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Study on blood group prevalence and its gender correlation in Jalgaon district

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Abstract
Blood group determination plays a critical role in medical science, genetics, and population studies. This study aimed to investigate the prevalence and gender association of blood groups in the Jalgaon district, located in the northern region of Maharashtra. A total of 2,010 individuals, comprising randomly selected males and females, participated in this research. A non-invasive methodology was employed, wherein data were collected solely through verbal communication. Subjects unaware of their blood group were excluded from the study to ensure data accuracy. The analysis revealed the distribution pattern of blood groups across the population, with statistical evaluation conducted using the chi-square test of independence to assess the association between gender and blood group prevalence. The findings provide insights into the gender-based prevalence of various blood groups within the district, contributing valuable information to regional genetics and medical research. Further implications of this study include its utility in healthcare planning, blood donation drives, and epidemiological studies.

Keywords: North Maharashtra, blood group, gender association

Introduction

Blood groups are genetic systems of antigens present on the surface of red blood cells, with the ABO and Rh systems being the most well-known and clinically significant (Huang *et al*., 2000) [9]. These systems are determined by specific genes and exhibit considerable polymorphism, making them valuable markers for population genetics studies (Chester & Olsson, 2001) [5].

In population genetics, blood group systems help researchers understand genetic diversity, migration patterns, and evolutionary relationships between populations. For instance, the ABO blood group gene shows significant variation in allele frequencies across different geographic and ethnic groups (Chester & Olsson, 2001) [5]. This variation can be used to trace population movements and admixture events. Additionally, the high polymorphism rate in the ABO gene has been linked to susceptibility to different pathogens, suggesting a potential role in natural selection (Lalueza-Fox *et al*., 2008) [11].

Recent paleogenetic analysis of Neanderthal DNA revealed the presence of a human-specific deletion associated with blood group O, indicating that this genetic change predates the human-Neanderthal divergence (Lalueza-Fox *et al*., 2008) [11]. This finding provides insights into the evolutionary history of blood groups and their potential selective advantages. Blood group genotyping has been used to investigate associations between specific alleles and disease risk, such as the increased risk of pancreatic cancer observed in individuals with non-O blood types in a Japanese population (Nakao *et al*., 2011) [12].

Blood group distribution and its association with gender have been studied in various contexts, revealing some interesting patterns and potential relationships. The study found that CHIKV infections were more prevalent in individuals with Rh-positive blood groups, particularly those with AB and A blood types.

Research on ovarian cancer showed a higher incidence in women with blood group A compared to other blood groups (Henderson *et al*., 1993) [8]. While these studies suggest potential links between blood groups, gender, and specific health conditions, it's important to note that the relationships are not always consistent across different diseases or populations. A study on colorectal cancer found no significant difference in ABO blood group distribution between patients who were Rh-positive and Rh-negative (Slater *et al*., 1993) [14]. While some studies indicate possible associations between blood groups, gender, and certain health conditions, the relationships are complex and may vary depending on the specific context and population studied. Therefore, the studies investigating the association between blood groups and gender are of significant importance.

In general, blood group O is the most prevalent globally, followed by A, B, and AB. For instance, in a Mexican study, the distribution was O: 61.82%, A: 27.44%, B: 8.93%, and AB: 1.81% (Canizalez-Román *et al*., 2018) [4]. Similarly, in a Kuwaiti population, the distribution was O: 44.6%, A: 26.7%, B: 24.1%, and AB: 4.6% (Al-Bustan *et al*., 2002) [2]. However, there are regional variations. In Ethiopia, for example, blood type A was the most frequent (44.07%) among 'highlanders', while 50.42% of Nilotic natives had type O (Golassa *et al*., 2017) [7].

Some studies have found associations between blood groups and specific health conditions. For instance, there may be a genetic linkage between ABO blood groups and the molecular structure of Achilles tendons, with a higher incidence of Achilles tendon rupture in individuals with blood group O (Kujala *et al*., 1992) [10]. Additionally, a significant association was found between ABO blood groups and asymptomatic malaria parasitemia, with blood group O donors showing a higher rate of parasitemia (Alemu & Mama, 2016) [3]. The global trend shows O as the most common blood group, regional variations exist. The distribution of ABO blood groups may have been influenced by various factors, including selective genetic pressure from diseases like P. falciparum infection (Cserti & Dzik, 2007) [6].

The prevalence of blood group distribution in India exhibits notable differences.

