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Research Article

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Two Decades of Blood Group Data in Palestine: Insights from a Comprehensive Retrospective Study

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Abstract

Background and Objectives: *Understanding the distribution of blood groups is crucial for the effective planning of healthcare, particularly in the fields of genetic research, public health policy, and transfusion medicine. The objective of this study is to employ a comprehensive dataset that spans 24 years to analyse the distribution of ABO and Rh blood groups in Palestine. The objective is to offer insights into regional, age, and gender variations.*

Materials and Methods: *Data from 77,136 individuals were collected from the Medicare Lab information system between September 2000 and August 2024. The study used descriptive statistics and chi-square tests to investigate variations in blood group distributions by gender, age, and city.*

Results: *A Positive (37.2%) and O Positive (31.1%) were the most prevalent blood groups. Significant regional differences in blood group frequencies were observed across various cities. However, gender-based differences were not statistically significant ($p > 0.05$).*

Conclusion: *The results demonstrate substantial variations in the distribution of blood groups, emphasising the necessity for specific strategies in blood bank administration and healthcare planning in Palestine. This research provides significant data for the development of public health strategies and genetic studies.*

Keywords: Blood Group Distribution, ABO and Rh Blood Types, Palestine, Gender Differences, Regional Variations, Healthcare Planning

1. Introduction

The ABO and Rh blood group systems are fundamental to transfusion medicine and organ transplantation due to their significant immunological properties [1]. The importance of the ABO system arises from the strong antigenic characteristics of A and B antigens, and the naturally occurring anti-A and anti-B antibodies in individuals lacking these antigens. These antibodies can cause hemolysis if incompatible blood is transfused [2]. Similarly, the Rh blood group system is crucial for safe transfusion practices, ranking as the second most important after the ABO system [3].

The discovery of the ABO blood group system by Karl Landsteiner in 1901 laid the foundation for modern transfusion medicine [4]. This discovery was followed by the identification of the Rh system in 1940 by Landsteiner and Weiner, significantly improving transfusion safety [4]. The presence or absence of the Rh antigen, particularly the D antigen, classifies individuals as Rh-positive or Rh-negative, which has clinical implications in conditions such as hemolytic disease of the newborn [5]. Furthermore, these blood groups play a role beyond transfusions, influencing genetic studies, population migration patterns, and even forensic medicine [6].

In addition to their relevance in transfusions, the ABO and Rh blood groups are valuable in genetic research, population migration studies, and resolving medico-legal issues such as disputed parentage [5]. Knowing the distribution of these blood groups is vital for managing blood bank inventories effectively [6]. Therefore, detailed knowledge of blood group distributions within any population is essential for both clinical and research purposes.

Blood group distribution varies significantly across different populations and geographical regions. For example, studies in China and Pakistan have shown that blood group O is the most

prevalent in certain regions, while blood group A is predominant in others. Regional variations in blood group distribution can be influenced by genetic factors, migration patterns, and environmental conditions, making it crucial to have localized data for effective healthcare management [7-9].

In Palestine, however, comprehensive data on blood group frequencies have been historically scarce due to geopolitical challenges. The limited available studies have reported variations in ABO and Rh blood group distributions across different cities, but these studies are often small in scale or geographically limited [10]. This study aims to fill this gap by analysing blood group distributions across Palestine, using data collected over nearly two and a half decades.

From September 2000 to August 2024, the Medicare Lab information system documented blood group data from 77,136 individuals across various Palestinian cities. This extensive dataset provides an opportunity to examine blood group frequencies in depth, offering insights into gender, age, and regional variations within the Palestinian population. Accurate knowledge of blood group distributions is crucial for managing blood banks, organizing donation drives, and ensuring a sufficient supply of all blood types for medical procedures [11]. Additionally, understanding regional variations can help adapt healthcare strategies to specific areas, potentially improving patient outcomes and resource allocation [12].

This article presents a comprehensive overview of the study's findings, discussing the overall blood group distribution in Palestine, gender-based differences, age-related patterns, and regional variations. It aims to contribute to the body of knowledge on Palestinian genetics and public health, serving as a valuable resource for healthcare professionals, policymakers, and researchers in the region and beyond.

2. Materials and Methods

This retrospective study analysed blood group data from the Medicare Lab information system (LIS) over a 24-year period, from September 2000 to August 2024. Data were extracted from the LIS, which includes records of blood group tests conducted for walk-in patients across the West Bank region of Palestine. The LIS serves as a comprehensive database for laboratory test results, ensuring data integrity and accessibility for research purposes.

