Original Article

Awareness of sickle cell disease among nursing undergraduates in Farasan: Its interference with malaria

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Abstract

Aim: The present study was conducted to generate data on awareness and incidence of sickle cell disease (SCD) and also to adduce the widespread myths peddled about SCD. **Materials and Methods:** Students studying in the Department of Nursing were recruited. A pretested, self-administered sickle cell assessment questionnaire was distributed electronically through WhatsApp group to collect necessary data. Participants were screened for malaria by thin blood smear analyses, and their hemoglobin (Hb) contents (g/dL) were determined by Sahli's haemoglobinometer. Statistical analyses were done using Origin (version 8.1, USA). A reliability study was performed for the validity of questionnaire data. **Results:** Study participants had significantly high awareness regarding SCDs (89.9%, $P < 0.001$). Most participants (96.3%) were aware about government policy regarding premarital screening for genetic disorders and replied that the government has strict health policies backed by equally robust laboratory diagnostics. Moreover, none of the participants had SCDs, although their parents had a consanguineous marriage. Thin blood smear analyses of participants did not reveal any cases of *Plasmodium falciparum*. However, significant percentages (33.1%) were found to be anemic, probably due to their dietary habits and lifestyles, as has been reflected by questionnaire analyses. Furthermore, a very less number of students had knowledge about genetic variations that might occur in malaria-endemic regions after long exposure to offer protection from malaria. Knowledge about management practices was also lacking among study participants (29%). **Conclusion:** This research points to the necessity that the nursing study plan should focus on providing specific training on management skills and preventive measures for SCDs, which is of paramount importance.

Keywords: Awareness, incidence, malaria, nursing undergraduates, *plasmodium falciparum*, SCDs

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Introduction

As per the World Health Organization (WHO), about 20–25 million people globally have hemoglobin S (HbS). Of this, nearly 12–15 million people reside in Sub-Saharan Africa, 5–10 million on the Indian subcontinent, and 3 million are dispersed throughout

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the rest of the world.[1] The Premarital genetic screening (PMGS) program and genetic counseling (PMGSGC) program are two major intervention initiatives of the Saudi Arabian government that have seen the greatest success in the Kingdom and are free at all government facilities. Saudi populace has benefited greatly from the PMGS program and free genetic counseling due to the excellent geographic and financial accessibility of healthcare services.[2,3] Premarital genetic screening (PMGS) has, therefore, been a very significant preventative medicine approach.

In the Kingdom of Saudi Arabia (KSA), scientific studies from different regions have reported varying prevalences of sickle cell diseases (SCDs),[2,4-10] including for Jazan Province in southwestern Saudi Arabia, which is reported in the literature as one of the most affected regions by SCD. In a study carried out by Alhazmi *et al*.,[10] it was found that complications associated with SCD, such as vaso-occlusive crisis (VOC) and acute chest syndrome (ACS), were the most common cause of hospital admission in Jazan.

As per published data,[11] Farasan Island is considered free of malaria-endemic, including *Plasmodium falciparum* type of malaria, which is common in Jazan. However, information on awareness and incidence of SCDs from Farasan Island is not available. In view of this, there is a need to study awareness and incidence of SCDs among nursing undergraduates and its interference with malaria in the Farasan campus.

The outcomes of the study would be of high significance as it will add new data to the existing literature that would help the policymakers to make health programs to curb the incidence of SCDs at the community level.

Materials and Methods

Study design and setting

The research employed a descriptive cross-sectional analytical study design. The study was carried out in the Department of Nursing, University College Farasan.

Sample size and sampling technique

The study recruited 188 eligible undergraduate students of the Department of Nursing, Farasan University College, College of Nursing, Jazan University, KSA, with age groups ranging between 18–23 years. Study participants were randomly selected.

Inclusion criteria

Those who voluntarily agreed to participate in the study and were full-time students enrolled at Jazan University during the academic year 2020–2021 included [Table 1].

Exclusion standards

Participants not affiliated with Jazan University.

