# Study on the Distribution Characteristics and Blood Type Analysis of Voluntary Blood Donors in the Linxia Region

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**Abstract:** *Objective:* To analyze the distribution and blood type characteristics of unpaid blood donors in Linxia area from 2012 to 2021, provide the basis for the strategy of recruiting safe blood sources in the future, ensure sufficient and safe blood supply, and promote the sustainable development of unpaid blood donation in this area. *Methods:* Collect the data of unpaid blood donors in Linxia area, and make statistics, comparison and analysis based on the query information of the fourth generation safe blood transfusion standardization system and the free blood donation registration form. *Results:* The total number of blood donors was 151131 and the ratio of male to female blood donors was 2.61:1. People aged 18–45 were the main blood donors, accounting for 80.78% of all unpaid blood donors. 37.19% of people with junior high school education or below; Farmers, other professionals and civil servants were the main subjects of blood donation, accounting for 15.74%, 14.98% and 12.12%, respectively. The blood group distribution was O > B > A > AB, and the negative rate was 8.2%. Blood type O was the most common in Hezheng County (34.08%). The distribution of blood type B in Kangle County (31.99%), blood type A in Yongjing County (29.58%), blood type AB in Dongxiang County (10.18%). *Conclusion:* The unpaid blood donors in Linxia area have significant characteristics in terms of gender, age, occupation, education level, etc. to master the distribution characteristics of the unpaid blood donors and blood types in Linxia area is helpful to carry out targeted publicity and recruitment of unpaid blood donation and blood collection, and is of great significance to continuously strengthen the contingent of unpaid blood donors and fully guarantee the clinical blood demand under the new situation.

**Keywords:** Voluntary blood donation; Population distribution; Blood analysis

## 1. Introduction

The Central Blood Station of Linxia Hui Autonomous Prefecture was established in August 2004. Over the past 20 years of steady development, the volume of unpaid blood donations and clinical blood supplies has increased

annually. The prefecture has been honored as a "National Advanced City for Voluntary Blood Donation" four times. In recent years, the work of unpaid blood donation in the Linxia area has made significant progress, with a steady improvement in blood quality and an effective guarantee of clinical blood demand. To conduct an in-depth study on the distribution and blood type characteristics of unpaid blood donors in the Linxia area, relevant data from unpaid blood donors from 2012 to 2021 were analyzed. This study aims to provide scientific data and strategic bases for future publicity and recruitment efforts to secure safe blood sources, ensuring the scientific, reasonable, and efficient use of blood and promoting the healthy and sustainable development of unpaid blood donation work in the region.

## 2. Materials and methods

### 2.1. Survey participants

From January 1, 2012, to December 31, 2021, a total of 151,131 voluntary blood donors participated in blood donation at all blood collection sites in Linxia region. These donors met the health consultation and examination requirements specified in the "2019 Edition of Technical Operating Procedures for Blood Stations" after undergoing pre-donation health consultations and preliminary blood tests [1].

### 2.2. Survey method

The registration forms of voluntary blood donors and the Cross Fourth Generation Standardized System for Safe Blood Transfusion were utilized to query and retrieve detailed information on blood donors for data statistics and analysis (each donation counted as one individual).

### 2.3. Testing methods and reagents

The ABO blood group was determined using the forward and reverse typing method. Forward typing employed anti-A and anti-B blood typing reagents (produced by Beijing Jinhao Pharmaceutical Co., Ltd.), while reverse typing utilized red blood cell reagents (produced by Shanghai Blood Biopharmaceutical Co., Ltd.) [2].

RhD blood typing was performed using a specialized cardboard direct agglutination method, where red blood cell suspensions were mixed with anti-RhD serum, and O-type ccdee and CCDee red blood cells were used as negative and positive controls, respectively (produced by Shanghai Blood Biopharmaceutical Co., Ltd.) [2].

### 2.4. Statistical analysis

The SPSS statistical analysis software was used to conduct statistical analysis on relevant data, with counts expressed as n%.

## 3. Results

### 3.1. Gender composition

There were 109,239 male donors, accounting for 72.28%, and 41,892 female donors, accounting for 27.72%. The ratio of males to females was 2.61:1. (see **Table 1**)

**Table 1.** Gender and age distribution

| Characteristic | Category | n | Proportion (%) |
|---|---|---|---|
| Gender | Male | 109,239 | 72.28 |
| | Female | 41,892 | 27.72 |
| Age | 18–25 years | 37,813 | 25.02 |
| | 26–35 years | 45,175 | 29.89 |
| | 36–45 years | 39,096 | 25.87 |
| | 46–55 years | 27,252 | 18.03 |
| | 55–60 years | 1,795 | 1.19 |

