RESEARCH ARTICLE

Sickle Cell Trait among Blood Donors in the Ho Teaching Hospital, Ghana: A Cross-Sectional Study

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BACKGROUND: Studies in Ghana show a high percentage of the population having the sickle cell trait. The aim of this study was to determine the prevalence of the sickle cell trait among blood donors in the Ho Teaching Hospital.

MATERIALS AND METHODS: This study was a prospective cross-sectional study where two hundred and seventy-two blood samples were obtained from donors by convenience sampling from December 2018 to January 2019, and analyzed to determine their sickling status and haemoglobin genotypes at the blood bank of the Ho Teaching Hospital. A structured questionnaire was administered to get the demographics of participants and other relevant information. The data was entered into Microsoft Excel 2016 and analyzed using graph pad prism.

RESULTS: Out of the 272 donors sampled for the study, 35(12.87%) tested positive for sickling and had HB genotype AS, with those in the age bracket, 31-40, having the highest prevalence. Among the participants who tested negative for sickling, 216(79.41%) and 21(7.72%) had HB genotypes AA and AC respectively. The study also revealed majority of the donors had no knowledge on their sickling status/HB genotype.

CONCLUSION: Due to the high prevalence of the Sickle Cell Trait (SCT) among donors in the municipality, screening for haemoglobin S should be made routine to ensure that high risk patients are not transfused with such blood units.

Key Words: *Sickle cell; Haemoglobin; Genotype; Blood types*

INTRODUCTION

In medicine, transfusing blood and its products encompasses the infusion or transfer of blood components into a client to ensure that certain physiological needs such as adequate haemoglobin level for the oxygenation of tissues, white blood cells to improve immunity, and platelets, as well as, coagulation factors replacement to serve as a remedy for bleedings disorders or coagulopathies, are met [1]. Worldwide, about 90 million units of blood are collected each year which makes blood transfusion an essential therapy that saves many lives in modern medicine each year [2]. In the quest to ensure the safety of both the donor and recipient, the permanent or temporary deferment of identified prospective donors with high-risk behaviors leads to a fairly good reduction in the risk of transfusing unsafe blood products [3]. However, the quality of donated blood may be compromised during processing, storage or when transfused to the patient in cases where the donor has the sickle cell trait, which unfortunately is not part of the screening protocol [4]. Sickle cell disease, which is an autosomal inherited blood disorder, occurs when there is a point mutation in genes responsible for the globin chains, resulting in the production of an abnormal haemoglobin, which form tactoids, i.e. long fibrous aggregates under low oxygen concentration causing the red blood cell to assume a sickle shape and loose its flexibility [5]. An individual is said to have the sickle cell trait or is a carrier of the sickle cell disease when he has inherited only an abnormal gene from either parents and a normal one from the other [2]. Studies in France show that, for every two thousand four hundred births, one child is born with the Sickle Cell Trait (SCT) making it the most vital genetic disorder in the country and one of the commonest in the United States of America [6]. The sickle cell trait as compared to other genetic RBC pathologies may be common among a number of geographical locations and ethnic groups in Africa [7]. This has made it common for persons who have the mutated haemoglobin to be encountered as prospective donors since the asymptomatic nature of the condition makes the HB level, RBC count and indices normal, hence not detectable by the routine Full Blood Count (FBC) [7]. Moreover, medical history obtained from persons who do not know their status or have not experienced acute hemolytic episodes as a result of the condition, may form part of the blood donor population [7]. Studies indicate that in the United States of America about one hundred and forty thousand blood units are unknowingly from donors with the sickle cell trait specifically HBAS out of the estimated fourteen million units of blood donated each year [8]. According to a research conducted in Ghana, a high percentage of the population ranging from about 25-30% have the sickle cell trait [2]. Blood donations from donors with the trait may pose some health implication to themselves and recipients, especially neonates suffering from Hemolytic Disease of Fetus and Newborn (HDFN), who are at risk of developing kernicterus, and patients experiencing some hemolytic disorders such as Sickle Cell Disease (SCD) patients [2].

MATERIAL AND METHODS

Study site: The study was carried out in the blood bank of the Ho Teaching Hospital. Ho is the capital city of the Ho Municipal assembly and the Volta Region of Ghana. This city lies between mount Adaklu and mount Galenkui or the Togo Atakora range, with Ewe being the predominant language. The municipality shares boundaries with the Adaklu-Anyigbe district to the south, Hohoe Municipality to the North, South-Dayi district to the west and the republic of Togo to the east. The Ho Municipality is the largest urban center in the Volta Region with a population of 177,281 (83,819 males and 93,462 females) according to the 2010 population and housing census, and the major occupation of the inhabitants are farming and trading. The Volta Region is the seat of numerous tertiary institutions, including the University of Health and Allied Sciences. The Ho Teaching Hospital serves as the major referral Hospital in the Region hence the ideal site for this study.

