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KNOWLEDGE AND PREVALENCE OF THE SICKLE CELL TRAIT AMONG UNDERGRADUATE STUDENTS OF THE UNIVERSITY OF CALABAR

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ABSTRACT

Sickle cell trait (SCT) is a benign condition characterized by the inheritance of a normal hemoglobin gene (HbA) from one parent and an abnormal, mutated β1-globin gene, the sickle hemoglobin gene (HbS), from the other parent, resulting in a heterozygous haemoglobin genotype of HbA/HbS (HbAS). The prevalence of SCT worldwide is estimated to be about 300 million, with the highest prevalence observed in regions where malaria is endemic, such as sub-Saharan Africa and tribal India. Despite its high prevalence in the Nigerian population (about 25%), there is limited research on the knowledge and awareness of SCT among university students. This study was aimed at assessing the knowledge and prevalence of the sickle cell trait among undergraduate students of the University of Calabar. This was a cross-sectional interviewer administered questionnaire study, involving 300 undergraduates of the University of Calabar, who were selected using the multistage sampling technique. Information collected include socio-demographic information, as well as questions to assess their knowledge of sickle cell trait. Data obtained were analyzed using SPSS version 22.0. Blood samples were also collected from the participants and analyzed for the presence of sickle cell trait using the Alkaline cellulose acetate method of haemoglobin electrophoresis (pH 8.6). The total knowledge score was 10, and depending on the total score of the respondents, knowledge levels were grouped as poor (0-3), fair (4-6), and good (7-10). One hundred and forty-seven respondents had poor knowledge (45.7%), while 35.3%, and 19.0% had fair, and good knowledge respectively. The knowledge level of the respondents based on the score revealed a mean score of 4.37 ± 2.44, indicating fair general knowledge of the respondents. The study also revealed that females showed better knowledge of SCT (19.7%) than males (18.1%). Respondents who were above 30 years gave more correct answers (27.2%), while the age group of 21-25 years was the next best (21.4%). Married persons, showed a better level of awareness of SCT (23.1%) than the single individuals (18.7%), while those in their sixth year of study appeared to have better knowledge of the trait than the other groups. However, demographics had no statistical significance on the respondents' knowledge of the trait ($p > 0.05$). Results also showed that the prevalence of SCT was relatively high among the participants, with 26% of the participants having the trait. Males had a higher carrier percentage than females (26.8% vs 25.4% respectively). These findings underscore the importance of increased public education about SCT among undergraduates, in order to increase their knowledge of sickle cell trait, and can help inform the development of targeted public health interventions aimed at improving knowledge and understanding of sickle cell trait among this population, as well as sensitizing students about the need for genetic counselling and informed decision-making.

KEYWORDS: Knowledge, prevalence, sickle cell trait, students, sickle cell aneamia, anaemia.

INTRODUCTION

Sickle cell trait (SCT) is a benign condition in which an individual has one abnormal allele of the haemoglobin beta (β) gene.[1] In other words, sickle cell trait is characterized by the inheritance of a normal haemoglobin gene (Haemoglobin A) from one parent and an abnormal, mutated beta globin gene, the sickle haemoglobin gene (Haemoglobin S) from the other parent,[2-7] hence, they are said to be heterozygous. Sickle cell trait is not a mild form of sickle cell disease; having sickle cell trait simply implies that the individual carries a single sickle haemoglobin gene and can pass this gene along to their children.[8]

The global distribution of sickle cell trait (SCT), which varies widely by geographic region, is hypothesized to have been driven by the protection that SCT confers against falciparum malaria in malaria-endemic regions

such as sub-Saharan Africa, India, southern Europe, and the Middle East.[1] Unlike sickle cell disease (SCD), erythrocyte sickling does not generally occur in SCT carriers, and the carrier status has historically been described as benign.[9] However, several high-profile cases involving SCT-associated clinical complications among athletes and military personnel continue to raise questions about the benignity of the heterozygous state. Research has suggested that some individuals living with SCT are at higher risk of certain conditions, including venous thromboembolism, chronic renal diseases, renal medullary cancer, haematuria, renal papillary necrosis, hyposthenuria, and splenic infarction.[10-12]