Study tool

The questionnaire served as a research tool for data collection. A questionnaire was created after an in-depth literature analysis on related studies and was evaluated and modified by researchers from within and outside of the study.[12-22] The questionnaire was translated into Arabic for easy understanding by participants. However, for validation, the English version was kept with the researcher.

Ethical considerations

The research was done in complete adherence to Jazan University's ethical standards (College Ethical Committee No. 1/1/1442H, 2021). The rights of participants were protected as per Helinski's rule.

Data collection was started from 11 September 2021 until the end of October 2021.

Hemoglobin (Hb) content analyses

Using Sahli's instrument, finger prick blood was taken to measure Hb level (Superior, Marienfeld, Laboratory). Hb levels were classified using WHO's classification system of mild, moderate, and severe.[23] The Hb content was expressed in g/dL.

The measured values were tabulated and compared to the reference ranges for grading anemia in accordance with WHO recommendations, with Hb levels below 12 g/dL being considered anemic.[23] In contrast, Hb levels between 10.0 and 11.9 g/dL, 7.0–9.9 g/dL, and less than 7 g/dL were noted as Grade 1 (mild) anemia, Grade 2 (moderate) anemia, and Grade 3 (severe) anemia, respectively.

Anthropometric examination

Weight and height measurements of anthropometric proportions were taken on a self-calibrating digital weighing system (Seca, Digital, Germany).

Underweight was defined as having a body mass index (BMI) under 18.5 kg/m^2, normal weight as 18.5–24.9 kg/m^2, pre-obesity (overweight) as 25.0–29.9 kg/m^2, and obese as having a BMI of 30 kg/m^2.[24-26]

Malaria analyses

Malaria testing was done at the Biology Laboratory, Department of Nursing, Farasan Campus, Jazan University, KSA. Thin blood smears were made on a glass slide, air dried, and stained with 10% Giemsa (thin film fixed with methanol) for microscopy under an oil immersion microscope (100x magnification Kruss Optronic, Hamburg, Germany) to detect both asexual and sexual stages of parasites.

Statistical analyses

For qualitative and quantitative variables, respectively, means and standard deviations (SD) were used to present the data using descriptive statistics. The association was determined using the Chi-square test. Each accurate response received a score of one, while incorrect or may be responses received a score of zero. Each

Table 1: Frequency distribution of anthropogenic characteristics, awareness, general and specific knowledge, management practices, and attitude regarding SCD and PMGS among study participants (*n*=188)

Section A: Sociodemographic characteristics

Variables	Frequencies	%	*P*
Age groups			
18–20	20	11.4	*P*<0.0001
20–22	112	59.6	
22–24	56	31.8	
Sex			
All female	188		
Nationality			
Saudi	188		
Siblings			
Between 1–4	113	64.2	*P*<0.002
>4	75	40.4	
Family's Educational Background			
Educated	188	100	*P*<0.001
Uneducated	-		
Social status			
Lower middle class	-	3.19	*P*<0.05
Middle class	6	53.2	
Upper middle class	100	43.6	
Affluent	82		
Residence			
Farasan	142	75.5	*P*<0.55
Outside Farasan	46	24.5	
Accommodation			
Hostelers (living in rented apartments)	21	11.2	*P*<0.01
Day scholars	167	88.8	
Daily travellers	-		
Study Year 2020-2021			
1st	17	9.0	*P*<0.05
2nd	34	18.2	
3rd	62	32.9	
4th	75	39.9	
Marital status			
Single	174	92.6	*P*<0.45
Married	14	7.4	
Divorced	-	-	
Separated	-	-	
If married, then is this a marriage with a cousin? (consanguinity)			
Yes	11	78.6	*P*<0.55
No	3	21.4	
If unmarried, then any of the family history of cousin marriage?			
Yes	171	90.9	*P*<0.45
No	17	9.1	
Family history of any genetic diseases?			
Yes	7	3.7	*P*<0.64
No	181	96.3	
Have you been diagnosed with SCD?			
Yes	None	None	*P*<0.01
No	188	100	
Have you ever had malaria?			
Yes	4	2.1	*P*<0.02
No	184	97.9	
If yes, which species?			
Plasmodium falciparum	0	0	
P. vivax	2	1.0	
P. malariae	2	1.0	

Contd...