Sample size determination: Using the average monthly attendance of blood donors from previous months, a total study population of 600 was generated for this 2-month study (December, 2018 and January 2019). Using Raosoft online sample size calculator, the recommended minimum sample size representative of the said population was found to be two hundred and

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thirty-five (235). This was calculated at 95% confidence level, 5% margin of error and response distribution of 50%. However, a total of 272 participants partook in the study.

Study design and eligibility criteria: The research was a cross sectional study of which samples were taken in December 2018 and January 2019 at the Ho Teaching Hospital blood bank to test for prevalence of the sickle cell trait among the blood donors. All voluntary and family replacement donors, who visited the blood center and passed all screenings at the stipulated time, were recruited for the study. Moreover, voluntary donors, who consented to partake in the study during mobile donations organized by the HTH and passed all screenings, were recruited.

Sample collection and procedure: Blood samples of qualified donors, who gave consent to take part in the study, were aseptically collected into K2EDTA tubes. The samples were labelled with a unique code generated for the study after they had filled a questionnaire to capture their socio demographic, socio-economic and clinical data, as well as their knowledge on their haemoglobin genotype or sickling status. The sickling status of the participants was checked using 2% sodium metabisulphite. This was followed by preparing a hemolysate for the HB genotype of the donors to be determined by Alkaline Cellulose Acetate Electrophoresis.

Statistical analysis: The data obtained were entered into Microsoft Excel 2016 and double-checked for elimination of errors. The data was then exported to graph pad prism for analysis. The data was presented as frequencies and percentages. A p-value of <0.05 was considered statistically significant.

RESULTS

The total number of prospective blood donors, who reported to the facility within the period of the study, was 322. Meanwhile, two hundred and seventy-two (272) participants consented to be part of the study, hence were enrolled. Out of the 272 participants, 194 were males while 78 were females, representing 71.32% and 28.68% respectively. It was observed in the study that, more than 90% of the study participants fell within the ages of 17-40 years. The age group 21-30 years recorded the modal frequency of 108 participants representing 39.71%. The age group 17-20 years recorded the second highest frequency of study participants with 100 respondents whereas the age group 51-60 years recorded the least frequency of study participants with only 2 respondents representing 36.76% and 0.74% respectively as seen in **Table 1**.

Table 1
Age and gender distribution of participants.

Parameter	Frequency(n=272)	Percentage(%)
Gender		
Male	194	71.32
Female	78	28.68
Age		
17-20	100	36.76
21-30	108	39.71
31-40	46	16.91
41-50	16	5.88
51-60	2	0.74

Data is presented as frequency and percentage

Majority (58.46%) of the participants were found to have at a maximum, secondary education, while, 25.00% have at a maximum, tertiary education with 15.81% having basic education. The study recorded no divorced participant but 81.99% were single with 18.01% being married. One hundred and thirty-one (131) respondents were students representing 48.16% while 27.94% and 13.60% had informal and formal employment respectively and 5.51% were unemployed. One hundred and ninety-nine (63.24%) of the participants were replacement donors with 36.74% being voluntary donors. More than half (59.19%) of the recruited participants were of the ABO blood group 'O' type while a few (4.41%) of the donor population belonged to the blood group 'AB'. There were more Rh 'D' positive blood group (88.97%) compared to Rh 'D' negative blood group (11.03%). Among the study participants 54.78% were first time donors while 43.01%, 1.84% and 0.37% had donated 1-5 times, 6-10 times and >10times respectively as shown in **Table 2** below.

Table 2
Socio-demographic characteristics of participant.

