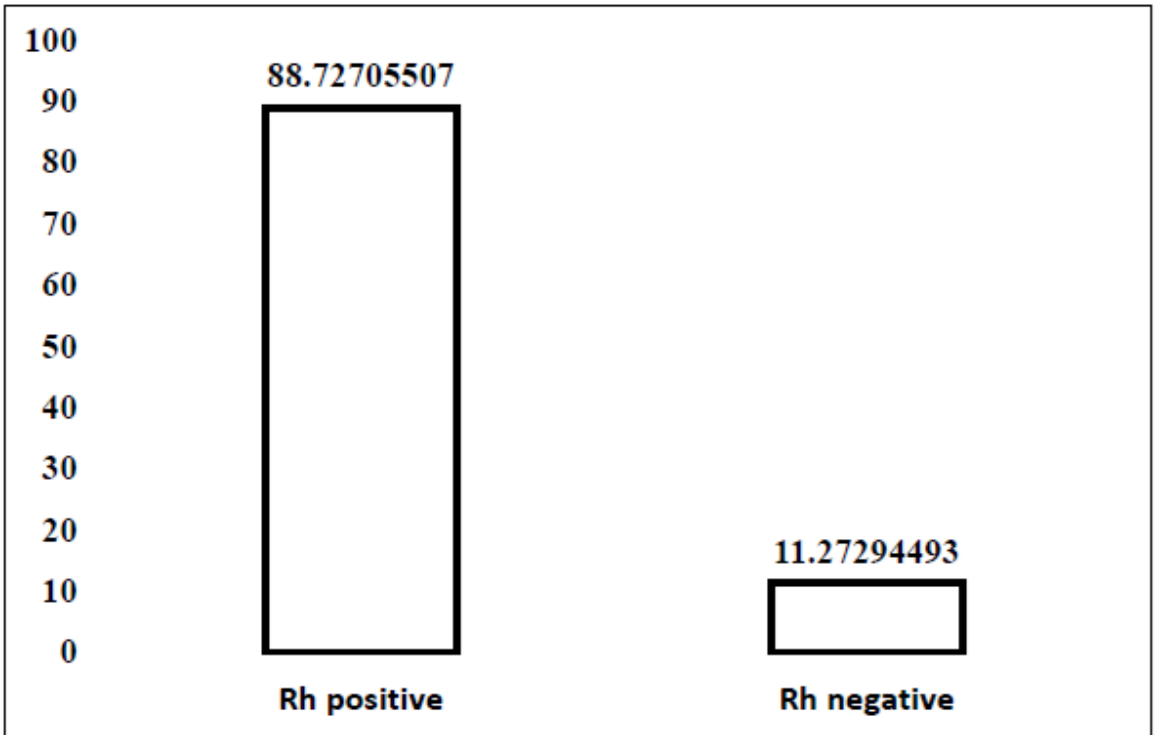

Figure 2 Distribution of Rh blood groups among study population**.**

Table 3 and Figure 3 show the resulting prevalence pattern when ABO and Rh blood group phenotypes were combined. Group O positive was the most common blood phenotype (32.5%), followed by A positive (29.5%), B positive (19.9%), AB positive (6.9%), O negative (4.6%), A negative (3.6%), B negative (2.3%) and AB negative (0.8%).

Table 3 The association results between ABO and Rh blood groups (n = 5012)

ABO-Rh blood group	O+	A+	B+	AB+	O-	A-	B-	AB-
Frequency (n)	1627	1479	996	345	232	178	116	39
Percentage (%)	32.5	29.5	19.9	6.9	4.6	3.6	2.3	0.8