Table 1: Contd...

Variables	Frequencies	%	*P*
Section A: Sociodemographic characteristics			
Present Hb content (g/dL)			
<7	11	5.9	*P*<0.001
>7-10	15	8.0	*P*<0.05
>10-11	59	31.3	*P*<0.03
12	103	54.8	*P*<0.09
Section B: Awareness and general knowledge regarding SCD			
Have you heard about SCD?			
Yes	169	89.9	*P*<0.0001
No	19	10.1	
May be			
Are you aware of the genotype of SCD			
Yes	171	91	*P*<0.003
No	17	9.0	
May be	-	-	
If yes, then which source?			
Government hospitals	134	71.0	*P*<0.0001
Electronic media	24	13.0	
Family/Friends	21	11.0	
Academic lectures	9	5	
Do you think Sickle Cell Anemia is due to genetic/Hereditary reasons?			
Yes	173	92.0	
No	15	8.0	
May be	-	-	
Are consanguinities (cousin marriages) the only reason for SCD?			
Yes	15	7.9	*P*<0.051
No	178	94.6	
May be	3	1.5	
Are SCDs more prevalent in malaria-endemic regions?			
Yes	51	27.0	*P*<0.0001
No	131	69.7	
May be	6	3.2	
Is SCD a contagious disease?			
Yes	26	13.8	*P*<0.003
No	165	86.2	
May be	-	-	
How is SCD diagnosed?			
Blood test	44	23.4	*P*<0.0002
Genetic screening	61	32.4	
Electrophoresis	83	44.2	
Others	-	-	
Have you heard about premarital genetic screening (PMGS)?			
Yes	181	96.3	
No	7	3.7	
May be	-	-	
What is the risk for children to have sickle cell anemia if both parents are sickle cell patients?			
100%	113	60.1	*P*<0.001
75%	69	36.7	
50%	6	3.2	
25%	-	-	
Section C: Specific Knowledge regarding Clinical manifestations of SCD and Management Practices			
Does SCD cause Vaso-occlusive problems?			
Yes	67	35.6	*P*<0.009
No	105	55.9	
May be	16	8.5	
Does SCD cause some Hemolytic issues?			*P*<0.001
Yes	75	39.9	
No	75	39.9	
May be	38	20.2	

Contd...

Table 1: Contd...

Variables	Frequencies	%	*P*
Section C: Specific Knowledge regarding Clinical manifestations of SCD and Management Practices			
Does SCD cause an acute splenomegaly?			-
Yes	79	42.0	
No	78	41.5	
May be	31	16.5	
Does SCD cause Osteomyelitis?			-
Yes	89	47.3	
No	76	40.4	
May be	23	12.2	
Does SCD cause episodes of infections?			
Yes	89	47.3	
No	79	42.1	
May be	20	10.5	
Does SCD lead to episodes of hospital admissions?			
Yes	78	41.5	
No	98	52.1	
May be	12	6.4	
Does nutrition help in better management of the daily life of those with SCD?			
Yes	93	49.5	
No	49	26.1	
May be	46	24.5	
Should SCD patients be treated with prophylactic antibiotics?			
Yes	99	52.7	
No	69	36.7	
May be	20	10.6	
Is it important to give vaccination to those with SDCS?			
Yes	89	47.3	
No	70	37.2	
May be	29	15.4	
Is genetic counseling a good way to manage those with SCD?			
Yes	89	47.3	
No	59	31.4	
May be	40	21.3	
Is it true that an active lifestyle with daily physical activities such as exercise could help to manage those with SCD in a good way?	147	78.2	*P*<0.003
Yes	21	11.2	
No	20	10.6	
May be			
Does dietary supplementation of folic acid help to manage those with SCD?			
Yes	99	52.7	*P*<0.002
No	57	30.3	
May be	32	17.0	
Section D: Attidude towards PMGS			
Do you think that as a preventive measure, premarital screening for SCD is important?			
Yes	175	93.1	*P*<0.0001
No	9	4.8	
May be	4	2.1	
Can your partner's genotype influence the decision to marry them?			
Yes	145	77.1	*P*<0.0003
No	31	16.5	
May be	12	6.4	
Premarital genetic screening reduces the burden of hereditary diseases including SCD			
Yes	175	93.1	*P*<0.0001
No	10	5.3	
May be	3	1.6	
In your opinion, what is the appropriate time to undergo premarital genetic screening for SCD?			
After birth	13	6.9	*P*<0.0004
During high school	33	17.6	
Just before marriage	142	75.5	

Contd...