Parameters	Frequency(n=272)	Percentage(%)
Educational status		
Basic	43	15.81
Secondary	159	58.46
Tertiary	70	25.74
Marital status		
Single	223	81.99
Married	49	18.01
Divorced	0	0
Employment status		
Formal	37	13.6
Informal	76	27.94
Student	131	48.16
Unemployed	15	5.51
Type of donor		
Voluntary	100	36.76
Replacement	172	63.24
ABO blood group		
A	45	16.54
B	54	19.85
O	161	59.19
AB	12	4.41
Rh 'D' blood group		
Positive	242	88.97
Negative	30	11.03
No. of donations		
First time donors	149	54.78
2-5	117	43.01
6-10	5	1.84
>10	1	0.37

Data is presented as frequency and percentages

In this study, 35 donors were sickling positive and accounted for 12.87% of the participants. Of the sickling positive cases, the males were 4 times more than the females that are, 80.00% and 20.00% respectively. The prevalence of the sickling positive was 14.43% among males and 8.97% among the females. Out of the 272 participants, (79.41%), (12.87%) and 21(7.72%)

had HB genotypes of AA, AS and AC respectively. The highest sickling positivity (15.22%) was recorded among individuals who were between the ages of 31 and 40 years. The participants in the 17-20 age bracket followed with 13.00% however, none of the donors who were above 50 years tested positive for sickling as see in **Table 3**.

Table 3
Gender and age group distribution on sickling status and HB genotypes.

	Sickling status		Hemoglobin genotype		
Parameter	Negative	Positive	AA	AS	AC
Total	237/272(87.13)	35/272(12.87)	216/272(79.41)	35/272(12.87)	21/272(7.72)
Gender					
Male	166/194(85.57)	28/194(14.43)	149/194(76.80)	28/194(14.43)	17/194(8.76)
Female	71/78(91.03)	7/78(8.97)	67/78(85.90)	7/78(8.97)	4/78(5.13)
Age group					
17-20	87/100(87.00)	13/100(13.00)	81/100(81.00)	13/100(13.00)	6/100(6.00)
21-30	94/108(87.04)	14/108(12.96)	86/108(79.63)	14/108(12.96)	8/108(7.41)
31-40	39/46(84.78)	7/46(15.22)	34/46(73.91)	7/46(15.22)	5/46(10.87)
41-50	15/16(93.75)	1/16(6.25)	13/16(81.25)	1/16(6.25)	2/16(12.50)
51-60	2/2(100.00)	0/2(0.00)	2/2(100.00)	0/2(0.00)	0/2(0.00)

Data presented as frequencies with their percentages in parenthesis.

Socio-economic distribution of donor knowledge on their Sickling/HB genotype status:

Table 4
Socio-economic distribution of donor knowledge on their sickling/HB genotype status.

Parameter	Yes	%	No	%	p-value
Total	27	9.93	245	90.07	-
Educational status					
Basic	1	2.27	43	97.73	< 0.0001
Secondary	9	5.66	150	94.34	-
Tertiary	17	24.29	53	75.71	-
Marital status					
Single	21	9.42	202	90.58	0.5972
Married	6	12.25	43	87.75	-
Employment status					
Formal	11	29.73	26	70.27	< 0.0001
Informal	3	3.95	73	96.05	-
Student	8	5.75	131	94.25	-
Unemployed	5	25	15	75	-
Donor type					
VD	6	6	94	94	0.1399
RD	21	12.21	151	87.79	-

Data presented as frequency and percentages.

VD: Voluntary Donor, RD: Replacement Donor;p-value <0.05 is considered significant

From **Table 4** above, it was observed that majority (90.07%) of the participants had no knowledge about their sickling status/HB genotype, with just a few (9.93%) knowing their status. Interestingly, the study revealed significant association between one's educational status and their knowledge of their sickling status. Participants with tertiary education recorded 24.29% as the highest among the three categories. Knowledge levels among the secondary and basic education cohorts on their sickling status were 5.66% and 2.27% respectively. Also, single participants with knowledge about their status were 9.42% while 90.58% didn't know their status. However, 12.25% of married participant knew their status while 87.75 had no knowledge with respect to their status. Whereas 29.73% who were employed in the formal sector knew of their sickling status, only 3.95% of those in the informal sectors knew of their sickling status. Few (5.75%) of the donors who were students knew their status whiles 25% of unemployed participants had knowledge about their status. This association between the employment status and knowledge of sickling status was statistically significant (p<0.0001). Finally, this study showed that a greater percentage (94.00%) of the voluntary donors did not know their sickling status compared to replacement donors (87.79%).