Sickle cell trait (Hb-AS) is one of the red-cell polymorphisms known to protect against severe forms of malaria in tropical Africa, as it provides a survival advantage against malaria fatality over people with normal haemoglobin (Hb-AA) in regions where malaria is endemic.[13-14] The protection appears to increase with age from only 20% in the first 2 years of life to a maximum of 56% by the age of 10 years and decreasing to 30% in those aged more than 10 years. Proposed protective mechanisms include reduced parasite growth and enhanced removal of parasitized cells through innate and acquired immune processes. The protection is specific for *falciparum* malaria and not any of the other three types of malaria (*Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae*).[13,15-19]

Sickle cell trait is one of the most common haemoglobin mutations in the world.[14] It is estimated that around 300 million people worldwide are sickle-cell carriers, with the highest prevalence (approximately 30 - 40%, or 1 in 3 carriers) seen in sub-Saharan Africa. In Western countries, the prevalence is much lower, around 1 in 500 (8% of Americans of African descent). This frequency might increase due to the migration of people moving from high-endemic regions to Western countries.[1] The condition is more prevalent in regions where malaria is endemic, such as Nigeria and tribal India, and is thought to confer a remarkable 90% risk reduction against severe and cerebral malaria.[14] In Nigeria, the prevalence of sickle β-gene trait is as high as 25-30%. With the largest back population of over 200 million, SCT frequency of 25-30% and SCD prevalence of 1-3%, Nigeria carries the heaviest burden of the sickle cell gene in the world.[20] The high prevalence of SCT also leads to several reproductive counselling and clinical management issues that are relevant to sickle cell trait carriers, primary care physicians, and general hematologists. SCT carriers are at risk of having children with sickle cell disease (SCD) as well as developing various clinical consequences, including extreme exercise-related injury, venous thromboembolism, and chronic renal disease (albeit in rare cases), in contrast to other carrier states.[21-23] Therefore, increasing our understanding of the prevalence of the sickle cell trait among undergraduates at the University of Calabar as well as the associated clinical consequences can aid in the development of genetic counselling recommendations.

MATERIALS AND METHODS

Study area

The study was conducted within the University of Calabar, Nigeria.

Study population

Undergraduates of the University of Calabar were enrolled from various departments for the study using a multistage sampling technique where ten faculties were selected using a balloting system. The ten faculties selected were Arts, Basic Medical Sciences, Management sciences, Medical Laboratory Science, Physical sciences, Biological sciences, Medicine and Surgery, Social sciences, Environmental sciences, and Allied Medical Sciences. Next, the same method (simple random balloting method) was used to select two departments from each of the faculties chosen. The departments of English and Literary Studies, Philosophy, Biochemistry, Physiology, Accounting, Public administration, Haematology and Blood Transfusion Science, Clinical chemistry and Immunology, Physics, Mathematics, Genetics and Biotechnology, Microbiology, Community Medicine, Obstetrics and Gynaecology, Economics, Sociology, Architecture, Urban and Regional planning, Public health, and Radiography were selected. Fifteen (15) students were selected from each department to constitute the sample size of 300.

Study design

A cross-sectional survey was adopted for this research.

Sample size

The sample size was determined using the formula described by Kadam and Bhalerao (2010).

$$n = \frac{z^2 \times p(1-p)}{d^2}$$

Where n=required sample size
z=confidence level at 95% (standard value of 1.96)
p=expected prevalence or proportion
d=margin of error or precision (standard value of 5%) $=(^5/_{100})=0.05$
Prevalence of sickle cell trait in Nigeria is 25%, i.e., $p=(^{25}/_{100})=0.25$.[20,24]

$$n = \frac{1.96^2 \times 0.25(1 - 0.25)}{0.05^2}$$

Therefore, n= 288
Using the above formula, sample size calculated was 288 subjects.
A total of 300 subjects were enrolled for this study to give a better statistical representation.

Ethical consideration/informed consent

Ethical clearance was obtained from Research and Ethical Committee of the Ministry of Health, Cross River

State, with REC no.: CRSMOH/RP/REC/2022/238. Detailed explanation of the purpose, objectives, risks, and benefits to the study subject and the confidentiality of responses were given to participants, after which verbal consent was obtained. The respondents' right to refuse or withdraw from participating in the interview was fully maintained. Data were collected after obtaining informed consent and agreement from the patients under study. Sample collection was performed following ethical steps and procedures.

Inclusion criteria
Only respondents who gave informed consent and who were identified by a valid student identification card were co-opted into the study.