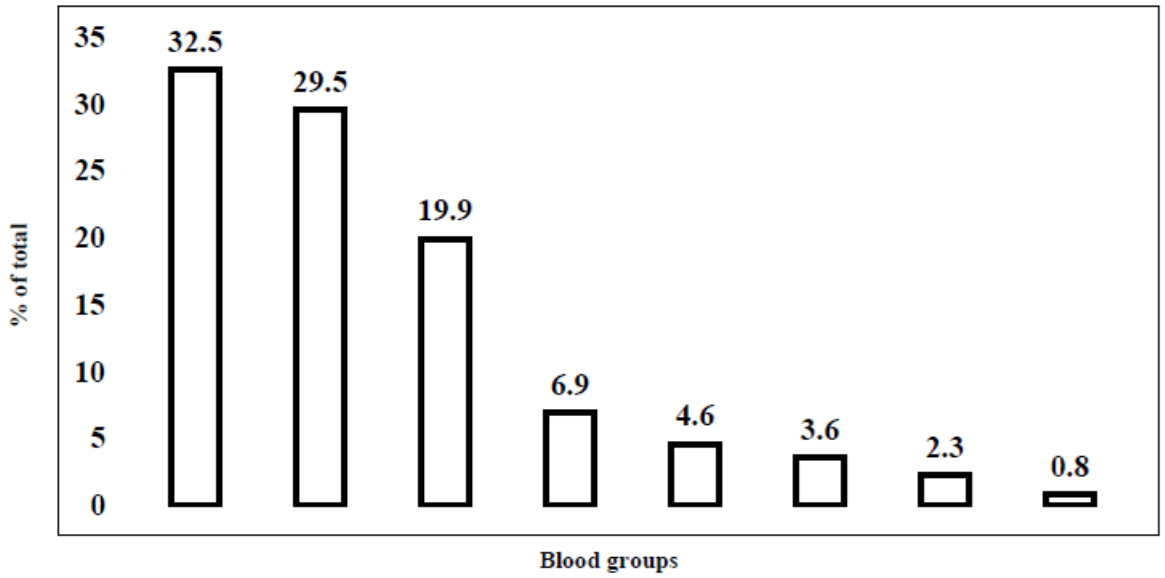

Figure 3 Distribution of ABO-Rh blood groups among study population.

Extensive research was conducted worldwide to examine the prevalence of the ABO and Rh blood groups in different populations, geographical regions, and ethnic groups, with vast majority of the research targeted blood donors of both genders. To our best knowledge in Libya and with the exception of one unique study performed in Sabratha, Northwest, Libya [21], all the other studies conducted focused on determining the distribution pattern of the ABO and Rh blood groups among blood donors of male and female donors attending central blood banks, and medical laboratories in particular geographical regions. [22-29]

In this research work which encompassed blood samples from 5012 pregnant women, the most frequently occurring blood group was O (37.09%, n = 1895), followed by A (33.06%, n = 1657), B (22.18%, n = 1112) and AB (7.66%, n = 384). Our findings were in coherence with the findings of previous studies from different countries, including Libya, Jordan, Saudi Arabia, Iran, Ethiopia, Nigeria, Uganda, and USA. [21, 30-38] Despite the observation that there was a minor proportional variation, the frequency remained consistent for all of the studies with the order of O > A > B > AB. However, comparable data were recorded in Turkey, Pakistan, and Nepal where the most frequently occurring blood group in Pakistan was B and that in Nepal, and Turkey was A. [4, 39, 40] Such disparity in the prevalence pattern of blood type O among different populations raises interesting questions about genetic makeup variation in each ethnic group that may have influenced the distribution of blood groups in various regions. Likewise, investigations in Turkey (partly Asian and partly European country) and Nepal (Asian country) indicated that A blood groups was the commonest among pregnant women, and investigation in Pakistan (Asian country) indicated that B blood group was the commonest. [1] Furthermore, Upon comparison with European and African populations, the high incidence of O blood group in African population, and A blood group in European population can be accounted for the genetic inheritance, population history, and natural selection factors, [2, 3] such as resistance to diseases like malaria. [4]

The results of the present study also indicated that the Rh positivity rate was strikingly higher (88.72%, n = 4447) than the Rh negativity rate (11.17%, n = 565). The finding of low Rh negativity rate concurs with the general understanding that Rh negative blood types are less common. The rate of Rh negative trait varies by population and ethnicity, with higher rates being reported in Caucasian populations (about 15% in Europeans) and lower rates in Asian and African populations (below 1% in some groups). The finding of low Rh negativity rate in the present study (11.27%) implies that the studied population may have a moderate prevalence of Rh-negative trait, possibly uncovering a mixed ethnic genetic profile. [18] As compared to the other studies, the finding of the present study of a relatively higher frequency of the Rh negative rate (11.27%) among the studied population, may importantly be understood as a sign of a more possibility of haemolytic outcomes of newborn.