Table 1: Contd...

Variables	Frequencies	%	*P*
Section D: Attidude towards PMGS			
Marrying a partner with incompatible PMS results is a wrong decision			
Yes	89	47.3	*P*<0.01
No	54	28.7	
May be	45	24.0	
Section E: Attitude towards SCD person			
Do you think those with SCD should be isolated			
Yes	0	0	*P*<0.01
No	188	100	
May be	-	-	
Do you accept your roommate with SCD			
Yes	0	0	*P*<0.01
No	188	100	
May be	-	-	
Would you accept an SCD person as your friend			
Yes	0	0	*P*<0.001
No	188	100	
May be	-	-	

P<0.0001 is statistically significant

Table 2: Performance of study participants in specific knowledge and management practices domains

Domain	Scores	Percentage
Specific Knowledge		
Clinical manifestations	2.27	45.4
Episodes of pain	2.54	50.8
Splenic issues	1.87	37.4
Hemolytic issues	2.39	47.8
Mean	2.27	45.3
SD	0.19	
P	0.03	
Management Practices		
Dietary management	1.17	23.4
Prophylactic drugs	1.96	39.2
Analgesic drugs	2.11	42.2
Lifestyle modifications	2.29	45.8
Mean	1.88	37.7
SD	0.07	
P	0.01	

domain's mean, as well as total scores, were then calculated. Any score over the mean was considered as good awareness, and any score below the mean was regarded as an indicator of poor awareness. Cronbach's alpha was used to determine reliability, which came out to be 0.875. The required sample size was determined by Cochran's formula. To compensate for a nonresponse rate, 5% of the calculated samples were taken into account to get the final result of sample size. Significance was fixed at $P < 0.0001$. To ensure confidentiality, the data were entered into a password-protected personal computer. Origin software (Chicago, USA) was used to analyze the data.

Results

Data indicated that significantly higher percentages of the study participants ($N = 169$, 89.9%) had good awareness about SCD and the measures to better manage the SCD and showed high statistical significance ($P < 0.0001$) among the respondents for nearly all evaluation points of the awareness domain [Table 1]. There was an overall appreciable general knowledge and understanding of the disease. However, not all of the subjects ($N = 19$, 10.1%) were able to clearly differentiate between sickle cell anemia and sickle cell trait (SCT). Only 20.7% of study participants ($N = 39$) had correct knowledge of the genotype that causes SCD. We received a response rate of 96%, with 188 questionnaires received that were perfectly completed for all domains of the evaluation questionnaire. Response analyses of the evaluation questions under the awareness domain are depicted in Table 2.

Furthermore, some study participants ($N = 26$, 13.8%) had misconceptions regarding SCD as a contagious disease, caused exclusively due to relative marriages etc., Significantly less number of participants ($N = 51$, 27.1%) were of the opinion that in regions where malaria is endemic, SCDs are more prevalent, and they cited the neighboring province Jazan and other high malaria-endemic regions for its higher prevalence ($P < 0.0001$).

The majority of participants ($N = 149$, 79.26%) did not know their Hb genotype (SCT carrier status). The most common reason for not checking was lack of curiosity (68%), followed by the consideration that they would undergo a test before their marriage. Some participants responded that they did not want to undergo screening due to fear of being detected with the carrier genotype. Scores for all queries under the Clinical manifestations domain ranged from 1.87 (37.4%) to 2.4 (50.8%), with an average score of 2.27 (45.3%), indicating unsatisfactory knowledge regarding clinical symptoms of those with SCDs [Table 2].