## 3.2. Age composition

The majority of voluntary blood donors were aged between 18 and 45, accounting for 80.78% of all donors. Specifically, those aged 18–25 accounted for 25.02%, 26–35 accounted for 29.89%, 36–45 accounted for 25.87%, 46–55 accounted for 18.03%, and 55–60 accounted for 1.19%. (**Table 1**)

## 3.3. Educational attainment distribution

The proportion of donors with a bachelor's degree or higher was 8.19%, those with a junior college degree accounted for 17.33%, those with a high school or technical secondary school education accounted for 14.23%, and those with a junior high school education or below accounted for a significant 37.19%. (**Table 2**)

**Table 2.** Distribution of educational level and occupation

| Characteristic | Category | n | Proportion (%) |
|---|---|---|---|
| Education level | Junior high school or below | 56,201 | 37.19 |
| | High school / Technical secondary school | 21,500 | 14.23 |
| | College | 26,186 | 17.33 |
| | Bachelor's degree or above | 12,375 | 8.19 |
| Occupation | Student | 12,800 | 8.47 |
| | Teacher | 8,456 | 5.60 |
| | Civil servant | 18,318 | 12.12 |
| | Worker | 6,572 | 4.35 |
| | Military personnel | 5,981 | 3.96 |
| | Medical staff | 7,609 | 5.03 |
| | Farmer | 23,786 | 15.74 |
| | Other | 22,640 | 14.98 |

Other occupations: Includes self-employed individuals, freelancers, migrant workers, and the unemployed.

## 3.4. Occupational distribution

Farmers, individuals in other occupations, and public officials constitute the main group of voluntary blood

donors, with blood donation rates of 15.74%, 14.98%, and 12.12%, respectively. Students and teachers together account for 14.07%, while workers and military personnel only make up 4.35% and 3.96%, respectively (**Table 2**).

## 3.5. Blood type distribution

The predominant blood types are A, B, and O, with AB type accounting for 9.64%. The distribution is O > B > A > AB. There was a total of 1,243 RHD-negative blood donors, with an average negativity rate of 0.82%. Among the A, B, O, and AB blood type distributions, the proportion of RhD-negative is 0.72%, 0.81%, 0.81%, and 0.85%, respectively. Statistical analysis using SPSS 25.0 software on the data in **Table 3** yielded an $\chi^2$ value of 30.323 and a *p*-value of 0.00001.

Since the *p*-value is less than 0.05, the difference is statistically significant (**Table 3**). Blood type O is the most prevalent in Hezheng County, accounting for 34.08%; blood type B is the most prevalent in Kangle County, accounting for 31.99%; blood type A is the most prevalent in Yongjing County, accounting for 29.58%; and blood type AB is the most prevalent in Dongxiang County, accounting for 10.18%.

**Table 3.** Distribution of blood types among voluntary blood donors

| ABO blood type | n | Proportion (%) | RhD blood type | | | | $\chi^2$ | *p*-value |
| | | | RhD (+) (n) | Constituent ratio | RhD (-) (n) | Constituent ratio | | |
|---|---|---|---|---|---|---|---|---|
| A | 42,904 | 28.39% | 42,595 | 99.28% | 309 | 0.72% | | |
| B | 44,713 | 29.59% | 44,349 | 99.19% | 364 | 0.81% | | |
| O | 48,943 | 32.38% | 48,547 | 99.19% | 396 | 0.81% | 30.323 | < 0.05 |
| AB | 14,521 | 9.64% | 14,397 | 99.15% | 124 | 0.85% | | |
| Total | 151,131 | 100% | 149,888 | 99.18% | 1,243 | 0.82% | | |

## 3.6. Statistical analysis

Statistical analysis using SPSS 25.0 software on the distribution of A, B, O, and AB blood types in Kangle County, Yongjing County, Hezheng County, and Dongxiang County in the Linxia region yielded an $\chi^2$ value of 63.826. Since the *p*-value is less than 0.05, the difference is statistically significant (see **Table 4**).

**Table 4.** Distribution of blood types by county and city

| County (City) | Blood type and its proportion | | | | | | | | Total |
| | A | Proportion | B | Proportion | O | Proportion | AB | Proportion | |
|---|---|---|---|---|---|---|---|---|---|
| Linxia City | 23,965 | 28.50% | 24,439 | 29.07% | 27,539 | 32.76% | 8,131 | 9.67% | 84,074 |
| Kangle County | 4,716 | 27.13% | 5,561 | 31.99% | 5,532 | 31.82% | 1,577 | 9.07% | 17,386 |
| Guanghe County | 2,542 | 28.46% | 2,725 | 30.51% | 2,823 | 31.61% | 841 | 9.42% | 8,931 |
| Yongjing County | 2,634 | 29.58% | 2,572 | 28.89% | 2,862 | 32.14% | 836 | 9.39% | 8,904 |
| Jishishan County | 2,434 | 28.67% | 2,504 | 29.50% | 2,735 | 32.22% | 816 | 9.61% | 8,489 |
| Hezheng County | 2,063 | 27.62% | 2,151 | 28.80% | 2,546 | 34.08% | 710 | 9.50% | 7,470 |
| Linxia County | 1,720 | 28.01% | 1,873 | 30.50% | 1,956 | 31.86% | 591 | 9.63% | 6,140 |
| Dongxiang County | 1,693 | 29.36% | 1,664 | 28.86% | 1,822 | 31.60% | 587 | 10.18% | 5,766 |