Exclusion criteria
Non-undergraduates of the University of Calabar, and undergraduates who did not consent to participate in the study were excluded.

Screening for sickle cell trait
The assay method used was the Cellulose Acetate Electrophoresis at Alkaline pH (8.6).

Assay Procedure
The samples were washed and the packed red cells lysed with the haemolysing agent (water).

With the power supply disconnected, the electrophoresis tank was prepared by placing equal amounts of Tris-EDTA Borate (TEB) buffer (pH 8.6) in each of the outer buffer compartments to a depth of about 2.5cm. Two wet chamber wicks were then placed one along each divider/bridge support ensuring that they make good contact with the buffer.
The cellulose acetate paper was soaked by lowering it slowly into a reservoir of buffer and left for about 30 minutes prior to use.

A drop each of the control and test haemolysates were placed accordingly on the well-plate.

The cellulose acetate strip was removed from the buffer and blotted twice between two layers of clean blotting paper to remove excess buffer but not allowed to dry.

By means of an applicator, the control and test haemolysates samples were applied on the cellulose acetate membrane and carefully introduced onto the frame of the electrophoretic tank, with both ends in contact with the buffer.

The lid of the tank was replaced and the tank connected to a power supply of 250 volts and current 50mA and allowed to run for 20 minutes.

After 20 min electrophoresis, the power was disconnected, the membrane was removed and the results were read against the control (haemolysates from a known sickle cell trait sample).

Data processing and software used in statistical analysis
The data collected during the study were recorded, checked, and fed into Microsoft excel and then exported to Statistical Package for the Social Sciences (SPSS) (version 22.0) software for statistical analysis where a chi-square analysis was done and expressed at 95% confidence interval. The p-values were considered significant at $p \leq 0.05$, and the results were presented using tables and figures.

RESULTS
Table 1 shows the socio-demographic variables of undergraduates of the University of Calabar. A total of 300 undergraduates responded to the invitation to participate in the study. Most of the respondents were females 173(57.7%), while males constituted 42.3% of the study population. Those within the age group of 21-25 years had the highest participation (44.7%), while those within the age groups of 16-20 years, 26-30 years, and >30 years constituted the remaining 31.3%, 13.7%, and 7.5% respectively. Majority (91.3%) of the participants were single, while the remaining 8.7% were married. Those in their third year of study had the highest participation in the study (31.3%), closely followed by those in their first year of study (30.3%), while those in their second, fourth, fifth, and sixth years of study constituted 19.3%, 13.0%, 4.0%, and 2.0% of the study population respectively. Almost all the participants were Christians 296(98.7%), with just 4(1.3%) being Muslims.

Table 2 summarizes the knowledge about sickle cell trait (SCT) displayed by the participants. The total knowledge score was 10, and depending on the total score of the respondents, knowledge levels were grouped as poor (0-3), fair (4-6), and good (7-10). Out of the 300 respondents examined, 137(45.7%) demonstrated poor knowledge of sickle cell trait, while 106(35.3%), and 57(19.0%) had fair, and good knowledge respectively.

Table 3 shows the influence of some demographics on respondents' level of knowledge. In terms of age, 46.6%, 35.0%, and 18.4% of respondents belonging to the age group of 16-20 years had poor, fair, and good knowledge of sickle cell trait respectively. Those aged 21 to 25 years had poor, fair, and good knowledge in proportions of 47.0%, 34.3%, and 18.7% respectively, while those aged 26 to 30 years had poor, fair, and good knowledge in proportions of 43.9%, 39.0%, and 17.1% respectively. For those above 30 years, 36.4%, 36.4%, and 27.2% had poor, fair, and good knowledge of sickle cell trait respectively. In terms of gender, males who had poor, fair, and good knowledge of sickle cell trait were 43.3%, 38.6%, and 18.1% respectively, while for females, 47.4%, 32.9%, and 19.7% had poor, fair, and good knowledge respectively. Regarding marital status,

47.1%, 34.3%, and 18.6% of single respondents, as well as 30.8%, 46.2%, and 23.1% of those who were married had poor, fair and good knowledge respectively. In terms of level of studies, 56.0%, 36.3%, and 7.7% of first year students, 48.3%, 34.5%, and 17.2% of second year students, 41.5%, 37.2%, and 21.3% of third year students, 38.5%, 30.8%, and 30.8% of fourth year students, 25.0%, 33.3%, and 41.7% of fifth year students, and 16.7%, 33.3%, and 50.0% of sixth year students had poor, fair, and good knowledge of sickle cell trait respectively. Finally, in relation to religion, 45.6, 35.5, and 18.9% of Christians, as well as 50.0%, 25.0%, and 25.0% of Muslims had poor, fair, and good knowledge of sickle cell trait respectively. There was however no statistical difference between the knowledge of SCT demonstrated by the different groups examined ($p > 0.05$).