In light of ABO and Rh blood group altogether, the results revealed that the O positive phenotype was the most widespread blood phenotype among the studied population (32.5%, n = 1627), followed by A positive (29.5%, n = 1479), B positive (19.9%, n = 996), AB positive (6.9%, n = 345), O negative (4.6%, n = 232), A negative (3.6%, n = 178), B negative (2.3%, n = 116), and AB negative (0.8%, n = 39). These results are in line with the results obtained previously from different regions. [30-38]

Despite the fact that several blood bank centres have been established in different cities in Libya, the city of Derna essentially lacks such vital facility. The city's main hospital (Al Wahda Teaching Therapeutic Hospital) provides health care and curative facilities not only to city's inhabitants, but also to considerable number of citizens from various suburbs. This, along with the catastrophic consequences of the Daniel Storm devastatingly affecting the city very recently, makes blood and blood derivatives supply planning and programs unsatisfactory to encounter the local demand. The intention to ascertain the distribution pattern of ABO and Rh blood groups therefore emerges importantly to sustain the sufficiency of safe blood supply for pregnant women who are at threat of developing pregnancy and delivery related complications. [15]

Conclusion

The current study is the pioneer comprehensive study in the province of Derna, if not in Libya, that investigated the prevalence pattern of the ABO and Rh blood phenotypes among pregnant women on large scale basis. Our analyses deduce that the most prevalent blood phenotype was O positive, followed by A positive, B positive, AB positive, O negative, A negative, B negative and AB negative. The data offered by this study could be of value in proper management of blood inventory, pregnancy, all immunity, and healthy blood transfusion.

Future Directions

The finding reported by this study reflects data of a particular geographical locality. Further research directed to the prevalence of the ABO and Rh blood phenotypes among pregnant women and their associations with medical, demographic, and ethnic factors in different regions in Libya is highly warranted, collectively with an intention of establishing more reliable database and enhancing the health care sector.

