Prevalence of anemia and its associated sociodemographic factors in apparently healthy individuals presenting as prospective blood donors at a Medical Institute of Rohilkhand region

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ABSTRACT

Background: Anemia is widely prevalent in general and also in prospective blood donors with varying rates of prevalence at different places resulting in substantial loss in the blood donor pool. **Objective:** This study was conducted to observe the prevalence of anemia and its associated demographic risk factors in apparently healthy individuals registered as blood donors. **Materials and Methods:** Blood donor records from August 2015 to July 2016 were analyzed retrospectively at the blood bank of Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh to observe the prevalence of anemia and its associated demographic risk factors in the prospective blood donors for which Pearson's Chi-squared test was applied, and odds ratio (OR) was calculated using Microsoft Excel 2007 and statistical software - VassarStats. $P < 0.05$ at 95% significance level was considered statistically significant. **Results:** Among 6273 blood donors registered, prevalence of anemia was 25.75% overall, 25.31% in males and 38.03% in females ($\chi^2 = 17.4$, OR $= 0.532$), 27.56% in rural and 22.50% in urban donors ($\chi^2 = 19.33$, OR $= 1.311$), 27.11% in donors below senior secondary, and 22.93% in donors above senior secondary education level ($\chi^2 = 12.65$, OR $= 1.251$). Males <30 years had significantly less chance of anemia than males above 30 years ($\chi^2 = 4.27$, OR $= 0.884$). Results were statistically significant at 95% significance level. In Hindu and Non-Hindu donors, prevalence was 25.81% and 24.88%, respectively. In replacement, family replacement and voluntary donors the prevalence rate was 25.14%, 27.03% and 24.39%, respectively. No statistically significant association for anemia with respect to religion and donor category was found. **Conclusion:** Anemia in healthy prospective blood donor population requires urgent attention for its prevention and control for retention of the blood donor pool.

KEY WORDS: Anemia in Blood Donors; Prospective Blood Donors; Blood Donor Pool; Anemia Prevalence

INTRODUCTION

The World Health Organization recognizes anemia as a global public health problem. A survey carried out during 1993-2005 for the WHO database on worldwide prevalence of anemia presents that anemia affects a population of 1.62 billion people and in India and it is a severe public health problem.[1] Data from various blood banks and blood centers highlight low hemoglobin and anemia as the most common cause of deferral among young and middle-aged adults, irrespective of gender.[2-4] Blood transfusion services have largely focused on the promotion of voluntary blood donation, for adequacy of blood supply; and eliminating chances of transfusion transmissible infections, by improving technology and testing methods; however, the responsibility to be shared is far more and should involve comprehensive care of the prospective blood donors to secure the blood donor pool.

Anemia can result from several causes such as dietary deficiencies of iron, vitamin B12 and folic acid, non

bioavailability of iron due to the presence of phytates and tannins, chronic blood loss due to hookworm infestation and malaria, thalassemia and thalassemia trait.[5-8] Iron deficiency alone accounts for 50% cases.[1] A blood donor, irrespective of gender can donate 350 ml or 450 ml of whole blood depending upon the body weight[9] and with every donation men lose 242 ± 17 mg and women, 217 ± 11 mg of iron[10] which implies that if not properly cared for, repeated blood donation may lead to iron deficiency, iron deficiency anemia and hence reduction in donor pool.

In adults, anemia may be a reflection of a more serious underlying disease such as gastrointestinal cancer.[11] Annen et al.[12] reported 13 cases of serious diseases incidentally discovered in donors deferred for low hemoglobin that included mantle cell lymphoma, multiple myeloma and prostate cancer. Delaney et al.[13] identified donors with metastatic lung cancer and acute lymphocytic leukemia within few months after their deferral.

Not only high prevalence of Iron deficiency has considerable adverse impact on the people's well-being, but also there is loss in productivity and physical work capacity in adults with its effect on the economic potential of the individuals, families and the nation, leading to loss in gross domestic product.[14,15]

Blood banks being the prime centers incidentally discovering anemia should feel the responsibility to develop a multidisciplinary approach in the investigation and treatment of these incidentally discovered cases; to prevent further iron deficiency in regular blood donors; to create awareness about the consequences and implications of anemia and necessary medical advice in order to secure their blood donor pool. The present study was, therefore, undertaken to explore the first step of this issue by observing the prevalence of anemia and its associated demographic risk factors in the individuals of Rohilkhand region registering as prospective blood donors at the medical institute.