The study included all walk-in patients who underwent blood group testing at Medicare Lab facilities during the specified period, covering all age groups, both male and female patients, and residents from all West Bank cities. This inclusive approach ensured a representative sample of the Palestinian population in the West Bank.

Data collection focused on ABO blood groups (A, B, AB, O), Rh factor (positive or negative), patient demographics (age, gender, city of residence), and the date of the test. Statistical analysis was conducted using IBM SPSS Statistics Version 26, employing both descriptive and inferential statistics. Frequency distributions and percentages were calculated for ABO blood groups and Rh factors, and cross-tabulations were generated to examine distributions across demographic variables. Chi-square tests were conducted to assess differences in blood group distributions between genders, variations across different cities, and associations between blood groups and age categories.

To ensure data accuracy and reliability, data were extracted directly from the LIS to minimize transcription errors. Outliers and inconsistencies were identified and verified against original records, and missing or incomplete data were excluded from the analysis. By adhering to these methodological procedures, the study aimed to provide a comprehensive and accurate analysis of blood group frequencies in the West Bank Palestinian population over the 24-year period.

3. Results

The study analysed blood group data from 77,136 individuals in Palestine over 24 years, comprising 58.2% females (44,869) and 41.8% males (32,267). The most prevalent blood group was A Positive, accounting for 37.2% of the population (28,668 individuals), followed by O Positive at 31.1% (23,957 individuals). B Positive was observed in 15.5% (11,948 individuals), and AB Positive in 6.5% (4,998 individuals). Among Rh-negative blood types, A Negative was the most common at 4.0% (3,097 individuals), followed by O Negative at 3.3% (2,568 individuals), B Negative at 1.7% (1,331 individuals), and AB Negative at 0.7% (569 individuals) as shown in (table 1).

Type	Frequency	Percent (%)
A Negative	3097	4.0
A Positive	28668	37.2
AB Negative	569	0.7
AB Positive	4998	6.5
B Negative	1331	1.7
B Positive	11948	15.5
O Negative	2568	3.3
O Positive	23957	31.1
Total	77136	100.0

Table 1: Overall Blood Group Frequencies and Percentages

Participants were drawn from various cities across the West Bank, with Ramallah contributing the largest proportion at 37.2% (28,682 individuals), followed by Hebron at 18.3% (14,142 individuals) and Jenin at 11.0% (8,499 individuals). Other cities, including Nablus, Salfeet, Tulkarem, Bethlehem, Azariah, Qalqilya, Jericho, and Tubas, also provided a diverse geographical representation (table 2). Age distribution analysis revealed that most participants fell within the 20-29 age group, accounting for 44.5% (34,298 individuals) of the sample, followed by the 30-39 age group at 17.7% (13,631 individuals), and the 10-19 age group at 15.2% (11,756 individuals). Other age groups, from 0-9 to 90-99, were also represented, providing a comprehensive age spectrum for the study.

City	A Negative	A Positive	AB Negative	AB Positive	B Negative	B Positive	O Negative	O Positive	Total
Azariah	100	849	25	190	43	389	78	637	2311
Bethlehem	112	957	21	184	69	426	81	814	2664
Hebron	668	5402	123	867	243	1950	570	4319	14142
Jenin	326	2668	52	429	181	1309	389	3145	8499
Jericho	43	371	6	88	31	184	41	356	1120
Nablus	273	2682	64	546	132	1292	235	2346	7570
Qalqilya	41	453	8	84	26	213	43	406	1274
Ramallah	1140	11023	188	1839	453	4435	845	8759	28682
Salfeet	219	2688	55	466	79	1055	153	1793	6508
Tubas	10	81	3	17	5	28	12	78	234
Tulkarem	165	1494	24	288	69	667	121	1304	4132
Total	3097	28668	569	4998	1331	11948	2568	23957	77136

Table 2: Blood Group Distribution by City

A chi-square test examining the relationship between gender and blood group distribution resulted in a Pearson Chi-Square value of 14.030 with 7 degrees of freedom and an asymptotic significance (2-sided) of 0.051. This indicates that there is no statistically significant association between gender and blood group distribution at the conventional 0.05 significance level, although it is remarkably close to being significant (table 3).