References

[1] Patel, P., Frequency and distribution of blood groups in blood donors in western Ahmedabad–a hospital based study. blood, 2011: p. 202-206.
[2] Transfusion, I.S.o.B., Red cell immunogenetics and blood group terminology. 2021.
[3] Singh, A., et al., Distribution of ABO and Rh types in voluntary Blood donors in Jharkhand area as a study conducted by RIMS, Ranchi. Journal of family medicine and primary care, 2016. 5(3): p. 631-636.
[4] GÜNDEM, N.S. and E. ATAŞ, Distribution of ABO and Rh Blood Groups among Patients Admitted to a Gynaecology, Obstetrics and gynecology Children Hospital in Konya, Turkey. Journal of Clinical & Diagnostic Research, 2019. 13(3).
[5] Mitra, R., N. Mishra, and G.P. Rath, Blood groups systems. Indian journal of anaesthesia, 2014. 58(5): p. 524-528.
[6] Gates, M.A., et al., ABO blood group and incidence of epithelial ovarian cancer. International journal of cancer, 2011. 128(2): p. 482-486.
[7] Tufano, A., et al., Non-O blood group as a risk factor for cerebral vein thrombosis. Thrombosis and haemostasis, 2013. 110(07): p. 197-199.
[8] Wang, D.S., et al., ABO blood group, hepatitis B viral infection and risk of pancreatic cancer. International journal of cancer, 2012. 131(2): p. 461-468.
[9] Wiggins, K., et al., ABO genotype and risk of thrombotic events and hemorrhagic stroke. Journal of thrombosis and haemostasis, 2009. 7(2): p. 263-269.
[10] Zhang, H., C.J. Mooney, and M.P. Reilly, ABO blood groups and cardiovascular diseases. International journal of vascular medicine, 2012. 2012(1): p. 641917.
[11] Sazama, K., Reports of 355 transfusion-associated deaths: 1976 through 1985. Transfusion, 1990. 30(7): p. 583-590.
[12] Stainsby, D., et al., Serious hazards of transfusion: a decade of hemovigilance in the UK. Transfusion medicine reviews, 2006. 20(4): p. 273-282.
[13] Erhabor, O., et al., Singh S. Rh (D) Phenotype among Pregnant Women in Sokoto, North Western Nigeria. Implications on Haemolytic Disease of the New-Born and Haemolytic Transfusion Reaction. Health Sci Res, 2014. 1: p. 19-24.
[14] Ibrahim, U., N. Garba, and I. Tilde, Acute Blood Transfusion Reactions in Pregnancy, an Observational Study from North Eastern Nigeria. J Blood Disorders Transf 4: 145. doi: 10.4172/2155-9864.1000145 Page 2 of 3 Volume 4• Issue 3• 1000145 J Blood Disorders Transf ISSN: 2155-9864 JBDT, an open access journal rate in the study population is 10.5% which is higher than the 6% reported for United Kingdom [7]. Blood transfusion rate of, 2013. 37.
[15] Ajroud SM. Head of obstetrics and gynecology gynecology ward at Al Wahda Therapeutic Educational Hospital, Derna, Libya, 2007–present..
[16] Delaney, M. and D.C. Matthews, Hemolytic disease of the fetus and newborn: managing the mother, fetus, and newborn. Hematology 2014, the American Society of Hematology Education Program Book, 2015. 2015(1): p. 146-151.
[17] Iwo-Amah, R.S., et al., Purse-string Compression sutures at Cesarean Section: its role in Prevention of primary Post-partum Hemorrhage (PPH) in Port Harcourt. Tropical Journal of Obstetrics and gynecology Gynaecology, 2021. 38(1): p. 46-50.
[18] Garratty, G., et al., ABO and Rh (D) phenotype frequencies of different racial/ethnic groups in the United States. Transfusion, 2004. 44(5): p. 703-706.
[19] Liao, H. and J. Li, Distribution characteristics of ABO and RhD blood groups among the voluntary blood donors in Chongqing: A retrospective study. Medicine, 2020. 99(42): p. e22689.
[20] Claudia S.Cohn, M.D., Susan T.Johnsom, Louis M.Katz, Joseph Schwartz. Technical manual. 2023; 21. Available from: https://www.aabb.org/.
[21] Azab, A. E., Albasha, M. O., & Elhemady, S. Y. (2017). Haematological parameters in pregnant women attended antenatal care at sabratha teaching hospital in Northwest, Libya. American Journal of Laboratory Medicine , 2 (4), 60. Matough FA, Alhoderi J, Abdukader A, et al. The frequency of ABO and Rhesus blood group phenotypes, genotypes from Sebha city from Libya. Journal of Pure& Applied Sciences. 2019;18(1):17–22.
[22] Sakal IDA, et al. Prevalence and Distribution of ABO and Rh (D) Factor among Blood Donors in Sabratha-Libya. Haya Saudi J Life Sci. 2019; 4(9): 283-286.
[23] Fayrouz IN, Faridaa N, Irshad A. Relationship between fingerprints and different blood groups. J Forensic Leg Med. 2012;19(1):18–21.
[24] Othman MF, Alfalos AM, Jaber ZM, et al. Prevalence od ABO and Rh-D blood groups in Elmergib Province, Libya. Journal of Survey in Fisheries Sciences. 2023;10(35):2555–2559.

