

Determination of Haemoglobin Concentration of Prospective Voluntary Blood Donors using Digital Haemoglobinometer in North Central Nigeria

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Abstract

Haemoglobin estimation is one of the most important criteria in donor selection so as to safeguard the health of donors. To achieve this, reliable and cost-effective methods should be employed during blood donation drive. The aim of this study was to determine the haemoglobin concentration of voluntary blood donors using digital haemoglobinometer.

This study was a prospective, community based conducted in five tertiary institutions in Kwara and Kogi States. Blood samples were taken from consecutive male and female donors within the age of 15-63 years following blood donation campaign. Assessment of haemoglobin concentration was done using Diaspect haemoglobinometer.

A total of 905 students and staff of five tertiary institutions participated in this study. The mean age of the respondents was 21.98±5.17 years and 96.3% were below 30 years of age. The mean, median, and standard deviation of haemoglobin level were 13.22, 13.20, and 1.62 g/dl respectively. Using the WHO haemoglobin cut-off value of 12.5g/dl for donor selection, about 64.1% of the prospective donor had haemoglobin value of greater. There was a statistically significant difference between haemoglobin level of male and female donors ($p=0.001$).

This study revealed that 64% of blood donors had haemoglobin concentration greater than 12.5g/dl and were fit for blood donation. Students of tertiary institutions could therefore be encouraged for regular blood donation to meet WHO vision 2020 towards attaining 100% voluntary non-remunerated blood donors.

Keywords: Haemoglobin Concentration Voluntary blood donor Nigeria

Introduction

Blood donation is relatively a safe procedure when stringent measures are put in place in donor selection. Of all the criteria in donor selection, the most crucial and significant is the level of haemoglobin of the prospective donors. This is because the donation should not cause harm to the donor and the recipient of such blood should benefit maximally from the blood transfusion.¹ The primary purpose of haemoglobin screening is donor protection so that such an individual does not become anaemic thereby jeopardizing the health and the second purpose is to ensure the patient receives a minimum infused haemoglobin dose per red blood cell transfusion.²

Various methods of haemoglobin estimations are available depending on the setting and how buoyant institutions are. The methods vary from simple paper scale reading especially in rural setting to a more advanced method of Photometry. Each of these methods has its own advantages and limitations.^{3,4} In most developing countries of the world, Nigeria inclusive, Copper Sulphate specific gravity is the traditional method used for donor screening.³ The solution is prepared and specific gravity of 1.053 and 1.055 are set to determine hemoglobin concentration of 12.5g/dl and 13.5gdl for female and male respectively.⁴ Despite its wide applicability, it is faced with a lot of false positive and false negative results and does not give quantitative result of haemoglobin as compared with digital haemoglobinometer.⁵

Common sources of error in its usage include incorporation of air bubbles and the use of an inadequate height for

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dropping the blood. In some circumstances, donors with high plasma protein or high white cell count could be accepted due to false positive result whereas in some situation it could result in unnecessary donor rejection or deferral with attendant consequences of serious blood shortage.⁵ Proficiency testing methodology for this method is also not well established. In most setting in developing world, majority of blood donations are less safe because they are gotten from family replacement and commercial donors who donate blood too frequently for monetary gain and are thus prone to anaemia.⁶ According to the Indian Drugs and cosmetics Act, 1940, for blood donation the minimum acceptable haemoglobin is 12.5g/dl or haematocrit of 38% for both male and females.⁷ In the Canada and the United States the minimum value for donor Hb concentration is set at 12.5g/dl regardless of gender, age, race and ethnicity⁸, while in European countries the cut off is 12.5g/dl and 13.5g/dl for female and male respectively.⁹ In view of higher false positive and false negative results of Copper Sulphate in determining donor fitness, a more quantitative methods will be most suitable to determine haemoglobin concentration and thereby prevent unnecessary donor rejection or acceptance. Although there is no consensus among blood banks about what is the best method, the International Committee for Standardization in Hematology proposes the measurement of hemoglobin by an automated technique using the cyanmethemoglobin method.¹⁰

The aim of this present study was to determine the quantitative haemoglobin concentration of prospective blood donors recruited during voluntary blood donation campaign in Kwara and Kogi States, North central geopolitical zone of Nigeria with newly acquired quantitative digital haemoglobinometer.