Data analyses of the management practices domain indicated that there was a very low understanding of management practices among study participants. The average performance of study

participants on their knowledge regarding management practices for those with SCD was <50% in all evaluation questions for section C devoted for this [Table 2].

Data from questionnaire analyses for SCD and SCT questions revealed that none of the study participants reported having SCD, and none reported having SCT. Since at-risk participants were not found in this study, the incidence of SCD was considered zero.

The major source of information about SCD was the Government health centers (*N* = 92, 49%), followed by the internet (*N* = 58, 31%), family and friends (N = 28, 15%), and academic lectures (*N* = 9, 5%) as has been depicted in Figure 1. Data pertaining to BMI revealed that 28.9% (*N* = 54) of study participants were underweight.

Approximately 7% (N = 14) of participants were married at the time of the study, followed by 92.55% (*N* = 174) unmarried participants. The rate of consanguinity among married participants was 78.6% (N = 11). The majority of the participants (*N* = 175, 93.1%) were aware of PMGS for SCD, and 181 of them (96.2%) had correct knowledge about it [Table 2]. Most participants (75.5%, N = 142) were of the opinion to undergo the PMGS test just before marriage, while 17.6% (N = 33) chose during high school and 6.9% (N = 13) in college.

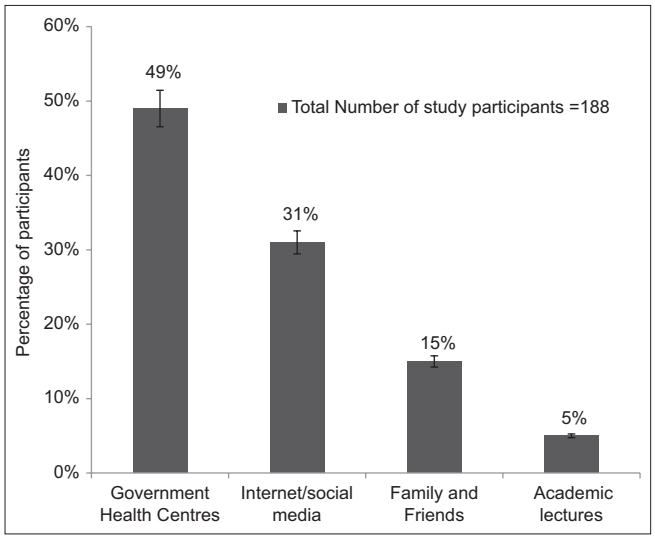

Figure 1: Source of information for sickle cell disease

However, age and study year had a significant impact on the attitude of study participants toward the premarital genetic screening program, as those in the age range between 18–20 years and in their first year of study have a significantly negative attitude toward the PMGS program ($P < 0.0001$). None of the study participants responded with a negative attitude about those who are the sufferers of the disease. In fact, while during random face-to-face interviews with the study participants, the majority of participants had the opinion that the disease may happen to anyone and should not be treated in any discriminatory way. The participants had no issue in making friendships or sharing their rooms with persons with SCDs [Table 3].

The results of the parasitological examination of the study participants revealed no infection with any *Plasmodium* species.

The mean Hb of the study population was 11.7 g/dL. Nearly 31.3% of study participants (*N* = 59) were diagnosed with anemia, with cases of mild anemia in 19.7% (N = 37), moderate anemia in 7.4% (*N* = 14) and cases of severe anemia were found among 4.2% (N = 8) study participants [Table 4].

Discussion

Data of the present study clearly indicate that study participants had a high awareness regarding SCD. Despite the prevalence of consanguineous marriages among their families, none were reported to have SCDs, as per the data analyses of the questionnaire. However, less number of students had knowledge about genetic variations that might occur in malaria-endemic regions after long exposure to offer protection from malaria. In addition, the level of awareness among participants was high, as 89.9% of the study participants responded correctly to awareness

Table 3: Relationship between attitude for premarital genetic screening and sociodemographic variables of the study participants