[25] Samira Daw Ameigaal SD, Ageel AA. A Cross sectional preliminary study on the prevalence of ABO and Rhesus blood groups in Bani Waleed City, Libya. Libyan International Medical University Journal. 2019; 4(2): 56 – 61.
[26] El Moghrabi HA, Drussi IA, Ziuo FY, et al. Prevalence, Gender Distribution, and Allelic Distrinution of ABO and Rh-D Blood Groups in Al Salim Laboratory for Medical Analysis, Ajdabiya, Libya. International Journal of Science and Research (IJRS). 2021;10(2):125–1258.
[27] El Moghrabi HA, Jwieli LA, Elramli NA, et al. A Comparative Study of Prevalence, Phenotype and Genotype of ABO and Rh (D) Factor among Blood Donors from the Central Blood Bank in Benghazi, Libya. International Journal of Science and Research (IJRS). 2021;10(9): 1068– 1074.
[28] Saad KA. Distribution of ABO Blood Groups and Rhesus Factor (Rh) in Al Bayda, Libya. Journal of Medical and Dental Science Research. 2016;3(9):28–32.
[29] Eljamay SM, Elshalwi HE, Alqabaeli MF, Alkarimi AA. Distribution of ABO Blood Groups and Rhesus Factor in Derna, Libya. Tobruk University Journal for Medical Sciences (TUJMS). 2022;4:16–25.
[30] Al-Kuran, O., et al., Distribution of ABO and Rh blood groups among pregnant women attending the obstetrics and gynecology gynecology clinic at the Jordan University Hospital. Scientific Reports, 2023. 13(1): p. 13196.
[31] Bahkali, N.M., et al., Association between intrauterine fetal growth restriction and ABO blood groups at King Abdulaziz University Hospital, Saudi Arabia: Retrospective study. Saudi Medical Journal, 2023. 44(12): p. 1295.
[32] Hassanzadeh-Nazarabadi, M., S. Shekouhi, and N. Seif, The incidence of spontaneous abortion in mothers with blood group O compared with other blood types. International Journal of Molecular and Cellular Medicine, 2012. 1(2): p. 99.
[33] Alemu, M., et al., Frequency of ABO and Rh (D) blood groups and hemoglobin threshold among pregnant women in family guidance association, Mekelle model clinic, North Ethiopia. Int J Pharm Sci Res, 2014. 5(12): p. 892-895.
[34] Chanko, K.P., Frequency of ABO blood group and Rh (D) negative mothers among pregnant women attending at antenatal Care Clinic of Sodo Health Center, SNNPR, Ethiopia. American Journal of Clinical and Experimental Medicine, 2020. 8(2): p. 10-14.
[35] Mukhtar, I.G. and A.Y. Abdulkadir, Frequencies of ABO and Rhesus (D) blood group phenotypes among pregnant women attending antenatal clinic at Murtala Muhammad Specialist Hospital, Kano, Nigeria. Journal of Medicine in the Tropics, 2019. 21(1): p. 31-36.
[36] Medugu, J.T., et al., Distribution of ABO, Rh D blood groups and hemoglobin phenotypes among pregnant women attending a Tertiary Hospital in Yola, Nigeria. Journal of Medicine in the Tropics, 2016. 18(1): p. 38-42.
[37] Mbalibulha, Y., et al., ABO and rh antigen distribution among pregnant women in South Western Uganda. Journal of Blood Medicine, 2022: p. 351-355.
[38] Linn, S., S. Schoenbaum, and E. Lieberman, ABO and rhesus blood groups and adverse outcomes of pregnancy. Human heredity, 1993. 43(6): p. 366-370.
[39] F.A. Bhalti, Amin. Spectrum of ABO and D blood groups of donors at Rawalpindi/ Islamabad. Pakistan J Pathol, 1996; 7(2):26 - 28.
[40] T.Pramanik, S.Pramanik. Distribution of ABO and Rh blood groups in Nepalese students: a report. Eastern Mediterranean Health J. 2000; 6(1):156 -158.
[41] Cavalli-Sforza, L.L., P. Menozzi, and A. Piazza, The history and geography of human genes. 1994: Princeton university press.
[42] Cserti, C.M. and W.H. Dzik, The ABO blood group system and Plasmodium falciparum malaria. Blood, The Journal of the American Society of Hematology, 2007. 110(7): p. 2250-2258.