MATERIALS AND METHODS

In this cross-sectional study, demographic details of all prospective whole blood donors from August 2015 to July 2016 were evaluated from the blood donor records at the blood bank of Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India. Complete demographic information - such as age, gender, educational status, place of residence (rural/urban), religion (Hindu, Non-Hindu) - was included in the study along with their hemoglobin level. As per blood bank protocol, hemoglobin of all prospective blood donors which include replacement donors (relatives and friends), family replacement donors (family members) and voluntary donors was initially screened by copper sulfate solution specific gravity method followed by alkaline hematin method for recording hemoglobin level. In the case of

discrepancy, hematology analyzer (RFCL Limited) was used for the final result. Donors with hemoglobin level <12.5 g/dl or those who were not eligible for donation as per standard guidelines (Drugs and Cosmetic Acts and Rules [1989], Ministry of Health and Family Welfare, Government of India) were deferred, rest were selected for donation.[16]

Statistical Analysis

All prospective blood donors based on WHO cutoff values for anemia, 13.0 g/L in men and 12.0 g/L for women were categorized in two groups, anemic and nonanemic and further on the level of hemoglobin into grades of severity as mild (10-12.9 g/dl in males and 10-11.9 g/dl in females), moderate (7-9.9 g/dl) and severe (<7 g/dl) anemia.[17] Their distribution among various demographic variables was evaluated in terms of frequency and percentage. Pearson's Chi-squared test was applied to assess the association of anemia in the study population with various demographic variables followed by odds ratio (OR). $P < 0.05$ at 95% significance level was considered statistically significant. Data were analyzed using Microsoft Excel 2007 and statistical software - VassarStats.
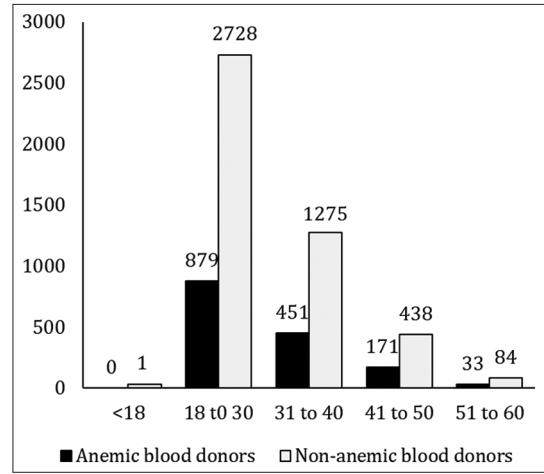
RESULTS

The sample size of the registered prospective blood donors was 6273 comprising 6060 (96.60%) males and 213 (3.40%) females, male-female ratio being 28:1.