# 4. Discussion

According to statistics, from 2012 to 2021, there were 151,324 instances of voluntary blood donation in the Linxia region. From 2012 to 2021, the average permanent population in Linxia region was 2.0517 million, resulting in a blood donation rate per thousand population of approximately 7.4% in Linxia region [3]. This rate is lower than the national average of 11.1% in 2020 and significantly lower than the 15.0% recommended by developed countries, China's Hong Kong and Macao regions, and the World Health Organization [4]. The primary reasons for this disparity include the late establishment, weak foundation, and poor infrastructure of the Central Blood Station in Linxia Prefecture, coupled with relatively low public awareness and acceptance of voluntary blood donation. However, from another perspective, this indicates a vast potential and scope for voluntary blood donation in Linxia region. Strengthening publicity and recruitment efforts in future work will encourage more people to participate in voluntary blood donation.

The gender ratio of voluntary blood donors in Linxia region is 2.61:1, with significantly more male donors than female. This trend is generally consistent with findings reported in other cities within the province, but it differs significantly from the results of a survey conducted by the Gansu Provincial Blood Center [5,6]. The disparity is primarily attributed to physiological reasons that prevent women from donating blood during pregnancy and childbirth (lasting more than one year), miscarriage (lasting more than six months), lactation (lasting more than one year), and menstruation (three days before and after). Additionally, blood tests reveal a significantly higher rate of unqualified hemoglobin levels in women compared to men [4]. Therefore, during specific publicity and recruitment campaigns, it is essential to provide appropriate explanations for deferred blood donations based on these reasons. Learning from the good experiences and methods of other blood stations in this regard can help increase the proportion of female blood donors in Linxia region.

The age group primarily engaged in voluntary blood donation in Linxia region is between 18 and 45 years old, which aligns with findings reported in other domestic cities [7]. This indicates that individuals in this age group are relatively healthy, possess a strong sense of social responsibility, have mature mental development, and exhibit a high level of participation in voluntary blood donation. Targeted publicity and recruitment efforts should be strengthened for this age group to enhance blood donation services. Efforts should be made to develop this age group into regular blood donors. The online reservation service platform for voluntary blood donation should be fully utilized to improve the convenience and efficiency of blood donation services.

From an educational perspective, individuals with junior high school education or below constitute a significant proportion. This trend is related to the fact that the region is a small to medium-sized city in western China, with relatively slow economic and cultural development and a lower average level of education per capita. As socioeconomic development and educational reforms continue to advance, the educational level of voluntary blood donors is expected to rise, leading to a substantial increase in awareness and acceptance of blood donation.

In terms of occupational distribution, individuals in other professions, such as self-employed workers and freelancers, had the highest blood donation rate at 14.98%. The Linxia region has historically been a vital hub for the tea-horse trade and the Tang-Fan Ancient Road, serving as a crucial junction along the Silk Road. As a result, the commerce and logistics industries are relatively well-developed, leading to a large number of people engaged in commercial logistics and service industries [8]. Comparatively, these groups have more flexible and ample time to participate in blood donations. The blood donation rate among public officials is also relatively high (12.12%), primarily due to the strong emphasis placed on voluntary blood donation by governments at all levels, which has been incorporated into government performance evaluations and spiritual civilization assessments. This is also

attributed to the effective functioning of voluntary blood donation leadership groups and the Red Cross Society at various levels, which actively promote voluntary blood donation efforts [9]. In the Linxia region, the rural population accounts for 67.16% of the total population, yet farmers only contribute 15.74% of blood donations. The primary reasons for this include the relatively low educational levels among farmers, leading to low awareness and acceptance of voluntary blood donation. Additionally, their dispersed living conditions make it difficult to promote voluntary blood donation, and most blood collection points are located in bustling urban areas or county seats, making it inconvenient for farmers to donate blood nearby. Moving forward, different recruitment strategies tailored to local conditions, timing, and individuals, and launch a series of "down-to-earth, practical, and effective" promotional activities to strengthen blood donation services should be developed. This will help structurally, holistically, and effectively address the challenge of recruiting voluntary blood donors in rural areas, significantly reversing the situation in the Linxia region where "urban residents donate blood, while rural residents receive blood transfusions" [8].

