African Journal of Laboratory Haematology and Transfusion Science

Vol 4, Issue 1, Page 69 - 79 | March 2025 | www.ajlhtsonline.org
ARTICLE DOI: doi.org/10.59708/ajlhts.v4i1.2512
DOI URL: 10.59708/ajlhts.v4i1.2512

ORIGINAL ARTICLE

Distribution of Haemoglobin Genotypes, Awareness, Motivators, and Barriers to Genotype Testing Among Health Science Students at Maflekumen Higher Institute Tiko, South West Region of Cameroon

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ABSTRACT

Background: Haemoglobin genotype testing is a crucial preventive measure against sickle cell disease (SCD) which encompasses all conditions associated with sickling of the red blood cells including sickle cell anemia, sickle cell trait and compound heterozygous. While students enrolled in health science programs are expected to be aware of genotype testing, various factors influence their decision to undergo screening. This study aimed to determine the distribution of haemoglobin genotypes, assess awareness of genotype testing and identify motivators and barriers to early genotype testing among health science students at Maflekumen Higher Institute, Tiko.

Materials and methods: A cross sectional study was conducted among health science students from December 2024 to January 2025. Haemoglobin genotype screening was performed using the sickle SCAN and data on their awareness, motivators, and barriers to testing were collected using a semi-structured questionnaire. The data was analyzed using the Statistical Package for Social Sciences version 25.0 software application. The Chi square statistical test was employed to assess the association between variables. A p value <0.05 was considered statistically significant.

Results: The majority (81.3%) of the 134 participants were females and 57.5% were in their second year of studies. Haemoglobin genotype distribution showed that 84.3% of participants had normal adult human haemoglobin (HbAA) and 15.7% had the sickle cell trait (HbAS), with no cases of sickle haemoglobin S (HbSS), sickle haemoglobin C (HbSC) and sickle haemoglobin C trait (HbAC) detected. The distribution of haemoglobin genotypes was not influenced by socio-demographic factors such as gender (p=0.06), age group (p=0.71), level of study (p=0.62) or marital status (p=0.46). The awareness of haemoglobin genotype testing was high (95.5%),

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Received: 11-02-2025
Accepted: 06-03-2025
Published: 30-03-2025

with significant differences by level of study (p=0.009) as students in their first year of study had the lowest awareness (66.7%). The primary motivators for undergoing testing were personal curiosity (51.5%) and relationship or marriage considerations (43.3%). Other motivators to genotype testing identified were affordable cost of testing (14.2%), family history of sickle cell disease (13.4%), institution requirement (12.7%) and peer influence (3.0%). The key barriers identified were high cost of the testing (48.1%), lack of awareness (35.1%), and limited access to testing services (20.9%). Other barriers to testing were no perceived need to know genotype (6.7%), fear of results (2.2%) and religious/cultural beliefs (1.5%).

Conclusion: The study demonstrates that while awareness of haemoglobin genotype testing is high among health science students, barriers to testing such as cost of testing and lack of accessibility persist. This study underscores the need of policies that integrate haemoglobin genotype screening into students' health programs, subsidize cost of testing and establish on campus screening facilities.

Keywords: Haemoglobin genotype, sickle cell disease, genotype testing, awareness, motivators, barriers, health science students

INTRODUCTION

Sickle cell disease (SCD) is a hereditary qualitative disorder of haemoglobin characterized by the production of defective hemoglobin known as sickled haemoglobin (HbS) [1]. SCD encompasses all conditions associated with sickling of the red blood cells including sickle cell anemia which is the most severe and commonest form of the disease, sickle cell trait and compound heterozygous. The sickle haemoglobin imparts sickle shape to red blood cells on low oxygen tension or deoxygenation leading to vascular occlusion of small blood vessels associated with tissue ischemia, acute pain and gradual end organ damage [2].

Recognizing its public health burden, the World Health Organization (WHO) declared SCD a public health priority in 2006, followed by the United Nations (UN) in 2008 [3,4]. Despite these efforts, SCD remains an under recognized health issue in Africa where over 300 000 babies are born annually with severe haemoglobin disorders predominantly sickle cell disease [5]. Sub Saharan Africa bears the highest burden of SCD with an estimated 75% of babies born with SCD each year occurring in this region [6]. Countries such as Nigeria, Cameroon, Ghana, and the Democratic Republic of Congo report a high prevalence of the sickle cell trait [7]. The high prevalence of SCD in these regions has been linked to Plasmodium falciparum malaria endemicity as carriers (HbAS) exhibit a survival advantage against severe falciparum malaria [8].