Figure 1 represents the distribution of anemic and nonanemic blood donors in the registered population as well as in both gender groups. Figure 2 shows distribution of donors with respect to various grades of anemia. Ratio of anemic males and females was 19:1. The overall prevalence of anemia in registered population, males and females was 25.75%, 25.31% and 38.03%, respectively. χ^2 value for association with anemia with respect to gender in prospective blood donors was 17.4 which was statistically significant ($P < 0.001$) at 95% significance level with females being at a higher risk (OR = 0.552). Although the majority of anemic blood donors were only mildly anemic (98.82%), rate of prevalence being 25.44%, moderate degree of anemia was present in 1.18% with rate of prevalence 0.31%. No case of severe anemia was observed in this study. Rate of the prevalence of mild and moderate anemia in males was 25.16% and 0.15%, respectively, and in females it was 33.34% and 4.69%, respectively. There was also a significantly lesser risk for mild anemia in males than females ($P = 0.001$, OR = 0.627, 95%, confidence interval [CI]: 0.467-0.841), however, no significant association of gender was seen with moderate anemia.
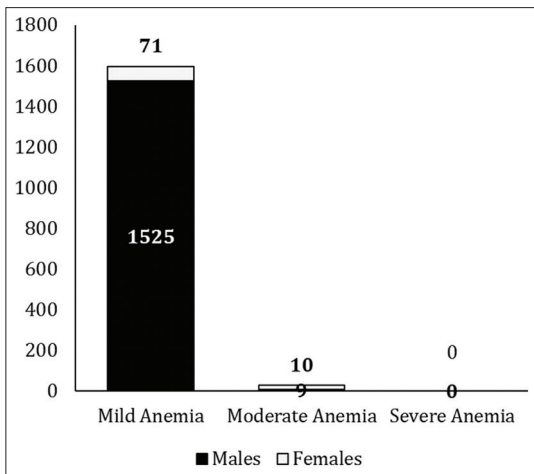
Figures 3-5 represent age distribution of anemic and nonanemic blood donors overall, in males and in females, respectively. The prevalence rate of anemia was least in 18-30 years age group (24.93%) and highest in the age group 51-60 years (28.33%). Males <30 years had
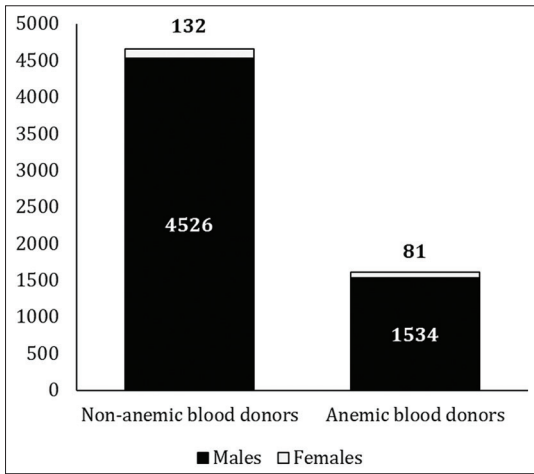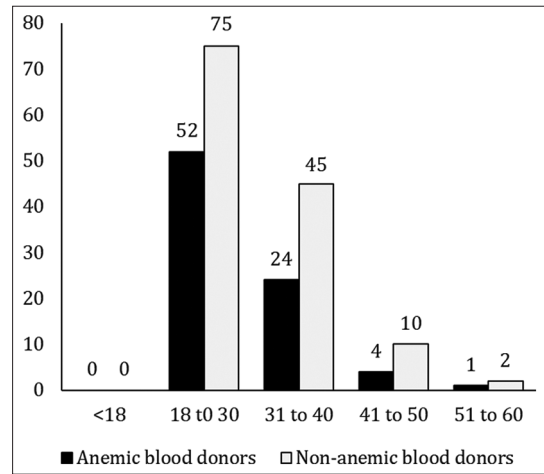
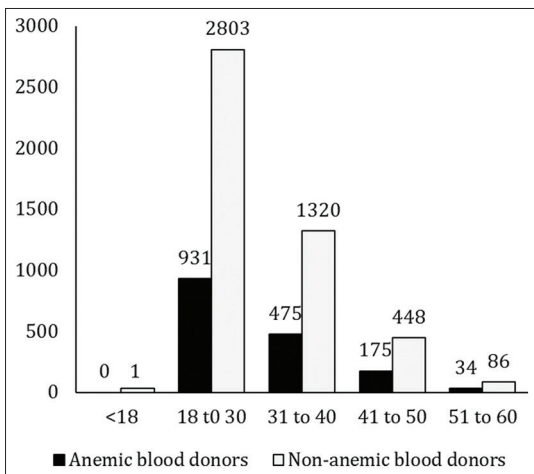**Figure 1:** Total and gender distribution of anemic and nonanemic registered prospective blood donors

Figure 2: Frequency distribution and percentage of male and female blood donors with respect to grade of anemia

Figure 3: Age distribution of anemic and nonanemic registered prospective blood donors

lesser risk of anemia than males >30 years (OR = 0.884 [CI: 0.786-0.994]), which was statistically significant at 95% significance level ($P < 0.0001$). χ^2 value for association was 4.27. In females, a decreasing rate of prevalence was

Figure 4: Age distribution of anemic and nonanemic registered male prospective blood donors

Figure 5: Age distribution of anemic and nonanemic registered female prospective blood donors

observed with increasing age till 50 years (40.94-28.57%) with a slight increase in prevalence in females between 51 and 60 years (33.33%), although risk for anemia in various age groups was not statistically significant.