In terms of blood types, the distribution follows the order of O > B > A > AB, which is consistent with the blood type distribution characteristics of the Gansu population reported in the literature [2]. Based on these blood type distribution characteristics, targeted blood donation recruitment strategies should be developed, with a particular focus on understanding the seasonal variations and clinical application patterns of each blood type to ensure the matching, consistency, and coordination of "blood collection" and "blood utilization," thereby avoiding clinical blood supply difficulties or blood wastage caused by blood type imbalances. The RHD negative rate is 0.82%, slightly higher than the 0.75% reported in the literature for the Linxia region [10]. Compared to other regions, the Linxia region has a relatively abundant supply of RHD negative blood resources [11,12]. RHD-negative blood is a scarce and precious blood resource that should be fully utilized by promptly allocating it to blood stations in other regions. Additionally, by applying the technology for preparing frozen red blood cells, red blood cells with rare blood types can be frozen and stored, enabling more rational utilization of this valuable blood resource and more timely transfusions. This effectively mitigates the risk of patients missing the optimal window for rescue due to the inability to locate a blood source promptly.

Currently, the voluntary blood donation program in the Linxia region is progressing smoothly, with an increasing number of individuals participating in voluntary blood donation. Through comprehensive and scientific data analysis, this study can grasp the characteristics of the voluntary blood donor population and blood type distribution in this region. This allows us to formulate corresponding publicity and recruitment strategies, continuously expand the ranks of voluntary blood donors, enhance blood safety standards, effectively safeguard the life and health rights of the people, and robustly ensure medical safety and social stability.

## 5. Conclusion

Based on the analysis, it can be concluded that the voluntary blood donor population in Linxia region exhibits distinct characteristics in terms of gender, age, occupation, and education level. Understanding the distribution patterns of these donors and their blood types is crucial for developing targeted recruitment strategies and optimizing blood collection efforts. This approach will significantly contribute to strengthening and expanding the voluntary blood donor base, thereby ensuring a stable and sufficient blood supply to meet clinical needs in the evolving healthcare landscape.

## Disclosure statement

The authors declare no conflict of interest.

## References

[1] Medical Administration and Supervision Bureau, National Health Commission, 2019, Technical Operating Specifications for Blood Stations. 2019 Edition: 1–3.

[2] Department of Medical Administration, Ministry of Health, 2006, National Clinical Laboratory Procedures. 3rd Edition. Beijing: People's Medical Publishing House: 249–251.

[3] Statistics Bureau of Linxia Hui Autonomous Prefecture, 2013–2022, Statistical Data Handbook of Linxia Hui Autonomous Prefecture.

[4] Wei Q, 2019, Investigation and Analysis of the Distribution Characteristics of Unpaid Blood Donors in Laibin City. Minimally Invasive Medicine, 14(3): 398–399.

[5] Bai G, Dang J, 2012, Investigation and Analysis of the Distribution Characteristics of Unpaid Blood Donors in Jiayuguan City from 2009 to 2010. Chinese Journal of Blood Transfusion, 25(1): 56–57.

[6] Wang S, Bai S, Chen B, et al., 2013, Blood Collection and Supply Status and Distribution Characteristics of Unpaid Blood Donors in Lanzhou Area from 2002 to 2011. Chinese Journal of Health Statistics, 30(3): 418–419.

[7] Meng X, Ma L, Yuan Y, et al., 2009, Analysis of Unpaid Blood Donation in Tianjin from 2005 to 2007. Chinese Journal of Blood Transfusion, 22(7): 578–580.

[8] La G, You M, 2017, Investigation and Analysis of the Distribution Characteristics of Unpaid Blood Donors in Linxia Hui Autonomous Prefecture from 2011 to 2015. Chinese Journal of Blood Transfusion, 30(2): 171–173.

[9] Lu L, Wu X, Yang B, et al., 2008, "New Four Shifts" in Blood Collection and Supply Work at the Shenzhen Blood Center. Chinese Journal of Blood Transfusion, 2(6): 411–412.

[10] Cui J, You M, Hou Z, et al., 2014, Investigation of RHD Negative Blood Types Among Han and Ethnic Minorities in Linxia Prefecture. Gansu Medical Journal, 33(4): 306–307.

[11] Tan Y, Deng F, 2008, Investigation of RH Blood Type Distribution Among Han People in Bozhou Area. Medical Innovation Research, 5(23): 3–4.

[12] Mao H, 2002, Establishment and Application of a Rare Blood Type Bank in Qinghai Province. Qinghai Medical Journal, 32(4): 35.