In Cameroon, haemoglobin genotype testing is not a routine laboratory investigation despite the country ranked 6th country with the highest number of sickle cell births per year [9]. Approximately 30% of its estimated 30 million population carries the sickle cell trait [10]. The diagnosis of SCD relies on haemoglobin electrophoresis, isoelectric

focusing and high performance liquid chromatography. However, these methods are costly, required well trained experts and inaccessible in most African settings resulting in 50-90% of undiagnosed cases [8]. This has led to the introduction of new point of care diagnostic testing for SCD such as the lateral flow immunoassay device (Sickle SCAN) which offers a sensitivity of 90% and specificity of 97% compared with the gold standard high performance liquid chromatography [11]. Studies suggest that the widespread use of sickle SCAN could revolutionize the survival prospects for individuals born with SCD in resource limited settings [12]. Given the high burden of SCD in Cameroon, and its substantial economic, social, and psychological impact, early haemoglobin genotype screening is a crucial strategy for disease management.

Increased awareness and early interventions such as early haemoglobin genotype screening have led to a considerable reduction in the morbidity of this disorder in high income countries. However, in many African countries including Cameroon, the lack of systematic public health interventions has contributed to the continued high prevalence of the disease. Despite the importance of early screening, there is paucity of data about the level of awareness, the motivators and barriers to genotype testing in Cameroon most especially among health science students who are future health advocates. Therefore, this study aims to determine the distribution of haemoglobin genotypes, assess the level of awareness about haemoglobin genotype testing, identify the motivators and barriers to early haemoglobin genotype testing among health science students at Maflekumen Higher Institute Tiko, South West Region, Cameroon.

MATERIALS AND METHODS

Study Design

This was a cross sectional study conducted from December 2024 to January 2025.

Study Area

The study was carried out at Maflekumen Higher Institute, a Higher Education Institution located in Tiko Sub-Division, Fako Disivion, South West Region, Cameroon.

Study population

The study targeted health science students enrolled at Maflekumen Higher Institute. A total of 134 health science students participated in the study selected using a convenience sampling technique.

Eligibility criteria

Participants were eligible for inclusion if they were actively enrolled in a health science program at Maflekumen Higher Institute and consented to be part of the study. There were no restrictions to participation based on age, gender, nationality, or academic level. Health science students who had received a blood transfusion within six (06) months prior to sample collection were excluded from the study.

Data collection

Data were collected using a semi structured questionnaire which captured socio-demographic variables, assessed level of awareness of haemoglobin genotype testing and identified motivators and barriers to haemoglobin genotype testing.

Method of haemoglobin genotype testing

The sickle SCAN lateral flow immunoassay device (Jiangsu Medomics Technology Co.Ltd, China manufactured on the 12/08/2024) was used for point of care haemoglobin genotype determination. This test device detects HbAA (adult human haemoglobin), HbAS (sickle cell trait), HbSS (sickle haemoglobin S disease), HbAC (sickle haemoglobin C trait), and

HbSC (sickle haemoglobin C disease) with a reported 100% agreement with haemoglobin electrophoresis based diagnosis. The test was performed following the manufacturers instruction supplied with the test kit. Capillary blood collected using a sampler capillary tube was mixed with the extraction buffer and three (03) drops of the diluent added to the sample well of the test device. Results were read at 15 minutes.

Quality assurance of collected data

The questionnaires were checked on daily basis for consistency and completeness. Normal (HbAA) and pathologic (HbAS and HbSS) control samples were used to do a quality control of the test device.

Data analysis

Data were entered into Excel application software and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0 software application. Socio-demographic data and factors influencing haemoglobin genotype testing were analyzed using descriptive statistics, presented as frequencies and percentages. Continuous variables were expressed as mean±SD. The chi square statistical test was employed to assess the association between variables. A p value <0.05 was considered statistically significant.

Ethical consideration

Ethical approval for this study was obtained from the Institutional Review Board of the Faculty of Health Sciences, University of Buea (Approval No: 2024/2303-01/UB/SG/IRB/FHS).

RESULTS

Socio-demographic description of the study participants

The majority (81.3%) of the study participants were females and the mean age of the students was 23.27±3.85years. The majority of students screened (57.5%) were in their second year of study and majority (53%) were under the nursing department (Table 1).