Type	Female	Male
A Negative	1803	1294
A Positive	16481	12187
AB Negative	321	248
AB Positive	2871	2127
B Negative	782	549
B Positive	6989	4959
O Negative	1499	1069
O Positive	14123	9834

Table 3: Blood Group Distribution by Gender

The analysis of blood group distributions across different cities in Palestine showed intriguing patterns and variations. For example, Ramallah's blood group frequencies closely aligned with the overall expected distributions. Hebron exhibited a higher prevalence of O Negative blood type and a slightly lower occurrence of O Positive. Jenin displayed a notably higher frequency of O Positive blood type and a lower frequency of A Positive. Nablus showed higher-than-expected counts for AB Positive and B Positive blood types, while Salfeet demonstrated a markedly higher prevalence of A Positive and lower counts for O Positive. Smaller cities like Tubas showed some deviations in rare blood groups, but due to the small sample size, these variations should be interpreted cautiously.

4. Discussion

The comprehensive analysis of blood group frequencies in Palestine, based on data from 77,136 individuals over a 24-year period, reveals several significant findings and implications for public health and medical practice in the region.

In Palestine, the distribution of ABO blood groups shows similarities with patterns observed in other Middle Eastern countries, suggesting a shared genetic background in the region. However, the specific frequencies of blood groups in Palestine may differ from some neighbouring populations. For instance, in Saudi Arabia, studies have shown that blood group O is the most prevalent (51-52%), followed by A (26-26.5%), B (17-

18%), and AB (4%) [13, 14]. These variations in blood group distributions across different Middle Eastern populations could be attributed to unique genetic makeups shaped by historical migration patterns and geographical factors. Furthermore, the higher prevalence of A Positive in Palestine (37.2%) stands out compared to regions where O Positive predominates, such as Somalia, where 61% of the population has O Positive [15].

These regional differences in blood group distribution may have significant implications for blood bank management and healthcare services in Palestine. The higher prevalence of A Positive, for example, suggests that blood donation drives and transfusion services may need to adapt to ensure a sufficient supply of A Positive blood, while still maintaining adequate stocks of O Positive blood, which is universally compatible for emergency transfusions. Additionally, the distinct genetic makeup of the Palestinian population could provide valuable insights for genetic studies, helping to further understand the historical migration patterns and intermixing of populations in the Middle East.

Moreover, understanding the local distribution of blood types is critical for planning healthcare services, particularly in regions with limited resources. The variations in blood group frequencies emphasize the importance of region-specific strategies in managing blood supplies and organizing blood donation campaigns. Tailored approaches based on these findings could improve the efficiency of blood bank operations and ensure that rare blood types, such as AB Negative, are readily available when needed.

Overall, the analysis of blood group distribution in Palestine not only contributes to the broader understanding of population genetics in the region but also provides practical information that can be used to enhance public health initiatives and medical services. These findings underscore the need for continuous monitoring of blood group distributions to optimize healthcare strategies and respond effectively to the specific needs of the population.

4.1 Gender-Based Analysis

Gender-based analysis revealed minimal differences in blood group distribution between males and females, suggesting that gender-specific blood donation strategies may not be necessary in Palestine. However, slight variations, such as the marginally higher frequency of B Positive in males, warrant further investigation to determine if they have any clinical significance. Similar findings were reported in other Middle Eastern and African populations, such as in Mauritania, where slight variations between genders were also noted in certain blood groups [14]. This trend of gender-based distribution being statistically insignificant is consistent across multiple studies [15].

Although these variations are minor, they could still have implications for specific medical conditions. Research has shown that individuals with non-O blood groups, including B, exhibit a higher prevalence of cardiovascular risk factors. For instance, a community survey indicated that patients with familial hypercholesterolemia who had non-O blood groups, particularly B, had more than double the prevalence of cardiovascular disease compared to those with blood group O [16]. While the overall impact of gender on blood group distribution may be limited, exploring these subtle differences could provide valuable insights into gender-specific disease risks. Such insights could inform future healthcare strategies, particularly in personalized medicine and targeted screening programs

4.2 Age Group Distribution

The age group distribution analysis provides valuable insights for healthcare planning. The high representation of individuals in the 20-29 age group (44.5%) indicates a young population, which could influence future blood donation campaigns and healthcare needs. The observed variations in blood group frequencies across age groups, such as the higher percentage of O Positive in the 0-9 years category, may reflect changing demographic patterns over time or could be a result of sampling bias. Longitudinal studies would be beneficial to clarify these trends.