As shown in Table 1, the prevalence of mild anemia was more compared to moderate anemia in all age categories, and among both gender groups, both grades of anemia being more prevalent in females. The prevalence of moderate anemia was highest among blood donors between 31 and 40 years in both males and females, 0.41% and 7.25%, respectively. No statistically significant risk for different grades of anemia among both gender groups was observed with respect to various age categories.

Table 2 shows frequency distribution and percentage of anemic and nonanemic blood donors with respect to place, religion, education level and donor category, along with the prevalence of anemia in them and their respective OR, χ^2 and P-value. Anemia was more prevalent and with higher chances in donors from rural area (OR = 1.311) and those with

Table 1: Age distribution and prevalence rate of mild and moderate anemia in male and female registered prospective blood donors

Age (in years)	Anemic males				Anemic females			
	Mild		Moderate		Mild		Moderate	
	n (%)	Prevalence rate (%)	n (%)	Prevalence rate (%)	n (%)	Prevalence rate (%)	n (%)	Prevalence rate (%)
18-30	878 (57.24)	24.31	1 (0.07)	0.03	47 (58.02)	33.07	5 (6.17)	3.94
31-40	444 (28.93)	25.72	7 (0.46)	0.41	19 (23.46)	27.54	5 (6.17)	7.25
41-50	170 (11.08)	27.91	1 (0.07)	0.16	4 (4.94)	28.57	0 (0.00)	0
51-60	33 (2.15)	28.21	0 (0.00)	0	1 (1.24)	33.33	0 (0.00)	0

Table 2: Distribution, prevalence and risk association of anemia in registered blood donors with respect to place of residence, religion, and education level and donor category

Variables	n (%)			Prevalence rate (%)	χ^2	P value	OR
	Total	Anemic	Non anemic				
Place of residence							
Rural	4028 (64.21)	1110 (17.69)	2918 (46.52)	27.56	19.33	0.000	1.311 (CI: 1.162-1.479)
Urban	2245 (35.79)	505 (8.05)	1740 (27.74)	22.5			
Religion							
Hindu	5847 (93.21)	1509 (24.06)	4338 (69.15)	25.81	0.18	0.671	1.05 (CI: 0.837-1.318)
Non-Hindu	426 (6.79)	106 (1.69)	320 (5.10)	24.88			
Education level							
Below S. secondary	4223 (67.32)	1145 (18.25)	3078 (49.07)	27.11	12.65	0.000	1.251 (CI: 1.105-1.415)
Above S. secondary	2050 (32.68)	470 (7.49)	1580 (25.19)	22.93			
Donor category							
Replacement	4037 (64.35)	1015 (16.18)	3022 (48.17)	25.14	0.05	0.823	1.041 (CI: 0.724-1.498)
Family replacement	2072 (33.03)	560 (8.93)	1512 (24.1)	27.03	0.54	0.462	1.148 (CI: 0.794-1.661)
Voluntary	164 (2.61)	40 (0.64)	124 (1.97)	24.39	(Reference)		

OR: Odds ratio, CI: Confidence interval

education level below senior secondary (OR = 1.251) compared to donors from urban area and those with education level above senior secondary, results being statistically significant at 95% significance level ($P = 0.000$). Hindu and Non-Hindu donors showed almost similar prevalence rate. Among various donor categories, maximum prevalence was observed in family replacement donors, while replacement and voluntary donors had almost similar prevalence rate. No statistically significant association for anemia with respect to religion and donor category was observed in this study.

DISCUSSION

Anemia is a public health problem that can affect a person in terms of physical well-being, work capacity and work productivity.[18] Anemia diagnosed in patients attending health care centers represent only a small proportion of the widely prevalent problem. The majority of them remain undiagnosed for a long time or may never be diagnosed. Blood banks can evolve as prime centers for the incidental diagnosis of anemic individuals, who are largely unaware of their hemoglobin status; provide necessary advice to mildly

anemic cases and appropriate medical consultation to those requiring treatment.