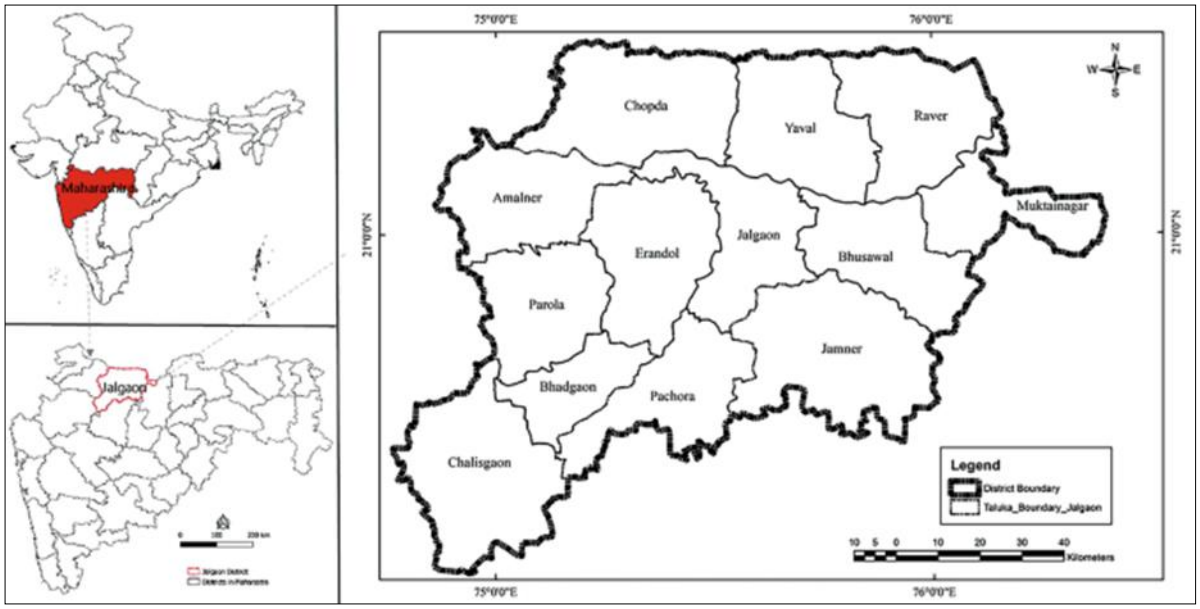
O is the most common blood group in India, accounting for 37.12% of the population, followed closely by B at 32.26%, A at 22.88%, and AB being the least prevalent at 7.74% (Agrawal *et al*., 2014) [1]. This overall distribution follows the pattern O > B > A > AB, which is consistent with the Asiatic trend (Periyavan *et al*., 2010) [13]. There are interesting regional variations observed in the distribution. A study in Bangalore, Karnataka showed a slightly different pattern with O at 39.81%, B at 29.95%, A at 23.85%, and AB at 6.37% (Periyavan *et al*., 2010) [13]. In contrast, several studies conducted in north Indian populations have reported group B as the most prevalent (Periyavan *et al*., 2010) [13].

Regarding the Rh factor, 94.61% of the Indian donor population was found to be Rh positive, while 5.39% were Rh negative (Agrawal *et al*., 2014) [1]. This is consistent with the findings from other studies, such as the one conducted in Bangalore, which reported 94.20% Rh positive and 5.79% Rh negative (Periyavan *et al*., 2010) [13]. The overall distribution of ABO blood groups in India follows the O > B > A > AB pattern, there are notable regional differences. The gene frequencies calculated for the Indian population are 0.1653 for IA (p), 0.2254 for IB (q), and 0.6093 for IO (r), with O (r) having the highest value (Agrawal *et al*., 2014) [1]. This information is essential for the planning of blood transfusion services and addressing future health challenges in India.

Similar to the requirement for blood group distribution information across Indian states to address the issue of uneven blood supply during emergency transfusions, prevalence studies are essential for this purpose. The scarcity of data on blood group distribution and its gender association in the Jalgaon district of North Maharashtra, India, represents a significant gap in our understanding of regional hematological profiles. This lack of information hinders the ability of local healthcare providers and blood banks to effectively manage blood supplies and address potential shortages for specific blood types. Additionally, it impedes researchers from conducting comprehensive studies on genetic variations and potential health implications associated with different blood groups in this particular population. This study aims to fill the gap by providing detailed insights into the prevalence of blood groups and their gender association in this specific region.