Materials And Methods

This was a descriptive community-based study conducted in Kwara and Kogi States, North Central Nigeria between August 2016 and January, 2018. It involved blood donation campaign which was carried out in five tertiary institutions in the two states. Letters were written and feedback obtained from the various institutions and organizations informing them of blood donation campaign and blood donation exercise to be carried out in their schools. This was done some weeks before the donation day. Approval was also obtained from Ethical committee of University of Ilorin Teaching Hospital. After obtaining approval from those organizations and communities, a day was set aside to

create awareness prior to the day fixed for the blood donation exercise. Blood donor recruiters were employed in passing information to the audiences. Emphasis on the need to be a voluntary blood donor and the importance of having blood from voluntary non-remunerated donors as against blood from commercial or touts was stressed.

This awareness day was a day before the donation proper. Various concerns of prospective donors were attended to and most of them went home satisfied. On the day of the donation exercise, the phlebotomists, counselors, donor recruiters, donor retention officers, scientists, technician and other people concerned including doctors were on ground early to set the stage for the blood donation. The prospective blood donors comprised of adult males and females between 15-63 years living in the North-Central Geopolitical zone of the country.

A brief biodata and physical examination (Checking for pallor, jaundice, blood pressure, pulse, weight and height) were done for each prospective donor before 10ml of venous blood sample was taken following strict antiseptic procedure. The blood sample was used in analyzing haemoglobin level and the remaining sample used for other investigations. Haemoglobin levels were determined using portable Diaspect Haemoglobinometer product of DiaSpect Medical GmbH, Sailauf, Germany (EKF Diagnostics, GmbH, Barleben, Germany) in accordance with manufacturer's instruction to check for donor fitness. The haemoglobin concentration of 12.5g/dl and above was considered as adequate and termed as fit for blood donation for both male and female especially when other physical examinations were perfect. The prospective donors that were fit for donation were moved to the bleeding couch. Those found not fit especially in term of haemoglobin level, tattooing of skin, signs of needle pricks or marks or any sign of alcoholism were counseled by the counselors in our team.

Data collection, vetting, auditing, entry and analysis

The various data instruments for the study were utilized. Research assistants and laboratory staff collected the data from the communities during administration of questionnaire and in the field during blood donation drive. The data generated from the study were entered into the computer. Similarly, data cleaning was done before analysis to detect possible errors during entry. The data was subjected to appropriate statistical analysis using IBM

SPSS version 20. Level of significance was set at $p < 0.05$. Results were illustrated with tables and charts.

Results

A total of 905 students and staff of five tertiary institutions participated in this study. The mean age of the participants was 21.98 ± 5.17 years (ranging from 15 to 63 years) and 96.3% of the respondents were below 30 years of age. There were more male respondents {541(59.8%)} than female {364(40.2%)} in this study. Most respondents were students of tertiary institutions (97.6%) and single (95%). Majority of the respondents were Muslim {634 (70%)} while 271(30%) were Christian. Yoruba-speaking respondents were the highest constituting 769 (85%) while Igbo/Edo was the least ethnic group in this study {18(2%)} . Table 1. Only 17.2% of the prospective donors had donated voluntarily in the past while a greater percentage have not donated blood in the past before this particular blood donation campaign. Figure 1

The haemoglobin level of the participants followed normal Gaussian curve (Figure 2). The mean, median, and standard deviation were 13.22, 13.20, and 1.62 g/dl respectively (Range 8.1- 17.6g/dl). There was a statistically significant difference in the level of haemoglobin concentration among different age groups with those less than 20 years of age having the lowest haemoglobin concentration of 12.73 ± 1.64 g/dl while age 40 years and above had the highest value of 13.76 ± 1.47 g/dl (p value 0.001) Table 2. The mean haemoglobin level of the male donors was significantly higher than that of the female donors (14.15 ± 1.24 g/dl vs 11.85 ± 1.05 g/dl; $p=0.001$) Table 3. Using the World Health Organization haemoglobin cut-off value of 12.5g/dl for donor selection, about 35.9% of the prospective blood donor had haemoglobin concentration of less than 12.5g/dl and 64.1% had values greater than 12.5g/dl. Also noted in this study was a significantly higher number of male donors (92.0%) compared with female donors (23.3%) having haemoglobin concentration of >12.5 ($p=0.001$).