Table 1: Socio-demographic description of study participants

Characteristic	Frequency n=134	Percentage (%)
Gender		
Male	25	18.7
Female	109	81.3
Age groups/years		
17-21	51	38.1
22-26	57	42.5
27-31	21	15.7
32-36	05	03.7
Mean age±SD/years	23.27±3.85	
Median (Min-Max)/years	23 (17-36)	
Level of Study		
Level 1	23	17.2
Level 2	77	57.5

Level 3	27	20.1
Level 4	01	0.7
Post graduate (Master)	06	04.5
Department of study		
Nursing	71	53.0
Medical Laboratory	50	37.3
Pharmacy	12	09.0
Midwifery	01	0.7
Marital status		
Single	122	91.0
Married	12	09.0
Religion		
Christianity	132	98.5
Muslim	02	01.5

** values for age as computed as Mean±SD/Median (Minimum-Maximum)

Distribution of haemoglobin genotypes among study participants

Among the study participants, 84.3% had normal adult human haemoglobin (HbAA) while 15.7% were carriers of the sickle cell gene (HbAS) (Figure 1). No cases of HbSS, HbAC, or HbSC were detected in the study population. The distribution of haemoglobin genotypes was not influenced by socio-demographic factors, p value >0.05 (Table 2).

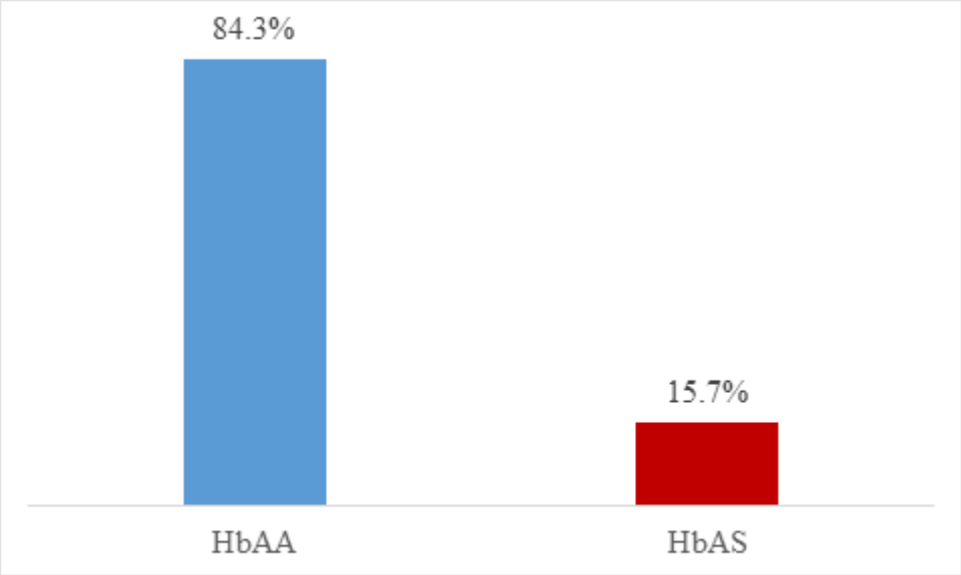

Figure 1: Distribution of haemoglobin genotypes among study participants, HbAA: normal adult human haemoglobin, HbAS: Sickle cell trait

Participants' awareness about haemoglobin genotype testing

A vast majority (95.5%) of students were aware of haemoglobin genotype testing (Figure 2). Awareness of haemoglobin genotype testing varied significantly by level of education (p=0.009) with first year students being the least aware (66.7%) (Table 3).