Study Area

The study was carried out in the Jalgaon district of Maharashtra state. Jalgaon district is situated in the northern part of Maharashtra state, India, between 20° and 21° North latitudes and 74° 55′ to 76° 28′ East longitudes. The city of Jalgaon, the district headquarters, is located at 21.0076578° N latitude and 75.5626039° E longitude. The district is bounded by the Satpuda Hills to the north, Aurangabad and Nashik districts to the south, Madhya Pradesh state and Buldhana district to the east, and Dhule district to the west. Jalgaon district comprises several major urban centers, including Jalgaon, Bhusawal, Kandari, Varangaon, Nimbore Bk., Fekari, Chopda, Pachora, Chalisgaon, Amalner, Yawal, Faizpur, Raver, Savada, Parola, Erandol, and Dharangaon.



Source: https://link.springer.com/chapter/10.1007/978-3-031-15501-7_7

Fig. 1: Map of Jalgaon district

Materials and Methods

The study was conducted in the Jalgaon district, located in the northern region of Maharashtra, India. This study aimed to determine the prevalence and gender-based association of blood groups in the population. A total of 2,010 individuals were included in the study. Participants were randomly selected, ensuring representation of both males and females. Subjects who were unaware of their blood group were excluded to maintain data accuracy.

A non-invasive and verbal communication-based approach was employed to collect data regarding the participants' blood groups. Information was obtained through direct questioning, and participants self-reported their blood group information. This method minimized discomfort and facilitated the data collection process. The chi-square test of independence was utilized to analyze the association between gender and blood group prevalence. The statistical analysis was performed using SPPS software, and a significance level of $p < 0.05$ was considered to determine

the strength of the association. Informed consent was obtained verbally from all participants prior to data collection. Anonymity and confidentiality were strictly maintained throughout the study.

Results

Gender wise percentage frequency distribution of blood typing.

Blood group B+ showed highest prevalence among all other blood groups. Blood group B+ showed higher prevalence in males (30.29%) than the females (29.21%). Blood group O+ showed higher prevalence in males (26.55%) than the females (24.17%). Blood group A+ showed higher frequency in females (25.60%) than the males (24.17%). Blood group AB+ showed higher prevalence in females (12.47%) than the males (11.95%). Blood group O- showed higher prevalence in males (3.10%) than the females (3.06%). Blood group AB- showed higher frequency in females (2.51%) than the males (1.55%). Blood group A- showed higher prevalence in females (2.40%) than the males (1.36%). Blood group B- showed higher prevalence in males (1.00%) than the females (0.54%) (Table 1).