Table 1: Socio-demographic characteristics of voluntary blood donors during campaign N=905

Variables	Frequency	Percentage
Age group		
< 20	121	13.4
20 – 29	597	82.4
30 – 39	20	2.2
≥ 40	18	2.0
Range	15 – 63	
Mean $\pm$ SD	21.98 ± 5.17	
Gender		
Male	541	59.8
Female	364	40.2
Ethnic group		
Yoruba	769	85.0
Hausa	24	2.7
Igbo	9	1.0
Nupe/ Igala/ Ebira	57	6.3
Others	18	2.0
Not stated	28	3.0
Literacy level		
Secondary	7	0.7
Tertiary	887	98.0
Quranic	6	1.0
None	5	0.3
Occupation		
Student	863	95.4
Lecturer	12	1.3
Teacher	10	1.1
Others	20	2.2
Marital status		
Married	38	4.1
Single	860	95.0
Widowed	7	0.9
Religion		
Islam	634	70.1
Christian	271	29.9
Designation		
Staff	42	4.6
Student	863	95.4

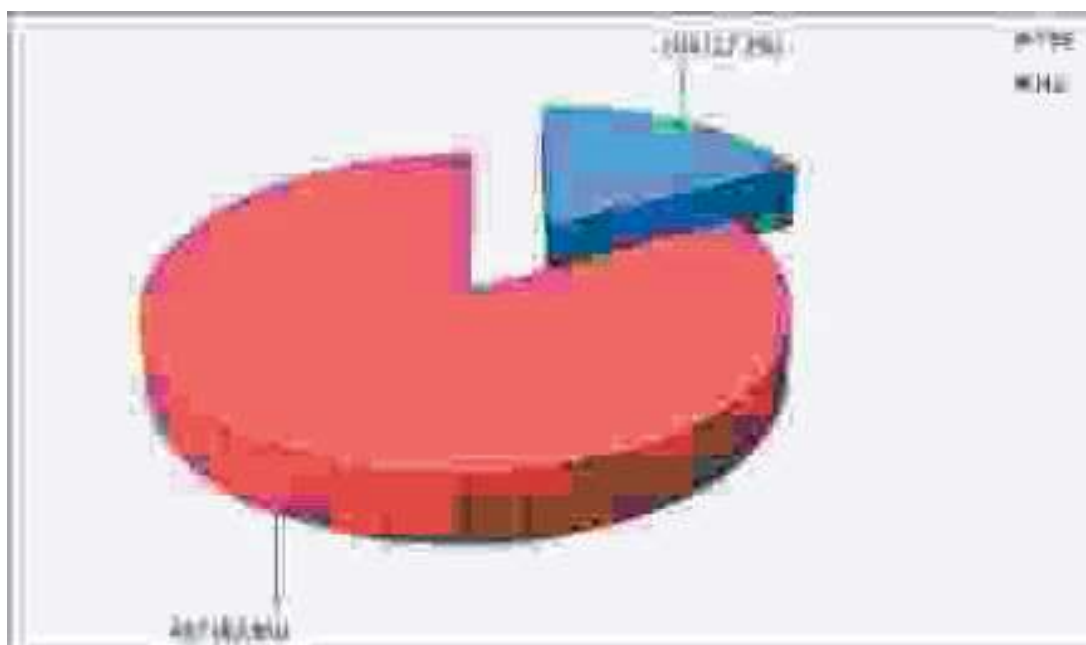


Figure 1: Ever donated blood

More than three quarters of the donors had never donated blood in the past before the blood donation campaign