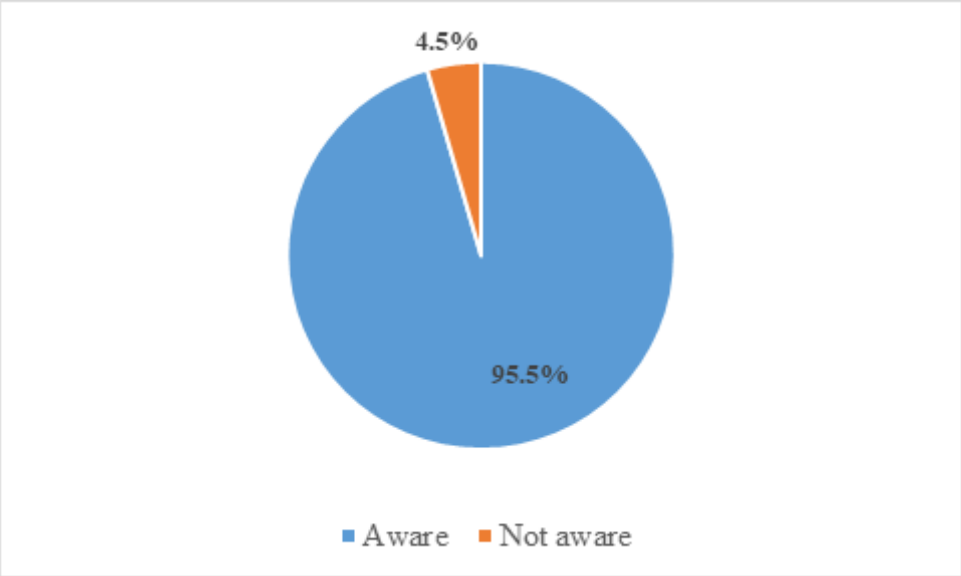

Figure 2: Participants' awareness about haemoglobin genotype testing

Table 2: Distribution of haemoglobin genotypes based on socio-demographic variables

Variable	Haemoglobin genotype		P value
	HbAA (n=113)	HbAS (n=21)	
Gender			
Male	18	07	0.06
Female	95	14	
Age groups/years			
17-21	42	09	0.71
22-26	49	08	
27-31	17	04	
32-36	05	00	
Level of Study			
Level 1	17	06	0.62
Level 2	66	11	
Level 3	24	03	
Level 4	1	00	
Post graduate (Master)	5	01	

Department of study			
Nursing	58	13	0.46
Medical Laboratory	45	05	
Pharmacy	09	03	
Midwifery	01	00	
Marital status			
Single	102	20	0.46
Married	11	01	
Religion			
Christianity	111	21	0.54
Muslim	02	00	

**Chi-square test used to assess significance, statistically significant at p<0.05

Table 3: Awareness about haemoglobin genotype testing based on level of education

Variable	**Awareness about haemoglobin genotype testing**		**P value**
	Aware n(%)	Not aware n(%)	
Level of Education			
Level 1	19 (14.8)	04 (66.7)	0.009
Level 2	77 (60.2)	00 (0.0)	
Level 3	25 (19.5)	02 (33.3)	
Level 4	01 (0.8)	00 (0.0)	
Post graduate Master	06 (4.7)	00 (0.0)	
Total	128 (100)	06 (100)	

**Chi-square test used to assess significance, statistically significant at p<0.05

Importance of haemoglobin genotype testing

The importance of haemoglobin genotype was measured on a scale of 5 with 1=not important, 2=slightly important, 3= moderately important, 4=important and 5=very important. The majority (94.8%) of students rated haemoglobin genotype testing as very important while 5.2% considered it important (Figure 3).

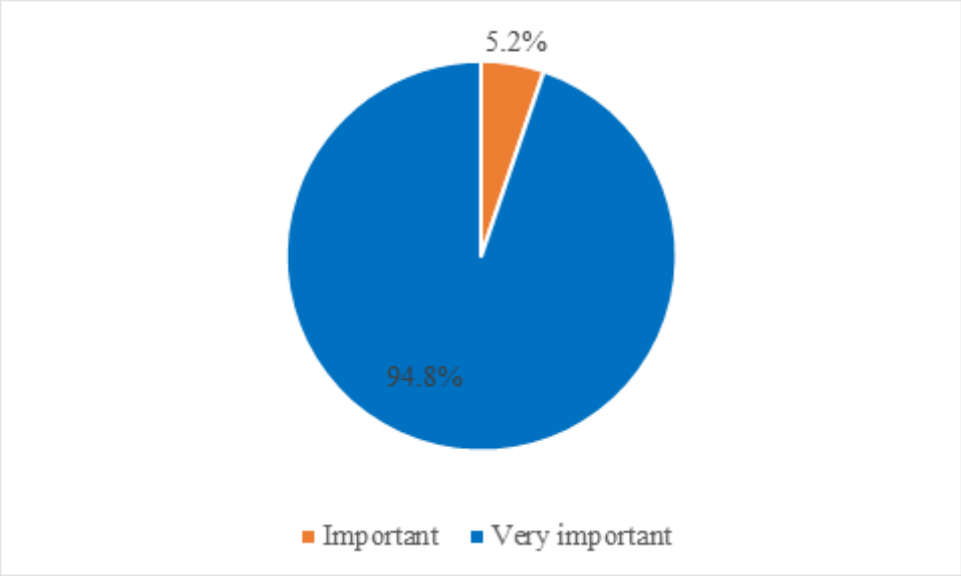

Figure 3: Importance of haemoglobin genotype testing as indicated by study participants