Table 4 shows the distribution of haemoglobin types among undergraduates of the University of Calabar. 215 participants (71.7%) were positive for Hb-AA, 78 (26.0%) for Hb-AS, 6 (2.0%) for Hb-SS, and 1 (0.3%) for Hb-SC.

Table 5 shows the prevalence of sickle cell trait among undergraduates of the University of Calabar based on gender. 26.8% of males and 25.4% of females enrolled in the study were carriers of SCT. There was however no statistical difference in the prevalence of sickle cell trait among both genders ($p > 0.05$). The distribution of Hb-AA, Hb-SC, and Hb-SS was 71.7, 0.0%, and 1.5% respectively among males, and 71.7%, 0.6%, and 2.3% respectively among females.

Figure 1 shows the distribution of ethnic groups of undergraduates of the University of Calabar. Ethnic groups in Cross River State were grouped into three (Cross River South, Cross River North, and Cross River Central) due to the multiple ethic groups in Cross River State witnessed in the study. Those from Cross River South, Cross River North, and Cross River Central constituted 18.5%, 16.1%, and 13.6% of the study participants respectively. Those belonging to the Anang, Igbo, Yoruba, Ibibio, Hausa, Idoma, and Ijaw made up the remaining 12.2%, 11.8%, 10.1%, 7.0%, 4.3%, 3.3%, and 3.1% respectively.

Table 1: Socio-demographic variables of undergraduates of the University of Calabar.

Variable	Number enrolled (n=300)	Percentage enrolled (%)
Gender		
Male	127	42.3
Female	173	57.7
Age group (Years)		
16-20	103	31.3
21-25	134	44.7
26-30	41	13.7
>30	22	7.3
Marital status		
Married	26	8.7
Single	274	91.3
Divorced	0	0.0
Widowed	0	0.0
Level		
100	91	30.3
200	58	19.3
300	94	31.3
400	39	13.0
500	12	4.0
600	6	2.0
Religion		
Christian	296	98.7
Islam	4	1.3
Traditional	0	0.0
Others	0	0.0

Table 2: Respondents' level of knowledge of sickle cell trait.

Variable	Frequency (n = 300)
Level of knowledge	
0-3 (Poor)	137 (45.7%)
4-6 (Fair)	106 (35.3%)
7-10 (Good)	57 (19.0%)
Mean knowledge score	4.37 ± 2.44

Table 3: Influence of some demographic characteristics on respondents' level of knowledge

Variable	Number enrolled	Level of knowledge			p-value	X^2
		Poor (0-3)	Fair (4-6) n (%)	Good (7-10)		
Age group (Years)						
16-20	103	48 (46.6)	36 (35.0)	19 (18.4)		
21-25	134	63 (47.0)	46 (34.3)	25 (18.7)		
26-30	41	18 (43.9)	16 (39.0)	7 (17.1)	**0.198**	**8.485**
>30	22	8 (36.4)	8 (36.4)	6 (27.2)		
Gender						
Male	127	55 (43.3)	49 (38.6)	23 (18.1)	**0.589**	**1.059**
Female	173	82 (47.4)	57 (32.9)	34 (19.7)		
Marital status						
Married	26	8 (30.8)	12 (46.2)	6 (23.1)		
Single	274	129 (47.1)	94 (34.3)	51 (18.6)	**0.634**	**0.910**
Divorced	0	0 (0.0)	0 (0.0)	0 (0.0)		
Widowed	0	0 (0.0)	0 (0.0)	0 (0.0)		
Level						
100	91	51 (56.0)	33 (36.3)	7 (7.7)		
200	58	28 (48.3)	20 (34.5)	10 (17.2)		
300	94	39 (41.5)	35 (37.2)	20 (21.3)	**0.064**	**7.266**
400	39	15 (38.5)	12 (30.8)	12 (30.8)		
500	12	3 (25.0)	4 (33.3)	5 (41.7)		
600	6	1 (16.7)	2 (33.3)	3 (50.0)		
Religion						
Christianity	296	135 (45.6)	105 (35.5)	56 (18.9)		
Islam	4	2 (50.0)	1 (25.0)	1 (25.0)	**0.728**	**0.636**
Traditional	0	0 (0.0)	0 (0.0)	0 (0.0)		
Others	0	0 (0.0)	0 (0.0)	0 (0.0)		