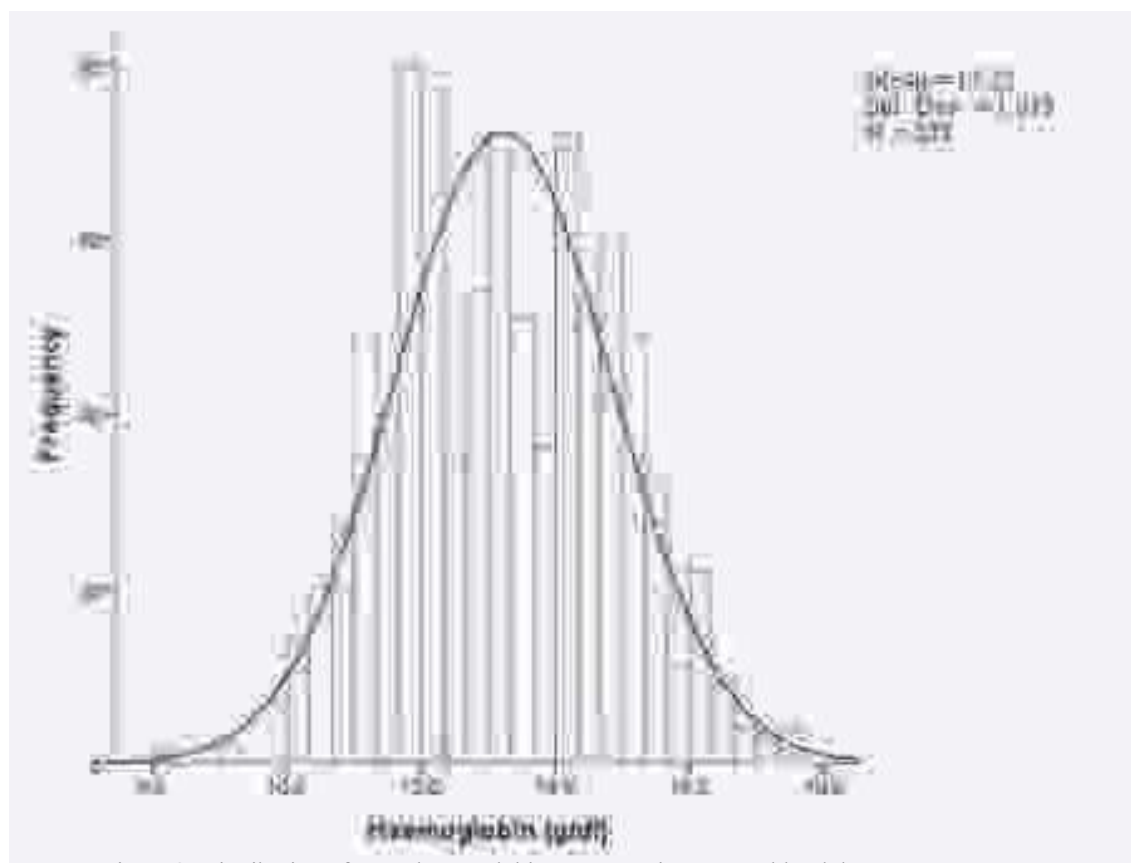


Figure 2: Distribution of mean haemoglobin concentration among blood donors

Table 2: Comparison of haemoglobin concentration of blood donors based on age range

Age (years)	N = 878 (%)	Haemoglobin (Mean $\pm$ SD)	F	p value
< 20	262 (29.8)	12.73 $\pm$ 1.64 ^a	12.446	<0.001*
20 – 29	580 (66.1)	13.41 $\pm$ 1.56 ^b		
30 – 39	18 (2.1)	13.73 $\pm$ 1.82 ^b		
≥ 40	18 (2.1)	13.76 $\pm$ 1.47 ^b		

F: ANOVA (Analysis of Variance); *: p value < 0.05

NB: Mean values with different alphabets indicates significant difference using Least Significant Difference (LSD) post-hoc test.

Table 3: Comparison of haemoglobin concentration of donors based on gender

	Gender			χ^2	p value
	Male	Female	Total		
Haemoglobin	n (%)	n (%)	N (100.0%)		
< 12.5 g/dl	42 (8.0)	273 (76.7)	315 (35.9)	433.454	<0.001*
> 12.5 g/dl	480 (92.0)	83 (23.3)	563 (64.1)		
Total	522 (100.0)	356 (100.0)	878 (100.0)		
Mean $\pm$ SD	14.15 $\pm$ 1.24	11.85 $\pm$ 1.05		28.691 ^t	<0.001*

χ^2 : Chi square test; t: Independent Samples T test; *: p value < 0.05

Discussion

The World Health Organization (WHO) recommends that all countries should be self-sufficient in all blood products and that every blood donation should be voluntary, anonymous, and non-remunerated. Nigeria as a signatory to these resolutions has envisioned reaching 100% voluntary non-remunerated blood donation by the year 2020. This was a community-based study carried out in five tertiary institutions among students and staff in Kwara and Kogi States, North-central, Nigeria. The mean age of the blood donors was 21.98 $\pm$ 5.17 years and majority were between 20-29 years (82.4%). This finding is similar to what was reported by Salaudeen et al¹³ and Shittu et al¹⁴ in Kwara State, and in other part of Nigeria¹⁵ as well as some other West Africa countries like Ethiopia¹⁶ and Sri Lanka.¹⁷ This perhaps could be due to the increasing population of youth not only in Nigeria but Africa in general. It was also reported

that this age bracket constituted ~15% of the nation's population.¹⁸ This was expected as most people within the age group are strong and healthy. The young population structure in Nigeria provides a window of opportunity for youths to serve as change agents in blood donation drive. The majority of respondents in this study were Muslims 634 (70.1%) while Christians constituted 29.9%, this could be due to the fact that Muslims are the majority in the geographic area of the study. Males constituted 59.8% of the donors and 40.2% were female. Surprisingly many females presented themselves for blood donation and showed enthusiasm and willingness to donate blood unlike in the hospital settings where majority of females are always turned down as being unfit for blood donation. This is also at variance with the study conducted by Shittu et al where a greater percentage of the donors were males (89.7%).¹⁴ In previous studies outside Nigeria also noted that significant numbers of blood donors are males. In