Motivators of haemoglobin genotype testing among study participants

The most common (51.5%) motivator of haemoglobin genotype testing among health science students was personal curiosity and relationship considerations or marriage plans (43.3%). Other motivators include affordable cost of screening (14.2%) and a family history of sickle cell disease (13.4%) (Figure 4).

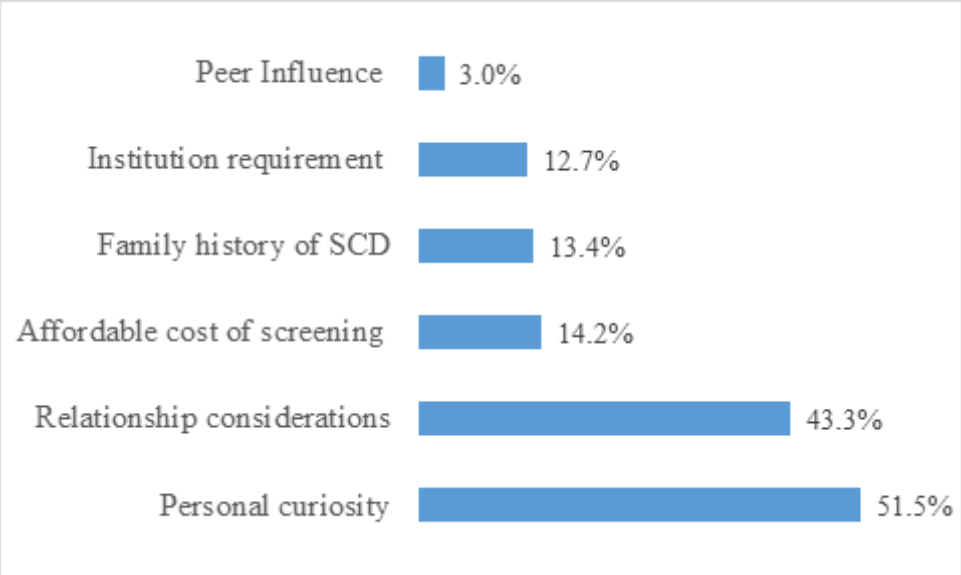

Figure 4: Motivators of haemoglobin genotype testing

Barriers of haemoglobin genotype testing

The most common barriers to haemoglobin genotype testing were high cost of the test (48.1%), lack of awareness about the test (35.1%) and lack of access to testing services (20.9%). Other barriers were no perceived need to know haemoglobin genotype (6.7%), fear of results (2.2%) and religious/cultural beliefs (1.5%) (Figure 5).