A similar observation was made in Egypt, where the age group composition in certain studies reflected a predominantly young population, driving the need for targeted health interventions [17]. Given the young demographic, future blood donation programs in Palestine may be more effective if focused on younger individuals, ensuring long-term sustainability of the blood supply.

4.3 Regional Variations in Blood Group Frequencies

The most striking finding of this study is the significant regional variation in blood group distributions across different Palestinian cities. These differences, confirmed by chi-square analysis ($p < 0.001$), suggest the influence of local genetic pools, historical migration patterns, and environmental factors on blood group frequencies. For instance, the higher prevalence of O Negative in Hebron (4.0%) and the markedly higher frequency of A Positive in Salfeet (41.3%) could have implications for local blood bank management and transfusion services.

In comparison, a study in Mauritania similarly found that O Positive was the dominant blood group in all regions but with notable regional variations [14]. The importance of understanding local differences in blood group distribution cannot be overstated, as it helps in planning region-specific blood donation campaigns and ensures that blood banks are adequately prepared to meet the needs of their populations [15,17].

4.4 Public Health and Practical Implications

The study's findings have several practical implications. Blood donation campaigns can target the most needed blood types in each region, potentially improving the efficiency of blood collection efforts. For instance, Hebron's higher frequency of O Negative suggests a greater need for donors of this rare and universally transfusable blood type, while Ramallah's distribution, which closely mirrors the overall sample, indicates a well-balanced need across all blood types. This could reduce

the strain on blood supply, especially for rare blood types like AB Negative, which only constitutes 0.7% of the total population [15].

Healthcare providers can better prepare for transfusion needs based on local blood group distribution, potentially reducing delays in emergency situations. In countries like Somalia, where the D-antigen was prevalent in 97% of the population, similar insights were used to manage emergency blood supplies efficiently. The Palestinian healthcare system can benefit from these data by improving the management of regional blood resources, ensuring quick response during emergencies when blood transfusions are critical [15].

Genetic researchers may find these data valuable for studying population genetics and migration patterns in Palestine. The high frequency of A Positive and the relatively lower O Positive prevalence compared to neighbouring regions could provide insights into historical population movements and genetic intermixing in the region. Moreover, these variations align with findings from Egypt and Mauritania, where blood group distributions suggested influences from African, Asian, and Arabian genetic markers [14,17].

Public health officials can also use this information to develop more targeted health screening programs, as certain blood groups are associated with higher risks of specific diseases. For example, blood group A has been associated with a higher risk of cardiovascular disease, while O blood group individuals may have a lower risk of blood clot-related conditions [14]. Tailoring healthcare screening programs based on these blood group data could improve preventive healthcare in Palestine.

4.5 Limitations and Future Research

While this study provides valuable insights, it also has limitations. The data, although extensive, come from a single laboratory network and may not fully represent the entire Palestinian population. Additionally, the study does not account for potential changes in population demographics over the 24-year period. Future research could address these limitations by incorporating data from multiple sources and conducting longitudinal studies to track changes in blood group frequencies over time.

Comparing these findings with more detailed genetic data could enhance our understanding of how historical migration and local intermarriages have shaped the current genetic landscape of Palestine. Additionally, including populations from Gaza and refugee communities in the region would provide a more comprehensive understanding of the blood group distribution among Palestinians globally. The inclusion of these broader populations may also offer further insight into whether the observed patterns are stable or subject to significant demographic shifts over time.

5. Conclusion

This comprehensive 24-year retrospective study of blood group frequencies in Palestine provides valuable insights into the genetic landscape of the population and has significant implications for healthcare and public health planning in the region. The analysis of 77,136 individuals from various cities across the West Bank reveals several key findings: the predominance of A Positive (37.2%) and O Positive (31.1%) blood types, minimal gender-based differences in blood group distribution, significant regional variations, and a high representation of young adults. These findings highlight the importance of tailored, region-specific approaches to blood bank management and healthcare planning, and they contribute to the broader understanding of population genetics in the Middle East.

By implementing these recommendations, Palestinian health authorities can significantly improve blood donation strategies, enhance the efficiency of blood supply management, and provide better healthcare services to the population.

Ethical Considerations and Data Confidentiality

This study utilized blind data, which were obtained from Medicare Labs without any identifying information about the patients. The research was conducted following ethical guidelines, and approval was granted by the Medicare Institutional Review Board (IRB) committee (Approval Number: 2024-IRB-12).

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