The prevalence of anemia is very high among all study population in India with children, adolescent girls and pregnant women contributing in large numbers.[19] Analysis performed on the global prevalence of anemia in 2011 which included data of 257 surveys between 1990 and 2012 was largely represented by women (80%) and children (87%).[20] As per blood bank deferral statistics from various regions most report low hemoglobin as the most common cause of deferral where males contribute to the majority of the prospective blood donor population.[2-4] This implies that anemia is also widely prevalent among adult men and cumulative data from various blood banks may be helpful in reflecting the magnanimity of the problem especially in adults of both gender groups.

In this study, out of 6273 prospective blood donors registered, the overall prevalence of anemia was 25.75%, a moderate public health problem as per WHO classification.[1] There was a statistically significant higher risk of anemia in female

donors (OR = 0.552), donors from rural area (OR = 1.311), and donors with education level below senior secondary (OR = 1.251) which is in agreement to the pattern of demographic correlates of anemia observed in the general population as reported in other studies.[21-24] Anemia is widely prevalent in apparently healthy individuals in at least mild form all over the world and in this study prevalence of mild anemia was 25.44%. Moderate anemia was prevalent in only 0.03% of the donors while no case of severe anemia was observed as it is unlikely for donors with higher grades of anemia to attend blood banks for blood donation.

Prevalence of anemia in male donors was 25.31%, much higher than the global prevalence (12.7%).[1] In female donors, prevalence was 38.03% much above the global prevalence of anemia as reported in 2011 (29.0%).[20] A comparable although higher prevalence rate in females was reported Bentley and Griffiths[21] in their study at Andhra Pradesh with overall, mild, moderate and severe anemia prevalence rates being 49.5%, 32.4%, 14.9% and 2.2%, respectively. Higher prevalence in younger females observed in this study was in agreement to the observations of Bharati et al.,[22] Parekh et al.[23] from Surat reported higher prevalence rate in both males (35.4%) and females (36.45%) in their community-based survey. Verma et al.[24] also reported higher prevalence rates compared to the present study in males (53.2%) and females (70.1%) in their community-based study in the North Indian adult population. This implies that anemia is a problem of public health significance with grades of severity varying from place to place, in different population groups and also includes apparently healthy individuals.

In this study, prospective blood donors from rural area and those with education level below senior secondary had a significantly higher risk of anemia than donors from urban area and education level greater than senior secondary. Poverty, dietary deficiency, poor dietary pattern and consumption of cereals, legumes and plant-based diets with poor bio-availability of iron could be the contributing factors in donors from rural area and those with low education level.[25]

Almost similar prevalence rate of 25.81% and 24.88% was observed in Hindu and Non-Hindu donors, respectively, in this study and no statistically significant risk for anemia with respect to religion (Hindu, Non-Hindu) was found which is in agreement with that reported by Verma et al.[24] in their community based study in the north Indian population. Findings although not significant, support the view that anemia is widely prevalent at least in mild form in all communities. In contrast to the above findings Chib[26] found a higher risk of anemia in Hindus in their study population groups that included both males and females of almost similar age group.

In this study, no statistically significant association for anemia with respect to donor category was found and the rate of prevalence of anemia in replacement, family donors, and voluntary donors was almost same. If voluntary blood donation has to be promoted in regions where anemia is prevalent in the prospective donor population, awareness on the risk of developing anemia and methods to combat the ailment should be judiciously dealt with by health professionals at blood centers in a manner that would help in the retention of blood donors. Interventional strategies are already in action in few countries.[27,28]

CONCLUSION

Anemia is very often incidentally discovered in blood banks, most commonly in mild form in apparently healthy individuals between 18 and 40 years among both gender groups presenting as replacement, family and voluntary blood donors. It is more prevalent in individuals from rural area and those with lower education level. Efforts to combat this public health problem by providing necessary medical advice and dietary counseling can be easily undertaken at blood banks through multidisciplinary approach. Consequently, increase in hemoglobin level of donors shall be helpful in retaining the blood donor pool and also it will benefit them in terms of work efficiency, work capacity and work productivity.

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