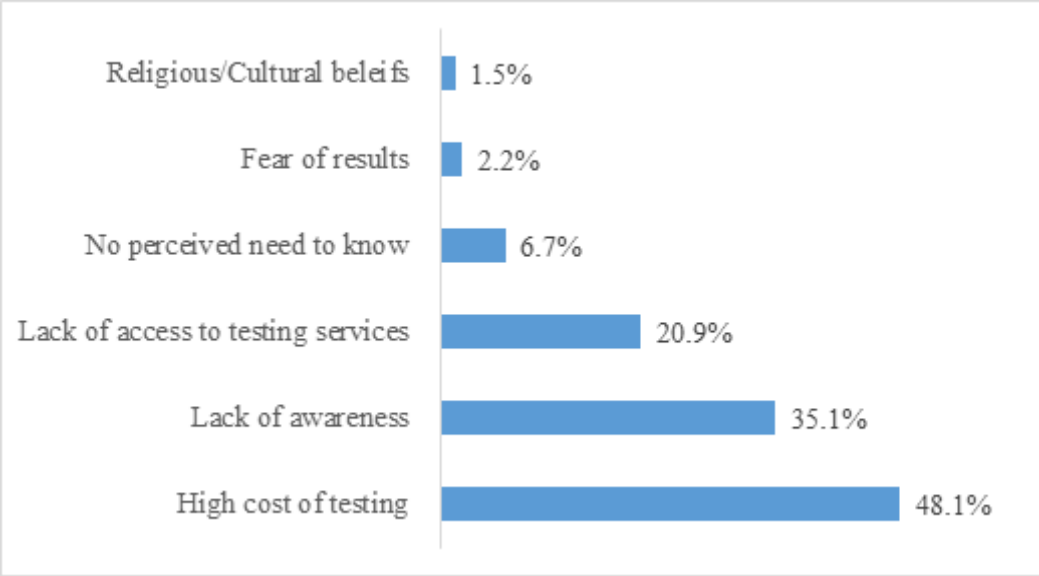

Figure 5: Barriers to haemoglobin genotype testing

DISCUSSION

Haemoglobin genotype testing is essential for preventing SCD through informed relationship and marriage decisions. While health science students are expected to be aware of haemoglobin genotype testing, various factors influence their decision to undergo a haemoglobin genotype test. This study aimed to determine the distribution of haemoglobin genotypes, assess awareness about haemoglobin genotype testing and identify the factors influencing haemoglobin genotype testing among health science students at Maflekumen Higher Institute Tiko.

The study revealed that majority (81.3%) of the students' population were females. This gender distribution aligns with existing trends as most students admitted into health science programs especially nursing are females. Also, the majority of participants were in their second year (57.5%) of study and this indicate that most of the participants had progressed beyond the entry level which could influence their awareness of genotype testing.

Findings from this study showed that 84.3% of students had normal haemoglobin (HbAA), while 15.7% were carriers of the sickle cell trait (HbAS). No cases of HbSS, HbAC, or HbSC were detected. This distribution is consistent with reports from similar studies conducted in African populations where the HbAS frequency is observed due to the high prevalence of the sickle cell gene in malaria endemic regions [13.14]. The absence of HbSS, or HbSC may be attributed to early mortality or the potential reluctance of individuals with sickle cell anemia to enroll in health science programs due to health related challenges.

The distribution of haemoglobin genotypes was not influenced by socio-demographic factors such as gender, age group, level of study, department of study, or marital status ($p>0.05$). This suggests that haemoglobin genotype testing is largely independent on these factors in our study population.

Haemoglobin genotype testing awareness was notably high (95.5%) with significant differences based on the level of study ($p=0.009$), first year students were the least aware (66.7%), while second year and postgraduate students had complete awareness (100%). This trend highlights the role of educational exposure in improving awareness about genetic diseases including SCD. The findings from this study are in line with those of Cargonja P. and colleagues (2021) who reported that a higher level of education enhances students' awareness about genetic diseases [15].

A striking 94.8% of the participants considered haemoglobin genotype testing very important while 5.2% rated it as important. This recognition underscores the perceived value of haemoglobin genotype screening in decision making particularly for relationship considerations/marriage planning and prevention of SCD.

Personal curiosity (51.5%) and relationship or marriage considerations (43.3%) were the top motivators for haemoglobin genotype testing. The findings from this study align with those of a previous study which indicated that haemoglobin genotype screening is often driven by personal and social concerns rather than medical recommendations [9].

The key barriers to haemoglobin genotype testing identified were high cost of testing (48.1%), lack of awareness (35.1%) and limited access to testing services (20.9%). These findings highlight the need for increased accessibility and affordability of genetic screening programs.

CONCLUSION

The study demonstrates that while the vast majority of the health science students are aware about haemoglobin genotype testing, key barriers such as cost of testing and lack of accessibility persist. Most of the students recognize the importance of haemoglobin genotype testing with personal curiosity and marriage considerations serving as the primary motivators. This study underscores the need of policies that integrate haemoglobin genotype screening into student health programs, subsidize cost of haemoglobin genotype testing and establish on campus screening facilities so as to promote routine haemoglobin genotype testing.

Competing interests

The authors declare no competing interests

Acknowledgements

The study participants for their cooperation throughout this work. The management of Maflekumen Higher Institute for granting permission for the work to be carried out within the institution.

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How to cite this article:
Deng CL, Sawah CN, Tangi FB, Bate AE, Atekwane NB, Labu SJ, Ewang AA. Distribution of Haemoglobin Genotypes, Awareness, Motivators, and Barriers to Genotype Testing Among Health Science Students at Maflekumen Higher Institute Tiko, South West Region of Cameroon. *Afr J Lab Haem Transf Sci* 2025;4(1): 69 - 79
DOI: https://doi.org/10.59708/ajlhts.v4i1.2512