Table 4: Distribution of haemoglobin types among undergraduates of the University of Calabar

Haemoglobin type	Number enrolled (n = 300)	Frequency (%)
HbAA	215	71.7
HbAS	**78**	**26.0**
HbSS	6	2.0
HbSC	1	0.3

Table 5: Prevalence of sickle cell trait among undergraduates of the University of Calabar based on gender.

Gender	Number enrolled	Frequency (%)	Haemoglobin type				Statistics
			AA	AS	SC	SS	
Male	127	42.3	91 (71.7%)	**34 (26.8%)**	0 (0.0%)	2 (1.5%)	p value = 0.309
Female	173	57.7	124 (71.7%)	**44 (25.4%)**	1 (0.6%)	4 (2.3%)	X^2 = 3.597
Total	**300**	**100.0**	**215 (71.7%)**	**78 (26.0%)**	**1 (0.3%)**	**6 (2.0%)**	

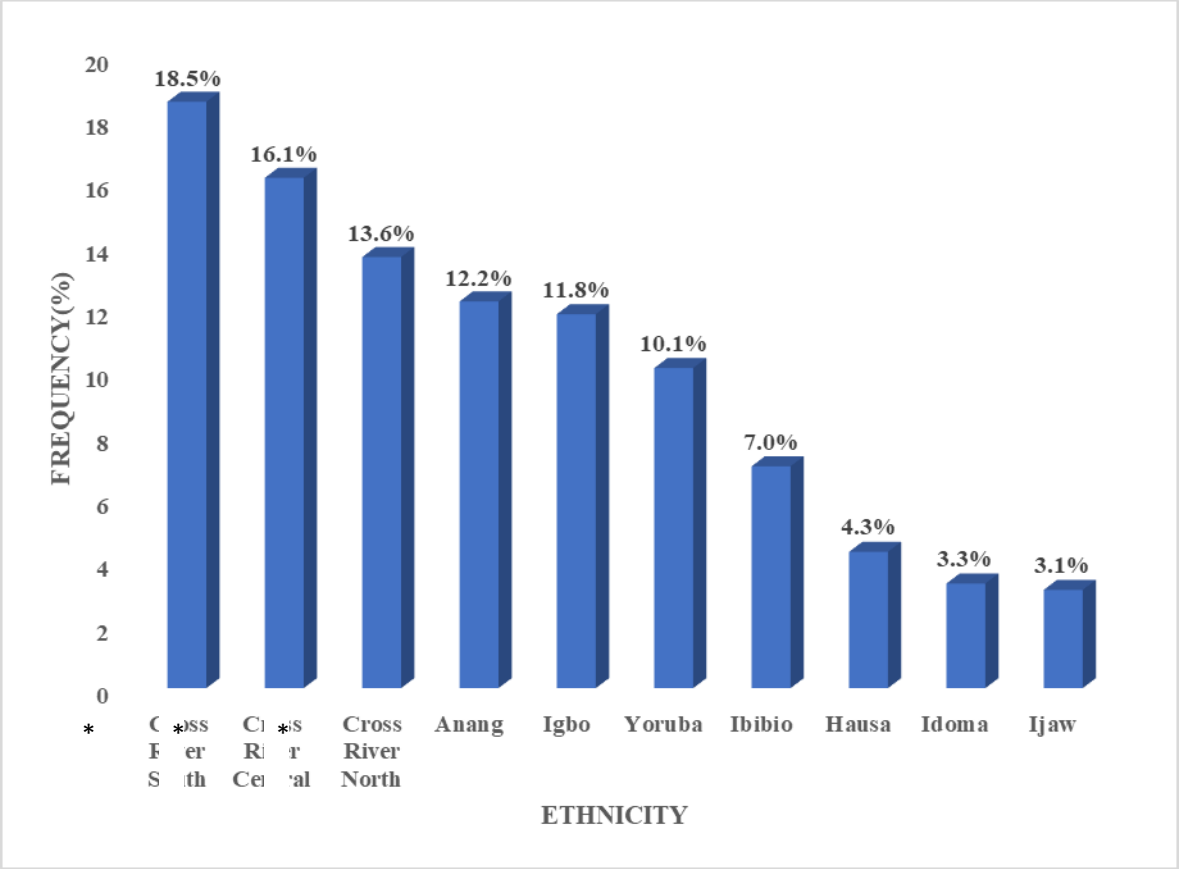

Figure 1: A bar-chart representation of the ethnic groups of undergraduates of the University of Calabar.