Variables of attitude domain	Negative attitude		Positive attitude		Total	χ^2, *P*
	Frequency	Percentage	Frequency	Percentage		
Age						
18–20	22	11.7	166	88.3	188	1.3, *P*<0.0001
20–22	41	21	147	78.8	188	
22–24	7	3.7	181	96.3	188	
Academic year						
1st Year	6	3.2	11	5.9		3.2, *P*<0.0003
2nd Year	11	5.9	23	12.2		
3rd Year	5	2.7	57	30.3		
4th Year	4	2.1	71	37.8		
Marital status						
Married	4	2.1	10	5.3	188	2.1 *P*<0.01
Unmarried	10	5.3	164	87.2	188	

Table 4: Distribution of study participants according to grade of anemia as per WHO's guidelines for anemia

Hemoglobin (g/dL)	Indicator	Frequency	Percentage
≥12	Nonanemic	129	68.6
10.011.9	Grade 1 (mild) anemia	37	19.7
7.09.9	Grade 2 (moderate) anemia	14	7.4
<7	Grade 3 (severe) anemia	8	4.2

and general knowledge questions about SCD. This may probably be due to the government's policy of mandatory PMGS. Also, the study participants consisted of marriage-able age groups as per Saudi law and are closer to making decisions related to marriages and hence are likely to be more concerned about knowing their own genotype as well as their partner's genotype. Moreover, in KSA, access of digital services is significantly easier, which has helped the government to establish mitigation efforts. According to General Authority for Statistics 2021 (URL http://www.stats.gov.sa),[27] 96.3% population in the Kingdom of Saudi Arabia (89% of the population) use the internet, and 98.2% of them own smartphones; therefore, all of these could be the reasons for high awareness regarding SCDs even among secondary school children.

In one of the studies conducted by Albagshi *et al*.,[17] among secondary school children, respondents, despite their young age, had good knowledge (89.9%) of SCD. In another similar study by Al-ghubishi *et al*.[28] conducted amongst high school students in Al Qunfudah, KSA, the respondents had high knowledge (71.7%) about SCD.

SCD causes chronic and acute complications that need specialized care to manage symptoms and improve clinical results.[29] The unsatisfactory performance of participants for sections dedicated to management practices clearly indicates that these future nurses lack the necessary training during their study period about the precise measures of caring for those with SCD related to physical investigations, vaccinations, medications such as folic acids, and prophylactic antibiotics, laboratory tests, and specific instructions for families. Since SCD is a chronic condition that usually triggers heightened suffering, especially among children, it deserves special attention.

In the attitude assessment section for PMGS, an overall positive attitude with a high level of acceptance was found for almost all evaluation points of PMGS, as has been shown by the data for this domain (87.8%). In the present study, the majority of the respondents (96.3%) knew about the PMS program. This could be attributed to the presence of various user-friendly governmental policies and centers where facilities are available for free genetic screening. About 87.8% of participants acknowledged the importance of performing screening tests. About 70% were willing to marry an SCT partner if they were SCD patients.

In a study by Mirghani *et al*.,[30] 99% of study participants think that premarital examination is necessary, and Al-Shroby *et al*.,[31] where 98.4% of respondents had their positive attitude toward PMGS, and 88.6% remained of the opinion that their partner's genotype could influence their decision to marry him or her. A high level of acceptance of PMS was observed in a study by Al-Qahtani *et al*.,[32] with about 88.6% of participants agreeing to undergo elective PMS, 78.2% responding that they would not marry someone with thalassemia or SCA, and 79.5% saying they would not marry someone with a genetic trait if they themselves had a trait. Similarly, in a study conducted at Princess Nourah University by Alahdal *et al*.,[33] 55.57% (*N* = 354) of study participants supported premarital counseling.