DISCUSSION

Blood is a scarce resource, with its availability dependent upon the altruistic nature of volunteer blood donors who provide Red Blood Cells (RBCs), plasma, and platelets, each an important component in helping to save lives through blood transfusions **[9]**. This study however seeks for the broadening of the scope of donor selection protocols to include testing for the haemoglobin S trait among the donor population. This is necessary since it is a requirement for transfusion in conditions such as neonates suffering from HDFN who may need exchange transfusion and patients with the sickle cell disease. The prevalence of the sickle cell trait among the 272 donors sampled for this study was 12.87%. This was seen to be slightly high as compared to a study than by Antwi-baffour et al and Adu P et al who reported a prevalence of 11.30% and 12.50% out of 150 and 200 participants respectively **[2,10]**. Conversely, a study by Omisakin et al in Nigeria reported a prevalence of 26.10% out of 314 donors which was seen to be higher as compared to the findings in this study **[7]**. The prevalence of

12.87% was comparatively lower than the reported general prevalence of 25.00% - 30.00% for Ghana and 20.00%-40.00% for Africa [2]. The haemoglobin S trait was seen to be more prevalent in male donors (14.43%) as compared to the females (8.97%). This was similar to the findings by Omisakin et al 2014 who recorded 27.9% and 19.4% in males and females respectively and may be as a result of more male donor participants as compared to females [7]. However a study by Antwi-Baffour et al showed a high prevalence among females as compared to that of males which may be as a result of few females recorded during the study [2]. There was a higher prevalence of the SCT among replacement donors employed in the study as compared to voluntary donors. This was seen to be comparable with Omisakin et al findings of 27.9% and 21.20% in replacement and voluntary donors respectively [7]. However a study by Adu et al 2016 revealed a higher prevalence in voluntary donors (30.00%) than in replacement donors (15.00%) of which the contributing factor maybe the lower number of voluntary donor sampled [10]. Also, the study revealed a higher prevalence of the SCT in the age group 31-40years with the least prevalence in the 51-60 age groups. The same pattern was observed in a study by Omisakin et al with 75% and 0% in the age groups 45-54 years and 55-60years respectively [7]. With regards to knowledge of blood donors on their sickling status and genotype, most (90.07%) of the participants had no knowledge about their status. The findings of this study reinforce previously published observations in other parts of Ghana that had even lower percentages of 3.00% and 2.70% [2,10]. Moreover, this study revealed a statistically significant association between one's educational status as well as employment status and knowledge on their sickling status and HB genotype. This may be due to improved education on the SCD in higher education institution. The study also revealed more male donors knew their status as compared to female donors this wasn't significant and could be due to the high number of males participating in the study. Out of the 272 participants 76.32% were males with 28.68% being females. This was consistent with other studies by Omisakin et al 2014, Antwi-baffour et al 2015 and Adu et al 2016 who recorded fewer female respondents of 21.34%, 8.00% and 6.00% respectively. This low turnout maybe due to physiological reasons such as menstruation and pregnancy which results in most females failing the medical history and HB screens [11]. The highest participating age group was 21-30 years with the least being 50-60 years. Comparatively, Omisikan et al 2014, Adu et al 2016 as well as Antwi-Baffour et al 2015 all had similar findings. The least participation among the 50-60 years age group could be as a result of most prospective donors failing the medical screens due to high blood pressure, increased heart rate and low HB levels which is common as one age [12]. The proportion of voluntary donors who showed up during the study was low (36.76%) as seen in other studies who reported 20.38%, 20.00% and 10.70%. However, the risk associated with transmission of Transfusion-transmissible infections is lower in voluntary donors who give blood solely for the benefit of others as compared to replacement and commercial donors and therefore should be encouraged to ensure safe and adequate blood supply (WHO, 2012).

CONCLUSION

Transfusion of blood units with the SCT can be detrimental other than helpful to high risk patients with conditions such as SCD and neonates, especially premature ones and those that need exchange transfusion due to HDFN [9]. Also, it has been reported to be the cause of WBC filtration failure which makes recipients prone to immune suppression or post transfusion infection [12]. With the SCT being prevalent in Ghana, policy makers are encouraged to incorporate the screening of blood donors or blood units for the SCT, in donor screening protocols and implemented. This would ensure the labeling of blood units with the SCT and prevent its administration to high risk patients. It is recommended that less resourced facilities should employ the use of the sickling slide test if the haemoglobin electrophoresis may be problematic. This will ensure proper management of high-risk patients and prevent waste of resources.

LIMITATIONS

The study could have employed Agarose Gel Electrophoresis which could have given more specific and clear separations of the various haemoglobin variants as compared to the Alkaline Cellulose HB Electrophoresis.

RECOMMENDATIONS

Public education on the sickle cell disease should be intensified and screening points should be made available.

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