*Cross River South = Efik and Ejagham.
*Cross River Central = Yakurr/Agoi/Bahunmono, and Mbembe.
*Cross River North = Etung, Olulumo, Ofutop, Nkim, Abanajum, Nseke, Boki, Yala, Igede, Ukelle, Ekajuk, Mbube, Bette, Bekwarra, and Utugwanga.

DISCUSSION

Results showed that out of the total of 300 undergraduates who participated in the study, majority were female (57.7%), within the age range of 21-25 years (44.7%), and single (91.3%). Most of the participants were also Christians (98.7%) and in their third year of study (31.3%). The preponderance of females in this study is similar to that obtained by Ngwengi *et al*.[25] A similar study by Ugwu.[26] on undergraduates of Ebonyi State University also had socio-demographic characteristics similar to those obtained in this study.

It was also observed that most of the participants had poor knowledge of sickle cell trait (45.7%), with only 35.3% and 19.0% demonstrating fair and good knowledge respectively. The mean knowledge score was 4.37 ± 2.44, indicating a fair general knowledge of participants. The majority did not know what the carrier status is, its pattern of inheritance, its prevalence and how it differs from the disease status. This is in agreement with findings from previous studies. One of such studies is that by Uche *et al*.[27] who also observed a fair general knowledge of SCT by study participants. This is of concern because sickle cell trait is a genetic condition that affects a significant proportion of the population and can have important health implications. One possible explanation for the low levels of knowledge about sickle cell trait is a lack of emphasis on genetics and genetic disorders in the Nigerian educational system. This may lead to a lack of awareness about the condition and its impact on health, even among students who are pursuing degrees in health-related fields.

The study also revealed that females showed better knowledge of SCT (19.7%) than males (18.1%). Respondents who were above 30 years gave more correct answers (27.2%). The age group of 21-25 years was the next best (21.4%). Married persons, showed a better level of awareness of SCT (23.1%) than the single individuals (18.7%), while those in their sixth year of study appeared to have better knowledge of the trait than the other groups. The reason for this may be due to their exposure to the subject matter of sickle cell in the course of their undergraduate programme. However, demographics had no statistical significance on the respondents' knowledge of the trait ($p > 0.05$). This finding contrasts the findings of Oluwole *et al*.[28] who observed statistically significant associations between demographics and knowledge among the study respondents. It is however in line with those of Uche *et al*.[27] who observed no statistically significant

association between socio-demographic characteristics and knowledge.

It was also observed that out of the 300 participants for which haemoglobin typing was done, 78 (26.0%) had the trait (Hb-AS), while Hb-AA, Hb-SS and Hb-SC had prevalence rates of 71.7%, 2.0% and 0.3% respectively. The 26% carrier status observed in this study is in line with the results of previous studies. A prevalence study by Garba *et al*.[29] of 420 respondents showed the prevalence of the sickle cell trait to be 27.1%, while another study by Okoroiwu *et al*.[30] recorded a carrier state of 25.4%, figures which are all in agreement with findings from this work.

Similarly, it was also observed that out of the 127 males enrolled in the study, 34 (26.8%) were carriers of the trait, while 44 females (25.4%) out of the 173 enrolled had the carrier status. The difference in the prevalence of SCT between both genders was however not of statistical significance. This is in agreement with the findings of Ngwengi *et al*.[25] who also recorded slightly higher prevalence of sickle cell trait among females than in males. This implies that gender has no influence on the haemoglobin type of an individual.

CONCLUSION

This study illustrates that knowledge of SCT among undergraduates of the University of Calabar is insufficient as only few respondents had good knowledge of SCT. It also showed a relatively high prevalence of SCT in the study population. These findings underscore the need for increased health education to help undergraduates make informed decisions that may help curb the occurrence of the preventable sickle cell disease.

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