As for the evaluation questions about the preventive measures, most individuals who participated in the current study (93.1%) answered PMGS as a preventive measure for SCD, which is in line with various other published studies.[16,17,34]

In contrast to this, in another study by Kotb *et al*.,[16] in Jazan and Alhowiti and Shaqran[34], many participants chose to get married regardless of the outcomes of premarital testing. Despite incompatible results, it was also found that 47.3% of participants opted to get married. For this reason, more awareness programs are required to guarantee that the healthiest practices to safely manage SCDs are adopted. Moreover, a strong, significant positive correlation has been found between the timing of the screening and the continuation of the marriages with partners of incompatible results as majority of the participants in the present study were of the opinion to undergo the PMGS test just before marriage (75.5%, N = 142), 17.6% (N = 33) want during high school and 6.9% (N = 13) were of the opinion of PMGS to be done once they are at college level. As per Al Zeedi and Al Abri,[35] one of the main documented significant reasons for the continuation of marriage despite abnormal PMS results is taking the test during the engagement period. This unexpected abnormal result in this critical time may be ignored by couples, and the couples choose to overlook this unexpected aberrant result at this crucial moment for a variety of cultural, societal, and emotional reasons.

Premarital genetic counseling and testing have been shown to considerably reduce the occurrence of hemoglobinopathies in other Middle Eastern countries, including Turkey[36] and Bahrain.[37]

The association between *P. falciparum* malaria and SCD is well-known (Elguero *et al*.[38] Starting from the discovery and even today, SCD is prevalent mostly in territories where malaria is endemic.[39,40] This gives strong agreement to the hypothesis even today, which was put forward a year before, that there might be a link between these two diseases[41,42] and the mechanisms of resistance of heterozygous (HbA) to malaria. Various studies have described an association between the heterozygote HbAS (sickle cell trait) and protection against malaria, with more than 90% protection against severe forms.[43-45]

The risk of malaria in Saudi Arabia is generally limited to the southwestern part, with Gizan and Aseer regions being the highest in reported cases of malaria.[46] Jazan region and the border region with Yemen were the most malarious parts in Saudi

Arabia.[47] The study conducted by Al-Mekhlafi *et al*.,[47] showed that average temperature and relative humidity were key climatic factors of autochthonous malaria in the Jazan region as high humidity (>60%) prolongs mosquito's lifespan and promotes the growth of parasites in mosquitoes.[48]

Carrier (HbAS) individuals are generally asymptomatic to infections and are best described as malaria-protective.[49-51] Presence of the malaria parasite in red blood cells (RBCs) with defective Hb causes it to rupture prematurely, preventing *P. falciparum* to reproduce. In addition, polymerization of Hb impacts the ability of the parasite to digest Hb. As a result, carrying SCT actually increases a person's probability of surviving in locations where malaria is an issue.[52,53]

The mechanisms proposed process entail reduced parasite development in infected erythrocytes and decreased cytoadherence of parasitized RBCs to endothelium, which heightens the removal of parasitized cells by the immune system.[51,54] Higher incidence of SCDs in the southern province of KSA, including the Jazan region, may be due to the high prevalence of malaria in these regions. Furthermore, the high prevalence of SCD in some regions of KSA may probably be due to the reasons that those regions had high malaria prevalence in the past years or may be due to the marriage between different ethnic groups from regions with more people either having SCT or SCD.

Since Farasan Island and Fyfa highlands are almost free of malaria, as per the data published by Alzahrani *et al*.,[11] the absence of SCDs in Farasan may be attributed to this reason.

Conclusion

In conclusion, we may say that there appeared to be a broad general awareness, and with basic knowledge of SCD, a high positive attitude in the identified target. However, less satisfactory results were obtained for specific knowledge about clinical manifestations of the disease, management practices, and preventive measures. However, all study participants agree that the government has a good health policy as PMGS to identify the mutated gene and, hence, individuals carrying the trait.

Recommendations

Study participants should be acquainted with the basics of clinical symptoms of SCD, which is essential for direct patient care for those with SCD. In addition, this research emphasizes the requirement of management skills training for SCD in field training of the nursing program.

Strength

The study focuses on understanding the interference of malaria in the prevalence of the sickle cell gene. The study further highlights training needs to prepare the indigenous nursing workforce for better management skills for SCD patients as it is a very important part in managing sicklers and their families.

Limitations

The small sample size was the first limitation, as the study sample for cross-sectional research should be large to get accurate findings.

Second, self-report questionnaires for aspiring young nurses could be another limitation of this study; it mostly affects the study with biased responses. Third, genetic screening data were not available to confirm if any of the participants were having or had SCT.

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Conflicts of interest

There are no conflicts of interest.

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