Greece and Ethiopia 94% and 62% respectively of the donors were males^{19,20}

The haemoglobin level of the participants followed normal Gaussian curve thus confirming the validity of defining the reference range as the mean ± 2 standard deviations. The mean, median, and standard deviation were 13.22, 13.20, and 1.62 g/dl respectively (Range 8.1- 17.6g/dl). There was a statistically significant difference in the level of haemoglobin concentration among different age groups with those less than 20 years of age having the lowest haemoglobin concentration of 12.73 ± 1.64 while age 40 years and above had the highest value of 13.76 ± 1.47 (p value 0.001). This could be due to the fact that those less than 20 years are actively growing and need more iron for their development. Using the World Health Organization haemoglobin cut-off value of 12.5g/dl for donor selection, 35.9% of the prospective blood donor in this present study had haemoglobin value of less than 12.5g/dl. This percentage is quite higher than what was reported in Libya where only 16.9% had haemoglobin concentration of less than the US cut-off value of 12.5 g/dl.²¹ This finding emphasises the importance of including quantitative haemoglobin estimation as an integral part of the donor selection process. The DiaSpect Hemoglobin T [DiaSpect Medical GmbH, Sailauf, Germany] which uses reagent-free cuvettes, and measure the absorbance of whole blood photometrically at the 506 nm wavelength was used in this study and it was found to be easy to operate and give a reliable result. It makes use of reagent-free polystyrene cuvettes that is not affected by the wide range of temperatures (10°C–40°C) and humidity. This haemoglobinometer do not require special storage conditions and thus suitable for use in outdoor blood donation camps in tropical counties.²² In addition, these cuvettes are cheaper and provide results more rapidly (<10 seconds).

Also noted in this study was a significant higher number of female prospective donors (76.7%) compared with male donors(8%) having haemoglobin value of <12.5g/dl (p=0.001) The mean haemoglobin level of the male donors was also significantly higher than that of the female donors (14.15 ± 1.24 g/dl vs 11.85 ± 1.05 g/dl; p=0.001) The mean haemoglobin concentration of 14.15g/dl among males in this study is similar to what was reported in Ghana, South Africa, Uganda and Libya but slightly lower that what was reported among males in Western Countries.^{23,24,21} The dominance of males in this study could be due to the low hemoglobin level and the monthly physiologic menstrual

cycle in females which make them unfit for blood donation. Greater percentage of females (76.7%) have haemoglobin less than 12.5g/dl so chances of female to donate is quiet less compared with the male counterparts. In a similar study carried out among blood donors in Brazil about 11.3% of female compared with 4.2% male donors were unfit to donate blood as a result of low haemoglobin level.²⁵ The study however identified women as being more predisposed to anaemia due to menstruation and pregnancy which is intensified by blood donations and that such a level of unsuitability observed in most studies would compromise blood supply and affect meeting the WHO Vision 2020.

Majority of blood donors were single 95.0% and students of tertiary institutions. The reason could be due to the fact that students constituted majority 95.4% of volunteered blood donors in this study compared with staff of each institution and the fact that some adults can have chronic health conditions that prevent them from blood donation. In Israel research findings indicates that married native Israeli men, aged 26–45 years, who are highly educated and are familiar with someone who needs a blood donation, are more likely to donate blood than the rest of the population.²⁶ This study revealed that only 17.2% had donated voluntarily in the past this is quite unacceptably low especially in meeting the vision 2020 of each country to be self-sufficient and to attain 100% voluntary blood donor. There is need to create more awareness about blood donation among the populace. More than half of the population is fit however greater percentage do not donate blood as a result of myths and misconceptions about blood donation.

Conclusion

This study revealed that more than half of blood donors had haemoglobin concentration greater than 12.5g/dl and were fit for blood donation with males and students of tertiary institutions constituting the majority. Students of tertiary institutions could therefore be encouraged for regular blood donation in order to meet World Health Organization vision 2020 toward attaining 100% voluntary non-remunerated blood donors.

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