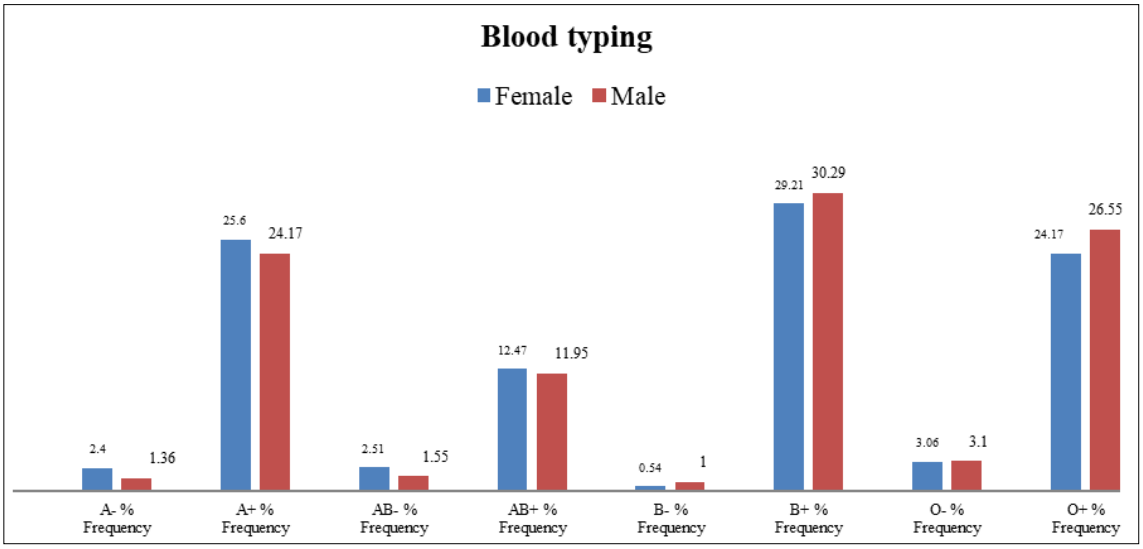


Fig 2: Gender wise percentage frequency distribution of blood typing

Table 1: Gender wise frequency distribution of blood typing

Blood typing	A-	% Freq.	A+	% Freq.	AB-	% Freq.	AB+	% Freq.	B-	% Freq.	B+	% Freq.	O-	% Freq.	O+	% Freq.	Grand Total
Female	22	2.40	234	25.60	23	2.51	114	12.47	5	0.54	267	29.21	28	3.06	221	24.17	914
Male	15	1.36	265	24.17	17	1.55	131	11.95	11	1.00	332	30.29	34	3.10	291	26.55	1096
Grand Total	37	1.84	499	24.82	40	1.99	245	12.18	16	0.79	599	29.80	62	3.08	512	25.47	2010

Evaluation of association of the blood typing/group with the gender (Test of independent association)

Table 2: Evaluation of association of the blood typing/group with the gender

Blood groups	Gender				Total	$\chi 2$	P	Significance *(LS=0.05)*
	Female	%	Male	%				
A	256	47.76	280	52.23	536	3.3062	0.346786	Not significant
B	272	44.22	343	55.77	615			
AB	137	48.07	148	51.92	285			
O	249	43.37	325	56.62	574			
RH Factor								
RH+	836	45.06	1019	54.93	1855	1.5933	0.206858	Not significant
RH-	78	50.32	77	49.67	155			

A Chi-square test of independence was performed to examine the association between gender and blood group characteristics, specifically the ABO blood group and the Rh factor. ABO blood group, the Chi-square statistic was calculated as 3.3062, with a p-value of 0.346786. This result indicates that there is no significant association between gender and ABO blood group distribution, as the p-value is greater than the significance threshold of 0.05 ($p > 0.05$). Gender and ABO blood group are independent of each other.

For Rh factor (Rh+ and Rh-) with respect to gender, the Chi-square statistic was found to be 1.5933, with a p-value of 0.206858. This also indicates a lack of significant association between gender and Rh factor distribution ($p > 0.05$). Gender and Rh factor are independent is supported by the data. Both analyses suggest that neither the ABO blood group nor the Rh factor shows a statistically significant association with gender in the study population.

Discussion

The present study found that blood group B+ was the most prevalent (29.80%), followed by O+ (25.47%), A+ (24.82%), AB+ (12.18%), O- (3.08%), AB- (1.99%), A- (1.84%), and B- (0.79%). Blood group B+ was determined to be the most common, while blood group B- was the least frequent in the study population. The frequencies of O+ and

A+ were observed to be approximately equal. Similarly, the frequencies of AB- and A- were also found to be nearly equivalent.

The results contradict the findings of global studies, wherein the most prevalent blood group globally appears to be O, followed by A, B, and AB, although regional variations exist. For example, in Australia, the prevalence was O (44.9%), A (37.6%), B (13.3%), and AB (4.2%) (Hirani *et al*., 2022) [15]. In Ethiopia, it was O (39.0%), A (32.2%), B (22.5%), and AB (6.4%) (Lendabo *et al*., 2024) [26]. However, in Northern India, B (34.84%) was most common, followed by O (29.75%), A (21.50%), and AB (13.91%) (Chandra, 2013) [17]. The study demonstrates similarity with the study of Gharwali donors in India, where blood type B was most prevalent at 31.68%, while blood type AB was least common at 11.70% (Ali *et al*., 2018) [18]. Among Kurds, the order was O (37.16%), A (32.47%), B (23.84%), and AB (6.53%) (Jaff, 2010) [20]. Regarding Rh factor, the majority of studies reported a high prevalence of Rh-positive individuals, which aligns with our results (92.28%), ranging from 72.2% in Libya (Ameigaal & Ageel, 2019) [19] to 93.51% in India (Ali *et al*., 2018) [18]. The global average seems to be around 85-90% Rh-positive. In conclusion, while O tends to be the most common blood group globally, there are significant regional variations. The Rh-positive factor is consistently prevalent across populations, though the exact percentage varies. These findings highlight the importance of population-specific blood group data for effective blood bank management and transfusion services (Jamali *et al*., 2024) [21].

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